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Detailed Project Report



Forestry Interventions for Rejuvenation of Chenab River

Prepared by
Himalayan Forest Research Institute
(*Indian Council of Forestry Research and Education*)

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Executive Summary

The Chenab River is one of the largest tributary of Indus River Basin which originates from the Chandertal Lake, situated towards South-Easterly side of Bara Lacha Pass in Lahaul and Spiti district of Himachal Pradesh. The Bhaga River, the major tributary of Chandra River originates from Surajtal, in the opposite direction of the Bara Lacha Pass. These two rivers join to each other at Tandi, 8 km southwest of Keylong in Lahaul and Spiti district. From Tandi onwards, it flows through Lahaul Valley and enters in Pangi Valley of Chamba district near Bhujind and leaves the district at Sansari *Nallah* to enter Paddar Valley of Jammu and Kashmir Union Territory (J&K UT). The Chenab River traverses through the mountainous tract of Himachal Pradesh, and hilly and plain regions in J&K UT. It ultimately merges with the mighty Indus River in the form of Punjnad at Mithankot in Pakistan. The Chenab River covers a distance of 453 km in India by meandering through narrow valleys, rugged terrain, steep slopes and deep gorges all along its course.

Ptolemy, the noted Greek scholar described Chenab River in his travelogues as 'Sandabal' and it is mentioned as 'Asikni' in Hindu Vedic literature. The Chenab River is also known as Chandrabhaga, the name attributed to the confluence of two streams Chandra and Bhaga at Tandi. The place is considered as very sacred by the main tribal communities due to its great mythological significance.

The Chenab River Basin constitutes a major part of theIndus River Basin and covers a vast area of 29,326.47 km^2 in India, of which 73.55% area falls in J&K UT, and 26.45% area occurs in the Himachal Pradesh. Majority of the catchment area of Chenab River in upper reaches abounds in snow, barren lands, glaciers and ice-fields. The Basin is also characterized by varied geomorphic features including rugged terrains, steep slopes, rocky cliffs and narrow gorges. The drainage pattern is dendritic and radial with presence of many perennial tributaries/small streams joining Chenab River from all directions.

Appreciating ecological significance of Chenab River and recognising the need of its conservation due to anthropocentric activities and environmental concerns, the Government of India through Ministry of Environment, Forest and Climate Change (MoEF&CC) has entrusted the task to the Himalayan Forest Research Institute(HFRI), Shimla, one of the Research Institutes under (Indian Coucil of Forestry Research & Education (ICFRE), Dehradun to prepare the DPR on rejuvenation of Indus River Basin through Forestry Interventions.

Restoration and Conservation Initiatives

The river restoration refers to a variety of ecological, physical, spatial and management measures, and practices aiming at reinstating the natural processes to restore biodiversity, providing benefits to both people and wildlife. Despite the absence of a rigorous scientific foundation and well-tested principles, river restoration is one of the most visible aspects of the hydrological science. Numerous studies over the past few years have been done with the issue of whether and to what extent large river floodplain systems are amenable for restoration. The studies have concluded that preservation should be the priority as far as

possible so that rivers may retain much of their natural attributes. River restoration now accepted by government agencies and various stakeholders as an essential complement for conservation and natural resource management. Societal perceptions and expectations of an ecosystem performance ultimately determine whether restoration is a viable management option or not. The involvement of stakeholders in restoration decisions is growing and they have diverse preferences, institutional mandates, and expertise. The interactions between scientists and stakeholders involved in restoration of rivers are limited. The information in scientific language often leading to poor communication between scientists, stakeholders and decision makers. However, it is beyond any doubt that achievement of restoration goals always gets influenced by a large number of scientific and non-scientific factors. Scientific limitations include unavailable information on critical ecosystem conditions or processes, and inadequate synthesis of available information during model development. Non-scientific limitations include infeasibility of certain desired restorative actions (i.e., eradication of exotic species & reintroduction of extinct native species) and philosophical differences among different stakeholders and disagreements over who should bear the social and economic costs of restoration. Resolving resource management issues across entire river basins and resolving conflicting interests among various stakeholders requires a high degrees of coordination and synergy.

The Government of India has recognized the concerns of growing water crisis as the main impediment in the country's development and in the process of nation building besides fulfilling various international obligations and commitments including the UN Agenda on Sustainable Development. Accordingly, the Government of India in recent decades has launched several countrywide priority programmes and initiated actions for sustainable management of water resources including restoration of major Indian River Systems vital for the maintenance of natural processes, healthy people and prosperous nation. The Government now aims for *Aviral Dhara* (Continuous flow), *Nirmal Dhara* (Clean flow), and ecological restoration of river basins. Current effort towards the preparation of present DPR on Forestry Interventions to restore the Chenab River is one such endeavour.

Conservation Significance

The Chenab River along with the Jhelum, Beas, Ravi and Sutlej Rivers within the Indian Territory constitute five principal rivers of the trans-boundary Indus River System. Certainly, the Indus River and its tributaries have immense significance for two neighbouring and human dominated nations i.e., India and Pakistan. In the context of Indian sub-continent, three mighty rivers (i.e., Indus, Ganga and Brahmaputra) originating in the Himalaya not only form major river systems of the Hindu Kush Himalayan (HKH) Ranges, but also exceptionally important from ecological, economical, historical, cultural and mythological perspectives. The Indus Water Treaty (1960) grouped Chenab, Jhelum and Indus Rivers as the 'Western Rivers' and the laid down provisions of the treaty allows India to use Chenab water for 'Non-consumptive uses' including irrigation, storage and for electricity production.

The Chenab River has vast catchment, which supports the livelihoods of human populace residing in geographically tough and hard areas of Himachal Pradesh and equally important

for a sizeable population in seven districts of J&K UT. The construction of weirs/ reservoirs/barrages on the upstream tributaries and large dams on the main stem of river for hydro-power development affects the flow regime of river and reduce the supporting services provided by the river ecosystem to the dependent communities.

The Chenab River Basin has tremendous hydro-power potential and contributes significantly for generation of green energy. Several hydro-electric projects (HEPs) of different capacities have been commissioned on the Chenab River in J&K UT e.g., Dulhasti, Baglihaar, Salal, and Pakal Dul.

The watershed of the Chenab River extends over the mountain ranges of the Pir Panjal, Great Himalaya, Lesser Himalaya, and Outer Himalaya or Shivaliks. Diverse forests along the vast altitudinal range are repository to a wide array of plant and animal diversity including several rare, threatened and endangered taxa. The Chenab River Basin is important as it has a wide diversity of natural and manmade wetlands including three famous Ramsar sites (i.e., Chandertal Lake, Mansar Lake and Surinsar Lake). The Kishtwar High Altitude National Park located in the upper reaches of Chenab River Basin represents pristine environment abounding in diverse forests, temperate grasslands, and several other ecosystems providing suitable habitats for important wildlife.

Forests and Rivers

The forests, water resources, and people are intensely interconnected, and have an intricate relationship among them. Both, quantity and quality of water are strongly influenced by forests. Forests form catchment of streams and rivers, absorb precipitation (i.e., rainfall and snow), slow runoff, reduce soil erosion, improve water infiltration and recharge groundwater and aquifers. Thus, forests have 'Sponge Effect'. Besides this, forests regulate the carbon, oxygen and hydrological cycles. Riparian forests are most complex ecological systems, disproportionately used by wide range of organisms, and are the interface between the terrestrial and aquatic ecosystems. Riparian forests serve as 'Natural Buffers' and 'Biological Filters', and have an ability to act as ecological machinery for self-regulation, self-purification and self-support for the dynamic flow of the river water and its quality. The Riparian forest buffers reduce the adverse impact of human activities on rivers. Forests help in sequestration of carbon and its storage and also act as rich repository of biodiversity. They are crucial for the sustainable management of freshwater resources, particularly river ecosystems, while water is essential for the sustainability of forest ecosystems. Humanity is strongly intertwined with forests and rivers, as both offer various ecosystem services to human kind. Since time immemorial, humanity has been using forests as well as rivers for multiple uses, benefits and values. The strong linkages and intricate interdependence between forests and rivers epitomises the significance of managing ecosystems in their entirety with the involvement of stakeholder and cooperation across a multitude of sectors concerned with the cause of land and aquatic resources.

Interactions between Forests and Rivers

Throughout its journey from source to sea, a river integrates all that happens in the basin/surrounding landscapes, particularly the impact of human activities. Thus, rivers have

been regarded as ‘Arteries of the Catchment’, ‘Life blood’, ‘Highways’, ‘Pantries of the world’ and even as the ‘Sentinels’. The rivers provide early clues as special signals of human impact and associated risks. Hence, the society can take advantage of early warnings and plan mitigation strategies to deal with adverse human impacts and likely risks. Closer cooperation between the forest and water sectors is a precondition for sustainable development as interactions between forests and water (i.e., flow, yield, and quality) are complex. In recognition, there has been an increasing international action to address ‘Forest-Water’ interactions.

Integrated Riverscape Approach to Restoration

For a long, humans have altered rivers for multiple uses and benefits. The alteration of rivers has been carried out with the best of intention, but without knowledge of the potential implications and repercussions for the diversity, connectivity and ecological integrity of the river ecosystem. The complex subject of ‘River Science’ has emerged, especially in light of anthropogenic disturbances and regulations which have simplified most rivers and resulted into adverse consequences for structure, composition and functions of a river. The earlier interventions towards river management were mainly small scale interventions, piecemeal, fragmentary in nature, focused on isolationist scientific approaches for management of river degradation and attempted to tackle the symptoms rather than the causative factors.

The complex and dynamic nature of river ecosystems require a comprehensive strategy following a system-based approach, recognizing physical, biological, ecological, socio-economic, and political aspects of the river and human systems which are intricately interconnected. The newer science of river management calls for integration and involvement of allied multidisciplinary subjects *viz*., geomorphology, hydrology, climatology, landscape ecology, hydraulic engineering, forestry, and aquatic and terrestrial ecology besides social sciences. ‘River Restoration’ is now a common response to declining river health and its importance to water resource management can only be expected to grow. River restoration has been defined as ‘Assisting the recovery of the ecological structure and function in a degraded ecosystem by replacing lost, damaged or compromised components and re-establishing the processes necessary to support the natural ecosystem and to improve the ecosystem services it offers’. The concept of river restoration has been evolved over the time and it is different than other terms *viz.,* ‘Rehabilitation’, ‘Remediation’, ‘Reclamation’, ‘Replacement’, ‘Rejuvenation’, ‘Mitigation’, etc. used in the context of river management.

Rivers are complex mosaic of habitat types and environmental gradients and characterized by spatial complexity and four types of connectivity (i.e., longitudinal, vertical, lateral and temporal). Hence, rivers are increasingly investigated from a landscape perspective, both as ‘Landscapes’ in their own right and as ‘Ecosystems’. A landscape perspective of streams and rivers has emerged and the riverine landscapes are viewed as ‘Riverscapes’. The concept of Riverscape is used to describe the broad scale physical, biological and aesthetic nature of rivers as the Riverscape approach integrates the elements of flowing water and surrounding lands those have been imperilled by human activities. The notion of Riverscape is applied across multiple hierarchical scales as it recognizes a stream or river, its floodplain, and riparian area as an integrated ecological unit.

Preparation of DPR on Forestry Interventions

Appreciating the occurrence and abundance of diverse forests/vegetations all along the river course from its origin to mouth; strong linkages between forests and rivers; intricacy of forest ecosystems; and critical functions performed by them, the recent focus of river restoration in India is on the Riverscape and the Ecosystem based approaches. River restoration efforts are multifaceted in nature as they try to accomplish concurrently the broader goals of management of river ecosystem by ensuring multiple benefits and values to varied users, four dimensional connectivity of a river, enhanced e-flows, biodiversity conservation, improved ecosystem services, and sustainable livelihoods.

The river restoration incorporates a wide range of activities including policy and legal interventions and regulations; catchment management; forestry interventions including afforestation/ reforestation, soil and moisture conservation measures, wetland management, and biodiversity conservation; flow modification and retrofitting (i.e., engineering designs; structures and development;) floodplain reconnection; spring management and recharge of aquifers; bank stabilization; channel reconfiguration; instream species management; riparian management; treatment and appropriate disposal of sewage waste, industrial effluents and other pollutants; enhanced aesthetics and recreational facilities; and passive change of human behaviour. Thus, it is evident that Forestry Interventions are just one set of activities of a multipronged strategy aiming river restoration.

Vision, Aims and Objectives

The current project has been envisioned to achieve the larger objectives of management of river ecosystems considering the criss-cross linkages between aquatic, biological and physical environments. The project basically aims at improving the aims of the river flow regime, increase in the environment flow (i.e., e-flows), habitat enrichment, biodiversity conservation, and improvement of the ecological and aesthetic attributes and generation of more avenues and opportunities for sustainable livelihoods. The project is set to adopt a multi-sectoral, multi-pronged, inclusive and holistic approach for proposed forestry interventions to fulfil the twin objectives of maintaining the constant and clean flow of water in the rivers as per the *Aviral dhara* and *Nirmal dhara* concepts under *Namami Gange* programme of NMCG.

Goals and Objectives

(i) To review and assess the existing situation of river basin, past river management and implications and lessons learned

(ii) To identify and involve stakeholders and build consensus for design and development of strategies and approaches

(iii) To assess ongoing forestry activities of the State/UT engaged in the river management programme(s)

(iv) To assess potential and possibilities for regeneration, improvement, and restoration of forest catchments

(v) To assess the conditions of riparian forests and potential of biological filters

(vi) To examine the possibility of allied and other income generation activities

(vii) To assess the potential of cultivation of medicinal plants and restoration of conservation areas and identify appropriate species and suitable sites

(viii) To identify research and monitoring needs and develop a strategy for future research and monitoring

(ix) To formulate strategies, develop approaches, and plan activities for project implementation

Chenab Riverscape

Nature is complex to comprehend and so are the inter-relationships which exist between the different ecosystems. Rivers not only represent the most diverse ecosystems right from their origin up to the merger with the ocean, but also exhibit tremendous heterogeneity and complexity with the surrounding environments all along its course. The rivers passing through the terrestrial landscape displays longitudinal, lateral, hyporheic and temporal dimensions. Rivers and streams are like long ribbons of aquatic habitat, and inherently difficult to study. It is quite essential to have a continuous view of entire spatially heterogeneous scene of the river environment for effective research and conservation of river ecosystems. Any attempt aiming at the river conservation and restoration of river needs to appreciate and comprehend the river ecosystem in its entirety, and also requires to take into consideration the interconnectedness between the river with its surrounding lands as well as impacts of human influences on the river ecosystems. The quantity, function and ecology of water changes as it move from watershed to river. Riverscapes are interactive and open systems which are characterized by high levels of natural disturbances and interconnected ecotones. The Riverscape and River share the sheet of water which covers the land in whole or in part, permanently or intermittently. The Riverscape is that part of a landscape where the runoff water erodes the soil of the catchment and leads to sedimentation in river bed and sea. Thus, Potamology -The science of rivers underpin the various fluvial and ecological processes and emphasize on the riverine landscape perspective of rivers. Thus, the concept of Riverscape indicates a holistic approach linking the rivers and its banks, or the riparian areas. Consequently, the 'Chenab Riverscape' area has been selected on a scientific basis and boundaries of the riverscape have been delineated for the purpose of planning, assessment and proposed Forestry Interventions.

The Chenab River is a transboundary River and its catchment area/basin is spread across the Himachal Pradesh and J&K UT and extended up to Pakistan. As far as the mountainous state of Himachal Pradesh and the newly created J&K UT are concerned, the catchment area of Chenab River is 7755.44 km^2 and 21571.03 km^2, respectively. The entire catchment area of the Chenab River and its tributaries falling in Himachal Pradesh and J&K UT has been included for delineation of the Riverscape. The larger portion of the delineated Chenab River i.e., 73.55 % lies in the J&K UT and 26.45% area of the Riverscape falls in Himachal Pradesh.

The management of water resources or more specifically river management is a herculean task shrouded with many ambiguities and uncertainties. River managers face a wide array of

challenges and multiple problems posed by multiple stakeholders with competing needs and variety of issues. Thus, river management involves the interdisciplinary approach seeking collaboration from multiple sectors and pooling of individual knowledge/skills for the overall benefit of the river ecosystems. The multi-disciplinary approach recognises the past management practices, drivers of change in flow regime, factors responsible for ecological decline, and strengthening of the legal framework for restoration of rivers. Thus, the important integrated approach of river management entails the interplay of various traditional desciplines i.e., hydrology, fluvial geomorpholgy, and aquatic ecology with the river science. As the river act as a system of strongly connected components, so the more sophisticated and complex discipline of river management involve both active and passive management measures/practices including the physical changes in the natural infrastructure (i.e., riverine corridors and catchments) and policy level interventions for restoration of rivers.

Approach for the preparation of Detailed Project Report

During field level investigation of the project, the HFRI followed a multi prolonged and multi- stakeholder oriented extensive consultative approach for preparing the DPRs of the five tributaries (i.e., Chenab, Jhelum, Ravi, Beas and Sutlej Rivers) of Indus River Basin. The preparatory phase included review of literature, primary and secondary data collection and analysis. Expert consultations and inputs from the wide range of stakeholders (i.e., policy and decision makers; relevant authorities; scientific organizations dealing with environment, forestry, wildlife; civil society; non-governmental organizations and related interest groups) were recorded.

Contextual Analysis

All 'Change processes 'of the exercise formed a part of wider context impinging upon the very objectives of the project itself. As per the issues highlighted, the project on Forestry Interventions for rejuvenation of the Chenab River is constantly influenced by economic, social and political processes otherwise forming an integral part of the society also. The project planners and implementers accordingly sought inputs/information about the overall picture or the environment, including technical, national and sectoral information. Activities under the said project started with an overall preliminary study (pre-study), and feasibility study forming its inception phase. The pre-study involved the understanding and assessment of project's external environment by collecting information about various related sectors, states and organization's involved as well as the primary data that existed about the target disciplines, sectors, themes, etc.

Further, it was also realized that understanding the complex and dynamic nature of a river ecosystem and its linkages with the forests and other surrounding lands requires adequate knowledge of relevant multi-disciplinary subjects and application of various technologies. It is beyond any doubt that there is a lot of literature on the wider subject of river ecology and management besides a long historical perspective on the management of the Chenab River. Thus, the foremost and key step in the present planning exercise on the preparation of DPR was a systematic review of vast available literature on the subject through internet surfing and library consultations. The websites of prominent international, national, state level agencies

and organizations dealing with any of the aspects related to river resources and conservation approaches were extensively searched, and required information was downloaded for developing the desired insight. The relevant secondary information from related organizations was also collected. The combined efforts on the review of literature and collection of background information immensely helped in the contextual analysis. The contextual analysis also provided desired insight on the Chenab Riverscape and its physical, biological and socio-economic sub-environments.

Consultative Process

The second vital step for planning, assessment and preparation of DPR required broader participation of stakeholders at all stages of planning of the project activities. Broadly five groups of stakeholders i.e., (a) the Target group (i.e., primary and secondary target groups and beneficiaries); (b) Project owners; (c) Decision makers; (d) Experts and subject matter specialists; and (e) Financing agencies. The preparatory phase included the extensive consultative process with identified groups of stakeholders right from the beginning were identified. The Inception Workshop, Project Launch and Brainstorming Workshop, sequential Consultative Meetings and Subject Matter Specialist (SMS) were organized at the State, Forest Circle/ Division levels in concerned State and UT so as to make the State and UT Forest Departments, other line agencies and other stakeholders aware about the project, the approach, field data formats and support required from them so as to achieve the objectives of the preparatory phase. During the Consultative Meetings, a wide range of themes *viz*., the Concept of Riverscape, delineation of Riverscape boundaries, strategies for project implementation, collection of primary field data, data formats, geospatial analysis of Riverscape, prioritization of sites, potential plantation and treatment models, monitoring, etc. were deliberated. Field functionaries were provided adequate trainings on collection of field data and filling of prescribed formats during sequential Consultative Meetings.

Situation and Problem Analysis

The third key step in the process of preparation of DPR was to delineate the Chenab Riverscape for the purpose of planning, situation and problem analysis thereby, developing an insight on the Riverscape environment and prioritization of areas for proposed Forestry Interventions. The background analysis/ contextual analysis and the consultative process adopted at the National, State, UT and Forest Circle levels provided the much desired insight on the issues pertaining to the Chenab River Basin and its tributaries, terrestrial and aquatic biodiversity, past management, associated states, and developmental activities. A Riverscape within the larger River Basin was delineated. Detailed geospatial analysis of the Riverscape using Remote Sensing and GIS technologies was carried out. The approach adopted for application of Remote Sensing and GIS for geospatial analysis for the Chenab Riverscape. It provided an understanding on the situation of physical attributes i.e., land use and land cover, altitudinal variation, slope, aspect, soil, erosion, forest types and forest cover, fragmentation, etc. The review of secondary information from a variety of sources (i.e., National/State Level Agencies/Departments, Scientific Organizations and Universities) allowed developing an understanding on the Riverscape environment (i.e., physical, biological, and socio-economic) and identification of challenges, constraints, problems, and threats in river conservation. The

situation analysis facilitated developing an insight on state specific challenges and threats for the Himachal Pradesh and J&K UT wherein the river flows which depicted contrasting situation owing to large variations in the physical, biological and socio-economic sub-environments. In fact, the extensive consultative process and the sequential meetings with varied stakeholders definitely helped in the identification and focusing on the main problems in the concerned State and UT in context with the Chenab River, besides comprehending the varied reasons/causes, and effects or implications of river degradation on the surrounding lands.

Development of Web Portal - Collection and Analysis of Primary Field Data

Outcome of the Consultative Meetings in the concerned State and UT developed an insight into the hierarchical organizational structure of the State and UT, and River Basin including the Forest Department, which has also been identified as the Nodal Agency for the purpose of planning and implementation of DPR. The present project has envisaged collection of primary field data for the entire Chenab Riverscape course with the support and involvement of Forest Department, Agriculture Department and other Line Agencies of concerned State andUT. Prior to the collection of primary field data, the essential requirements revolved around the development of plantation and treatment models, design of field data formats and software for analysis of the field data.

Plantation and Treatment Models

The multi-disciplinary expertise available at HFRI, Shimla became quite useful to the executing team, and was utilized in developing suitable plantation and treatment models for the proposed forestry and other conservation interventions in three types of landscapes visualized in the Chenab Riverscape. These interventions included the relevant Natural, Agricultural and Urban Landscapes. Considering the kind of natural ecosystems, local flora, soil conditions and agro-climatic zones, and models of various kinds of plantations have been recognized, designed and developed by the Institute professionally for implementation under the DPR. The process behind the various models proposed within the Natural Landscapes primarily revolved around protection, eco-restoration and conservation. Thus, applicable activities have been planned and proposed with equally diverse models.

Details of those potential models on Forestry Interventions and particular treatment plans were also sent to the concerned State and UT for selection and to propose suitable changes and adjustments, if necessary, based totally on the relevant information, and experience. Total 21 different treatment models applicable to the Natural Landscapes have been developed and recommended to the concerned State and UT of Chenab River, out of which 8 treatment models are for the Himachal Pradesh and the remaining 13 models are for the J&K UT for field application in the respective regions.

Similarly, 4 treatment models (i.e., boundary plantation and block plantations) have been envisaged for Agricultural Landscapes in the concerned State and UT. Likewise, considering Urban landscapes all along the Chenab and its tributaries, two treatment models *viz.*, (i) River front development; (ii) Institutional plantation have been for Himachal Pradesh State and four models focusing on; (i) Bio-remediation and Bio-filtration; (ii) River front development; (iii)

Institutional plantation, and (iv) Eco-park development for the Urban landscapes under Chenab Riverscape in the J&K UT.

Design of Field Data Formats

The Institute adopted and modified five field data formats earlier designed and developed for the Ganga River DPR. Modified data formats were used in the present exercise for collection of primary field data required for the preparation of DPR. The Details of five data formats, and the procedure to be adopted were shared with stakeholders, particularly the forest officials and frontline staff during the consultative process, so as to seek their valuable contribution in collection of primary field data, a prerequisite for the preparation of DPR.

Development of Software and Web Portal

In order to handle a large and voluminous data sets efficiently, better collation, analysis, and synthesis of the required information for report generation and preparation of DPR in a short time available, development of a desired software and web portal were considered essential. The software was developed in PHP/ Mysql, server Linux based that works on Codeigniter Framework basis. It is web based and easily accessed via internet. The software can compute cost calculations according to selected specified models for unlimited created models. In the software, field data can be entered as per the five specified types of models, *viz*., Natural Landscape, Agricultural Landscape, Urban Landscape, Conservation Interventions and Supporting Activities, and can be saved in digital format. The software is capable of generating reports in the desired formats i.e., State and UT-wise, District-wise, Division-wise, Model-wise and Activity-wise, and Annual Consolidated reports can be generated to obtain insight on year-wise areas under different landscapes to be treated and corresponding costs.

The Forest Departments of concerned State and UT provided a total of 1169 data sets. The State Forest Department, Himachal Pradesh provided in all 149 formats belonging to two Forest Divisions while the Forest Department of Jammu region in J&K UT provided 1020 data formats represented by fourteen Forest Divisions. Out of total received formats, nearly 19.16 % datasheets were meant for proposed interventions in Natural Landscapes while 8.21 % data forms were proposed for plantation activities and other treatments in Agricultural Landscapes. Rest of 72.63 % data forms were meant for proposed activities in Urban Landscapes, Conservation Interventions and Supporting Activities.

Objective Analysis and Strategic Planning

The extensive consultative process allowed an understanding to develop the long-term vision and goals that indicate the desired direction or pathways for actions and activities. In the process, it was also understood which changes in the project can contribute to in the longer term and why is the project important for the society, biodiversity and the river ecosystem. In the process, the HFRI team was able to decide the goals, objectives, outputs and outcomes that can be attained. The consultative process gave desired insights on the problems in achieving various objectives and identification of priority actions for restoration of the river. The process also facilitated in formulation of the strategies for programme implementation. Accordingly, it was decided that the programme implementation has to be concurrent in

Natural, Agricultural and Urban Landscapes within the Riverscape. Further, a variety of conservation and supporting activities would also be required for effective implementation, knowledge management and sharing, capacity development, monitoring, and adaptive management.

Preparation of Draft DPR – Activities, Resource Planning and Schedule

The aforesaid key steps and the process adopted ultimately helped the HFRI in the preparation of DPR presenting the details of proposed activities, resource planning and year-wise schedule of operations. The DPR (Vol. I and II) was shared with the concerned State and UT, FDs, Line Agencies and other stakeholders in the State and UT through the National Level Consultation Meetings seeking their feedback and valuable inputs. Copies of the draft DPR were also submitted to the ICFRE, Dehradun and the MoEF&CC, New Delhi and comments were invited. Necessary presentations were also made at ICFRE and MoEF&CC.

Finalization of DPR, Implementation and Monitoring

The draft DPR was finalized incorporating the feedback and specific comments received from the concerned State and UT, FDs, ICFRE and the MoEF&CC. The Phase I - i.e., Project implementating has been planned for the duration of five years by respective State and UT and FDs as the Nodal Agencies. A provision for inbuilt, Results-Based Monitoring has been made for continuous monitoring, organizational learning and adaptive management. The Phase II - 'Maintenance Phase' of five years duration would be executed after the implementation of Phase I, primarily with the objective to maintain plantations raised in three types of landscapes and planning for scaling up the replication of activities in the left over tributaries.

Organization of DPR

The DPR for Chenab River is presented in two Volumes i.e., Volume I and Volume II. The Volume-I deals with the main DPR while the Volume-II provides Summary of Concerned State and UT (i.e., Himachal Pradesh and Jammu and Kashmir UT) located along the course of the Chenab River.

The Volume-I comprised of total 8 chapters. The first two chapters provide detailed insight about multi-dimensional river ecosystems highlighting the evolving concepts of river ecology, past conservation and management initiatives, existing problems of river ecosystem and needs of river restoration, Riverine Landscape or 'Riverscape', and linkages between forests and water/river. In addition to this, the chapters also give a broad idea about the basis of the DPR preparation, Logical Framework Approach (LFA), vision, goals, objectives, and expected outcomes of the project. The remaining six chapters emphasises upon the policy, legal and institutional context, exhaustive consultative process undertaken during the preparatory phase, role of Implementing Agencies (IA)s and stakeholders, approach and methodologies, proposed Forestry Interventions, implementation mechanism, project budget, and potential benefits of envisaged Forestry Interventions. More precisely, these chapters include detailed account of envisaged Forestry Interventions by highlighting proposed plantation and treatment models, conservation interventions and supporting activities; project management, partner organizations and implementation mechanism; project budget outlay,

extent of proposed activities and schedule; and potential benefits of planned Forestry Interventions. The Volume II incorporates summary of concerned State and UT.

Chenab Riverscape and its Environment

A river is more than just the water inside it and water is only one component of the intricate and dynamic river ecosystem. The overall environment of a river is sum reflection of physical regime-climate, geology, topography and land cover; biological attributes i.e., terrestrial and aquatic biodiversity; and the socio-economic conditions in the surrounding lands of the river or beyond in its catchment.

The ecosystem based approach to river management as a prerequisite seeks appreciation and understanding of the physical, biological and socio-economic sub-environments of the river. The fluvial processes, hydrological regimes, and ecological processes are vital driving forces of the river ecology. Four types of connectivity are of paramount importance for the sustainability of river ecosystem. A dynamic river from source to sea reflects varied interconnectedness, intricacies, heterogeneity, and channel dynamics besides longitudinal changes, vertical interactions, lateral exchange processes, temporal variations, and the resultant spatial patterns in the overall environment in the river and its surrounding lands.

The Chenab Riverscape has been delineated or selected for the purpose of proposed Forestry Interventions on the basis of consensus emerged from the exhaustive and extensive consultations with various stakeholders. An area of 29,326.47 km^2 falling in Himachal Pradesh and J&K UT has been selected for the purpose of proposed Forestry Interventions. Thus, the area under consideration of this delineated Riverscape constitutes the total catchment area of the Chenab River Basin in India.

Presently, the Chenab River reflects fragmentation, decreased connectivity, reduced e-flow, enhanced pollution, and declined aquatic and terrestrial biota, diminished ecosystem services, and overall poor health of the river.

Legislative and Policy Context

The rivers are inherently and intricately linked with forests, wildlife, surrounding lands, and people. Hence, the subject of conservation and restoration of river ecosystem is quite complex. In the past five decades or so the Central and State Governments have enacted various legislations related to forests, wildlife, environment, river, etc. and formulated relevant policies. The DPR enumerates and reviews various legal and policy foundations relevant to river ecosystem and conservation, those exist in the country and also highlights that how various prominent judgments, directives and other interventions by different Hon'ble Courts including the National Green Tribunal have helped in safeguarding interests of forests, wildlife, rivers, and wetlands besides protection of the environment. Despite considerable concerted efforts made, much needs to be done so as to effectively and efficiently manage rivers and other freshwater resources pivotal for human well-being and sustainable development. The Cumulative Environmental Impact Assessment and Carrying Capacity studies commissioned in the context of prominent rivers are a welcome step. However, maintaining essential e-flow and four types of connectivity in the context of a river are challenging tasks.

Certainly, the Indian Forest Act, 1927; Wildlife (Protection) Act, 1972; Water (Prevention and Control of Pollution) Act, 1974; Forest (Conservation) Act, 1980; Environment (Protection) Act, 1986; and Biological Diversity Act, 2002 besides some of the provisions – namely, Article 48A and Article 51A (g) of the Constitution of India are pertinent from the perspective of river conservation. The National Forest Policy, 1988; Environment Impact Assessment Notification, 2006; Municipal Solid Waste (Management and Handling) Rules, 2000; National Water Policy, 2012; and Wetland (Conservation and Management) Rules, 2017 are some of the prominent policies and legal instruments applicable in case of river conservation. The agreement made and provisions incorporated as per the Indus Water Treaty, 1960 are of utmost importance in the context of Chenab River from the perspective of river water settlement, use and obligations as it is one of the 'Western Rivers' listed under the Treaty.

Implementing Agencies and Institutional Context

It is important to comprehend the various accountable institutions and agencies controlling the land, the protection of forests and wildlife. This helps in the engagement of right authorities or agencies in conservation of the rivers. Comprehensive information have been given in the particular sections of the DPR about the different Government and Non-Governmental Agencies at the Centre and State levels besides diverse stakeholders and the Civil Society which are involved with the prominent disciplines/sectors of forest management, wildlife conservation, environmental management, water resource management, river development and restoration of rivers in the country. The Chapter 3- on the Chenab Riverscape and its environment of the DPR elaborately describes the composition and complexities of sub-environments and delineates the various factors directly or indirectly involved for keeping the river clean and healthy. The Union Ministry of Jal Shakti (MoJS) and the Ministry of Environment, Forest and Climate Change (MoEF&CC) at the centre are the two prominent ministries which are directly concerned with the restoration of rivers and water resources of the country. The present DPR has envisaged the Ministry of Environment, Forest and Climate Change (MoEF&CC) as the Nodal Agency for overseeing and steering the programme implementation; the ICFRE, Dehradun and its institute, i.e., HFRI, Shimla as the National Partner Organization for capacity development and monitoring; and the crucial role is to be performed by the concerned Forest Departments of the State andUT as the Primary Implementing Agencies.

The MoEF&CC at the centre is the Nodal Ministry responsible for the planning, promotion, coordination and overseeing the implementation of Country's environmental and forestry policies and programmes aiming for sustainable management of wide range of natural ecosystems (i.e., forests, grasslands, wetlands including lakes and rivers, coastal, and marine), associated biodiversity, ensuring the welfare of animals, and the prevention and abatement of pollution. While implementing various policies and programmes related to forests, environment and wildlife, the Ministry is guided by the principle of sustainable development and enhancement of human well-being. The Ministry also serves as the Nodal Agency in the country for the United Nations Environment Programme (UNEP), South Asia Cooperative Environment Programme (SACEP), and International Centre for Integrated

Mountain Development (ICMOD), and for the follow up of the strategies and programmes of the United Nations Conference on Environment and Development (UNCED). The Ministry is also interested in the important tasks related to; multilateral bodies such as the Commission on Sustainable Development (CSD), Global Environmental Facility (GEF), and of regional bodies like the Economic and Social Council for Asia and Pacific (ESCAP) and the South Asian Association for Regional Cooperation (SAARC) on matters related to the environment, and implement programmes related to various international conventions *viz*., the United Nations Convention on Biological Diversity (UNCBD), United Nations Convention on Combat of Desertification (UNCCD), United Nations Framework on Climate Change (UNFCC), Ramsar Convention on Wetlands, Convention on Control of International Trade in Endangered Species of Wild Fauna and Flora (CITES), etc. for which the country is signatory and thus, committed. Till recent past the MoEF&CC also dealt with the various programmes and activities related to Ganga River *viz*., the Ganga Action Plan, National Ganga River Basin Authority (NGBRA), and National Mission for Clean Ganga. These subjects and activities were transferred to the Ministry of Water Resources (presently Ministry of Jal Shakti) with its broad mandate. The MoEF&CC is supported in its mandate, functions and responsibilities by wide range of Authorities, Agencies, Organizations/Institutions and Sub-ordinate offices.

The Indian Council for Forestry Research and Education (ICFRE), An Autonomous Council under the MoEF&CC is supported by nine Institutes and five advanced Forest Research Centres in performing the wide range of forestry related activities across the country which include conduct of research; transfer of innovative technologies in the field of forestry relevant to the different bio-geographic regions of the country to the States and UTs and other agencies; and to impart forestry education. The Himalayan Forest Research Institute (HFRI), Shimla is one of the institutions under the umbrella of ICFRE and mandated to generate, preserve, disseminate advance knowledge, technologies and solutions for addressing issues arising out of interactions between people, forests and environment on a sustained basis through research, education and outreach and the specific goal of contributing research relevant to the conservation of North Western and Western Himalayan forests and forest ecosystems. The HFRI has been working in Himachal Pradesh State and UTs of Jammu and Kashmir and Ladakh. The MoEF&CC has entrusted a major task to ICFRE on the preparation of DPRs on Forestry Interventions for rejuvenation of major Indian rivers. Considering the expertise and appropriate location of HFRI in the Himalayan State of Himachal Pradesh, the ICFRE assigned the responsibility of preparing the DPR on the Chenab River along with DPRs of four other rivers of the Indus River system. The HFRI with its expertise in the field of forestry relevant to the Trans, North Western and Western Himalaya, multi-disciplinary scientific staff including practising professional foresters, well-placed vast campus amidst deodar forests and adequately equipped various laboratories and other physical infrastructure is the most appropriate scientific agency not only for the preparation of present DPR, but for its effective implementation, capacity development and monitoring through the Forest Department(s).

River Conservation and Restoration

The subject of river conservation and restoration is multifaceted. A large number of organizations at the National and State levels are responsible for river management. Often, they work in isolation. Available research and monitoring information on rivers is widely scattered and in several instances obsolete and archival in nature, piecemeal, relevant to specific tributaries/segments/stretches of a river. Under the stated situation, it is difficult to develop a comprehensive understanding of complex inter-relationships of dynamic river ecosystems. The review of available literature highlighted that there are substantial gaps in the information and overall understanding on the river complexities. Several agencies are involved in diverse monitoring activities concerning river ecology. In spite of notable efforts made for quite some time, India faces enormous challenges in the field of river conservation and restoration. Certainly, the formidable task of restoration of major Indian rivers is challenging. It essentially requires the desired knowledge and technical know how to deal with the intricate discipline of river ecosystem. There is a felt need to improve, strengthen, and augment knowledge. Research and monitoring are pivotal to develop the desired information base for evolving strategies besides facilitating policy and decision making. Regrettably, understanding on interrelationships and dynamic linkages between forests/ forestry with hydrology and river ecology has been ignored in a populous country wherein more than a dozen major river systems including mighty Himalayan Rivers exist. There is an urgent need to develop a knowledge management centre in the fields of forest hydrology, river conservation and river restoration. Numerous rivulets, tributaries, and rivers suffer on account of pollution. Several countries have taken a lead in developing appropriate tools and techniques such as bio-remediation and bio-filters so as to treat polluted waters. However, much needs to be done in India in this grossly neglected field. In view of this, the present DPR envisages establishing a Knowledge Management Centre in the fields of forest hydrology, river conservation and river restoration besides support for multidisciplinary researches and monitoring activities relevant to priority disciplines/fields.

The HFRI, Shimla with its long standing, multidisciplinary team, well laid infrastructure and expertise in the field of Himalayan environment, forestry, natural resource management, climate change, etc. is suitably placed and visualized to develop as the Knowledge Management Centre for the above stated purpose.

Project Components and Proposed Interventions

The Plan envisages following four broad goals.

i) **Riverscape Management:** Aims a holistic Riverine Landscape (Riverscape) approach for sustainable management of the Chenab River, its banks, or its riparian areas, within its fluvial system.

ii) **Aviral Dhara, Nirmal Dhara, Ecological Restoration and Biodiversity Conservation:** Aim to address the drivers and stressors of river ecosystem and promote sustainable use by balancing ecological requirements with the needs of sustainable livelihoods.

iii) **Improved Ecosystem Services and Sustainable Livelihoods:** This goal aims to specifically seek enhanced ecosystem services so as to maintain sustainable livelihoods.

iv) **Effective Implementation, Knowledge Management and Innovative Approaches:** This goal aims to ensure effective implementation of the project, knowledge management, development of innovative approaches, and adoption of appropriate modern technologies.

Project Components and Proposed Interventions

Component 1: Implementation of Forestry Interventions in the concerned State and UT along the Riverscape - The Component 1 of the Project deals with the proposed Forestry Interventions in concerned State andUT along the course of river and includes three sub-components: (i) Forestry Interventions in three lower order sub-zones *viz*., (a) Natural Landscape (NL), (b) Agricultural Landscape (AL), and (c) Urban Landscape (UL) adopting appropriate plantation treatment models; (ii) Conservation Interventions; and (iii) Supporting Activities.

Component 2: Strengthening Knowledge Management and Capacity Development for Forestry Interventions and Conservation of Riverscape - India lacks desired experience in restoration of rivers as it is relatively an emerging discipline for the country. However, efforts are on in this direction. Positive outcomes from any such efforts aiming towards river restoration or river conservation are unlikely unless evidence and science based holistic strategies are actively involved in planning, assessment, management and development of rivers and policies relevant to river conservation and restoration. Thus, this component aims to incorporate science into policy, planning and management for informed decision making that can facilitate positive outcomes of concerted efforts towards sustainable management of rivers and river restoration in particular in India. The HFRI, Shimla has taken a lead in the preparation of present DPR adopting a multistep approach involving active participation of stakeholders. The HFRI, a reputed and established learning seat is envisaged to serve as the Knowledge Management/Learning Centre and to undertake concurrent research related activities essential for conservation and restoration of the Himalayan Rivers. It also plays a pivotal role in building desired national capacity for demonstrating the strong linkages between diverse forests in the Himalaya and rivers ecosystems. This component specifically seeks activities relevant to policy, advocacy, outreach, monitoring, evaluation, and capacity development.

Component 3: Scaling Up, Replication in Additional Sites and Maintenance Phase - The present DPR focuses on the programme implementation on the select tributaries, particularly once the river descends in the plains. This component plans to support the scaling up and replication of planned efforts in additional sites/tributaries besides primarily supporting the maintenance phase of plantations raised during the Phase I i.e., Implementation Phase.

Component 4: National Coordination for Forestry Interventions and Riverscape Conservations - In general, a major river involves two or more States and UTs in its basin. Thus, programmes related to river management and restoration requires National level

coordination for proposed Forestry Interventions and various conservation efforts among the participating State and UT located along the course of the river. As such, the MoJS is the Central Nodal Ministry for all aspects of management of water resources including river development and restoration of the rivers. However, several other Ministries are also involved for specific components/needs. This component envisages National level coordination for Forestry Interventions and river restoration and visualizes varied activities *viz*., policy and legal interventions, Riverscape level coordination, programme implementation, monitoring and impact evaluation besides extending support for the finances required for the project execution.

Strategies

The Riverscape is a mosaic of varied land uses and it includes: (a) natural ecosystems, (b) rural system predominated by agro-ecosystems, and (c) built-up urban environment represented by cities and towns. Each of these broad land use category represents significant area of the riverscape with unique conditions and situations, and varied use patterns, ownerships and management needs. Hence, three broad land use categories within the riverscape have been referred as the 'Natural', 'Agricultural', and the 'Urban' landscapes. These three landscapes immensely influence the intricate and vibrant nature of the Chenab River ecosystem, especially the environmental flow, water quality, and aquatic biota besides terrestrial biodiversity in surrounding lands, and the various ecological processes of the *lotic* system. Thus, in view of the prominence of three types of landscape elements within the riverscape, a multipronged strategy for proposed Forestry Interventions addressing specific requirements of each of the land use type/landscape category has been planned for execution. As a part of the broader strategy, zoning within the Riverscape is visualized keeping in view three distinct landscape categories and specific targeted Forestry Interventions are being planned in each of the zone.

i) **Natural Landscapes –** The 'Natural Landscapes' constituted the largest zone as various categories of land use/land cover of the natural environment. Altogether, 21 models/ treatment plans focusing on forests, grasslands and wetlands have been proposed in various prioritized sites based on geospatial analysis. Proposed interventions focus on protection, soil and moisture conservation works, control of invasive and alien species, plantations, eco-restoration, etc.

ii) **Agricultural Landscapes –** The second lower order zone (Agricultural Landscapes) largely in the rural environment all along the main channel and its tributaries constitutes the matrix of the Riverscape, predominated by agriculture and horticulture crops mainly on private lands. The purpose of this zone is to promote planting of economic and fruit trees so as to enhance the overall conservation values, and other expected ecological functions and ecosystem services. In all, different 04 models in Agricultural Landscapes have been proposed.

iii) **Urban and Peri-urban Landscapes –** A large number of settlements, towns and cities exist all along the course of the main river and its tributaries. A substantial proportion of the Riverscape is thus constituted by the urban/built-up environment. Proposed

interventions in the third lower order zone i.e., the urban landscape include activities related to development of riverfront, eco-park, institutional plantations and avenue plantations. Altogether, 06 models in the concerned State and UT have been proposed for the stated purpose.

Theme Plans

In addition to the above**,** the activities common to two or lower order zones are being referred as the Theme Plans. The theme based activities are broadly grouped in two categories: (i) 'Conservation Interventions' including soil and moisture conservation, riverine and riparian wildlife management, and wetland management; and (ii) 'Supporting Activities' including policy and legal interventions, concurrent action research, capacity development, awareness, participatory monitoring, and project management and evaluation. The theme based activities have been planned and proposed at the National, State and Local field levels. The State and UT level Implementing Agency i.e., the State and UT Forest Department will be responsible for execution of activities proposed as theme plans while the National Partner Organization (HFRI, Shimla) will concurrently carry out these activities at the National Level. Some of the supporting activities such as project management will be undertaken simultaneously by the Central Nodal Ministry and the State Project Management Unit (SPMU) based at the Headquarters of the concerned FD/IA.

Implementation Mechanism

The programme implementation has been planned in two phases of five years duration each. The Phase Ideal with project implementation while the Phase II primarily focuses on the maintenance of plantations established during the Phase I. The project visualizes constitution of two Programme Steering Committees (PSCs), one at the National level in the Central Nodal Ministry being referred as the 'National Programme Steering Committee (NPSC)' while the other one at the State/UT level in the concerned FD/IA, and being referred as the 'State Programme Steering Committee (SPSC)'. The NPSC and SPSC would be responsible for the efficient execution of the project at the National, State and UT levels, respectively. The NPSC would be responsible for approving the Annual Plan of Operations(APOs) submitted by participating State/UT and a National Level Partner Organization (NPO) in addition to primary functions of overseeing and steering the execution of the implementation plan. The NPMU at the Central Nodal Ministry will be responsible for the release of funds to IAs and the NPO once the APOs have been approved by the NPSC. The Project Facilitation Unit (PFU) at the NPO will follow its own mechanism of governance and will constitute its own monitoring and Steering Committee for overseeing the project.

Project Budget

The projected financial outlay of the Phase I on Project Implementation of five-year duration is Rs. 318.17 Crore. The projected budget outlay of Phase II (i.e., Maintenance Phase) of five-year duration is Rs. 58.10 Crore. As stated earlier, the project included four broad based components. Accordingly, financial cost of each of these four components is summarized below.

Principal Component- A on 'Implementation of Forestry Interventions' in concerned State and UT of the Riverscape amounts to Rs. 310.77 Crore and represents 82.59 % of the overall project budget.

Component-A the Sub-component on plantations and various treatment models in three types of landscapes within the Riverscape is the largest in terms of its spread, extent and quantum of funds provisioned. Amongst three landscapes, the obvious emphasis is on Natural Landscapes. Thus, a sum of Rs. 144.10 Crore has been provisioned for proposed afforestation/reforestation activities in Natural Landscapes, both in the mountainous state of Himachal Pradesh as well as in hilly and plain regions in Jammu region of J&K UT, under the delineated Chenab Riverscape. The projected budget outlay for proposed plantations in Natural Landscapes accounts for 72.45 % of the Sub-component or 38.30 % of the overall project cost. The projected budget outlays for Agricultural and Urban Landscapes are of the tune of Rs. 2.71 Crore and Rs. 52.86 Crore or 1.36 % and 26.58 %, respectively of the envisaged cost of the Sub-component. The second Sub-component on 'Conservation Interventions' includes four major types of interventions/activities. These are: (a) Soil and moisture conservation measures, (b) Moraine management, (c) Riverine and riparian wildlife management, and (d) Wetland management. The budget outlay for this Sub-component is Rs. 73.71 Crore and this would amount to 19.59 % allocation of the funds provisioned for implementation of Forestry Interventions in the concerned State and UT. The third Sub-component pertaining to 'Supporting Activities' is to be executed by the State and UT level's IAs. This Sub-component includes six broad based activities *viz*., (a) Policy and legal interventions, (b) Participatory monitoring, (c) Adaptive research, (d) Capacity development, (e) Awareness, (f) Project management, and (g) Evaluation. A budget of Rs. 16.92 Crore or 4.50 % of total funds proposed to involved State and UT has been provisioned for carrying out various supporting activities for five-year period.

Component - B on 'Strengthening Knowledge Management' and enhancement of National capacity for forest hydrology, Forestry Interventions, and conservation and restoration of rivers would require a sum of Rs. 10.45 Crore or 2.78 % of the overall project outlay. The highest budget amounting Rs. 4.49 Crore has been provisioned for cost of PFU, while budget of Rs.3.16 Crore has been provisioned for Research and Development, while 1.18 Crores, 1.26 Crore, 1.26 Crore, 0.45 Crore, 0.46 Crore, 0.99 have been envisaged for policy level interventions, capacity development, Scientific exchange, awareness, Monitoring and Evaluation respectively.

Component – C on the Phase II of the project of five-year duration for maintenance of plantations raised during Phase I of the project has also been planned. The Phase II would also include limited activities related to replication of efforts in additional tributaries/areas and scaling up of the planned effort. A sum of Rs. 58.10 Crore or 15.44% of the total project financial outlay has been envisaged specifically for the Component – C on 'Maintenance Phase'.

Component - D pertains to project management at the national level which would include the establishment of National Project Management Unit (NPMU) at the Central Nodal Ministry with the responsibility to oversee, steer and manage this priority project. A sum of Rs. 18.20 Crore, representing 4.84 % of the overall budget over a period of five-year during the Phase I has been provisioned. Thus, it is clear that the major portion of project budget outlay is meant for field

level activities incorporating proposed Forestry Interventions, conservation interventions and supporting activities to be implemented in concerned State and UT.

Thus, it is amply clear that the major chunk (~82.59%) of project budget outlay is meant for field level activities incorporating proposed Forestry Interventions, conservation interventions and supporting activities to be implemented by involving State and UT Forest Department (i.e., Himachal Pradesh and J&K UT). The higher proportion of budget allocation to the extent of Rs. 288.06 Crore or 87.39 % of overall budget is meant for J&K UT considering the fact that a larger extent of the Riverscape is located in this mountainous state while a budget of Rs. 41.58 Crore or 12.61% of the total budget has been provisioned for the State of Himachal Pradesh. Altogether, 16 Forest Divisions in participating State and UT will carry out proposed activities relevant to Forestry Interventions within the Riverscape. A total of 16 Territorial Forest Divisions and 4 Wildlife Divisions in Chenab Riverscape will carry out proposed activities relevant to Forestry Interventions within the Riverscape. A total of 8872.2 ha area of three landscapes, 235 ha area of Riverine and Riparian wildlife management and wetland management and 620860 m^3 extent of soil and moisture conservation in Chenab Riverscape is envisioned to be treated under the various Forestry Interventions.

Project Schedule

The execution period of Phase I and Phase II of the project has been designed and incorporated in the present DPR is of five-years duration in each case. Thus, the total duration for programme implementation including the maintenance phase is of ten-years. At this juncture, it is not clear when the project would commence and which will be the first year of programme implementation during Phase I. The Government of India may take its own time to decide the Central Nodal Ministry responsible for the implementation of the project and to allocate required funds for the execution of plan. Various proposed activities have been staggered over five-years of the Phase I. The experience illustrates that once the Government of India has accorded its approval for the project and earmarked required funds, the first year by IAs would be largely devoted for project initiation, preparatory works, particularly the establishment of nurseries and commencement of various activities related to conservation interventions and supporting activities. The planting material meant for high altitude Himalayan part of the riverscape would be ready in nurseries and earliest available by the end of second year of project implementation. Thus, the earliest effective establishment year of plantations would be the third year of Phase I in high altitude areas. Establishment of plantations is proposed in third, fourth and fifth years of Phase I. The Phase II of five years duration is specifically designed and incorporated for the purpose of maintenance of plantations and other activities. Considering the fact that most proposed activities are time bound and seasonal in nature, ideally the project initiation after all approvals, budget allocation, etc. should commence in April–May so as to allow adequate time for preparatory works, establishment of nurseries, development of planting material for afforestation/ reforestation in lower reaches of the Riverscape before the onset of monsoon season in the month of June or so in the next year. Thus, careful scheduling of project commencement would be vital for the overall success and effective implementation of envisaged activities. The quantum of activities is expected to be at its peak in third and fourth years of Phase-I. The Mid-Term Review (MTR) is proposed in the last quarter of third financial year of the project execution while the Terminal Evaluation (TE) is being envisaged in the third year of the Phase II.

Acronyms and Abbreviations

AFOLU	Agriculture, Forestry and Other Land Use
AGB	Above Ground Biomass
ALOS	Advanced Land Observing Satellite
AMC	Antecedent Moisture Conditions
AR	Afforestation and Reforestation
ASPT	Average Score Per Taxa
BBM	Building Block Methodology
BBMB	Bhakra Beas Management Board
BDO	Block Development officer
BEF	Biomass Expansion Factor
BGB	Below Ground Biomass
BMWP	Biological Monitoring Working Party
BOD	Biological Oxygen Demand
BSI	Botanical Survey of India
BVP	Bharat Vikas Parishad
CAMPA	Compensatory Afforestation Management and Planning Authority
CAPF	Central Armed Police Forced
CBD	Convention on Biological Diversity
CBO	Community-Based Organization
CDM	Clean Development Mechanism
CEIA	Cumulative Environmental Impact Assessment
CGWB	Central Ground Water Board
CIA	Cumulative Impact Assessment
CIFOR	Center for International Forestry Research
CPCB	Central Pollution Control Board
CPD	Chief Project Director
CRAP	The Chenab Revised Action Plan
CRS	Cut Root Stock
CS	Carbon sequestration
CSD	Commission on Sustainable Development
CSO	Civil Society Organizations
CSTP	Common Sewage Treatment Plant
CTE	Consent to Establish
CTO	Consent to Operate
CWC	Central Water Commission
CWLW	Chief Wildlife Warden
CWMI	Composite Water Management Index
DEM	Digital Elevation Model
DFID	Department for International Development

DFO	Divisional Forest Officer
DORD	Department of Rural Development
DSMIS	Decision Support and Management Information System
DSRO	Direct Surface Runoff
DY	Dependable Year
EAC	Expert Appraisal Committee
EDC	Eco-Development Committee
EPA	Environmental Protection Agency
ERDAS	Earth Resource Development Assessment System
ESCAP	Economic and Social Council for Asia and Pacific
ESZ	Eco Sensitive Zones
FAO	Food and Agriculture Organization
FSI	Forest Survey of India
FYM	Farm yard manure
GAP	Ganga Action plan
GEF	Global Environment Facility
GHGs	Green House Gases
GIM	Green India Mission
GIS	Geographical Information System
GLOF	Glacial Lake Outburst Floods
GoI	Government of India
GP	Gram Panchayats
GPG	Good Practice Guidance
GSLEP	Global Snow Leopard and Ecosystem Protection Program
HDBP	High Density Block Plantation
HFL	High Flood Level
HFRI	Himalayan Forest Research Institute
HIMCOSTE	Himachal Pradesh Council For Science, Technology & Environment
HIMURJA	Himachal Pradesh Energy Development Agency
HKH	Hindu Kush Himalayas
HoFF	Head of Forest Force
HPSCCC	Himachal Pradesh State Centre on Climate Change
IA	Implementing Agencies
ICFRE	Indian Council of Forestry Research and Education
ICIMOD	International Centre for Integrated Mountain Development
IHR	Indian Himalayan Region
IIRS	Indian Institute of Remote Sensing
IIWSC	Indian Institute of Soil and Water Conservation
INDC	Intended Nationally Determined Contribution
IP	Implementation Plan
IPCC	Intergovernmental Panel on Climate Change

IRBM	Integrated River Basin Management
ISFR	India State of Forest Report
IT	Information Technology
ITDPO	Integrated Tribal Development Project Officer
IUCN	International Union for Conservation of Nature
IUFRO	International Union of Forest Research Organizations
IWRM	Integrated Water Resource Management
IWT	Indus Water Treaty
JFM	Joint Forest Management
JFMC	Joint Forest Management Committee
JICA	Japan International Cooperation Agency
J&K UT	Union Territory of Jammu and Kashmir
JKPCB	Jammu and Kashmir Pollution Control Board
KBA	Key Biodiversity Areas
LFA	Logical Framework Analysis
LULC	Land Use and Land Cover
LULUCF	Land Use, Land Use - Change and Forestry
MAP	Medicinal and Aromatic Plants
MDF	Moderately Dense Forests
MEA	Millenium Ecosystem Assessment
MFP	Minor Forest Produce
MHWDP	Mid-Himalayan Watershed Development Project
MoDW&S	Ministry of Drinking Water and Sanitation
MoEF & CC	Ministry of Environment, Forest and Climate Change
MoT	Ministry of Tourism
MoUD	Ministry of Urban Development
MoWR, RD & GR	Ministry Of Water Resources, River Development & Ganga Rejuvenation
MSW	Municipal Solid Waste
MTR	Mid Term Review
MW	Mega Watt
NAEB	National Afforestation and Eco-Development Board
NAPCC	National action Plan on Climate Change
NATCOM	National Communication
NBA	National Biodiversity Authority
NBAP	National Biodiversity Action Plan
NBSS	National Bureau of Soil Survey
NCF	National Conservation Foundation
NDC	Nationally Determined Contribution
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NERIL	Naik Environment Research Institute Limited

NFP	National Forest Policy
NGRBA	National Ganga River Basin Authority
NGT	National Green Tribunal
NIR	Near-Infrared Radiation
NITI	National Institution for Transforming India
NMCG	National Mission for Clean Ganga
NMPB	National Medicinal Plants Board
NRCD	National River Conservation Directorate
NRCP	National River Conservation Plan
NRLP	National River Linking Project
NRSA	National Remote Sensing Agency
NSLEP	National Snow Leopard Ecosystem Priority Protection
NSS	National Service Scheme
NTFP	Non-timber forest products
NYK	Nehru Yuva Kendras
OF	Open Forests
PA	Protected Area
PBR	Peoples Biodiversity Register
PC	Project Coordinator
PCCF	Principal Chief Conservator of Forests
PMU	Project Management Units
PoA	Programme of Action
PPM	Parts Per Million
PSC	Project Steering Committees
PSL	Project Snow Leopard
PSP	Permanent Sample Plot
RCC	Reinforced Cement Concrete
RDBMS	Relational Database Control Machine
REDD	Reducing Emission from Deforestation and Forest Degradation in Developing Countries
RET	Rare Endangered Threatened
RFA	Recorded Forest Area
RFR	Rally for Rivers
RI	recurrence interval
RRC	River Rejuvenation Committees
RS	Remote Sensing
SANDRP	South Asia Network on Dams, Rivers and People
SCS	Soil Conservation Service
SCS–CN	Soil Conservation Service Curve Number
SDG	Sustainable Development Goals
SEAC	State Expert Appraisal Committee
SEIAA	State Level Impact Assessment Authority

SFD	State Forest Department
SFM	Sustainable Forest Management
SHG	Self-help Groups
SHP	Small Hydropower Projects
SKUAST-J	Sher-e-Kashmir University of Agriculture Science and Technology - Jammu
SLSS	Snow Leopard Survival Strategy
SLSWCMA	State Level Single Window Clearance and Monitoring Authority
SLUSI	Soil and Land Use Survey of India
SME	Small and Micro-Enterprises
SMS	Subject Matter Specialists
SOC	Soil Organic Matter
SPCB	State Pollution Control Board
SPSC	State Programmed Steering Committee
STP	Sewerage Treatment Plant
SWIR	Short Wave Infrared
TOF	Trees Outside Forests
UBDC	Upper Bari Doaba Canal
UC	Utilization Certificate
UEED	Urban Environment Engineering Department
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention On Climate Change
VAM	Vesicular Arbuscular Mycorrhizae
VCS	Verified Carbon Standard
VDF	Very Dense Forest
WB	World Bank
WMS	Web Map Service
WQI	Water Quality Index
WRIS	Water Resources Information System
WRR	Water Resource Regions
YAP	Yamuna Action Plan
ZSI	Zoological Survey of India

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Chapter 1

Introduction

1.1 Natural Capital – Human Well-Being and Sustainable Development

The Mother Nature usually reflects the mosaic of diverse natural ecosystems like mountains, forests, rivers, wetlands, grasslands, coral reefs, coastal and marine areas besides few others which are continuously nourishing, supporting and sustaining the life of all the living beings on this unique planet since, times immemorial. All these natural resources collectively constitute the 'Natural Capital'. Earlier, classical economists used to define the term as contribution made by the natural resources to human economies, however the first precise and scientific description of the word 'Natural Capital' was found in the compilation *Small is Beautiful* (Farley, 2012). In this book, E.F. Schumacher, the British economist asserted that unique natural capital represents larger and significant part of all the capital and its depletion at any point of time will jeopardize the very existence of life. Since then, this particular word assumed great importance and is frequently used in scientific parlance. The United Nations General Assembly has laid out comprehensive 17 Sustainable Development Goals (SDGs) in the document, 'Transforming our World: The 2030 Agenda for Sustainable Development' (UN, 2015). Largely, these SDGs are inter-linked and complementary which envisage to ameliorate the standards and lifestyle of human beings, bring prosperity, protect the nature and natural resources and mitigate the adverse impacts of climate change and global warming at universal scales. Conversely, huge irreversible damage had already occurred to the natural capital mainly due to indiscriminate use of natural resources. Technologies like hydro-power, bio-fuels, geothermal and tidal energy based on natural resources have been developed in unsustainable ways without buttressing the ecosystems behind these provisioning services. The human greed has threatened the sustenance of vital ecosystems. The so called rapid and unplanned development and industrial revolutions has played havoc with overall environment resulting in unprecedented biodiversity loss, habitat degradation of fresh water resources, excessive carbon-footprints, desertification, dry lands and many others including depletion of forests. These global issues compounded by the problem of the climate change are posing serious impediments to achieve the aspirational global objectives under the sustainable development goals.

1.2 Rivers – Complex and Dynamic Ecosystems

The rivers are the essential part of hydrological cycle and form a natural free flowing fresh water course towards an ocean, sea, lake or another larger river. In fact, rivers are strikingly different '*lotic'* flowing ecosystems with gravity mediated uni-directional and uneven flow of water. They are different from the *lentic* water system like lake and pond and connect the terrestrial freshwater and marine ecosystems (Van Der Velde *et al.,* 2008). River shows

characteristic and significant gradients over the longitudinal, transversal as well as vertical axis and these gradients normally display temporal variations. The different phenomena that structure the processes and patterns in riverine landscape occur differently in different temporal scale. In the river catchment, several processes lead to differentially structured river sections, varying in geomorphology, hydrology, biogeochemistry and ecosystem variables. The attributes like river flow, land water interface, influx and retention of substances in fact determine the structure and function of riverine ecosystem. Turnover times of water in rivers are short, since rivers are continuously fed by run-off water and groundwater flows, which mean that their water masses are replaced all the time. The movement of water also dissipates energy and influences stream morphology, sedimentation patterns and water chemistry (Van Der Velde *et al.,* 2008).

It is beyond any doubt that rivers and streams are fabulous aquatic ecosystems on this earth and are endowed with high degree of diversity, complexity, and vitality (Naiman and Bilby, 1998). Functioning of these systems fluctuate greatly in-between floods and drought conditions, and various organisms forming a part of such systems develop special tendencies for their adaptations to withstand the harsh and variable environmental conditions. No doubt, water is an essential component of life on earth and surface water resources are the most preferred locations for human settlements. Most of the human civilizations in the past also originated near water courses, especially along the major rivers and Indus River Civilization is one such example. In nutshell, a river is a large natural course of flowing water obtained from precipitation or snow melting. The surface water in general moves down along the slopes due to the action of gravity whereas streams, tributaries, brooks, creeks and springs are the different types of water courses classified based on their dimension and distribution (Balasubramanian, 2005). Streams are dynamic systems that balance water flow and sediment transport. Local stream conditions vary substantially depending on gradient, stream size, and location along a stream continuum. A stream's gradient profile can be generalized as gradually changing from steep to low gradient as we move from high to low elevation and from small to large rivers (Montgomery and Buffington, 1997).

In addition to the above description, rivers represent diverse habitats with changeable niches (McCabe, 2011). Gradients in physical characteristics, including flow, depth, substrate characteristics, and light penetration, exist across river channels. These physical differences within a river itself result in a diverse range of potential niches for aquatic organisms (Townsend, 1989). The natural flow regime represent unimpaired pattern of hydrologic variation for a river (Poff, 2007). The river's energy must be in balance with its size and volume of sediment load.

1.2.1 River Ecosystems – Human Use and Disturbance

Human beings are reliant on the rivers for drinking water, irrigation, hydropower generation, transportation, etc. Since ages, rivers are fulfilling the multiple human requirements and nurturing the people inhabiting on its banks. Rivers, as a perpetual and perennial source of water also provide a wide array of social, economic and strategic benefits to the society.

Famous civilizations across the world e.g., Mesopotamian, Egyptian, Nile Valley, Shang, Zhoou and Indus developed and subsequently flourished on the banks of rivers. The main reason behind such settlements had been the need for food, which invariably led to production of crops along the river banks. The Rivers around the world have been personified as goddess. Every culture of the world has represented the river in iconic form or figural form as in Indian context; Ganga River is symbolized as 'mother' and revered as such. There are also rich traditions of pilgrimage on the river-banks and their confluences. People observe a wide range of rituals on the banks of these rivers to endorse the sanctity of the rivers (Hashik, 2012).

The ever growing human population is however, causing a rapid and a lot of pervasive disturbances to these rivers and fresh water resources of high significance by constructing large dams, channelizing and diverting the water, draining, polluting the streams and rivers (Vorosmarty *et al*., 2010). Apart from this, removal of riparian vegetation from the river catchments had further added towards the vow since human disturbances impact river basins by reducing its quality and services provided by aquatic ecosystems (Shen and Cao, 2017). Human activities in river basin change the ecosystem processes, composition, and structure at multiple spatial scales, making evaluation of ecological security more complicated (Baral *et al*., 2014). Human activities like infrastructure development, intensified agriculture, industrial waste and soil erosion due to degradation of forests in the catchment areas augments the pollution of rivers thereby, adversely affecting the flow regimes. Construction of dams and canals reduce the water flow and ultimately impacts the floral and faunal elements, adding towards degradation of habitat for aquatic birds. Introduction of exotic species in the river system disturb the life cycle of the native species and excessive fishing can reduce the number of species. All these processes threaten the river ecosystem by altering land use and producing wastes, resulting in long-lasting problems (Shen and Cao, 2017). Similarly, a number of factors like climate change and natural variability of natural resources also affect and alter the behavior of river ecosystems. Heavy rainfall and snowmelt can greatly magnify the volume of stream water in a relatively short period of time. Rapidly flowing water carry large quantities of sand and gravel, and remove the periphyton layer (McCabe, 2011). When river channels are altered by humans or nature, the rivers normally do not get the required time for readjustments due to the continuous malpractices, which ultimately lead to ecological imbalance. Rivers systems keep up dynamic equilibrium and people often erect structures too close to eroding banks. The human activities on river bank and catchments accelerate the natural rate of erosion (Couture, 2008).

1.2.2 Rivers – Past, Present and Future

Fresh water is widely regarded as the world's most essential natural resource, supporting human life and economic development as well as the existence of innumerable organisms ranging from microscopic life to fish, amphibians, birds and terrestrial animals of all kinds. Over many millennia, humans have exerted an increasingly pervasive influence on fresh water resources. As also discussed in earlier pages that rivers are the most important freshwater resources for human beings for their social, economic and political developments.

These riverine systems of course, provide profound benefits by nurturing the habitations they flow through and because of this fact most of major ancient civilizations and present cities/townships flourished on the river banks only (Chapman, 1996). Presently, a grim scenario of the rivers exists world over mainly because of the effects of pollution, construction of dams, agricultural runoff, and conversion of wetlands, introduction of exotic species and host of other issues. Nearly 80% of the world's human population lives in areas where river waters are highly vulnerable thereby, posing a major threat to human water security and subsequently resulting in degradation of the aquatic environments where thousands of species of plants and animals become prone to risk of extinction. Chemical pollution, burgeoning human populations, and the accidental as well as purposeful global redistribution of plants, fish, and other animal species have had far-reaching effects on rivers and their aquatic inhabitants (Science Daily Report, 2010).



Anthrogenic Pressure on Chenab River Basin, Bhaderwah, J&K UT

Synergistically, all these factors have caused immense damage to the river ecology and accordingly, our revered rivers and their tributaries slowly and slowly converted into stinking drains. Many anthropogenic activities with the passage of time modified the river water and affected the functioning of entire river eco-system. River pollution through untreated urban sewage, industrial effluents, agricultural runoff, mining wastes, congregation for religious ceremonies and navigational operations also added to the existing vow. Indiscriminate destruction of drainage basin mainly due to clearing of riparian zone vegetation, resulted in elevated load of suspended solid and increased magnitude and frequency of flood, changing the level of interaction between land and water; and hence, affecting the allochthonous input of energy source. River regulation, lift irrigation and water allocation without considering the ecological consequences had adversely influenced the density, diversity and productivity of aquatic bio-resources. Further, the population of migratory fishes also get negatively affected

(Srivastava, 2007). More importantly, drying up of the streams, deforestation, and concretization of river courses have reduced e-flows of rivers and drastically impacted the entire river ecology. This represents the dismal scenario of aquatic ecosystems, and the issue of global water crisis is the moot point of discussion on various international forums and inter-governmental panels. For the conservation of the vulnerable river ecosystems and protection of riparian zones or forest buffers more attention is essentially required for the improvement of hydrological regimes of rivers through scientific interventions in the catchment landscapes.

1.3 Scientific Basis of River Management

The multifold human impacts have deteriorated the quality and quantity of water in the river ecosystems throughout the world. Water being a very limited natural resource, its demand for existing and new users necessitates the need for conservation of this precious resource for maintaining the current and enhancing the additional supply. In wake of the miserable condition of river ecosystems, immediate and effective actions on scientific lines are essentially required to ensure the supply of water on sustainable basis. River basins are the large and open landscapes from where the drainage falls into the river channels and characteristics of basin substantially influence the river ecology and health. The present problems of rivers create a compelling case for integrated river basin management. Basin planning, therefore, should basically be focused on overall augmentation of water resources and conservation for meeting out the future needs. Linkages between water and land management are also an important issue as the activities in upstream catchment areas have a striking impact on the water resources downstream (ADB, 2016). Proper scientific understanding of various catchments attributes e.g., knowledge of headwaters, links between catchment processes, habitats and aquatic species, etc. Extrapolation of the small scale observations to entire catchment and devising strategies to tackle the supra-catchment pressures from invasive species are essentials components of this approach (Boon, 2005).

Integrated management of river basin for long term sustainability is an important part of rehabilitating aquatic ecosystems and their related services functions. For long term and optimal use of water resources, assessment of the ecological values and basic needs of river basin management seems to be an important and significant criterion. In view of this, basin management should be considered from a multidisciplinary perspective. The crossed and comprehensive use of scientific knowledge related to watershed management, ecology, geography including information science will certainly provide a powerful scientific support for river basin management, improve basin water ecosystems including their services, and also revive the river ecosystems downstream and solve the basin water resource problems such multidisciplinary approaches for river management and intricacy of interaction at different spatial and sequential scales calls for creation of a new discipline of river science (Zhang *et al.*, 2018). It is the study of various hydrological, geological, chemical, and ecological processes interacting and influencing the morphology and dynamics of riverine systems (NAS, 2007). This innovative methodology will surely encompass the linkages

between rivers interrelated developments and patterns at various scales, from small streams to large rivers (Sinha *et al*., 2012).

1.3.1 River Ecology

An ecosystem basically is a self-sustaining, self-perpetuating and interacting system where biological, physical and chemical relationships exist between a community of organisms and the environment in which they live. It is a dynamic complex functional unit composed of different biotic and abiotic components. The biotic components of the environment includes living entities including plants (flora) and animals (fauna) and man as an important factor, while abiotic components include light, moisture, soil, temperature, wind, and chemical factors such as oxygen levels, salt concentrations, presence of toxins, and acidity. Ecosystems provide variety of benefits and services to people e.g., food, fuel, fiber, fresh water, genetic resources, climate regulations, erosion control, spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences (Alcamo *et al.*, 2003;Muoghalu, 2009).



Pristine Riparian Vegetation along Chenab River,

Broadly, river is considered as the water flowing from mountain to sea. But, actually rivers have multiple dimensions in terms of length, width, height (depth) and time. The river ecology infact embraces a majority of characteristics and limiting factors including the river corridors, slopes and velocity of water, water quality, pH and water temperature, suspended solids, dissolved oxygen, toxic substances, particle size of sediment, and its runoff, hydrological and topographical floodplains, back swamps, aquatic flora, fauna and riparian vegetation (Mihov and Hristov, 2011). Biotic component of any aquatic ecosystem also act as an indicator to determine the productivity potential and health of the system (Srivastava, 2007).

1.3.2 River – Ecological Concepts and Connectivity

In fact, rivers are amongst the most vibrant, diverse, and complex ecosystems on the planet. It is also true that they are also probably the most degraded among all ecosystems (Dudgeon, 2010). The river ecosystems are dynamic networks of channels and floodplains, connected and disconnected through the action of flow. As a result, the patterns that exist and the processes that operate in rivers are unique. The scientists working on river system have to understand and characterize the patterns and processes in the functioning of river ecosystem. During twentieth century, attempts were made by river scientists to understand and characterize the patterns, processes and change of river ecosystems from source to mouth

(Humphries *et al.*, 2014). With the passage of time, several major concepts and their spinoffs have emerged about the ecology of running waters (Hyness, 1970). These concepts holistically describe the sources of energy, change of production ratios longitudinally, laterally, and with discharge (Vannote *et al.*, 1980; Junk *et al.*, 1989; Thorp and Delong 1994; Thorp *et al*., 2006, 2008). The main concept and the underlying principle behind such studies is the River Continuum Concept (Vannote *et al.*, 1980). It was the first model to conceptualize the sources and transport of carbon and energy in river ecosystems. The River Continuum Concept (RCC) emphasised the longitudinal links in a river, combining stochastic, abiotic (i.e., geomorphology and hydrology) and deterministic, biotic (i.e., trophic relationships) aspects and primarily involving upstream inputs of organic matter and its processing by macro-invertebrates. After this, the Flood Pulse Concept (FPC) came, which stress the floodplain as the primary source of material and energy that fuels food webs in Floodplain Rivers. Inundation of the floodplain by a flood pulse is the catalyst for material transport, primary production and for movement of material and energy from the floodplain into the main channel (Fig 1.1).

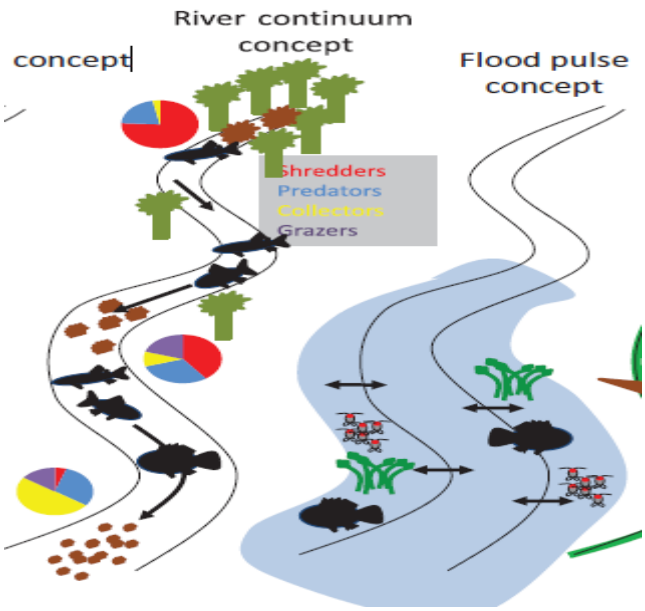


Fig. 1.1 - Schematic presentation of River Continuum Concept (RCC) and Flood Pulse Concept (FPC)

(Adopted and modified from Humphries *et al.*, 2014)

Therefore, the emphasis, is more on lateral connectivity than on a longitudinal continuum. As the concepts of river ecosystem functioning have developed gradually, parallel ideas about the geomorphology and habitat, hierarchical framework for stream habitat classification, and processes have also been formulated that underpin and contextualize patterns and processes associated with riverine biota (Winemiller *et al.*, 2010). Later, river wave concept was proposed which explains the river flow as wave. River wave model provides the basis for description of river flow and facilitates in closer integration of in-stream ecology and stream

hydrology. The overarching hypothesis of the River Wave Concept (RWC) is that the location and source of autochthonous production and allochthonous inputs, storage, transformation, and the longitudinal or lateral transport of the material and energy derived from that production are largely a function of the position (ascending or descending limbs, trough, and crest) on a river wave, either temporally or spatially. The wave concept simply and suitably illustrates the functioning of river ecosystems.

Connectivity is a vital element of natural landscapes, which invariably helps in regulating the flow of genes, species, materials, and energy. However, alteration of habitats by human often disrupts these flows thereby, reducing connectivity and threatening biodiversity and ecosystem services worldwide. River networks are especially susceptible to human-induced augmentation effects due to their dendritic and linear structure (Eros *et al*., 2019). For long, rivers have been considered as two-dimensional elements of terrestrial landscapes neglecting their own internal structure and heterogeneity. It was, therefore, in early 1980s the term "River Corridors" started to appear in scientific literature, then gradually replaced by the term 'Connectivity' for describing the spatial connections within river systems. Riverine systems are characterized by their inherent water-mediated connectivity wherein the river itself represents both habitat and migration corridor. Connectivity acts on one temporal and three spatial dimensions that longitudinally form the connection right from headwaters to confluences and the sea whereas laterally, it is from the main channel to floodplains. When vertical directions are taken into consideration this connectivity is from the river towards the hyporheic interstitial and the groundwater. The importance of each dimension changes along the river course which then leads to the development of different river concepts. Hydrologic connectivity supports the passive downstream transport of matter and energy, but enables a multidimensional dispersal of organisms (Seliger and Zeiringer, 2018).

1.3.3 Riverscapes

The rivers and streams are like long ribbons of aquatic habitat, and inherently difficult to study. From the banks of lotic systems, only a short fragment of the entire stream can be sighted and there is a little appreciation for the important features those lie beyond. Accordingly, a continuous view of entire spatially heterogeneous scene of the river environment is quite essential for effective research and conservation of river ecosystems (Fausch *et al*., 2002).



Chenab River (Pattan Valley), H.P.

The quantity, function and ecology of water changes as it move from watershed to river. Riverscapes are interactive and open systems which are characterized by high levels of natural disturbances and interconnected ecotones. The riverscape and river share the sheet of water which covers the land in whole or in part, permanently or intermittently. The River is a stream of water flowing along a bed in

the earth down to the sea. The Riverscape is that part of a landscape and the runoff water erodes the soil of the catchment and leads to sedimentation in river bed and sea (Haslam, 2006).

1.3.4 The River - Ecological Integrity

In general term, ecological condition refers to the state of the physical, chemical, and biological characteristics of the environment, processes and interactions that connect them. Ecological integrity of any ecosystem is the net summation of related chemical, physical, and biological parameters. Thus, the concept of ecological integrity extends beyond fish and enthuses to take up a holistic approach for ecosystem management that is especially applicable to aquatic systems. While the concept of ecological integrity may appear unambiguous, its assessment and practice are much less clear (Kwak and Freeman, 2010).

The term ecosystem health is often raised in discussions of ecological integrity. Perhaps, it is natural to anthropomorphize the concern of health to ecosystems, so that it reflects a useful metaphor for understanding the concept of ecological integrity. However, whether or not an ecosystem should be considered an entity, such as a super organism is a debate without end that began with early ecologists and continues today (Clements, 1916; Suter, 1993; Simon, 1999). Regardless, the ecosystem is indeed a natural unit with a level of organization and properties beyond the collection of those species that occupy it and presents the most appropriate spatial and organizational scale to assess and study ecological integrity. Streams and rivers serve as integrators of chemical, physical, and biological conditions across the landscape, and while the theory and practice associated with ecological integrity of aquatic systems is easily applied to flowing waters, they are broadly applicable among all aquatic systems (Kwak and Freeman, 2010).

1.3.5 River Restoration

The river restoration refers to a large variety of ecological, physical, spatial and management measures and practices basically aiming at reinstating the natural processes to restore biodiversity, providing benefits to both people and wildlife. Despite the absence of a rigorous scientific foundation and well-tested principles, river restoration is one of the most visible aspects of the hydrological science (Malakoff, 2004). Numerous studies over the past few years have done with issue of whether and to what extent large river floodplain systems are amenable for restoration. The studies have concluded that preservation should be the priority as far as possible rivers may retain much of their natural attributes (Haslam, 2006). River restoration now accepted by government agencies and various stakeholders as an essential complement for conservation and natural resource management. Societal perceptions and expectations of an ecosystem performance ultimately determine whether restoration is a viable management option. The involvement of stakeholders in restoration decisions is growing and they have diverse preferences, institutional mandates, and expertise (Wohl *et al.*, 2005). The interactions between scientists and stakeholders involved in restoration of rivers

are limited. The information in scientific language often leading to poor communication between scientists, stakeholders and decision makers. However, it is beyond any doubt that achieving of restoration goals always gets influenced by a variety of scientific and non-scientific factors (Angermeier, 1997; Hennessy, 1998). Scientific limitations include unavailable information on critical ecosystem conditions or processes, and inadequate synthesis of available information during model development. Non-scientific limitations include infeasibility of certain desired restorative actions (e.g., eradication of exotic species, reintroduction of extinct native species) and philosophical differences among stakeholders and disagreements over who should bear the social and economic costs of restoration. Resolving resource management issues across entire river basins and resolving conflicting interests among stakeholders require high degrees of coordination and cooperation (Naiman, 1992).

1.4 Rivers – Concerns for Conservation

The rivers are an essential and integral part of our landscape. They serve as the chief source of renewable freshwater for humans and provide numerous goods and services to the society. Apart from that, they are most diverse ecosystems on Earth, which abound in profuse biodiversity. Rivers are threatened by variety of stresses like changes in water flow, increase in pollution, over exploitation of resources and habitat depletion resulting in decrease in riverine biodiversity (Sabater *et al.*, 2013).

Threats to rivers have become severe in many regions of the world for both securing human water supply needs and maintaining aquatic biodiversity. This dual challenge has resulted in nearly 80% of the world's population being exposed to high levels of threat to water security with 65% of riverine habitats classified as moderate to highly threatened. Changes in human population demographics and global economic activity in the coming decades will be predominant factors impacting future water supply and aquatic biodiversity. Threats to river biodiversity can be categorized into impacts from over exploitation, water pollution, flow modification, destruction or degradation of habitat, and invasion by non-native species. Threats to water supply include water pollution, salinization, and human-induced climate change. Meeting ecological and societal needs for freshwater is one of the grand challenges of the 21st century. The two major challenges for the effective use of science in water resources management are: i) applying contemporary and integrated knowledge of water resources in management; and ii) planning and doing a better job of communicating with and educating water managers, decision makers, and the public (Sabater *et al.*, 2013).

1.4.1 Indian River System

The Indian sub-continent is fed by numerous rivers and most of these rivers pour their water into the Bay of Bengal, except some of the rivers whose courses take them through the Western part of the country and emptying the water into the Arabian Sea (Balasubramanian, 2013). The rivers and mountains have a greater significance in the history of Indian culture,

economy, and development, including religious and spiritual aspects. Nearly most of the major cities of India are located on the banks of rivers. Besides, perennial rivers are considered as the life supporting resources by all the farmers in India. Indian rivers are mainly classified into Himalayan Rivers, Peninsular Rivers, Coastal Rivers and Inland Rivers based on their geographical locations and origin. The Himalayan Rivers are mostly glacier fed and perennial, while Peninsular Rivers are altogether monsoon fed. The Perennial Himalayan Rivers of the country constitute three major river systems (i.e., Ganga, Brahmaputra and Indus), which cover various types of catchments and provide a variety of microhabitats from headwater to mouth (Srivastava, 2007).

The Ganga River system is comprised of the major tributaries like Yamuna, Ghaghara, Gandak, Gomati, Sone and Tons whereas Brahmaputra River System with Siang river as a main channel with major tributaries like Dibang, Lohit, Subansiri, Ranganadi, Manas, Kulasi, Dhansiri, Champamati, Sankhosh and Digaru rivers. In Indus River System, major tributaries are – Chenab, Jhelum, Ravi, Beas and Sutlej. These are the principal Himalayan Rivers of India. Among the tributaries of Indus, the drainage area of Chenab River in Indian Territory is only 9.8% of total geographic area (Balasubramanian, 2013). The Himalayan Rivers are antecedent rivers having deep gorges, chasms and steep slopes (Valdiya, 1998). They exhibit gradient of habitat heterogeneity from its headwater to mouth for colonization of aquatic fauna. Further, because of fragility of soil and deforestation of riparian catchments, the soil erosion in upper stretch of Himalayan Rivers is very much prevalent and cause severe siltation to downstream (Srivastava, 2000).

The Peninsular River System includes Narmada, Tapi, Godavari, Krishna, Cauvery, and Mahanadi Rivers. The Peninsular Rivers flow through shallow valleys. A large number of them are seasonal as their flow is dependent on rainfall. The intensity of soil erosion is also comparatively low because of the gentle slope. Therefore, many rivers have straight and linear courses (Murugan *et al*., 2014).

The Coastal Rivers are comparatively small in size and numerous in numbers, with nearly 600 flowing on the west coast itself. Rivers of the Inland Drainage Basin are centered in western Rajasthan, parts of Kutch in Gujarat and mostly disappear before they reach the sea due to scarse rainfall and their seasonal nature. Some of them drain into salt lakes or simply get lost in the vast desert sands (SANDRP, 2014).

1.4.2 River Basin

The river basin describes the river system of an area. Small streams flowing from different directions come together to form the main river, which ultimately drain into a large water body such as a lake or a sea or an ocean. The area drained by a single river system is called a basin. Any elevated area, such as a mountain or upland acts water divide and separates two basins. A river basin is the landscape through which a main river and all its tributaries flow. The river basin collects all the surface water from rain runoff, snow/glacial melt and streams that run downwards towards a common outlet, as well as the groundwater underneath the earth surface (Fig. 1.2).

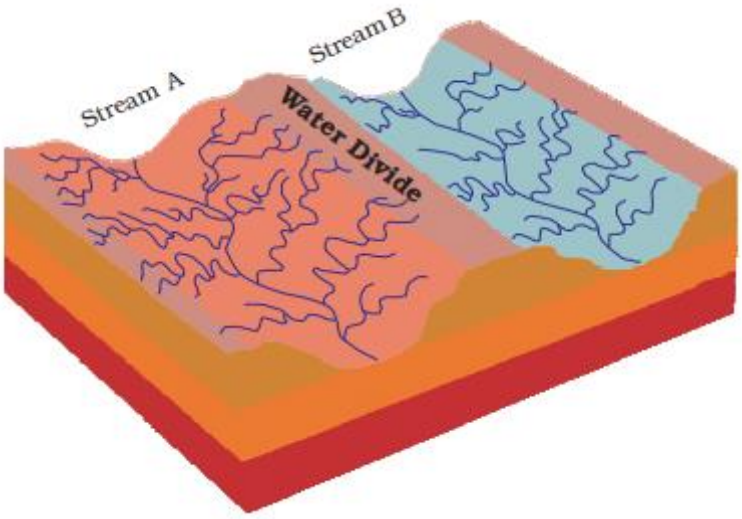


Fig.1. 2– Water Divide

(Source: www.ncert.nic.in).

The streams within a drainage basin form certain patterns, depending on the slope of land, underlying rock structure and the climatic conditions of the area. These are dendritic, trellis, rectangular and radial patterns. The dendritic pattern develops where the river channel follows the slope of the terrain. The stream with its tributaries resembles the branches of a tree, thus the name dendritic. A river joined by its tributaries, at approximately right angles, develops a trellis pattern. A trellis drainage pattern develops where hard and soft rocks exist parallel to each other. A rectangular drainage pattern develops on a strongly jointed rocky terrain. The radial pattern develops when streams flow in different directions from a central peak or dome like structure. A combination of several patterns may be found in the same drainage basin. The water resources of India drain from 19 major drainage basins (Fig. 1.3). The largest drainage area, Ganga-Brahmaputra-Meghna, covers 34% of the area of the country. These rivers join before draining into the Bay of Bengal. The basin of the Indus River that flows in a South-westerly direction to Pakistan covers 10% of the total drainage area in India. The basins of the Godavari, Krishna and Mahanadi rivers drainsinto the sea in the east after covering 22% of the total drainage area. Eight other medium-sized basins of the Sabarmati, Mahi, Narmada and Tapi rivers flowing towards west and Subarnarekha, Brahmani Baitarani, Pennar and Cauvery rivers flowing east, cover 15% of the total drainage area. The remaining small river basins are divided into four major drainage areas: i) the westerly flowing rivers in the Kutch and Saurashtra regions, and the Luni river; ii) the westerly flowing rivers south of the Tapi basin; iii) the easterly flowing small and medium-sized rivers between the Mahanadi and Pennar basins; iv) the easterly flowing small and medium-sized rivers between the Pennar basin and Kanyakumari at the southern tip of India (Amarasinghe *et al.*, 2004).

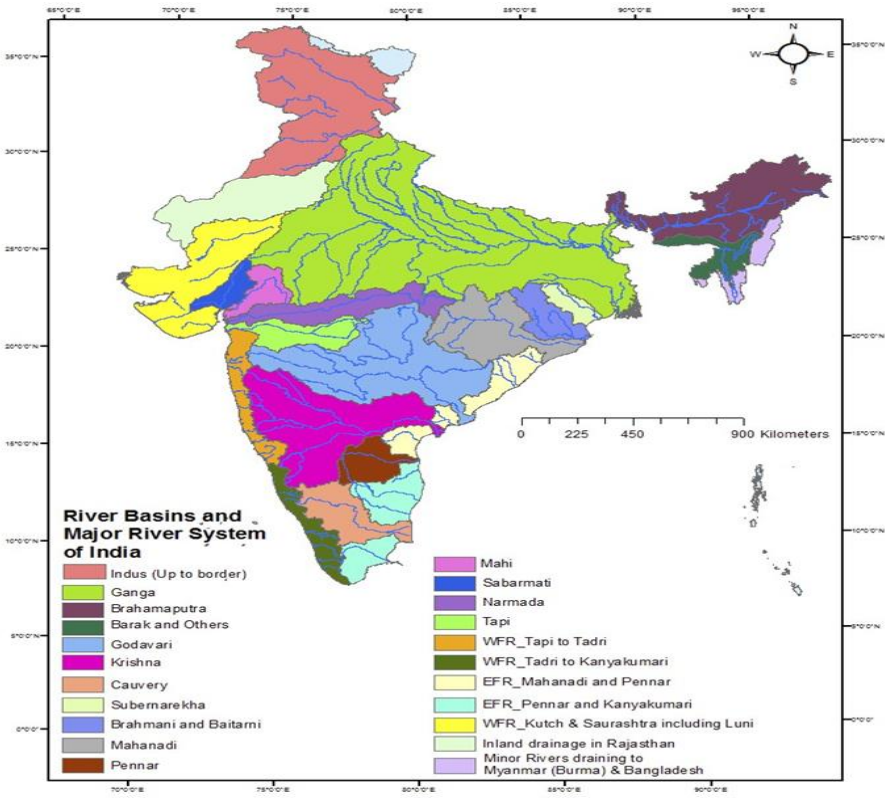


Fig.1. 3- River Basin of India

(Source: CWC, 2017)

1.4.3 Hindu Kush Himalaya: A Rich Repository of Global Fresh Water

The Hindu Kush Himalaya (HKH) is the freshwater towers of South Asia and parts of Southeast Asia. Water originating from their snow, glaciers and rainfall feed ten largest river systems *viz.*,Indus, Ganges, Brahmaputra, Irrawaddy, Salween, Mekong, Yangtze, Yellow, Amu Darya and Tarim. Together these rivers support the drinking water, irrigation, energy, industry and sanitation needs of very large populace living in the mountains and downstream (Shrestha *et al.,* 2015). The region extends some 3500 km across the northern part of the Indian sub-continent with spatial expansion from 70^{o} to 105^{o}E longitudes and $25^{o}$to 40^{o}N latitudes. It includes the mountain territories of Afghanistan, Pakistan, India, Nepal, China, Bhutan, Bangladesh and Myanmar. The Hindu Kush-Himalayan region is characterized by extremes of altitude and climate. As a consequence, the hydrology of the region is quite different from most other parts of the world. There exists a complex mosaic of topo-climates that are determined by variations in slope, aspect and altitude. It is critically important geo-ecological asset, encompassing over 4.2 million km^2 area (Bajracharya and Shrestha, 2011; Bajracharya *et al.,* 2015). The HKH and Tien Shan Mountains together form the largest area of permanent ice cover outside of the North and South Poles and also referred to as the 'Third Pole'. The Hindu- Kush Himalaya is home to four global biodiversity hotspots, and 330 important bird areas (Chettri *et al*., 2008). The region provides ecosystem services i.e., water, food, and energy that directly sustain the livelihoods of 240 million

people in the mountain and hills of the HKH. Nearly 1.9 billion people living in the 10 river basins also benefit directly and indirectly from its resources. The region is geologically fragile, with young and rising mountains, usually vulnerable to erosion and landslides, even without human interference. The region is undergoing rapid change driven by development, migration, tourism and urbanization. The outcome of interplay of these complex drivers of change will have major consequences, not just in the region but globally (Sharma *et al.*, 2019).

1.4.4 Indus River System: Broad Context

The Indus River Basin is one of the largest river basins in Asia extending over four South Asian countries mainly, China, India, Afghanistan and Pakistan. The major portion of its basin lies in Pakistan (Shahzad, 1993). Geographically, the Indus River Basin is bounded by the Great Himalaya on the East and by the Karakoram Range on its North. Suleiman and Kirthar ranges bound the basin on its West whereas Arabian Sea forms its boundary on the South. The Indus River Basin has majestic high mountain ranges of the sub-continent, striking valleys, deep gorges, rugged plateaus and the alluvial plains. Its drain area is about 11, 20,000 km^2 (Table1.1). The geographical extent of the basin is between 72°28' to 79°39' E longitudes and 29°8' to 36°59' N latitudes (WRIS, 2014). In India, the Indus River basin extends over the States of Himachal Pradesh (15.98%) and Punjab (15.66%) with the major area (60.31%) in Ladakh and Jammu and Kashmir UT. In addition to it, smaller parts lie in Rajasthan (4.92%), Haryana (3.09%) and Chandigarh (0.04 %) (Fig. 1.4, Table 1.2).

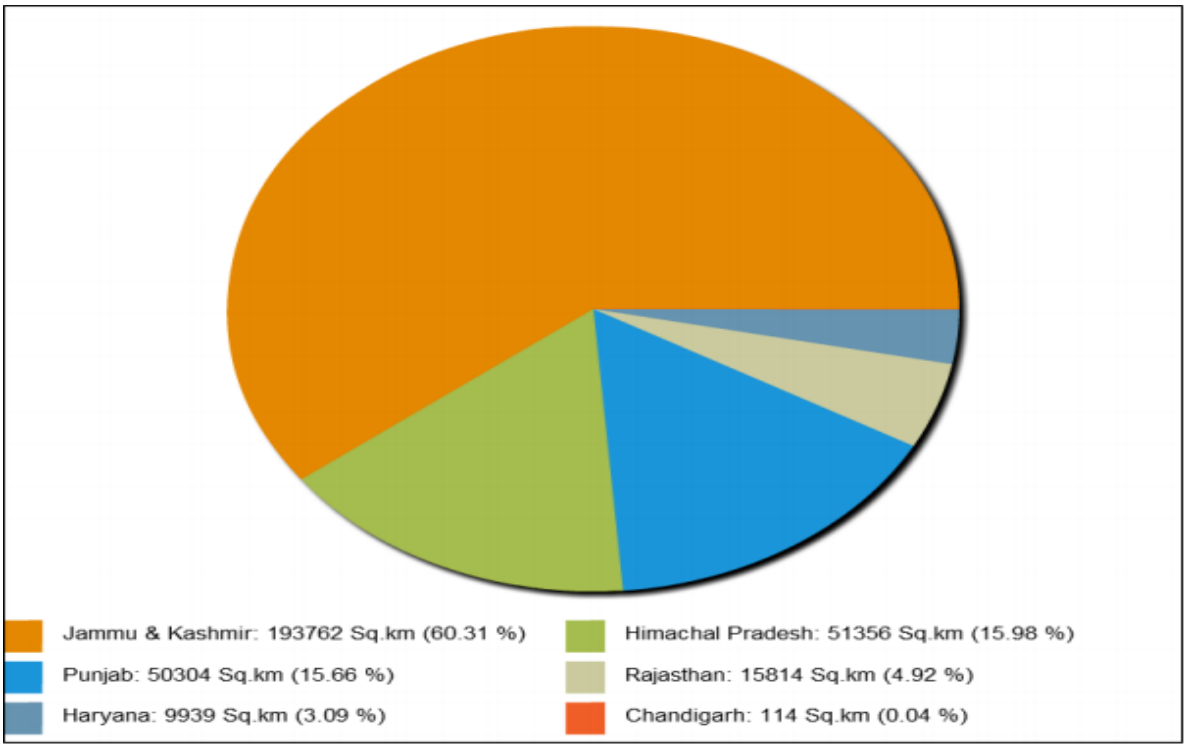


Fig.1. 4- State Wise Distribution of Indus Basin

(Source: WRIS, 2014. Indus River Basin Report).

Table: 1.1 - Country Areas in Indus River Basin

Basin	Area (km^2)	Countries	Area of Country in Basin (km^2)
Indus River Basin	11,20,000	Pakistan	5,20,000
		India	4,40,000
		China	88,000
		Afghanistan	72,000

(Source: AQUASTAT Survey, 2011).

Table: 1. 2–Salient Features of Indus River Basin

S.No.	Silent Features of Indus River Basin	
1	Basin Extent	72° 28' to 79° 39' E 29° 8' to 36° 59' N
2	Area in Indian territory (km^2)	3,21,289 (CWC Report)
3	States/UTs in the basin	Ladakh and Jammu and Kashmir UT (60.31%), Himachal Pradesh (15.98%), Punjab (15.66%), Rajasthan (4.92), Haryana (3.09%), Union Territory of Chandigarh (0.04%)
4	Districts (Census 2011)	67
5	Total Population	4,25,05,47,911
6	Number of villages	42,431
7	Number of Sub-Basins	11

(Source: WRIS, 2014 Indus River Basin Report)

1.4.5 Climate of the Indus River Basin

On the basis of geographical location the Indus River Basin can be divided into two sub regions namely, the upper Indus River Basin and the lower Indus basin. The former is predominantly influenced by western disturbances whereas the latter is influenced by monsoon wind system originating from the Arabian Sea (Archer and Fowler, 2004). The Indus River Basin has great variation in climatic conditions that ranges from Tundra in source region to Tropical humid near its out flow. The upper basin has cold climatic conditions. The area remains under snow cover throughout the year and receive very low rainfall. The upper Indus River Basin is highly mountainous and constitutes the greatest area of perennial glacial ice outside the polar region (Fowler, 2006). The lower Indus River Basin experiences arid to semi-arid conditions which prevails with significant variability throughout the year.

Broadly, Indus River Basin spreads over a large chunk of area with diversified geographical features. A large amount of population inhabiting this area derives their livelihood from the

tributaries of Indus Rivers Basin by way of agriculture, hydro-electricity, fisheries, tourism and river transportation (Fig.1.5).



Fig.1. 5- Map of Indus River Basin

(Source: wikimedia.org: Indus River)

1.4.6 Indus River: From Source to Mouth

The Indus River is one of the mighty rivers in the world. It originates from a spring called Sinh-Kha Bab (The Mouth of Lion) near the Manasarowar Lake in Tibet. The name Indus is derived from the Sanskrit word 'Sindhu' meaning 'Ocean' (Gulia, 2007). Indus River, from its source passes through stony valleys, across the high plateau of Tibet, and takes North westerly turn. Traversing the North-westerly direction through the high plateau of Ladakh, various small tributaries pour down from the Karakorum Range to join the Indus River. Subsequently, the Indus River circumvents to the northern flank of Nanga Parbat and then it pursues southerly direction through the plain of Punjab till Panjnad (Ahmed, 1995). In Muzaffargarh district of Pakistan, it receives the water of five rivers i.e., - Chenab, Jhelum, Ravi, Beas and Sutlej. After receiving the water from these rivers, the Indus River becomes larger and wide while flowing through Sindh. The Indus River spreads over a large catchment area with numerous right and left bank tributaries feeding a significant volume of water and finally drains into the Arabian Sea.

1.4.7 Indus Water Treaty (IWT): A Geo-Political Entity

The Indus River and its tributaries (i.e., Chenab, Jhelum, Ravi, Beas, and Sutlej) are major sources of irrigation and hydropower for India and Pakistan. After the partition, water dispute started between the two countries, and was later resolved through the Indus Water Treaty. The Indus Water Treaty- 1960 is considered as a successful instance of conflict-resolution between India and Pakistan. The water-sharing treaty between the Republic of India and Islamic Republic of Pakistan was signed on September 19, 1960 in Karachi, by Shri Jawaharlal Nehru (Prime Minister of India) on behalf of India and by Field Marshal Mohammad Ayub Khan (President of Pakistan) on behalf of Pakistan under the auspices of the World Bank (WB). The IWT is a complex instrument comprising of 12 Articles and 8 Annexures. Under IWT India got 33 MAF (million acre feet) of annual flows from the eastern rivers and Pakistan got 165 MAF from the western rivers (Siyad and Muhammed, 2005). The IWT is the world's most generous water-sharing pact and this treaty's munificence is unsurpassed in scale in the annals of international water treaties (Hill, 2013).

Indus Water Treaty has been quite successful for over forty years however, with the increasing needs for water and power in India and Pakistan a woe of discontentment started flowing thereby subjecting the Treaty to tensions. But, treaty defused a major source of potential conflict and allowed each country to develop its share of the basin's water (Sachan and Ul-Haq, 2015). There are four essential elements to the treaty.

(i) The waters of the three western rivers *viz*., Indus, Jhelum, and Chenab were allocated to Pakistan, and the waters of the three eastern rivers *viz.*, Ravi, Beas, and Sutlej were allocated to India.
(ii) The second was a financing plan to assist Pakistan in building the vast -replacement works needed to store and transport water from rivers in the west to the irrigated areas of Pakistan.
(iii) The third element relates to use of the hydro-electric potential of Pakistan's rivers before they reach Pakistan.
(iv) The fourth element of the treaty is the dispute resolution mechanism, which sets up rules whereby first recourse is for the Indian and Pakistani IWT Commissioners to resolve potential problems.

1.5 Chenab River – Statement of Significance

The Chenab River originates from the Chander Tal Lake, lying towards South- Easterly side of Baralacha Pass in Lahaul and Spiti district of Himachal Pradesh. Bhaga River, the major tributary of Chandra River originates from Suraj Tal. After their Confluence, the river is known as Chenab (Gosal, 2004). Ptolemy, the noted Greek scholar described Chenab in his travelogues as 'Sandabal', and it is mentioned as 'Asikni' in Atharva Veda (Kaul, 2001). The Chenab River is also known as Chandrabhaga, the name attributed to the confluence of two streams Chandra and Bhaga at Tandi near Keylong. The river is about 453 km long having

catchment area of about 29,326 km^2, of which about 73.55 % falls in Jammu and Kashmir UT, and 26.45% in Himachal Pradesh.



Confluence of Chandra and Bhaga Rivers at Tandi, Lahaul (H.P.)

After the confluence at Tandi, it is known as Chandrabhaga or Chenab. The Chenab River enters Pangi valley of Chamba district near Bhujind and leaves the district at Sansari *Nallah* to enter Paddar Valley, Jammu and Kashmir UT. The River traverses a distance of nearly 118 km and 334 km in Himachal Pradesh and Jammu and Kashmir UT, respectively. It is fed by innumerable tributaries from its headwaters *viz.*, Chandra, Bhaga, Saichu *Nallah*, Thirot *Nallah*, Miyar *Nallah*, Bhut *Nallah*, Marusudar River, Kalnai River, Neeru *Nallah*, Lidar River, Manawar Tawi River, Raggi, Bischeleri River, Ans River, Mihari Tawi River, Naushera Tawi River, etc. It gains immense power and momentum on entering Jammu region of Jammu and Kashmir UT above Kishtwar. From Kishtwar, it follows in south-westerly direction for Doda, through deep gorges along the northern base of the Pir Panjal Range. Then, it pursues westerly direction towards the fort of Reasi up to Akhnoor. The river enters in Pakistan through Sialkot district, near Dewara village at 32º40´N latitude and 76 º 29´E longitudes. From Pakistan border, the river pursues the south-west direction, and is joined by the Jhelum River a little above Trimmu. Nearly 64 km below Trimmu, it is joined by Ravi River. Thus, meandering all along its course in Punjab with other tributaries, it makes a junction with Sutlej River, the combined rivers are called Punjnad and about 64 km below Punjnad, it meets with Indus River at Mithankot (SANDRP, 2013).

1.5.1 Chenab River Basin and Its Uniqueness

The Chenab River Basin in India is spread over Himachal Pradesh and Jammu and Kashmir UT. It comprises the extreme western sector of Himalaya. Upper catchment lies in Lahaul valley in Lahaul and Spiti district and Pangi valley of Chamba district in Himachal Pradesh. This region is roughly rectangular in shape, with main Himalaya on the North, mid-Himalaya on the South. The Chenab River basin in Jammu and Kashmir UT lies in its southern part covering the districts of Doda, Udhampur, Jammu, Rajouri, etc. The drainage basin covers the areas partly between Shivaliks and Outer Himalaya. Major portion of the Chenab River Basin remains under permanent snow cover throughout the year. The drainage pattern is dendritic and radial with presence of many perennial tributaries/small streams joining Chenab River from all directions. Chenab River and its tributaries are snow-fed, perennial and free flowing with steep bed slopes in their mountainous reaches, and a series of loops and bends.



Chenab River near Doda, J&K UT

The majority of the catchment area of Chenab River in upper reaches abounds in snow, barren lands, glaciers and ice-fields. The basin is also characterized by varied geomorphic features including rugged terrains, steep slopes, rocky cliffs and narrow gorges. The Chenab River Basin represents continuum mosaic of diverse habitats from the mountain valleys to plain areas which support immense biodiversity including several rare, threatened and endangered taxa. The basin has a many natural and manmade wetlands including three famous Ramsar sites (i.e., Chandertal Lake, Mansar Lake and Surinsar Lake). The Kishtwar High Altitude National Park located in the upper reaches of Chenab River Basin represents

pristine environment abounding in diverse forests, temperate grasslands and several other ecosystems providing suitable habitat for important wildlife. The Chenab River and its vast catchment is dynamic, complex, and large covering land in two countries. It holds immense significance from ecological, economic, cultural, historical and national perspectives.

1.5.2 Ecological Significance

The Chenab River Basin is one of most important river basins in Himachal Pradesh and Jammu and Kashmir. Due to a variety of habitats comprising of forests, riverbeds, rangelands and rocky outcrops, there is a formation of different climatic regimes and a wide range of altitude. The Chenab River Basin is ecologically very significant with rich and diverse flora and fauna. The vegetation on the right bank of Chenab River in Himachal Pradesh comprises mainly of *Juniperus* spp.(Juniper) interspersed with plantations of *Salix* spp. (Willow). The left bank of the river areas have sporadic distribution of forests comprising of *Pinus wallichiana* (Kail), *Cedrus deodara* (Deodar), *Abies pindrow* (Fir), *Picea smithiana* (Spruce) mixed with broad leaved species like walnut, ash maple, and hazzelnut. The forests in high altitude contain many medicinal and aromatic plants (MAPs) like *Dactylorhiza hatagirea* (Salam Panja), *Aconitum heterophyllum* (Patish), *Picrorhiza kurroa* (Kutki), etc. Besides it, some endemic plant species found only in this part of the basin are *Crucihimalaya axillaris*, *Pseudomertensia lahulensis*, *Meconopsis bikramii* and *Ranunculus bikramii*, etc. The Chenab River Basin also habours unique faunal diversity, some of the prominent wild animals and birds are *Capra ibex* (Ibex), *Pseudois nayaur* (Bharal), *Panthera uncia* (Snow Leopard), *Moschus chrysogaster* (Musk Deer), *Nemorhaedus goral* (Ghoral), *Marmota bobak* (Himalayan Marmot), *Bos grunniens* (Wild Yak), *Columba leuconota* (Himalayan Snow Pigeon), *Corvus caurinus* (Northwestern Crow), *Alectoris chukar* (Chukor), *Anser indicus* (Bar-headed Goose), *Columba leuconota* (Snow Pigeon) and *Tetraogallus himalayensis* (Himalayan Snow Cock).

Equally, the physiography and topographic of Chenab River Basin is complex in Jammu and Kashmir resulting in extreme habitats and microclimatic heterogeneity. There exists a variety of habitats and life zones, such as sub-tropical dry scrubs, temperate broadleaf and pure conifer forests, tree line and alpine rangelands between 820 - 4,500 m amsl. Major vegetation comprises of sub-tropical dry scrubs (850 - 1,100 m), temperate broadleaf mixed forests including riparian habitats (1,400 - 1950 m), broadleaf-conifer mixed forests (1,900 - 2,600 m), pure conifer forests (2,300 – 3,000 m), conifer-oak mixed forests (2,700 - 3,200 m), dense oak forests (2,900 - 3,400 m, moist alpine scrubs and rangelands (3,200 - 4,300 m), and rocky outcrops with cushion and mat formations (>4,300 m) (Sharma *et al*., 2018). The phytobenthos of Chenab River include *Achnanthidiu*m *minutissima*, *A. affinis*, *Cymbella ventricosa*, *Gomphonema olivaceum* and *Reimeria sinuata* and the zooplanktons of the Chenab River represent species belonging to protozoa, rotifers and crustacean *viz.*, *Arcella crenulata, Peridinium cinctum*, etc.

1.5.3 Economic Significance

The Chenab River is important for the State of Himachal Pradesh and Union Territory of Jammu and Kashmir. The people of riparian State and Union Territory inhabited along the banks of Chenab River use its water for fulfilling multiple socio-economic ends. Flowing through mountainous course, the river offers great scope for hydro-power. In the mountainous region, it is not feasible to use river water for irrigation, but when it flows through the plain areas of Jammu region, the river plays important role to boost agrarian economy of the farmers. In this region, various small and large canals have been constructed to use water of Chenab River for irrigation.

1.5.4 Historical and Cultural Significance

Tandi, the place of confluence of Chandra and Bhaga Rivers has great cultural significance. It is considered very sacred by the people of Lahaul due to its great mythological connection. Three mythological stories are connected with Tandi. First narrative is related to Draupadi, the wife of Pandavas. It is believed that Druapadi left her body at this place and the name Tandi has evolved from 'Tan Dehi' means giving up of the body. Second story described that Rishi Vashishtha who meditated near the hot water springs of Manali was cremated at this confluence. According to the third, narrative, Chandra and Bhaga streams are symbolically considered to be son and daughter of the Moon and the Sun gods, respectively. It is held that the two divine entities fell in love with each other and decided to celebrate their heavenly marriage after starting their run from Bara Lacha Pass, in opposite directions. In doing so, they run down in South-east and South-west directions and after encircling an enormous expanse of Lahaul, ultimately met each other at Tandi to enter the wedlock (District Census Handbook, 2011).



Mrikula Devi Temple (ASI site)



The Chenab River has the same place in the consciousness of the people, as the Rhine holds for the Germans or the Danube for the Austrians and the Hungarians. Several other legendary folklores e.g., Heer-Ranjha, Sassi-Punan, Sahiba- Mirza and Sohni- Mahiwal are also associated with the banks of this majestic river. (Source: wikipedia). In Himachal Part,

famous Mrikula Mata temple which is a protected monument (ASI site) of national importance is located in Pattan Valley of Lahual and Spiti falls under Chenab catchment. Similarly, Akhnoor Fort, on the bank of the Chenab River is a monument of immense historical and archaeological significance. It was built by Raja Alam Singh in 1802. It is extremely important for reconstruction of the past history, and has been declared a National Monument protected under the Monument Act, 1958.

1.5.5 Problems of Chenab River Basin

The Chenab River Basin is characterized by the uplands, undulating ridges, valleys, gravels, hills, hillocks and rocky outcrops. The Chenab Riverscape exhibits two prominent physiographic and geo-morphologic features i.e., the Himalayan Mountainous Zone in Himachal Pradesh and plains in the Jammu and Kashmir UT. Both these features affect the characteristics of Chenab River Basin, the riverscape and the river hydrology considerably. Most of Chenab River Basin spread largely in the high-altitude region (>2,500 m) and the area is characterized by difficult terrain, fragile and loose mountains, prone to avalanches and landslides, and it also falls in Seismic Zone-IV.



Loose Strata along Chenab River, HP

The forest cover in the high altitude areas is sparse due to which runoff water cause high siltation in the river. In the plain areas, Chenab River and its tributaries are facing the problem of water pollution due to disposal of untreated sewage, unabated disposal of municipal solid waste, unauthorized dumping of construction and demolition wastes and pollution from minor/major establishments. Construction of new buildings and establishments is generating lot of wastes and demolition material finding its way into the

river and further adding to its degradation. Key issues and problems of Chenab River Basin discussed below

a) Topography and Terrain

The Upper Chenab River Basin in Himachal Pradesh and Jammu and Kashmir is topographically difficult consisting of rugged terrain, fragile slopes and deep gorges. The mountainous topography is ecologically very loose and landslide prone.

b) High Seismic/Tectonic Activity Prone Zone

The Kisthwar-Doda-Bhadarwah belt in the Chenab River basin is vulnerable to earthquakes due its geological and tectonic setting. Several earthquakes of small and large magnitude occurred in the Kishtwar and Doda districts around SNF (Sunder Nagar Fault) circumscribing Kishtwar (Sandeep *et al.*, 2013). An earthquake of Mw 4.1 occurred in the Jangalwar area of Chenab valley of Jammu and Kashmir on 29th May, 2017. The Cascade development of Hydro Power Projects in Chenab river basin is a major cause of concern in view of the mountainous topography and tectonic activity.

c) Soil Erosion and Siltation

High sedimentation and silt load due to thin tree cover, forests, road construction/ clearing, climatic factors, overgrazing, farmland cultivation, etc. repeated events of landslides and construction of so many mega projects on the Chenab river e.g. Salal, Baglihar, Dulhasti, etc., has increased the silt load of the river and it is known to be highly silt laden river (Dams, Rivers and People, 2005).

Climatic and other Factors

Various factors such as extreme climatic conditions, heavy snowfall and torrential rainfall, retreat of glaciers and increased snow melt runoff and other vagaries of nature. In the plain areas, Chenab River and its tributaries are facing the problem of water pollution due to disposal of untreated sewage, unabated disposal of municipal solid waste, unauthorized dumping of construction and demolition wastes and pollution from minor/major establishments.

1.5.6 Need for Scientific Management

The river is one of the major natural resources that play important role in supporting and sustaining human life, maintains aquatic and terrestrial biodiversity by establishing vertical and horizontal cross linkages. It must be protected from all forms of pollution and unscientific exploitation. Chenab River is an important tributary of Indus River which flows through Western Himalayas. The river flows along the northern base of Pir Panjal Range before entering Kishtwar area of Jammu and Kashmir from Himachal Pradesh. Different anthropogenic activities have affected the catchment characteristics and the river ecology drastically. The inherent complexity of Chenab River Basin, existence of many vulnerable ecosystems, national importance and trans-boundary nature of the Chenab River better

planning, long term national and regional collaboration framework on scientific lines is urgently required for conservation and management.

1.6 River Conservation Initiatives

Life and water are inseparable entities and are connected in one way or the other. Water constitutes for >80 % of an organism, and is, therefore, the limiting factor for life. In addition, water moves in a cycle mountains to river, river to ocean, ocean to rain, rain to mountain and so on. Water is a natural resource, and is available in ocean, rivers, ponds, lakes, icecaps, wetlands, etc. Our river systems are suffering badly from water scarcity and non-point source pollution (Saha, 2019).

In view of the above many initiatives have been taken for conservation of the fresh water resources. The concept of watershed management or river basin management is as old as the concept of crops under irrigated conditions. It is one of the largest developmental programmes implemented by the Government of India. As a programme of state intervention, it endeavors to ensure productive and sustainable use of natural resources *viz.*, water, soil, vegetation and animal wealth. Management of water resources in India has been a challenge due to a variety of reasons, like the rising demands and growing environmental degradation (Jain, 2019). The river basin management in India was initiated in the early 1980s and 1990s (Kerr, 2007). The Integrated Water Resource Management (IWRM) has been introduced in the early 2000 (Lal, 2004). The conservation, planning and management of water in the country had been administered by the Ministry of Water Resources, through River Development and Ganga Rejuvenation (MoWR). The Ministry has a programme called Flood Management Programme under which flood management, river bank erosion and sediment erosion among the selected catchments were to be addressed with the help of State Governments (Kumar and Prakash, 2018). In addition to it, the Ministry of Environment, Forests and Climate Change also deals with the river related issues in a piecemeal manner. Recently, Government has formed a new ministry 'Ministry of Jal Shakti' with the integration of various ministries and organization dealing with the water related issues to address the water woes and plight of the river ecosystems across the country.

i) Conservation Initiatives of Major Rivers

The Ganga River is a sacred river and Hindus see to it as Goddess with great reverence. The Ganga River traverses from the Himalaya to the Indian Ocean. It is a life line for survival of millions of people in the Indian sub-continent. The Ganga River also sustains some unique aquatic fauna and flora e.g., Shark, Mugger Crocodile, and the Dolphins. Over the years, the natural characteristics of the ecology and environment of the Ganga River have been disturbed due to rampant urbanization, industrialization, construction of Hydro Electric Projects (HEPs), pollution, and agricultural practices in the flood plains. The Ganga River being a life saving entity, it becomes imperative on our part to save Ganga River from further degradation. The GoI has been attempting to maintain the sustainability of the Ganga and other rivers since 1956 when the parliament passed the River Boards Act (Kala, 2018).

In 1970s, the environmental and ecosystem sustainability has been given top priority by enacting and promulgating Acts such as Wildlife Protection Act, 1972; the Water Prevention and Control of Pollution Act, 1974 and the Water Cess Act, 1977. A more comprehensive Act was also passed in 1986, in the form of the Environment Protection Act, in order to protect the environment and also to set standards for environmental sustainability. In view of conserving all life forms, the Biological Diversity Act was enacted in 2002.

ii) Ganga Action Plan (GAP)

To reduce the pollution pressures, exclusively in the Ganga River and also to clean it for posterity, the GoI launched the Ganga Action Plan (GAP) in 1985. Accordingly, the Central Ganga Authority was established as the apex body for policy formulation and its implementation. Under GAP I, Pollution Abatement Schemes were taken up in 25 Class-I towns in three States of Uttar Pradesh, Bihar and West Bengal. As GAP I addressed only a part of the pollution load of Ganga River, GAP II was launched in stages between 1993 and 1996, 59 towns along the main stem of Ganga River in five States of Uttarakhand, Uttar Pradesh, Jharkhand, Bihar and West Bengal are covered under the Plan and tributaries of the Ganges *viz.*, Yamuna, Gomti, Damodar and Mahananda were also included later in the plan (Rai, 2013).

iii) National Ganga River Basin Authority (NGRBA)

On November 4, 2008, the Ganga River was declared as the National River of India. Subsequently, the National Ganga River Basin Authority (NGRBA) was constituted on February 20, 2009 in order to develop strategic plans for conservation and cleaning up of the sacred Ganga River. A part of the Bhagirathi River, which forms the upper reaches of the said river was declared as an Eco-Sensitive Zone (ESZ) in 2010 in view of maintaining sustainability of the fragile mountain ecosystem.

To support and strengthen the Ganga River cleaning and rejuvenation, the Ministry of Water Resources was renamed as the Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR,RD&GR) in 2014. The National Mission for Clean Ganga (NMCG), An Autonomous Body, which was originally formed by the Ministry of Environment, Forest and Climate Change on 12 August 2011, was shifted to the MoWR,RD & GR. The NMCG implements the policies made by the NGRBA (http://nmcg.nic.in).

On May 13, 2015, the GoI approved Rs 20,000 Crore for Namami Gange for 2015-20 which is in addition to Rs 2,037 Crore sanctioned in 2014. While safeguarding the Ganga's ecosystem and environment by setting up sewage treatment plants and drawing achievable schemes for ghat (set of steps descending to the river) development, solid waste management and biodiversity conservation, the GoI also plans to develop the Ganga River as a means of transport and tourism destination. In the first phase, many steps are to be taken to beautify the major banks of Ganga River (Das and Mohan, 2014). The Namami Gange programme is also planned to free all villages falling under 1,632 gram panchayats along the Ganga banks from open defecation by 2022. Further, it proposes to incentivize the state governments to expand sewerage infrastructure in 118 unban habitations along the Ganga River (Mohan, 2014).

The chronology of various initiatives of Government of India for conservation and management of the Ganga River are summarized in Table 1.3.

Table: 1.3-Major policies, Acts and decisions for the Ganges Conservation and Management

S. No	Year	Activity
1.	1956	The Indian Parliament passed the River Boards Act
2.	1972	Wildlife Protection Act
3.	1974	Water (Prevention and Control of Pollution) Act
4.	1977	Water Cess Act
5.	1985	Ganga Action Plan
6.	1986	Environment Protection Act
7.	2002	Biological Diversity Act
8.	Nov. 4, 2008	Declaration of the Ganga as National River.
9.	Feb. 20, 2009	Constitution of National Ganga River Basin Authority for developing strategic plans for conservation and cleaning up of the Ganga.
10.	2010	Declaration of upper reaches of the Ganga River, a part of Bhagirathi catchment area, as an Eco-Sensitive Zone.
11.	August 12, 2011	Shifting of National Mission for Clean Ganga (NMCG), An Autonomous Body, from Ministry of Environment, Forest and Climate Change to the MoWRRDGR.
12.	2014	Adding up Ganga River Rejuvenation in the name of the Ministry of Water Resources, which is now called as Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR,RD & GR)
13.	2014	Cabinet approved Rs 2,037 Crore for Namami Gange
14.	October 29, 2014	The Supreme Court of India directed all the polluting industries along the banks of the Ganga to adhere all environmental norms and empowered National Green Tribunal (NGT) to issue orders for closing down industries not following such norms
15.	May 13, 2015	Cabinet approved Rs. 20,000 Crore for Namami Gange for 2015-20 which is in addition to Rs. 2,037 Crore sanctioned in 2014
16.	Feb 1, 2016	NGT imposed complete ban on use of plastics in the first stretch of the Ganga River from Goumukh to Haridwar
17.	July 7, 2016	To ensure clean water flow in the Ganga River, the GoI launched 231 projects under NMCG at 100 locations in all five states through which the Ganga River flows
18.	July 10, 2016	Use of vast network of postal services for marketing of the Ganga River water at the doorstep of the needy people
19.	October 7, 2016	The GoI issued a notification for rejuvenation and protection of the Ganga River which is called as Ganga River (Rejuvenation, Protection and Management) Authorities Order, 2016
20.	March 20, 2017	The High Court of Uttarakhand declared that the Ganga River has to be treated as a living human entity

iv) Yamuna Action Plan

Another sacred river Yamuna originates from Uttarakhand and travels via Himachal, Haryana, Delhi and Uttar Pradesh and eventually merges into Ganga River at Prayag, Allahabad. It is a major tributary of Ganga River and used by millions as a source of drinking water, bathing and irrigation. It is one of the most polluted rivers in the world. Indiscriminate use of the river by the people around has turned it from the category of being a lifeline to a sewer (Singh, 2011). It is now amongst the most polluted rivers of the world. In view of the severe deterioration and associated public health implications, Government launched Yamuna Action Plan (YAP) in April, 1993 during the second phase of the Ganga Action plan (Nema, 2007). Yamuna Action plan was mainly launched for abatement and conservation of river water of Yamuna by National River Conservation Directorate (NRCD), Ministry of Environment, Forest and Climate Change in 12 towns of Haryana, 8 towns of Uttar Pradesh and Delhi. The Japan Bank for International Cooperation (JBIC) provided financial assistance to Yamuna Action Plan.

v) Conservation of River Narmada

The Narmada River rises at an elevation of 1,057 m amsl in the Amarkantak Plateau of Maikala range in the Shahdol district of Madhya Pradesh. The river travels a distance of 1,312 km before it falls into Gulf of Cambay in the Arabian Sea near Bharuch in Gujarat. Before merging with the sea, Narmada River flows through the states of Madhya Pradesh, Maharashtra and Gujrat (Jain, *et al.,* 2007). The Narmada River is the life line of Madhya Pradesh and basis of prosperity for the farmers of state. Narmada Bachao Andolan (NBA) in 1985 was started to bind the valley together against destructive development. The movement was an important step to raise the concern of the people affected by construction of dams under the Narmada Valley Development Project. Narmada Seva Yatra was launched by MP Government in 2017 to conserve the Narmada River. It was projected as a biggest river conservation campaign with public participation. This mass campaign was mainly aimed at soil and water conservation, afforestation along the river banks, pollution control and organic farming.

vi) Inter-Linking of Rivers

The recurrent occurrence of floods and droughts across the different parts of the country has always been a cause of major concern for India. The National River Linking Project (NRLP) through National Water Development Agency was pondered over and discussed by the Govt. with major aim to transfer water from the water surplus Himalayan Rivers to the water-scarce river basins of Western and Peninsular India (NWDA, 2006). The project aims to connect Himalayan and Peninsular Rivers to form a gigantic South Asian Water Grid (Shah *et al*., 2001). 50 - 100 m wide and more than 6 meters deep canals have to be constructed to facilitate the navigation of water.

xii) Rally for Rivers: A Noble Initiative to Save Indian Rivers

Rally for Rivers (RFR) was launched by Isha Foundation, a Coimbatore-based non-profit organization in September, 2017. In this initiative, a procession of 16 vehicles travelled

across 16 states of the country and covered a distance of over 9,000 km. The objective was to aware and sensitize the people about the importance of rivers and to control the micro-climate and reduce vulnerability to extreme rainfall events, greening of a 1 km wide patch both sides of all the rivers of the country throughout their lengths is also proposed in the policy document of Isha foundation. The RFR is the largest ecological movement in the world, offering a sustainable long-term solution to water flow depletion. Six Indian States have signed MoUs with Isha Foundation to implement river revitalization projects; 18 State Governments are working to implement RFR recommendations, changing the national discourse on how India handles her natural resources (Isha Foundation, 2019).

xiii) NITI Aayog – Action to Revitalize India's Rivers

The National Institution for Transforming India or NITI Aayog was constituted by the Government on 1st January 2015 in place of erstwhile Planning Commission. An Expert Group was formed under the Chairmanship of CEO of NITI Aayog in November, 2017 by the Government of India to look into the policy recommendations made by Rally for Rivers (RFR). The group framed a programme for detailed actions commensurating with recommendations of Aayog so as to revitalize India's rivers for their implementation subsequently on the ground. The Program for Action was prepared by the Department of Rural Development (DoRD). The institution has prepared a three year action document to recommend policy changes and programmes for action from 2017-18 to 2019-20. The proposed document is quite comprehensive and is comprised of seven parts and 24 chapters. The VII part of the document deals with the sustainability aspect and focuses on the sustainable management of fresh water resources (NITI Aayog, 2017).

xiv) River and Water Conservation as a National Movement

Composite Water Management Index (CWMI) report of the NITI Aayog as released in 2018, highlights the mega cities of the country *viz*., Delhi, Bengaluru, Chennai and Hyderabad, are fast approaching towards zero groundwater levels by 2020. Since, water is one of the precious natural resource and its necessity and relevance to the survival of all living organisms provide it high significance. Even though, 97% of the earth is surrounded by water, only 3% is fresh and two thirds of this is frozen, the remaining unfrozen is found mainly as groundwater, and a small fraction present above the ground or in the air. The usage of water across various sectors in India is on the rise. Therefore, its sustainable management is essential to protect the water environment and to meet the increasing water demand in the future (Ramappa *et al.*, 2014). Water Conservation which primarily involves the following three objectives: i) Enhance water availability, ii) Improve water quality, and iii) Reducing water-related risks finally focuses upon a comprehensive approach towards water conservation by the Government of India. The unified Central 'Ministry of Jal Shakti' has been made responsible for laying down policy guidelines and coordination of programmes for the development and regulation of country's water resources including dealing with related disciplines *viz.*, establishment of multipurpose projects, development of ground water resources, river development, rejuvenation, irrigation, and flood control. Resolving inter-state river disputes and inter-linking of rivers (Savita, 2019). Recently, huge investment has been made towards implementation of 'Integrated Watershed Development Programme' and more

or less it has taken a shape of a national movement. Some of the other prominent programmes/schemes launched by concerned Ministries are: PMKSY 'Har Khet ko Pani' and 'More Crop Per Drop'; Jal Shakti Abhiyan; River Basin Management; National Water Mission; National Mission for Clean Ganga-Namami Gange, National Mission for Sustainable Agriculture, National Mission for Sustainable Himalayas; Dam improvement and Rehabilitation Programme; Interlinking of Rivers, Ground Water Management, Flood Control and Forecast, Biodiversity Conservation, and Wetland Conservation. Green India Mission, Compensatory Afforestration Management and Planning Authority (CAMPA) and National and State Level Action Plans on Climate Change More precisely, management of scarce and precious water resources and river conservation adopting a holistic approach have become a National Movement (Savita, 2019).

vii) River Valley Project Development in the Indus River Basin

The Indus River Basin is comprised of lofty Himalayan Mountains in the North and flat plains of Punjab and Sindh in the East and South. These mountains with immense repository of snow cover gave birth to the Indus River and its tributaries. Many smaller tributaries join the Indus River on its way including Shyok, Zanskar, Gilgit, Swat, and Kabul. Five tributaries *viz*., Chenab, Jhelum, Ravi, Beas, and Sutlej traversing from Himachal Pradesh and Jammu and Kashmir joins Indus River in the form of Punjnad. The mighty river runs as a large single channel through the Sindh province and ends up draining into the Arabian Sea. The rivers of the Indus River Basin receive >50% water from the glaciers, followed by well-defined monsoon system in the upper catchment during the said season. The Indus River Basin favored the development of a large irrigation system in the British Era, with the clear objective to increase the crop production in order to develop the agriculture-based economy, which then turned the basin into a densely populated area (Gupta, 2008). In the initial phase of development of irrigation canals, the rulers of states in upper Indus River Basin areas played a vital role and accordingly, lead to construction of the complex irrigation system. Significant works were accomplished in Jammu and Kashmir, Punjab, and Sindh regions and even today, expansion of Indus irrigation system could be observed in different regions of Pakistan and India (Irfan *et al.*, 2019). Development of the canal irrigation system started in the eighth century in Kashmir region when King Lalitaditya set the drainage system in a suitable direction and distributed the Jhelum River water to different villages for increased production of crops. Early development of irrigation system in Punjab province, located downstream to the Kashmir, occurred during thirteenth to sixteenth century. Hajiwah and Tiwana canals were developed in Punjab with support of British rulers to irrigate croplands. Later on, 11 canals were built on the Indus River in the region to irrigate the agricultural lands (Gilmartin, 2015). Development of the existing modern Indus irrigation system infact, started in the mid of nineteenth century during the British regime. Several permanent headworks were constructed to ensure the water supply in cropland of Punjab, Sindh. The construction of Marala Headworks started on Chenab River in 1887 to irrigate the Upper Rachna Doab through Upper Chenab Canal, whereas, in 1890, Chenab River water was diverted to Sandal Bar from Lower Chenab Canal subsequently, in 1897, Rasul Headworks were constructed on the Jhelum River to irrigate the agricultural land in the Chaj Doab works on Madhopur Headworks were completed in 1902 on the Ravi River so as to

provide water for the agriculture fields to the Upper Bari Doab (*www.waterinfo.net*). The Triple Canal Project was designed, and was finally sanctioned in 1905 to transfer the river water from one to another river. Construction work of the Lower Chenab Canal was completed in 1917 and the Upper Chenab Canal, originating 58 km upstream of Khanki from Marala Barrage, was designed to irrigate almost 2,62,236.7 ha of cropland. The third canal, the Lower Bari Doab canal, originated from a 0.5 km long weir on the Ravi River near Balloki and irrigated almost 3,54,910 ha of lands in Sahiwal and Multan (Naqvi, 2012). The Sukkur Barrage Project was the first-ever barrage to be built on the Indus River was sanctioned in 1923 and was completed in 1932 with seven canals. The Trimmu Barrage with three canals was constructed on the Chenab River below the confluence of the Jhelum River during 1937–1939. The Rajasthan Feeder Canal was upgraded in 1961 with the construction of Bhakra Main Line Canal and a large network of distributary canals under Indira Gandhi Irrigation Canal system to irrigate the Rajasthan desert (Varis *et al.,* 2008). At the time of partition, the Bhakra Dam was in progress and completed in the early 1970s under the Bhakra Nangal Project. Downstream of Bhakra, another dam called as Nangal Dam was constructed at a distance of 13 km. The whole project generates about 1325 MW of electricity and provides irrigation water for about 4.04 million hectares of land in Punjab, Himachal Pradesh, Haryana, and Rajasthan (https://ejatlas.org). The Pong Dam was built in 1975 on Beas River to store water and use it through Shah Nahr. In 1977, Pandoh Dam was constructed on Beas River along with the construction of Beas-Sutlej Link Canal for linking Beas River to Sutlej River.

xv) Chenab River Basin Management

The Chenab River is one of the largest tributary of Indus River Basin. The river is formed at the confluence of the two streams called Bhaga and Chandra those flow along two different sides of Baralcha Pass and joins at a place called Tandi. It flows through the Himachal Pradesh and Jammu and Kashmir and enters Pakistan just upstream Marala. The distance from Marala Barrage to confluence point with Indus River at Mithankot is 598 Km. Downstream of Marala the river width varies from 700 - 1400 m whereas the flood plain is about ten times as wide as the river. The Chenab River flows in a rugged and hilly terrain and all its upper drainage basin is situated in Himachal Pradesh and Jammu and Kashmir UT.Many big dams and barrages have been constructed on the Chenab River e.g., Salal, Baglihar for hydro-power development and Marala, Khanki, Qadirabad, Trimmu, and Punjnad barrages for Irrigation (FAO, 2012). The Chenab River Basin is a dynamic, complex, and large by covering two countries. It represents a marvelous blend of many ecological, political, and socio-economic systems. For the better planning and management of Chenab River Basin long term national and regional collaboration framework is essentially required for generation of scientific data and relevant information for the ultimate benefit of different stakeholders.

xvi) Chenab Revised Action Plan (CRAP)

The Chenab River is an important tributary of Indus River which flows through Western Himalayas. In fact, the river flows along the Northern base of Pir Panjal ranges before entering Doda area of the Jammu and Kashmir UT from Himachal Pradesh. As per the

Pollution Control Board (PCB) report of Jammu and Kashmir, 12 km stretch of the river from Jal Pattan (Jio-Pota) to Pargwal in Akhoor is highly polluted (JKSPCB Report, 2018). Some of reasons behind this pollution are given below;

i) Unabated disposal of Municipal waste including Disposal of untreated sewage directly into Chenab River.

ii) Un-authorized dumping of construction work and demolition wastes along its banks.

iii) Pollution from minor and major establishments.

It is in contrast to the fact that there is neither any industrial estate nor any other industrial activity along the polluted stretch of Chenab River and water is being generally polluted by disposal of untreated sewage, unabated disposal of municipal solid waste, unauthorized dumping of construction and demolition wastes and pollution from minor/major establishments. Three main drains are discharging untreated sewage with common physico-chemical characteristics directly into Chenab River near Jio Pota Mandir and other downstream locations. There is no proper treatment facility for municipal solid waste being generated from households and other activities and the same is dumped in open along the banks of Chenab River which is contributing to the pollution of this river. Many new buildings and establishments besides Army cantonments have come up in the recent past, as a result of which the wastes from construction and demolition activities have also contributed to the pollution of Chenab River.

The following Action Plan was proposed by the Jammu and Kashmir Government for mitigation of the pollution load of the polluted stretch of Chenab River.

a) Disposal of Untreated Sewage Waste into Chenab River

Establishment of Common Sewage Treatment Plant (CSTP) with capacity of 3.0 MLD for the sewage load of Akhnoor town. The District Local Bodies and Municipal Committee Akhnoor were required to take the action within a time frame of twelve to eighteen months.

b) Unabated Disposal of Municipal Waste

Establishment of identified Municipal Solid Waste (MSW) dumping sites and scientific disposal of municipal solid waste had been proposed. Besides, segregation of MSW at household/activity level was also suggested. The District Local Bodies and Municipal Committee, Akhnoor were required to take the action within a time frame of six to twelve months.

c) Unauthorized Dumping of Construction and Demolition Waste

Setting up of facility for disposal of the material from construction and demolition activities. District Level Local Bodies and Municipal Committee, Akhnoor were designated as the responsible agencies to establish the facility within six months.

d) Pollution From Minor/Major Establishments

Establishment of the sewage treatment plant and effluent treatment plant at source point level for primary treatment of the wastes/pollutants generated minor establishments, banquet halls, and bio-medical wastes from health care establishments. District Local Bodies, Urban Environment Engineering Department (UEED) and Municipal Committees and Health Department were designated as responsible agency to take action in six months to one year time.

e) Catchment Area Treatment

Afforestation up to 200 ha area up/down stream of polluted river stretch was proposed so as to prevent soil erosion, for improvement of river environment by reducing silt and to augment ground water charging (RAP, 2018). Jammu and Kashmir UT Forest Department was to take action within 2-3 plantation seasons.

xvii) Outcome of the Chenab Revised Action Plan (CRAP)

The much-hyped action plan aimed at checking pollution of Chenab River in Akhnoor area remained confined to the papers only as different Government agencies, who were supposed to initiate steps to reverse the present situation, have only acted as mute spectators. Till date there is no headway on this vital aspect as pre-feasibility report prepared by the Urban Environmental Engineering Development (UEED) is yet to be cleared by an agency of the Union Government. After approval by the Union Government, the funds will be released for start of the work on ground. In absence of any common Sewerage Treatment Plant (STP) the administration is not in a position to put pressure on the banquet halls and other establishments to set up STP for primary treatment followed by connectivity with the Common STP. In the action plan, it had specifically been mentioned that the Directorate of Urban Local Bodies and Municipal Committee, Akhnoor will ensure scientific disposal of municipal solid waste as per the MSW Rules-2016. Though land measuring 12 kanals was identified at village Allenpur for scientific disposal of municipal solid waste generated from Akhnoor town, but the said plant is yet to be established. The Health Department could not set up Effluent Treatment Plant (ETP) to cater the requirement of healthcare establishments and in the absence of ETP the liquid waste from healthcare establishments is being discharged directly into the drain, which ultimately pollutes the Chenab River (www.dailyexcelsior.com).

xviii) Jammu and Kashmir Water Policy and Plan

The Jammu and Kashmir Water Policy and Plan has been framed on 25th October, 2017to achieve the objectives of conservation of rivers, river corridors, water bodies and associated infrastructure and to also promote water conservation consciousness through education, awareness building, regulation, incentives, disincentives etc. (J&K SWPP, 2017).

xix) Jammu and Kashmir Environmental Policy

The Jammu and Kashmir Environment Policy, 2018 proposed to achieve the twin objectives of environment conservation and improve the quality of life for present and future

generations by conservation, protection, and restoration of natural resources. It is comprehensive document which aims to fulfill following objectives.

i) To develop and implement a strategy for rehabilitation and restoration of degraded forest ecosystems and water catchment areas

ii) To promote plantation of only such species as are conducive to the conservation and sustainability of given ecosystems

iii) To adopt appropriate land use planning and watershed management practices for sustainable development of mountain ecosystems

iv) To promote sustainable alternatives in respect of shifting cultivation practices particularly in Chenab valley and other ecologically fragile areas

v) To promote sustainable use of freshwater resources and the conservation of river and lake ecosystems through development and implementation of river basin management plans

vi) To prepare catchment area treatment plans and social mitigation plans to mitigate the impacts on river

vii) To ensure rehabilitation and restoration of degraded riverbanks and lakeshores, etc.,

(Source: J&KSEP, 2018)

xix) Jammu and Kashmir State Forest Policy 2011

The important role of forests for maintaining the soil mantle, minimizing soil erosion, preservation of wildlife and in regulating the flow of water in rivers and streams is well recognized. The Jammu and Kashmir State Forest Policy, 2011 stresses to check the denudation and soil erosion in catchments through various integrated watershed management techniques and practices. It emphasizes upon the recharge of underground aquifers and regulation of surface water flows, sediment levels and water quality.

xx) Vision Document -2030

The Jammu and Kashmir Government has setup Soil and Water Conservation Department with a broad mandate of water conservation by taking up the works on watershed and micro-watershed basis. The department basically formulates and implements various site-specific treatment plans. Some of the previous projects completed by the department include Baglihar Catchment Area Treatment (CAT), Chenani Catchment, Lower Tawi, etc. The department has drafted Vision Document 2030 in order to conserve the valuable soil resources and increase water regime by implementing various vegetative and engineering works like DRSM, crate works, brush wood check dams, etc., The document envisages for 70,000 hectares area to be undertaken for Soil and Water Conservation activities by 2030 (SWCD Vision, 2030).

1.7 Legal, Policy and Institutional Context

The last century has witnessed large scale exploitation and massive degradation of rivers due to hydro-power development, channelization schemes and dumping of effluents and

pollutants from industrial, municipal, domestic and agriculture activities. Rivers have been viewed as a resource to be exploited recklessly, and not as a resource that has certain basic economic, social, environmental and cultural value. Consequently, rivers are facing many existential threats from dams, pollution, diversions, encroachments, excessive use of groundwater and catchment degradation. Legal framework provides a direction to the decision making process in a particular area of interest. Policy may be conceptualized as a rational, action-oriented tool or instrument that can be appropriately used to solve problems. Therefore, strong legal policies and institutional set up are quite necessary to determine the uses, protections, and prohibition related to water resource or rivers. In Indian context, the legal perspectives and policy scenario about the rivers is complex, perplexing and complicated. There are a number of laws and related institutions, but the robust legal and institutional mechanism which can regulate the perennial annual flow and ensure the decision making process for conservation of rivers is lacking.

The Chenab River is a trans-boundary Himalayan River which flows through Himachal Pradesh, Jammu and Kashmir and goes up to Pakistan. The provisions of Indus Water Treaty, 1960 regulate use and sharing of its water between India and Pakistan.Chenab River and its tributaries hold enormous potential for hydro-power development and it sustains the livelihoods of large population by providing innumerable goods and services. Being a Himalayan River, it is more vulnerable to climate change.

Therefore, an enabling legal and institutional framework favorable to stainable management of Chenab River for meeting the human demands and challenges posed by climate change must be in place. Moreover, as Union Territories of Jammu and Kashmir and Ladakh has recently come into existence after the enactment of Jammu and Kashmir Reorganisation Act, 2019. Earlier, the State of Jammu and Kashmir had its own Constitution and most of the laws which were applicable to the rest of the country were not applicable to the State. But, after reorganisation and the creation of new UTs, several central laws and acts enacted for the conservation of forests, wildlife and rivers and pollution related issues are equally applicable in UTs of Jammu and Kashmir and Ladakh (Appendix 2 to the Act of 2019). The mechanism needs to be developed for effective implementation of these laws and acts in the newly created UTs. The present DPR analyses the key issues and existing legal, policy and institutional context applicable for conservation and rejuvenation of Chenab River.

1.8 Present Task – Forestry Interventions for Chenab River

The river basin is a natural and ecological unit with vertical and horizontal cross-linkages and any degradation in the upper reaches can always have major impacts downstream. Forests in this scenario play a significant role to regulate climate, hydrological cycle, recharge the ground water level, reduce erosion and curtail the amount of silt going to rivers. In view of this fact, the following section has been attempted with a special objective to elaborate the role of Forestry Interventions for mitigation of the problems being faced by Chenab River. Hence, there is an urgent need to understand the values and potential of catchment forests to rejuvenate the river ecosystems.

1.8.1 Forests – Multiple Functions, Uses and Values of Mountain Forests

Forests are an important and integral part of any ecosystems and provide a variety of ecosystems services to the community in terms of food, timber, water, biological diversity, recreation, and cultural identity. The services from forests are normally classified in four categories.

a)Provisioning: The products humans acquire from ecosystems (e.g., food, timber and water)

b) Regulating: The role of ecosystems in the regulation of ecological processes, (e.g., water and climate regulation)

c) Cultural: The non-material benefits provided by ecosystems (e.g., recreational and spiritual values)

d) Supporting: Such as soil formation, photosynthesis and nutrient cycling (Tognetti *et al.*, 2017). Mountain forests have got additional roles to play including their role in watershed management, biodiversity and food security. They also form the inseparable part of complex land-use systems. The importance of forests to sustain mountain development is gaining importance and in view of this fact, mountain forests are essentially required to be managed following integrated and multi-sectoral approaches with the involvement of all stakeholders (Hofer and Zingari, 2003).

1.8.2 Riparian Forest Buffers as 'Biological Filters' – Ecological Machinery for Self-Purification and Bio-remediation River Ecosystems

The word 'Riparian' signifies the vegetation, habitats and ecosystems which are connected to the streams, springs or ponds, wetlands and rivers. These areas are green corridors of trees, shrubs, and herbs growing along watercourses and also act as 'Natural Biological Filters' as they brings about the purification of water for the dynamic flow of river and its water quality. Riparian forests act as effective filters for nutrients like nitrogen, phosphorus, calcium, potassium, sulfur, and magnesium (Lowrance *et al.*, 1984). These forests have got the capacity and capability to reduce impact of human disturbances on the river. Riparian zone represents a transition between the terrestrial and aquatic ecosystems, and is influenced by both longitudinal gradients of variation like climate and elevation as well transverse gradients like, flooding, groundwater availability and substrate. Riparian forests provide food and organic matter for terrestrial and aquatic organisms, moderate stream temperature, filter out sediments, nutrients, pollutants, and stabilize river.

Biological habitat diversity and water quality of the rivers are strongly influenced by land use within the surrounding area (Daniels, 2004). Many factors affect the ability of the riparian forest to remove pollutants from runoff, including pollutant load, field slope, type and density of vegetation, soil structure, and subsurface drainage patterns. Riparian forests protect water quality by reducing the amount of sediment, nutrients, and other pollutants that enter streams, lakes, and rivers. The riparian vegetation also take up the contaminants adsorb on to clay particles and soil microorganisms later converting them to less toxic forms (Osborne and Kovacic, 1993). They have the most influence on water quality where field runoff follows direct, shallow flow paths from the uplands to the stream and rivers. River conservation cannot be considered in isolation and hence, riparian zone function as a critical connection between the terrestrial and aquatic ecosystems. It also serves as an ecological corridor both between habitats and across elevation zones. Hence, a holistic and integrated riparian forest conservation and management plan is invariably required for regulation activities like agriculture, forestry, mining, and grazing along the rivers. It may also be kept in mind that the Riparian forest buffer systems must be managed considering the processes which remove or sequester nonpoint source pollutants, the effects of riparian management practices on the retention of non-point source pollutants, the effects of riparian forest buffer systems on aquatic ecosystems and the effects of the underlying soil and geologic materials on chemical and biological processes (Hubbard and Lowrance, 1994).



Riparian Vegetation Chenab River, Pangi Valley

1.8.3 Forest Ecosystems – Fragmentation and Degradation

Forests ecosystems play a pivotal role in the livelihood of the people living in its fringes by rendering them innumerable tangible and intangible services. Different anthropogenic activities and processes like agriculture, grazing, population growth, poverty, lack of education, development, etc., have made tremendous pressure on forests resources. These phenomena have also changed the composition of land cover with a significant change from natural habitats (i.e., forests, grasslands, and wetlands) to agricultural, pastoral, urban, and other man-made land uses (Tscharntke *et al.*, 2005). Forest fragmentation refers to any

process which results in the conversion of formerly continuous forest or habitat into patches of smaller forests or habitats separated by non-forested lands. Forest fragmentation occurs when a large region of forest is broken down or fragmented into smaller patches of forest habitat. Fragmentation infact is a complex phenomenon resulting from dynamic interactions between the natural landscape and society's ever-increasing demands on the land, creating a mosaic of natural and human-modified environments. Land cover changes due to various anthropogenic processes like agricultural intensification, logging and infrastructure development, construction of roads and power lines, illegal and indiscriminate felling of trees are some of the forests causing forest fragmentation (Karanth *et al.*, 2006). These changes have not only lead to the loss of habitat and biodiversity, but also to the modification of natural landscapes and ecosystem functions such as disruption in biogeochemical cycling, nutrient and water cycling, and ecological processes .

Forest degradation on the other hand is a process leading to a temporary or permanent deterioration in the density or structure of vegetation cover or its species composition. It is a change in forest attributes that leads to a lowering productive capacity caused by an increase in the disturbances. The time-scale of processes of forest degradation is in the order of a few years to a few decades. In a more general sense, forest degradation is the long-term reduction of the overall potential supply of benefits from the forest, which includes wood, biodiversity and any other product or service (Tejaswi, 2007).

1.8.4 Forests and Water – Strong Linkages

The ecological linkages between forests and water represent the intricate inter-dependence of ecosystems and related resources. No doubt, forests play a pivotal role in the hydrological cycle by affecting the rates of transpiration and evaporation. They also influence the rout and storage of water in a watershed. Forests also regulate soil erosion, pollution and prevent desertification and salinization. The capacity of forests to help capture and store water helps to mitigate floods in periods of heavy rain and ensures steady water flow during drier seasons.

The linkages between forests and water exemplify the importance of managing ecosystems in their entirety to protect their ecological character as well as the freshwater resources and related ecological services that are quite vital to human activity on Earth. The proper understanding of the hydrological cycle reveals how forest conservation and management are intimately linked to the health of water basins and the quality of water downstream. Forest soils readily absorb water and, as a result, surface runoff rarely occurs outside of stream channels in forested areas, causing important water catchments to form beneath forests. These catchments not only help store valuable fresh water, but they also increase the quality of water since forest cover reduces erosion and keeps rainwater within the enriched soil of forest beds and away from pollutants (Fig. 1.6). With water use growing at more than twice the rate of population growth, it is quite crucial and pertinent to understand the linkages between forests and water with a clear objective to protect our water resources (Blumenfeld *et al.*, 2009). The precise impact of forested catchments on water supply therefore, varies

dramatically between places, and can also vary in one place depending on such factors including the age and composition of the forest (Dudley and Stolton, 2003).

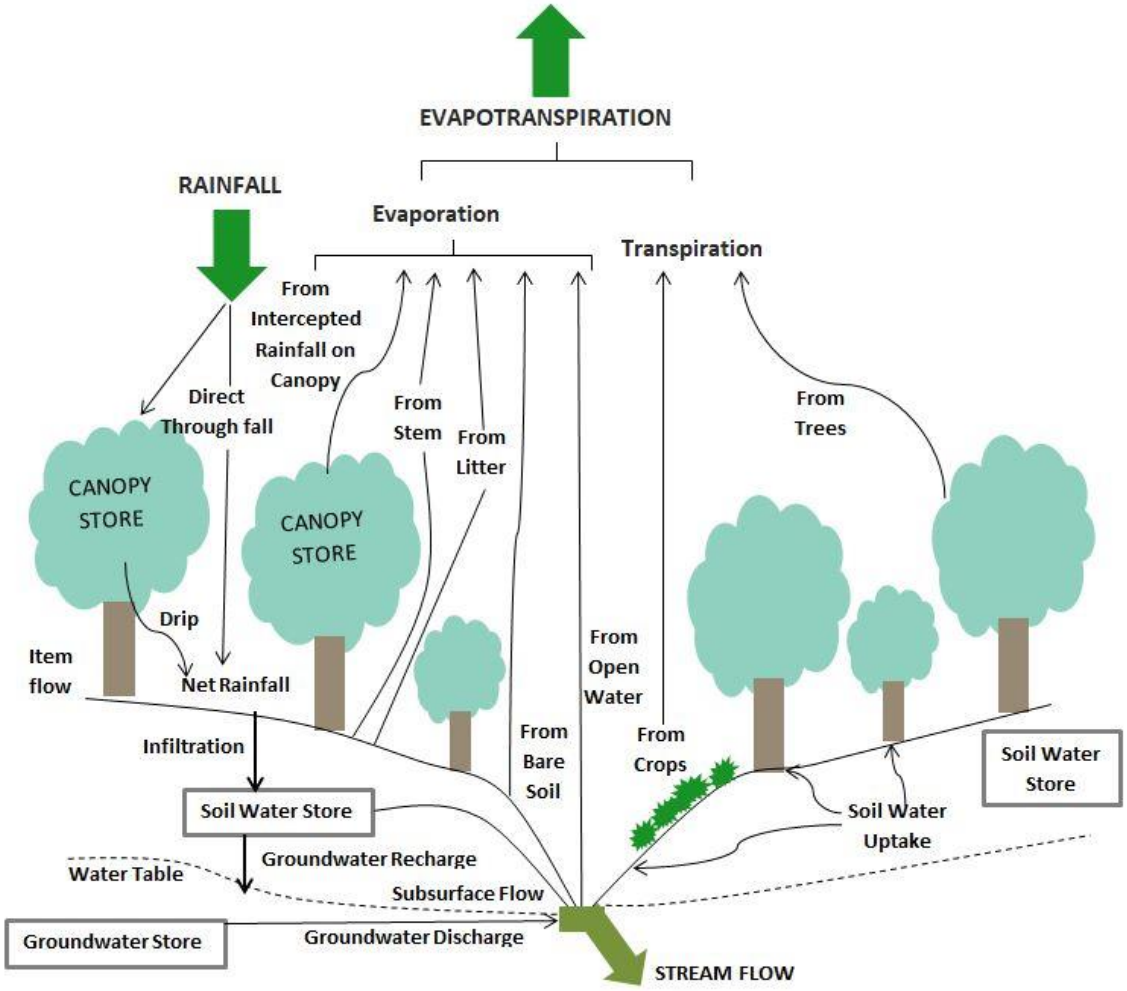


Fig. 1.6 - The hydrological cycle

(Source: Hamilton, 2005)

The multifarious and varied aspects of forests and water relationship are presented in **Box 1.1.**

Box 1.1

Forest and Water Linkages: Key messages for Policy Makers

- **WATER USE BY FORESTS**: In general, forests use more water than shorter types of vegetation because of higher evaporation.They also have lower surface runoff, groundwater recharge and water yield. Forest management practices can have a marked impact on forest water use.
- **DRY-SEASON FLOWS**: Forests reduce dry-season flows as much or more than they reduce annual water yields. In degraded agricultural catchments the extra infiltration associated with afforested land might outweigh the extra evaporation loss from forests, resulting in increased rather than reduced dry-season flows.
- **FLOOD FLOWS**: Forests can mitigate small, local floods by the combination of all elements that may cause flow resistance, such as forest litter, dead wood, twigs and tree trunk may slow down and desynchronize flood flows.
- **WATER QUALITY**: Natural forests and forests planted in agricultural and urban landscapes can reduce pollutants, especially when located on runoff pathways or in riparian zones.
- **EROSION:** Forests protect soils and reduce erosion rates and sediment delivery to rivers. Forestry operations such as cultivation, drainage, road construction and timber harvesting may increase sediment losses, but best management practices can control this risk. Planting forests on erosion-prone soils and runoff pathways can reduce and intercept sediment.
- **CLIMATE CHANGE**: In context of the marked changes in seasonal snowfall, rainfall and evaporation in many parts of the world, the influence of forests on water quantity and quality may be negative or positive. Where large-scale forest planting is contemplated for climate change mitigation, it is essential to ensure that it will not accentuate water shortages. Shade provided by riparian forests may help reduce thermal stress to aquatic life as climate warming intensifies.
- **ENERGY FORESTS**: Fast-growing forest has potential for high water demand, which can lead to reduced water yields. The local trade-off between energy generation opportunities and water impacts may be a key issue in regions where climate change threatens water resources.

(Source: IUFRO, 2007)

1.8.5 From 'Isolationist' to 'Holistic' Approaches to River Conservation

Freshwater resources of the country are under great stress due to a wide variety of factors. Since long, isolationist approaches were adopted for research on rivers, their management and conservation. However, their dynamic nature and complexities, intricacies and inter-connectedness, entire from the perspective of ecological integrity, connectivity, water flow

and livelihood including biodiversity conservation have been plainly overlooked. Since, water sustains life therefore; effective management of water resources is essentially required. A holistic river basin approach based on the concept of riverscape and linking social and economic development with protection of natural ecosystems is the basic requirement of river conservation initiatives and programmes. The active river area framework is a spatially explicit, holistic view of rivers that includes both the channels and the riparian lands necessary to accommodate the physical and ecological processes associated with the river system. The framework includes the areas and processes that form, change and maintain a wide array of habitat types and conditions in and along rivers and streams (Simth *et al.*, 2008).

The holistic approach in the integrated management of the watershed involves the orderly and coherent management of everything within its territory (i.e., ecosystems and infrastructure and services created by man to meet the needs of housing, transportation, livelihood, recreation, and work), articulated by the geo-hydrological system delimited by the watershed divide. The goal of management is to regulate human activities, both individual and collective, that take place in a geographical space or region, state, municipality, watershed or aquifer, be they performed by corporations or by social organizations, to execute them harmoniously with the function of the ecosystem. The end goal of watershed management is to maintain balance in the ecosystem and improve the water quantity and quality through interventions in the watershed (King *et al.*, 2002; Villela and Chávez, 2017). From isolationist approach to holistic approach is an ecosystem based management approach. Therefore, greater focus on river basins and river-scapes for planning, assessment and interventions are the need of the hour for maintaining ecosystem's integrity. Recently, Government of India has also launched several new initiatives and programmes in connection with the river rejuvenation and conservation. Amongst them, the *Namami Gange* programme initiated by the MoWR, RD&GR (Now Ministry of Jal Shakti) as a part of the National Mission on Clean Ganga (NMCG) focuses on the rejuvenation of the National River i.e., the Ganga River and adopted a comprehensive, multi-sectoral, multi-dimensional and multi-stakeholder strategy including 'Forestry Interventions' as an important and vital component. The Forest Research Institute (FRI), Dehradun on behest of the MoWR, RD & GR had prepared a Detailed Project Report (DPR) on Forestry Interventions for rejuvenation of Ganga River in the year 2016. From the financial year 2016-17, the five-year project on Forestry Interventions prepared by FRI is being implemented by five concerned states (i.e., Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal) lying along the main river course. The NMCG has supported implementation of plantation activities in Natural, Agriculture and Urban Landscapes within the delineated Ganga Riverscape besides other interventions as proposed in the DPR. FRI, Dehra Dun in its report on implementation of DPR in 2018 has revealed that five states have planted 7,685.16 ha, 2,840.72 ha and 2,731.29 ha area in Natural, Agriculture, and Urban landscapes, respectively during three years of project execution (DPR Ganga, 2016).

1.8.6 Current Task – DPR Preparation on Forestry Interventions for Rejuvenation of Chenab River

The NITI Ayog has developed an action plan for the implementation of the recommendations of the Run for Rivers (RFR) on ground with special focus on the re-vitalization of the rivers in the country. The Action Plan envisages the methodologies for revitalization, various measures to be taken and convergence of various on-going schemes under the various Central Ministries. It also contains the policy reforms with specific timelines and the way forward which could be considered by the Central and State Governments along with the programmes for undertaking the works of revitalization of rivers. The NITI Aayog issued an advisory to States along with Programme of Action (PoA) prepared by Department of Rural Development in collaboration of the NITI Aayog. Forestry Interventions for Ganga River under Namami Ganga Programme of Ministry of Water Resource River Development and Ganga Rejuvenation, Government of India as also indicated earlier was prepared by Forest Research Institute of Indian Council of Forestry Research and Education (ICFRE), Dehradun in 2016 which was highly appreciated at National and International levels. Subsequently, in line with the Forestry Interventions on Ganga River by NMCG, the MoEF&CC has assigned ICFRE to work on the project titled 'Preparation of Detailed Project Reports (DPRs) for Rejuvenation of major Indian rivers *viz*., Yamuna, Luni, Narmada, Godavari, Mahanadi, Krishna, Cauvery belonging to Brahmaputra Basin and tributaries of Indus Basin e.g., Chenab, Jhelum, Ravi, Beas and Sutlej through Forestry Interventions. The ICFRE is an umbrella organisation responsible for carrying out forestry research, education and extension activities in the country and an apex body in the National Forestry Research System. The Council has a pan India presence with its nine Research Institutes and five Centres located in different bio-geographic zones of the country. Each Institute has been mandated the task of research, education and extension in the States/UTs under their jurisdiction. Hence, ICFRE through its institutions has identified Chenab, Beas, Jhelum, Ravi, Satluj, Yamuna, Brahmputra, Mahanadi, Narmada, Krishna, Godavari, Cauvery and Luni River Basins for DPR preparation and their rejuvenation through Forestry Interventions following holistic approach. The Himalayan Forest Research Institute (HFRI), Shimla, has been entrusted the task to prepare DPR(s) of five tributaries of the Indus River. The present DPR specifically deals with the Chenab River, a major tributary of the Indus River. The ICFRE has allowed HFRI a time frame of 12 months to prepare the DPR envisaging that proposed Forestry Interventions will immensely increase e-flow of the river, improve the hydrological ecological regime and lead to the luxuriant growth of terrestrial flora and aquatic fauna.

1.8.7 Funding Agency Initiative

The Indian rivers and their tributaries are very important for sustainable livelihoods and economic prosperity of large riverine communities. Recognizing the immense importance of river resources of the country for well being of society and to ensure water security, the holistic programme to rejuvenate major Indian rivers and their tributaries by way of source augmentation and conservation has been envisaged by Government of India (GoI). The

Namami Gange flagship programme, launched by Union Government for rejuvenation of National Ganga River was a big initiative in this direction. A Detailed Project Report for rejuvenation of Ganga River through Forestry Interventions was prepared by Forest Research Institute, Dehradun in 2016. The National Mission for Clean Ganga (NMCG) which is a registered society under the Ministry of Jal Shakti (MoJS) had provided financial support for formulation and implementation Ganga DPR under the *Namami Gange* Programme. Budgetary outlay of 800 crores has been allocated by Union Government *Namami Gange* programme of the Union Government in the Budget 2020-21. Similarly, Rs 840 crores have been allocated to National River Conservation Plan (NRCP, 2010) and River Basin Management for conserving and treating other rivers in India**.** Currently, as per the instructions and directives by the NITI Aayog, the National Afforestation and Eco-Development Board (NAEB) under the MoEF&CC has assigned the major task to ICFRE and its institutes to prepare the DPRs of eight major rivers of the country including the five tributaries of Indus River Basin.

National Afforestation and Eco-Development Board (NAEB)

The National Afforestation and Eco-Development Board (NAEB) is the Central Nodal Agency under the Ministry of Environment, Forest and Climate Change (MoEF&CC), which promotes afforestation, tree planting, ecological restoration and eco-development activities especially in the degraded forest areas, national parks, wildlife sanctuaries and other ecologically fragile areas of the country. National Afforestation and Eco-Development Board (NAEB) releases funds to the Voluntary Agencies (VAs) and State Forest Departments (SFDs)/Forest Development Agencies (FDAs) for implementation of the afforestation projects. NAEB has provided the monetary assistance for formulation of the present project and recommended the use of widely acclaimed Ganga DPR as a prototype during the current assignment. NAEB will also coordinate, supervise, monitor the progress of the project and may provide grants/ aids for implementation of the envisaged proposals of the DPR. Besides NAEB, the Ministry can borrow financial assistance from other potential funding partners e.g., National Agricultural and Rural Development Bank (NABARD) and National Medicinal Plant Board (NMPB) for implementation of the proposals of the DPR.

a.) National Agricultural and Rural Development Bank (NABARD)

The National Agricultural and Rural Development Bank (NABARD) came into existence on 12 July 1982. It is fully government owned institution and mainly responsible for bringing out the prosperity in rural sector of the country. Besides this, NABARD has extended its mandate to support and sponsor various projects related to forestry, farm forestry, agroforestry, industrial plantation and wasteland development sector. It has also promoted a number of projects for rehabilitation of degraded forests. The NABARD has been designated as National Implementing Entity (NIE) under National Action Plan on Climate Change Fund (NAFCC)for implementation of Climate Change adaptation/mitigation projects and it is supposed to play a major role in facilitating the formulation of projects for Climate Change, its appraisal, disbursement of fund, monitoring and evaluation and capacity building of stakeholders including State Governments. Therefore, funds under the existing set up of the Bank or its subsidiaries can provide financial assistance for the implementation of project.

b.) National Medicinal Plants Board (NMPB)

The National Medicinal Plants Board (NMPB) was set up on 24 November 2000.The NMPB functions under the Ministry of AYUSH (Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy), Government of India. Its mandate focuses to establish coordination between different ministries/departments/organization for support and implementation of policies/programs for growth and conservation of medicinal plants. Under the Research and Development component, NMPB provides financial assistance for projects related to various aspects of medicinal plants.

The Ministry of Environment, Forest and Climate Change (MoEF&CC) is the central nodal agency under the union government for executing and supervising the country's policies and programmes for conservation of natural resources including lakes and rivers, forests, etc. For the implementation of project formulated in the present DPRs, the MoEF&CC may either decide to make use of its own funds or request any other Central Ministry/ National or International Agency to implement as well as to provide requisite funds for execution of project activities. The MoEF&CC can finance the execution of proposed DPR or explore the potential funding partners.

1.8.8 The Himalayan Forest Research Institute (HFRI) – A Knowledge Management Centre

The Himalayan Forest Research Institute (HFRI), Shimla, is one of nine research institutes under the ambit of ICFRE, Dehradun. It was established as a High Altitude Conifer Regeneration Research Centre during May, 1977 for carrying out research on problem associated with natural regeneration of Silver Fir and Spruce. During the reorganization of forestry research in 1998, Government of India appreciated the problems of Temperate Eco-system and decided to upgrade this centre into a full-fledged research Institute. The mandate of this Institute had also been enlarged to cater to forestry research, needs pertaining to eco-rehabilitation of Cold Deserts, mined areas and regeneration of coniferous and broad-leaved forests, besides activities on management practices including insect-pests and disease management in temperate forests and in alpine areas too. Popularization of agro-forestry and other related extension activities had also been included in its mandate. This center was re-designated as Himalayan Forest Research Institute, Shimla w.e.f., September 8, 1998 and is one of the Research Institutes of ICFRE with an area of responsibilities extending to the state of Himachal Pradesh and union territories of Jammu and Kashmir and Ladakh. The Institute has its campus located at Panthaghati, Shimla. It has well developed infrastructure with the state of the art laboratories and other facilities. The Institute has also established nine experimental field research stations in different parts of agro-climatic zones in Himachal Pradesh and UTs of Jammu and Kashmir and Ladakh. The Institute has a dedicated team of multidisciplinary scientists working in five research divisions and supported by technical staff. Since its inception, HFRI has made significant contributions towards the development of suitable nursery techniques for high valued medicinal plants propagation and regeneration of native plants species and eco-restoration of mined areas and cold deserts. Over a period of time, HFRI has been recognized as a Knowledge Management Center in the field of

mountain forestry, high altitude ecology, medicinal plants, alpine pasture management and conservation of diverse temperate forest ecosystems.

1.8.9 Project Development Phase and Preparation of DPR – The Approach

In accordance with the guidelines of MoEF&CC and ICFRE, HFRI undertook the ambitious task of preparation of present DPR following an extensive framework as adopted in the context of Forestry Interventions for rejuvenation of Ganga River. Past experiences, existing scientific knowledge base and varied expertise available at the institute have been best utilized for developing the structure, strategies and activities for the present DPR through an exhaustive consultative process by active involvement of policy and decision makers, scientists, conservationists, field practitioners, representatives of civil society and non-governmental organizations and State Forest Departments of Himachal Pradesh and Jammu and Kashmir UT. The above State and Union Territory not only form part of the Indus River Basin, but the Chenab River stems out and traverses from its origin to mouth through this region. The launch workshop and sequential Consultative Meetings organized in the State/UT included policy and decision makers representatives of State Forest Department and various Line Agencies i.e., Agriculture, Horticulture, Animal Husbandry, Mining, Irrigation, Hydroelectric Projects; state/national level scientific or specialized organizations i.e., – Soil and Water Conservation, Hydrology, Forestry, Wildlife, Environmental Management, Central Water Commission, Groundwater, Remote Sensing and GIS; Universities; Civil Society; and Non-Governmental Organizations besides conservationists and field practitioners. The feedbacks of the vast consultative process received from the stakeholders related to varied spheres of life have been the crucial step in the formulation of strategies and preparation of present DPR. Regular guidance, active involvement, keen interest and support at all stages by the Hon'ble Minister of the Union Ministry of Environment and Hon'ble Forest Ministers of concerned State/UT, and senior officials of the MoEF&CC, ICFRE and SFDs were immensely instrumental throughout the process of planning and giving a final shape to this DPR.

1.8.10 Logical Framework Approach

Water is the most important natural resource which flows in streams and rivers. The inter-connection between the human and fresh water resources is quite evident and this interaction impacts the ecological, economic and aesthetic integrity of the resources. Across the world, the rivers and their catchments are threatened as a consequence of various anthropogenic activities. In order to utilize the fresh water in a sustainable manner, the need for conservation of riverine environments and management of river basin is felt more and more. Planning for river system management is considered as the first step in river basin development to integrate all other sub systems. It is widely accepted that diverse and complex relationships between rivers and other components of environment need to be taken into consideration while planning river basin development. It involves a sound and practical approach that implies management of water along-with the management of inter-dependent natural

resources *viz*., soil, forest, air, biota etc., taking river basin as the basic planning and development unit (Puranik *et al.,* 2015). It recognizes the linkages between highland-lowland, upstream-downstream interaction processes effecting the life and livelihood of people and ecological balance in the region. River basins entail different components of natural resources including ecology and environment, water resources, agriculture, social, organizational and economical sub systems. Basically, River basin management is a complex process which emphasizes the spatial dimension of water by taking catchment as the single unit of management (Shahjahan and Harvey, 2012).

In view of the above, any effective tool or technique that is to be used for river basin planning by integrating physical, ecological, social and economic aspects of river basins through active involvement and participation of stakeholders for transparent and accessible processes of analysis and decision making had been taken care of logical framework or 'Logframe' analysis was used as a tool for planning, management and conflict resolution with special reference to stakeholders' participation in river basin development. Logical framework infact involved analysis of problems, objectives, alternatives, stakeholders and development of 'logframes'. 'Logframes' link cause and effect relationship through a hierarchy of objectives. When 'Logframes' are prepared with systematic participatory approach addressing concerns of all the major stakeholders, they provide for delineation of the most suitable programme strategy in a concise and phased manner for its implementation, monitoring, reporting and impact evaluation at every point of time. The Logical Framework Approach gives a structure to project planners and evaluators to specify the components of their river basin planning and management activities and recognize the logical linkages between means and ends. The Log Frame puts Monitoring and Evaluation (M&E) within a wider framework. Logical Framework Analysis (LFA) is an analytic tool and aid after result-based management offering systematic and logical approach and means by which a project may be structured and described for analytical purposes. The LFA process considers all factors which are essential for planning a project (Coleman, 1987). Recently, LFA has been established as the most efficient tools for designing, implementation, monitoring and evaluating development projects. The LFA facilitates common understanding and better communication between decision-makers, managers and other stakeholders involved in the project. The LFA methodology and process involves many steps *viz.*, the contextual analysis, situation and problem analysis, analysis of stakeholders, activity planning, resources planning, monitoring result, indicators and means of verifications, risk analysis and management, and analysis of assumptions. This process has been elaborately illustrated in Chapter of this DPR (Annexure: 1).

1.8.11 The Vision, Mission, Goal and Objectives

The current project had been envisioned to achieve the larger objectives of management of river ecosystems considering the criss-cross linkages between aquatic, biological and physical environments. The project basically aims at improving the river flow regime, increase in the environment flow (e-flows), habitat enrichment, biodiversity conservation, and improve the ecological and aesthetic attributes and generation of more avenues and

opportunities for sustainable livelihoods. The project is set to adopt a multi-sectoral, multi-pronged, inclusive and holistic approach for proposed Forestry Interventions to fulfill the twin objectives of maintaining the constant and clean flow of water in the rivers as per the *Aviral dhara* and *Nirmal dhara* concepts under *Namami Gange* programme of NMCG. Based on extensive consultative processes carried out as a part of this DPR, the following shared vision emerged for the implementation of plan.

Vision: The multi-dimensional ecological significance and immense biodiversity value of the Chenab River ecosystem is recognized, conserved, restored and wisely used while ensuring ecosystem integrity, improving ecosystem services and keeping the river healthy for delivering benefits essential to all life forms.

Mission: To fulfill the above vision by adoption of multifocal strategies and implementation of appropriate, effective and urgent actions for rejuvenation and conservation of the Chenab River ecosystem. For this, five strategic priorities namely (a) address drivers of environmental degradation and biodiversity loss, (b) adopt integrated solutions, (c) enhance resilience and adaptations, (d) build alliances and foster synergies, and (e) biodiversity, restore ecosystems promote sustainable use of biological and water resources, enhance capacities, mainstream biodiversity, augment policy and law support, and facilitate science based efficient decision making are to be pursued.

Goal: In light of the above and in conformity with global and national level priorities, commitments, strategies, agendas and approaches, the Implementation Plan on Forestry Interventions seeks to address the following focal areas or goals in an integrated manner:

(a) **Riverscape Management:** Aims a holistic riverine landscape (riverscape) approach for sustainable management of Chenab River, riparian areas, and its tributaries.

(b) **Maintenance of Continuous and Clean Flow, Ecological Rejuvenation and Biodiversity Conservation:** Aims to address the drivers and stressors of river ecosystem and promote sustainable use by balancing ecological requirements with the needs of sustainable livelihoods.

(c) **Improved Ecosystem Services and Sustainable Livelihoods**: Aims to specifically seek enhanced ecosystem services so as to ensure sustainable livelihoods.

(d) **Effective Implementation, Knowledge Management, and Innovative Approaches:** Aims to ensure effective implementation of the project, knowledge management, development of innovative approaches (i.e., nursery techniques, afforestation, bio-filters and bio-remediation), and adoption of appropriate modern technologies.

Project Objectives, Outputs and Outcomes: In commensuration with the broad vision and goals of any project, objectives and aims are defined. These aims of the project should be specific, measurable, and achievable preferably within the project period; and time framed (SMART) (Rutherfurd *et al*., 2000; WRC, 2001a). Outputs are various activities intended under the project to effect a change in the condition of river ecosystem and outcomes reflect the tangible changes that have taken place as a result of project activities (National Landcare Program Evaluation Coordinators, 1997). This plan also aims to fulfill the requirements of

above four focal areas under the set goals in a phased manner and visualizes specific outputs and outcomes. Following objectives are set- forth for the project.

(a) Objective 1: To promote community-driven sustainable land and ecosystem management of the Riverscape while improving and maintaining the forest/vegetation cover along the course of the Chenab River and its tributaries

(b) Objective 2: To protect and conserve the representative biodiversity of the Chenab Riverscape

(c) Objective 3: To promote and support sustainable livelihood opportunities for local communities

(d) Objective 4: To adopt, integrate and implement innovative approaches and modern technology for rejuvenation of the Chenab River and its tributaries, knowledge management, enhanced capacity, monitoring and evaluation

Above project objectives will be achieved through the following outcomes:

Outcome 1: Creation of an enabling environment for climate resilient, sustainable terrestrial, aquatic (i.e., rivers and wetlands), and floodplain ecosystem management.

Outcome 2: Inter-agency and civil society driven climate resilient approaches for appropriate forestry and other allied interventions demonstrated in adequate extent(s) of natural, agriculture, and urban landscapes of the riverscape

Outcome 3: Enhanced ecosystem services from natural (i.e., forests, grasslands, rivers, and wetlands) ecosystems, agro-ecosystems, and urban landscapes

Outcome 4: Shoring up the sustainable livelihoods of local populace, particularly vulnerable groups and ecological restoration

Outcome 5: Capacities for adaptive management, learning, and replication of project lessons are developed.

Specific outputs foreseen under above outcomes are described below:

Outcome 1: Creation of an enabling environment for climate resilient, sustainable terrestrial, aquatic, and coastal ecosystem management

The purpose of this significant project outcome is to build an appropriate environment wherein multiple agencies working for various production sectors (i.e., forests, watersheds, agriculture, livestock, mining, tourism, tribal welfare, infrastructure development - hydropower, communication and highways) converge and adopt climate resilient and sustainable approaches of land and ecosystem management by mainstreaming biodiversity concerns. These sectors shall also work together so as to address gaps and inadequacies in realizing global and national policy objectives relevant to environment, biodiversity, water resources, and climate change. Following outputs are envisaged to accomplish above broad based outcome.

Output 1.1 *Enhanced levels and enabling environment created for*

(a) Multi-sector convergence, alliances and integration.

(b) Favourable national and state level policies (i.e., forests, agriculture, animal husbandry, watershed management, river management, tribal welfare, infrastructure development and tourism) that reflect principles of climate resilience, sustainable land and ecosystem management, and mainstreaming biodiversity concerns in production sectors.

A large number of policies and legislations relevant to above production/environment sectors exist and piecemeal and preliminary efforts have been made for inter-sector convergence and adoption of Landscape/Riverscape/Seascape approaches to conservation and sustainable land and ecosystem management. However, these have not been enough. The review on intricacies of the Chenab River ecosystem and environmental degradation caused by different factors necessitates the demand for holistic approach, meaningful convergence, mainstreaming of biodiversity concerns, and harmonization among conflicting sectors through adequate support of relevant policies and laws. The project will provide an opportunity to bring together various sectors/agencies/Civil Society Organizations (CSOs) for the realization of vision and goals relevant to healthy river, sustainable ecosystem management, and climate resilient environment. The HFRI Nodal Institution responsible for planning, execution, technical backstopping and monitoring and evaluation along with primary implementing agencies i.e., SFDs in concerned states and Union Territory will facilitate the process while working with different sectors and CSOs. An exhaustive consultative approach is being planned in developing recommendations, necessary mechanisms, and enabling policy environment. The Nodal Institution and concerned stakeholders have a major role to play in addressing the threats arising from likely climate change and integrate them with current land use, management of production sectors and ecosystem management.

Output 1.2*Capacity of Civil Society Organizations and Government Officials is built while promoting community driven, climate resilient, sustainable land and ecosystem approaches, and holistic approach to river ecosystem*

The project envisages extensive plantations, soil moisture conservation works, and pilot trials on bio-filters and bio-remediation on various lands belonging to government and private owners. For such activities on government lands, in particular the forest lands, the SFDs will be the implementing agencies, while for large scale such efforts on private agricultural lands and other government owned riverfronts and urban/peri-urban lands, implementation of various activities is planned through various Central Armed Paramilitary Forces (CAPFs) (i.e., ITBP, Eco Task Force) and CSOs (e.g., Van Panchayats, Gram Sabhas, JFMCs, EDCs, BMCs, etc.). Integration of various production sectors and their convergence is vital for the success of this major project. Efforts towards awareness campaigns for the masses, in particular youth, and capacity building of CSOs and government officials are planned as a part of the DPR. The project envisages adoption of innovative approaches (i.e., bio-filters and bioremediation) that have been used and successfully tried in different countries besides modern technologies (RS and GIS, meteorological, water quality, aquatic animal monitoring - telemetry, etc). Pilot demonstrations on bio-filters and bio-remediation in select sites are envisaged. For successful execution of the Innovative Approach, periodic monitoring and evaluation are essential. Capacities of government officials and CSOs in this aspect would also be addressed.

Outcome 2: Civil Society driven climate resilient approaches for appropriate forestry and other interventions demonstrated in adequate extent of natural, agriculture, and urban landscapes of the Riverscape

The Riverscape includes wide ranging natural ecosystems (i.e., terrestrial and aquatic) besides vast agricultural, urban and peri-urban landscapes. Forestry Interventions in such landscapes are envisaged.

Output 2.1 *Plans to reduce/check erosion in the mountainous region of the Chenab River and its tributaries by appropriate soil and water conservation works. Sites of landslides to be adequately treated and stabilized.*

The project plans for considerable inputs by way of appropriate soil and moisture conservation works to check and reduce erosion and treat specific landslide-prone sites within the Riverscape. At the same time, convergence of related sectors and development of policy framework on sand mining in river beds are required on priority

Output 2.2 *Plans for restored and sustainably managed forest and agriculture lands in targeted villages and Forestry Interventions in urban environment for improved forest cover. Enhanced assisted natural regeneration through improved protection and other measures.*

The main focus of project is on an integrated ecosystem management approach in the context of Chenab River by taking into account all diverse natural (i.e., forests, grasslands, and wetlands) ecosystems by adopting sustainable land and ecosystem management principles. The primary objective of this output would be to improve the forests/vegetation cover in the Himachal Pradesh and parts falling under Chenab Riverscape in Jammu region of Jammu and Kashmir UT. In addition, this output envisages appropriate cover of Trees Outside Forests (TOFs) through suitable plantations on private agriculture lands and various government lands (i.e., along canals, cantonments, schools, institutions, public facilities, riverfronts, and urban and peri-urban landscapes). Enhanced forests and vegetation cover will directly help in improved biodiversity, productivity, reduction in erosion and function of bio-filters.

Output 2.3 *Plans for improved protected area management by implementing appropriate protection strategies, habitat management (e.g., weed control and water management), research and monitoring inputs, and enhanced capacity*

The Riverscape includes a large number of terrestrial and aquatic protected areas that are repositories of representative biodiversity and facilitate various ecological and evolutionary processes including climate resilience. These protected areas, particularly wetlands and river stretches are under severe biotic pressures. The significance of these protected areas in the context of the Chenab River ecosystem is immense. As highlighted in the section on biological environment (Chapter 2), some of these PAs receive adequate management and funding support while smaller scattered PAs suffer on account of various threats and stressors including inadequate funds and support. Interventions by way of improved physical and management infrastructure for enhanced protection, habitat management (i.e., control of exotic and invasive species), research and monitoring inputs, capacity building, mitigation of human-wildlife conflicts, and adoption of eco development measures are envisaged.

Considerable activities and investments are being proposed to address such priority requirements.

Output 2.4*Plans for improved management of prominent wetlands in the Riverscape by protection, restoration, zoning, habitat management, and sustainable use of wetland resources.*

Wetlands whether in the Himachal Pradesh, or in the Jammu region of J&K UT of the Riverscape are not just biological supermarkets but, they are vital ecosystems for retaining ecological flows in streams, tributaries and river downstream. Since, most wetlands are under severe biotic pressure therefore, the project envisages urgent plans for their improved protection, restoration and management.

Output 2.5 *Plans for improved riverfronts and development of eco-parks*

The project plans for the development of riverfronts and eco-parks in urban areas. Considerable activities and investments are envisaged in this regard.

Output 2.6 *Plans for development of forests and river-based ecotourism*

The Himalayan mountainous environment in Himachal Pradesh, the Chenab River itself, diverse forests, wetlands and several PAs within the Riverscape are major attractions for tourists, particularly pilgrims, and adventure sports, nature and wildlife enthusiasts. The mushrooming of tourism related facilities, unplanned infrastructure, and unregulated tourism and pilgrimage have severely impacted the ecology values of the Chenab River and its associated ecosystems. The project thus plans for effective conservation awareness campaigns, promotion and support for eco-tourism in and around different forests, wetlands, PAs, and other pilgrimage sites, besides development of site-specific guidelines for sustainable eco-tourism and engagement of local communities and Civil Society Organizations.

Outcome 3: Enhanced ecosystem services from natural (i.e., forest, grassland, river, and wetland ecosystems), agro ecosystems, and urban landscapes

The natural ecosystems are offering a variety of ecosystem services to the human society since time immemorial, but due to growing population and unplanned developmental activities the natural ecosystems are severely spoiled. Thus, there is urgent need to restrain the adverse human activities to rejuvenate the natural ecosystems. Hence, planned activities by means of protection, afforestation, reforestation, assisted natural regeneration, weed control and management, water management, etc. have been incorporated in the Plan.

Output 3.1 *Plans for enhanced levels of protection, conservation, and sustainable harvest of medicinal and aromatic plants and development of herbal gardens*

The Project plans to support protection, conservation, and sustainable harvest of medicinal and aromatic plants and development of herbal gardens particularly in the Himachal Pradesh, so as to ensure sustainable management of forest lands and provide alternate income sources to local communities.

Output 3.2 *Plans for reduced traditional resource dependence, alternate income generation avenues and improved livelihood activities*

Traditional resource dependence, faulty land use practices, and overexploitation and unsustainable means of harvests of forests/natural resources emerged as important factors responsible for degradation of forests and other natural ecosystems within the Riverscape. Plans for extensive as well as intensive Forestry Interventions by way of plantations, assisted natural regeneration, soil and moisture conservation works, eco-restoration of habitats, etc. aim to enhance forest/vegetation cover and native biodiversity; while plans for enhanced employment generation and improved livelihoods by way of alternate income generation options, value addition, and facilitation of appropriate marketing mechanisms aim to reduce pressure on natural forests and biodiversity.

Outcome 4: Shoring up the sustainable livelihoods of local populace, particularly the vulnerable groups and ecological restoration

One of the major outcomes expected from the implementation of present DPR on Forestry Interventions pertains to improved rural livelihoods, particularly, vulnerable groups of society inhabiting far-flung of the remote mountainous tract or living along the stretches of Chenab River and its tributaries. In line with the, sustainable livelihoods concept propounded by the Department for International Development (DFID), United Kingdom, emphasis would be on the maintenance of five focal livelihood assets *viz*., human, natural, financial, physical, and social. The uncertain climatic conditions and other natural exigencies pose enormous challenges, risks and vulnerability to the inhabitants of these areas, the susceptible and weaker groups in particular. The plan lays equal emphasize on ecological restoration and the sustainable livelihoods. Hence, essential and priority activities supporting the sustainable livelihoods of local populace are being planned. Efforts will be made to make them aware about the significance of natural capital besides other prominent livelihoods assets such as human and social.

Outcome 5: Capacities for adaptive management, learning, and replication of project lessons are developed.

One of the five outcomes predicted from the implementation of the project, pertains to enhanced capacity for adaptive management of natural resources including the river ecosystem. The following two outputs are anticipated.

Output 5.1 *Plans for integrated, science based, and Civil Society based monitoring and assessment of impacts, as well as periodic evaluations of the project.*

Humans are using natural resources infinitely to meet varied needs without considering the fact that these resources are limited. Due to such type of uninterrupted and non-adapted uses, the natural resources could not replenish the losses and become scarce. Therefore, sustainable use and management of natural resources is urgently required. The effective management of various closely linked natural resources requires different integrated and inclusive methods based on the fundamental principle of adaptive management. The concept of adaptive management requires monitoring, learning and adaption. Currently, the concept of results based monitoring has assumed much significance because it is stressed by various national

and international agencies as a compulsory part of any project. Chenab Riverscape represents very large area with extensive criss-cross of its tributaries, varied landscapes, verdant forests, wetlands, and lakes, etc. There are multiple stakeholders associated with Chenab River and a lot of activities have been envisaged in natural, agriculture and urban landscapes besides several conservation and supporting activities across Himachal Pradesh and Jammu region of Jammu and Kashmir UT. Since, these wide ranging activities would involve enormous monetary investments; therefore it is imperative to find out the impact of these activities on the river ecosystems, its surroundings, and dependent communities with the help of a logical, objective, evidence and indicator-based monitoring mechanism. Consequently, the plan aspires to assess the impact with an evaluative, inclusive and community based monitoring system.

Output 5.2 *Plans for documentation of lessons learned and preparation of information dissemination products for wider audience and applicability*

The conservation and restoration of rivers demand deep understanding of its ecological functioning, relationship with terrestrial environments, and the deleterious impacts caused by human interferences. The subject of river restoration is multi-dimensional and requires more integrated approach to address multiple issues and concerns. In Indian perspective, the past work on conservation and restoration of *lotic systems* has many draw backs and they are mostly fragmentary, localized, limited, in exhaustive and disconnected. Any precedent of successful restoration of river ecosystem is rarely available. Centrally sponsored flagship *Namami Gange Programme* on the Ganga River is the only initiative launched on massive scale for the restoration of a national river. The present DPR of Chenab River is first of its kind where large scale Forestry Interventions have been planned to improve the river ecosystem and its tributaries. Therefore, it is utmost important to keep track of all the planning works and implementation activities of different phases of project for better learning and replication at subsequent stages. Therefore, the documentation of project execution, scope for learning from gaps and extensive dissemination of knowledge so gained also have been foreseen under the plan. In addition to this, there is unavailability of a potential agency which could provide broad understanding, and complete information on the river ecosystem at one place. So, there is a dire need to develop a knowledge management centre specifically dealing with the essential subject of restoration of rivers and ecosystems.

Thus, lessons learned with regard to the holistic approach of Riverscape/ River management, convergence of various sectors, and engagement of Civil Society will be of great significance for replication of similar efforts elsewhere within the country and outside.

Accordingly, the particular output is related to development of new, holistic and integrated approaches appropriate for varied physiographic zones of Chenab Riverscape, documentation of experiences and lessons learned, and dissemination of knowledge gained and repetition of the activities during maintenance phase of the project or elsewhere in the country.

1.8.12 Expected Outcomes

The outcome of restoration project is basically related to integrity, resilience, and sustainability of river ecosystems. The projected endeavors for restoration of Chenab River through Forestry Interventions aims for enhancement of forest cover, grassland and wetland management, reduction in soil erosion, riparian management, and aquatic habitat management. In relation to this, different socio-economic benefits and upgraded ecological functions are anticipated as a consequence of envisaged extensive Forestry Interventions. The plantation forestry in the catchments corridors will improve the ecological resilience, integrity and natural dynamics of the Chenab River ecosystem. As extensive plantation activities on Natural and Agricultural Landscapes have been envisaged under the DPR of Chenab River. Plantation forests and Trees Outside Forests on Natural and Agricultural and Urban Landscapes, respectively will act as carbon sink in future and considerable amount of carbon credits can also be earned through the carbon sequestered by these plantations. Moreover, the existing mountain and dry land ecosystems and watersheds under Chenab Riversacpe are particularly vulnerable to climate change. These ecosystems have unique features and resources, and they perform many economical and environmental services. The envisaged Forestry Interventions on suitably selected sites will reduce erosion, increase slope stability and contribute to regulated water flow and facilitate adaptation to climate change. Besides this, there will be contribution to economic development and livelihood sustenance by the way of employment generation avenues.

1.8.13 The Organization of DPR

The Himalayan Forest Research Institute, Shimla (HFRI), has concurrently prepared DPR(s) of five Rivers of Indus River Basin. The DPR for Chenab River is presented in two Volumes (Vol - I and II). The Volume-I deals with the main DPR while the Volume-II provides summaries of concerned State/UT (i.e., Himachal Pradesh and Jammu and Kashmir UT). The Volume-I comprised of 8 chapters in total. The introductory chapter illustrates the ecological character, complexities and dynamic nature of multi-dimensional river ecosystems and provides insight on crucial aspects of spatial connectivity, riverine landscape or ‘riverscape’, and linkages between forests and water/river, evolving concepts of river ecology, past conservation and management initiatives, Chenab River Basin and its uniqueness, existing problems of Chenab River ecosystem and needs of river restoration. In addition to this, the chapter also give a broad idea about the basis of DPR preparation, Logical Framework Approach (LFA), vision, goals, objectives, and expected outcomes of the project. The second Chapter of the DPR exclusively deals with Chenab Riverscape and elucidates environmental, socio-economic and historical aspects of Chenab River. The chapter contains detailed description about source, confluence points and tributaries of Chenab River, its physical and biological environments. This Chapter dwells upon the details of biodiversity in terms of diverse forests, grasslands, wetlands and associated threatened species. The chapter-3 emphasises about the approach and methodologies, exhaustive consultative process undertaken during the preparatory phase, meetings with stakeholders, trainings to the field

staff of implementing agencies, and GIS based spatial analysis of Chenab Riverscape. The chapter-4 describes about the legislative, policy and institutional contexts. The chapter contains substantive comprehensive details of various Central and State Government Level Agencies and prominent scientific institutions that are directly linked to the policy and decision making, existing policies, conventions, treaties and laws in place pertaining to the themes of the DPR and simultaneously identifies gaps, potential measures and prospective needs of various users and those who either influence/impact or are responsible for the management of water resources. The chapter-5 provides the details of the proposed Forestry Interventions on different landscapes (i.e., Natural, Agricultural and Urban) present within the Chenab Riverscape. The chapter contains description about various site specific model-wise treatment plans, projected targets, and model wise extent, cost and theme plans. The chapter-6 explains the implementation mechanism and sustainability, elucidates about institutional framework, mechanism of fund flow, risk assessment, monitoring and evaluation, and cost effectiveness. The chapter-7 gives general idea about the outlay of the project budget, cost tables and schedule. The Chapter-8 explains the anticipated potentials benefits of envisaged Forestry Interventions in terms of reduced runoff and less siltation, improvement in the quality and quantity of water, avenues for livelihood generation, etc. References and annexures are appended at the end of document. Volume II contains the brief summary on different aspects pertaining to the DPR of Himachal Pradesh and Jammu and Kashmir UT.

CHAPTER 2

Riverscape and its Environment

2.1 River Environment

A river is fresh water natural resource that originates in the highlands and flow downwards. River crosses land, hills and plains on its journey up to sea and supports not only human life but, also innumerable flora and fauna. This way, river is essential to the environment and biodiversity as a whole. Fundamentally, river ecosystem and environment encompasses all the interactions in a given physical, climatic, geological, biological and morphological context. River represents a highly complex and dynamic environment which carries out fundamental processes in order to maintain environmental equilibrium benefiting both the natural and the human world (www.civiltacqua.org). River ecosystems and environment are controlled by different processes occurring at spatial and temporal scales. At the largest scale, it regulates climate, geomorphology, land use control channel morphology, stream hydrology, thermal regime, water chemistry, and biotic community structure and at finer scales, the accessibility of suitable habitat and food resources, as well as species relations regulate organism populations (Johnson *et al.,* 2003). Flow or hydrology is the central driving force of river ecology. Geomorphology represents the configuration of the Earth's surface, the distribution of land, water, etc. and is largely determined by topography and geology. Thus, geomorphology mediates the flow of water across the landscapes. Floods and high flows carve and shape river channels and valleys and deposit sediments to create wide, flat floodplains. Thus, the hydrology and geomorphology are interdependent and interconnected. Living systems in a river are comprised of wide ranging plants, invertebrates and vertebrates. These organisms interact with non-living systems. The river natural environment does not just develop along the river's length but, also between its banks. The riverscape perspective recognizes the heterogeneous habitat types within the stream corridor as a single, integrated ecological unit operating across spatial scales (Sullivan *et al.,* 2007).

In view of these intricacies and inter-relationships, an understanding of longitudinal changes from the source of river to its mouth, vertical interactions, lateral exchange processes, temporal changes and patterns in the overall environment of the river itself and its surrounding landscapes are vital for an effective, scientific basis to river management. The river basin approach is universally appreciated and recognized for rejuvenation of major rivers.

The present chapter endeavors to bring out the description and complexities of different sub-environments in the context of Chenab River Basin in general and the Chenab Riverscape in particular. This descriptive account about the environment of river basin/riverscape is mainly synthesized from review of existing information and efforts have been made to highlight the vital aspects of three sub-environments from the perspective of DPR and rejuvenation of the Chenab River through Forestry Interventions.

The Chenab Riverscape has been delineated or selected for the purpose of proposed Forestry Interventions on the basis of consensus emerged from the exhaustive consultations with various stakeholders. An area of 29,326.47 km^2 falling in Himachal Pradesh and Jammu and Kashmir UT has been selected for the purpose of proposed Forestry Interventions. Thus, the area under consideration of this delineated Riverscape constitutes the total catchment area of Chenab River Basin within India (Table 2.1, 2.2).

Table: 2. 1- Area coverage under the Chenab Riverscape

S. No.	Consideration Unit	Area Covered (km^2)	Coverage area (State/UT)
1.	Chenab Riverscape	29,326.47	Himachal Pradesh and Jammu and Kashmir UT

The catchment area of the Chenab River Basin occurs in the mountainous state of Himachal Pradesh and Jammu and Kashmir UT. The distribution of the riverscape area and percentage are presented in Table 2.2. The catchment area of Chenab River in Himachal Pradesh is 7,755.44 km^2 and a 21,571.03 km^2 area falls in the Jammu and Kashmir UT, rest of the catchment area lies in Pakistan. Thus, the larger portion of the catchment area, being 73.55% of the riverscape lies in Jammu and Kashmir UT while 26.45% area of the riverscape falls in Himachal Pradesh.

Table: 2. 2- State wise distribution of the Riverscape area of Chenab River

S. No.	State/UT	Total Geographical Area (km^2)	Per cent Drainage of Total Geographical Area (%)
1	Jammu and Kashmir UT	21,571.03	73.55
2	Himachal Pradesh	7,755.44	26.45
	Total	**29,326.47**	**100.00**

(Source: Micro-watershed Atlas of India; SLUSI)

2.2 Chenab – From its Source to End

Headstream: The Chenab River originates from the Chander Tal and Bara Lacha Pass of Lahaul valley in Lahaul and Spiti district of Himachal Pradesh. Bhaga River, the major tributary of Chandra River originates from Suraj Tal of Lahaul valley in Lahaul and Spiti district. These two rivers join each other at Tandi, 8 km southwest of Keylong in Lahaul and Spiti district. After the confluence at Tandi, it is known as Chandrabhaga or Chenab. The Chenab River enters Pangi valley of Chamba district near Bhujind and leaves the district at Sansari *Nallah* to enter Paddar Valley, Jammu and Kashmir UT. The river is about 453 km long having catchment area of about 29,326 km^2, of which 73.55% area falls in Jammu and Kashmir UT, and 26.45% in Himachal Pradesh. The Chenab River traverses a distance of nearly118 km and 334 km in Himachal Pradesh and Jammu and Kashmir UT, respectively. It is fed by innumerable tributaries from its headwaters *viz.*, Chandra, Bhaga, Saichu *Nallah*, Thirot *Nallah*, Miyar *Nallah*, Bhut *Nallah*, Marusudar River, Kalnai River, Neeru *Nallah*, Lidrari River, Manawar Tawi River, Raggi, Bichleri River, Ans River, Mihari Tawi River,



Chandertal



Surajtal

Nowshera Tawi River, Tawi etc. It gains immense power and momentum on entering Kishtwar region of Jammu and Kashmir UT. From Kishtwar, it flows in south-westerly direction for Doda, through deep gorges along the northern base of the Pir-Panjal Range. Then, it pursues westerly direction towards the fort of Reasi up to Akhnoor. The total length of the river from confluence point to Akhnoor is about 410 km.

Confluence Point: The river enters in Pakistan through Sialkot district, near Dewara village at latitude 32º40´ N and longitude 76º29´ E. From Pakistan border, the river flows in the south-west direction, and is joined by the Jhelum River a little above Trimmu. Nearly 64 km below Trimmu, it is joined by River Ravi. Thus, meandering all along its course in Punjab with other tributaries, it makes a junction with the Sutlej River, the combined rivers are called Punjnad and about 64 km below Punjnad, it meets Indus River at Mithankot (SANDRP, 2013). In the end, Indus River merges into the Arabian sea. The Chenab River, its catchment and major tributaries in the basin are shown in Fig. 2.1.



Confluence of Chandra and Bhaga

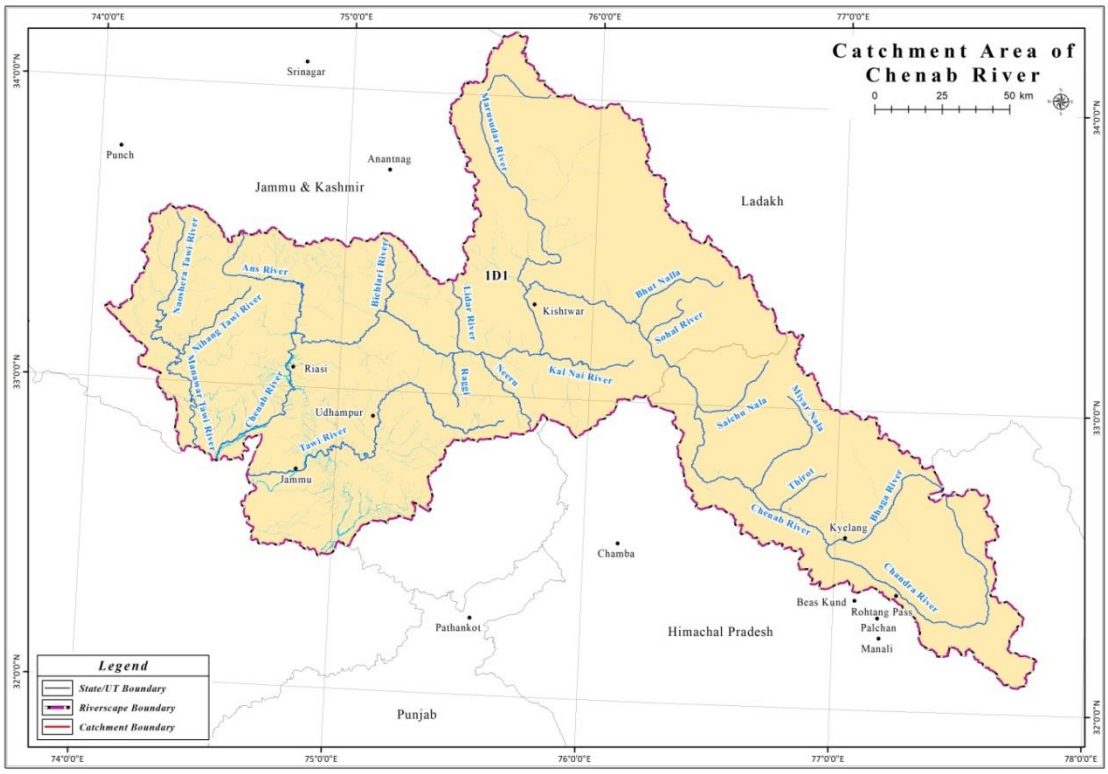


Fig. 2.1 – Chenab Riverscape, its Catchment and Major Tributaries.

Mainstream: In the present DPR, the main stem of the Chenab River and its 17 tributaries have been taken into consideration. Details on length of main stem of Chenab River and selected 17 tributaries in Himachal Pradesh and Jammu and Kashmir UT are presented in Table 2.3.

Table: 2. 3- - - Length of Chenab Main Stem and its Major Tributaries

S. No.	River Name	State/UT	River Length (in km)
Chenab main stem (India)			
1.	Chenab	Jammu and Kashmir	334.60
2.	Chenab	Himachal Pradesh	118.81
			Total length = 453.41
Major tributaries			
1.	Sarchu Nallah	Himachal Pradesh	15.49
2.	Chandra River	Himachal Pradesh	133.71
3.	Bhaga River	Himachal Pradesh	62.14
4.	Thirot Nallah	Himachal Pradesh	24.05
5.	Miyar Nallah	Himachal Pradesh	51.73
6.	Bhut Nallah	Jammu and Kashmir	44.87
7.	Marusudar River	Jammu and Kashmir	145.74
8.	Kalnai River	Jammu and Kashmir	45.48
9.	Neeru River	Jammu and Kashmir	43.00
10.	Lidrari River	Jammu and Kashmir	32.44
11.	Manawar Tawi River	Jammu and Kashmir	64.85
12.	Raggi Nallah	Jammu and Kashmir	26.01
13.	Bichleri River	Jammu and Kashmir	40.89
14.	Ans River	Jammu and Kashmir	81.39
15.	Mihari Tawi River	Jammu and Kashmir	46.97
16.	Tawi River	Jammu and Kashmir	173.13
17.	Nowshera Tawi River	Jammu and Kashmir	84.33
Total Length of Tributaries			**1,116.22**
Total Length of Chenab Main Stem and 17 Tributaries			**1,569.63**

Tributaries:

In the current DPR, following 17 tributaries of Chenab along with the main stem of the river have been taken into consideration.

(a) Sarchu Nallah

The course of the Sarchu *Nallah* has a total length of 15.49 km in Himachal Pradesh. Sarchu *Nallah* originates from the Ladakh region in Leh District. Sarchu (also known as Sir Bhum Chun) is a major halt point with tented accommodation in the Himalaya on the Leh-Manali Highway, on the boundary between Himachal Pradesh and Union Territory of Ladakh. It is situated between Bara Lacha Pass to the south and Lachulung La to the north, at an altitude of 4,290 m.

(b) Chandra River



Chandra River

The Chandra River originates from Chander Tal Lake in Lahaul and Spiti district of Himachal Pradesh. The Chandra initially flowing South-East for about 88 km, sweeps round the base of the mid Himalaya and joins the Bhaga at Tandi, after traversing a total length of about 133.71 km. The Chandra River traverses through the Chandra valley locally known as Tinan in district Lahaul and Spiti of Himachal Pradesh. This valley is sparsely inhabited and mostly represented by barren, eroding mountain slopes with large alluvial flats (Working Plan Lahaul Forest Division, Himachal Pradesh). The entire area is a vast cold desert and human settlements exist between Koksar and Tandi.

(c) Bhaga River

The Bhaga River, the major tributary of Chandra River originates from Suraj Tal, Bara Lacha Pass in Lahaul and Spiti district. The course of the Bhaga River has a total length of 62.14 km in Himachal Pradesh up to the confluence having a steep slope with an average fall of about 24 meters per kilometer. The inhabitation in Bhaga valley begins at Darcha. Bhaga valley is locally known as Stod and Gaar (Working Plan Lahaul Forest Division, Himachal Pradesh). U-shaped valleys, waterfalls, glaciers and moraines characterize the upper catchments of the Bhaga River. The entire tract is devoid of a vegetative cover. The discharge of this river increases during the summer months, when the glaciers and snow on the high mountains starts melting.



Bhaga River

(d) Thirot Nallah

The Thirot *nallah* is a right bank tributary of River Chenab River. It has a total length of 24.05 km.

(e) Miyar Nallah

It is one of the major right bank tributaries of the Chenab River having a total length of 51.73 km. The Miyar *Nallah* rises from Lopen Jot at about 5,100 m



Miyar *Nallah*

amsl. After traversing about 35 km in South-east direction, it takes a big loop and turns South-west. After flowing about 60 km, it joins the Chenab on its right bank at Udaipur in Lahaul and Spiti district of Himachal Pradesh.

(f) Bhut Nallah

It is the first stream that joins the Chenab River after entering into Jammu and Kashmir UT. The Bhut *Nallah* joins Chenab near Gulabgarh in Paddar valley after flowing a total length of 44.87 km. The Bhut *Nallah* is formed by two major streams near Matsel one flowing from North-west and the other from South-east. From Matsel it flows in the direction of South west. After traversing a distance of about 25 km, it joins the Chenab on its right bank downstream of Gulabgarh.

(g) Marusudar River

It is the biggest right bank tributary of the Chenab River having a long course of about 146 km. It originates from Nunkun glacier in Warwan valley from Higher Himalaya and joins Chenab at Bhandalkot. Marusudhar River is also known as Warwan River. It receives water from the four tributaries such as Maru, Rin, Kiar and Sudar. Maru originates from the Nunkun glacier near Lanwi Pass, and is joined by a large tributary Rin Nar near Nowgam. It is also joined by the Chattru *Nallah*. The Maru flows in southwardly direction, and is joined by another tributary known as Sudar.

(h) Kalnai River

The Kalnai River has a total length of 45.48 km. It joins the Chenab River in Doda district of Jammu and Kashmir UT.

(i) Neeru River

The Neeru River has a total length of 43 km and it originates near Bhadarwah. Initially, it flows in north-west direction and joins the Chenab River about 17 km downstream of Thathri near Doda. In this reach, the Neeru takes a few sharp bends and joined by two-three small nallahs.

(j) Lidrari *Nallah*

The Lidrari *nallah* arises from the southern side of the Pir Panjal and joins the Chenab River near Doda. The Lidrari *Nallah* is about 34.31 km long.

(k) Munawar Tawi River

The Munawar Tawi River originates at the Ratan Pir ridge of the Pir Panjal Range and flows through the Rajouri and Nowshera towns of Jammu and Kashmir UT. Its length is about 64.85 km. It is also called Rajouri Tawi and Nowshera Tawi. It joins Chenab River in Pakistan. Large number of smaller tributaries joins Munawar Tawi all along its course. Towards the end of its course, it flows through the plains of the Jammu district west of Akhnoor close to the Line of Control (LoC).

(l) Raggi *Nallah*

The Raggi *nallah* is a tributary of Chenab River and drains a total length of about 26.01 km in Jammu and Kashmir UT.



Silt Diposition in Raggi *Nallah*

(m) Bicheleri River

The Bicheleri River drains as tributary of Chenab River is about 40.89 km in length, in Jammu and Kashmir UT.

(n) Ans River

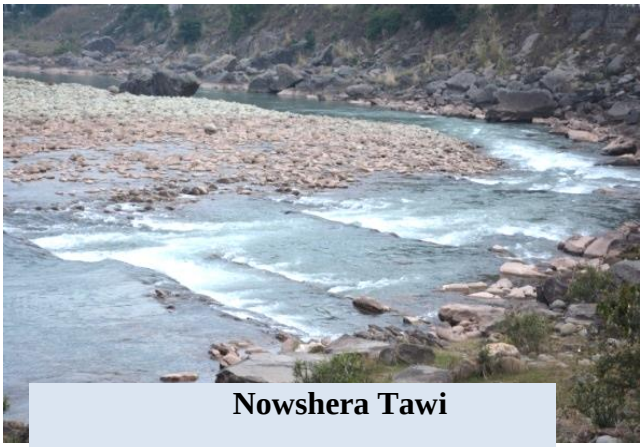
The Ans River 81.39 km, long tributary of the Chenab River (81.39 km). It is formed by two major streams, one flowing from west to east and the other from south to west. Initially, the Ans River flows for a distance of about 20 km and join the Chenab in its right bank, up stream of Salal Hydro-electric Project. Downstream of Ans River confluence, the Chenab River changes its direction and flows in southerly course for about 45 km up to Akhnoor where after it enters into Sialkot district of Pakistan.

(o) Mihari Tawi River

The Mihari Tawi River is a tributary of the Chenab River which drains a total length of about 46.97 km in Jammu and Kashmir UT.

(p) Tawi River

The Tawi River is the main left bank tributary of the Chenab River. It drains a total length of about 173.13 km in Jammu and Kashmir UT with catchment area about 2168 km^2. The Tawi River originates from Kali Kundi glacier at an altitude of 4,420 m amsl. In its upper course, it drains Doda valley that penetrates deep into the East for about 64 km from Chenani. It flows to north westerly direction towards Chenani for about 45 km. In upper part, it collects the water of some small streams. From Chenani, it turns to south-west for a distance of 24 km through a deep valley. Near Udhampur, the river pursues southerly direction. After flowing towards west, the river reaches the town of Jammu and finally joins Chenab River. Tawi is also called as Ark Nandini.



Nowshera Tawi

(q) Nowshera Tawi River

The Nowshera Tawi River is 84.33 km long tributary of the Chenab River in Jammu and Kashmir UT. The Nowshera Tawi is the main river of the district Rajouri, which joins Chenab River at Arnas and Chamb, respectively.

(r) Distributaries and Delta: The snow fed Chenab River finally merges with the Indus River and it has no distributaries. But, the high erosion activity in its catchments definitely contributes to formation of Indus Delta.

2.3 Physical Environment

The environment includes wide ranges of features and factors *viz.,* natural, physical, biophysical and social, etc. under its ambit. Physical environment refers to the different geological, climatic and soil factors which affect the availability of surface-water and ground-water resources. Geologic and soil factors determine the proportion of precipitation which runs off the land as surface water. The geographical extent of the Chenab sub-basin lies between 32°00' to 34°15' N Latitudes and 74°20' to 77°46'E Longitudes of the country. In India, the 49 watersheds of the Chenab sub-basin cover parts of Himachal Pradesh and Jammu and Kashmir UT (CGWB, 2013). Physiographically, Chenab Riverscape is characterized by the uplands, undulating ridges, valleys, gravels, hills, hillocks and rocky outcrops. The Chenab Riverscape exhibits two prominent physiographic and geomorphologic features i.e., the Himalayan Mountainous Zone in the State of Himachal Pradesh and plains in Jammu and Kashmir UT. Both these features affect the characteristics of Chenab River Basin, the riverscape and the river hydrology considerably.

2.3.1 Himalayan Mountains in Himachal Pradesh and Jammu and KashmirUT

Merely 26.45% drainage area of Chenab Riverscape occurs in Greater Himalayan range falling in Himachal Pradesh and nearly 73.55% catchment areas of riverscape covers Inner and Outer Himalayan ranges in Jammu and Kashmir UT. The spatial extent of the riverscape extend between 32^{o}05’ to 34^{o}15’ N Latitudes and 76^{o}13’ to 77^{o}48’ E Longitudes in Himachal Pradesh and 32°26’ to 34°12’ N Latitudes and 74^{o}03’ to 76^{o}46’ E Longitudes in Jammu and Kashmir UT. The nutshell account of the different Himalayan Zones in context with the State of Himachal Pradesh and Jammu and Kashmir UT is given below:

(a) Greater Himalaya

The Greater Himalaya is the highest mountain ranges that run across the north-eastern border of Himachal Pradesh through Lahaul and Spiti and Kinnaur districts. The elevation of the Great Himalaya ranges between 4,500 – 7,000 m amsl. This towering snow-clad mountain wall is a store house of many glaciers and acts as a source of many rivers. It also plays an important role in governing the climatic condition of the region as it acts as a barrier against the northward movement of the southwest monsoon. It forms the northern watershed of the Chenab River basin and separates it from Spiti basin and further east, it forms watershed between Spiti and Beas basins (Marh, 2000). The tract is mountainous and rugged with the inner Himalaya lying on the North and mid Himalaya lying to the south with connecting ranges in east and west except for small opening in the west through which the Chenab River passes. Geologically, the underlying rocks in these mountains consist of micaschist, conglomerates, shale and sandstone. This rock system is fragile and liable to erosion.

Himalayan region owing to distinct ranges variations in their evolutionary origin and wide altitudinal gradient, corresponding to geology, rock and soil types, and varied climatic conditions, largely influenced by glacial, glacio-fluvial and fluvial processes and sediments display a wide range of geomorphic features, ecological characteristics and rich ethnic groups. Greater Himalaya and the Trans Himalaya play a crucial role to the Chenab River Basin and Riverscape due to their structure, geological features, tectonic movements, seismicity, glaciers, snow cover, glacial hazards, hydrology, surface and groundwater resources, water quality, irrigation, hydro-electric projects, vulnerability, etc.

(b) Lesser Himalaya

The Lesser Himalaya or Central Zone can be divided into two zones. The Lower Himalaya towers abruptly from the north with steeper southern facing slopes than northern are characterized by deep gorges and sharp ridges and the Middle Himalaya lying further north are steeper and the peaks remain under permanent snow cover perennially like the Pir-Panjal range. The average elevation ranges from 1,000 – 4,000 m. Pir Panjal forming the southern watershed of the Chenab River in Chamba and Lahaul Spiti districts.

(c) Outer Himalaya

The Outer Himalaya or the Shivalik Hills consists of low hills of Shivalik zone with an elevation of 600 - 1200 m. Shivalik Hills are monoclonal hills dipping with steep scarps facing southward and merging with the small tract of Indus plain which has a general slope towards south-west. They represent the youngest part of the Himalaya, and are prone to erosion. Their morphology comprises of highly dissected and rugged residual terrain, hogback ridges, earth pillars, riled earth buttresses of conglomerate formations, talus cones, divides, terraces, etc. The Chenab Riverscape representing the outer Himalaya mostly falls in Jammu region of Jammu and Kashmir UT.

As mentioned earlier the inherent character, splendor and extensiveness, Himalaya has a considerable impact on the Chenab Riverscape, and it is quite pertinent to take a lead from past studies and available literature to describe the physical environment of Chenab Riverscape.

2.3.2 Glaciers and Snow Cover

Glaciers are huge bodies of snow and ice formed by yearly accumulation of fallen snow (Cuffey and Paterson, 2010). They represent Cryosphere which is comprised of glaciers, ice sheets, ice lakes, snow cover and ground ice (Benn and Evans, 2010). Basically, they are slow moving rivers of snow and ice which flow due to their own mass. Some glaciers are as small as football fields, while others grow to be dozens or even hundreds of kilometres long. Glaciers or snow cover play an important role to maintain the hydrological balance and stream flow sustainability. The glaciers and perpetual snow cover greatly influences the flow regime and dynamics of the Himalayan perennial rivers. Sain, (1946) was the first Scientist to investigate the role of snow, ice and glaciers in a comprehensive assessment of the surface water resources of the Himalaya. The concerns over the sustainability of water resources due

to shifting dynamics of glaciers and associated runoff changes are growing more and more (Immerzeel *et al*., 2010; Kaser *et al*., 2010; Pritchard, 2017). In general, the Himalaya is the largest reservoirs of snow and ice outside the Polar Regions and all the rivers in northern India are nourished by meltwater of the Himalayan glaciers. The high Himalayan terrain holds a great concentration of glaciers and permafrost at elevations more than 3,000 m. The molten water from these cryospheric components supplies a large part of the total river runoff (Bajracharya and Shrestha, 2011; Sharma *et al*., 2016). Kaul (1999) has reported about 8,500 km^2 area of the glaciers in the Indian Himalaya.

Specifically, scientific studies have reported more than 52,000 glaciers in the Hindu Kush Himalaya, which is the origin of ten major river systems of Asia including Indus (Bajracharya and Shrestha, 2011; Miller *et al*., 2012.). There are 989 glaciers covering 2,280 km^2 in the Chenab basin as per the scientific inventorization mentioned in Glaciers of India (Vohra *et al.,* 1970). In total, 2,554 glaciers have been documented in the State of Himachal Pradesh. Altogether, they cover an area of 4,160.5 km^2 and hold ice reserves of 387.3 km^3scientific reports also illustrates 200 glaciers in the Chenab River basin in Lahaul & Spiti District of Himachal Pradesh. Some of these are worth mentioning in context with the Chenab Riverscape and described below.

(a) Bara Shigri Glacier

Bara Shigri is the largest glacier located within the boundaries of Himachal Pradesh. It is also the second largest Himalayan glacier after Gangotri. The glacier is located in the Chandra Valley of Lahaul and Spiti district and feeds the Chenab River. The term Bara Shigri literally means a big glacier in local language of Lahaul. It is about 3 km wide and 25 km long, and lies between 3,950 - 4,570 m.

(b) Chhota Shigri Glacier

It is a valley type glacier located in the Chenab River basin on the Northern ridge of the Pir-Panjal Range in the Lahaul and Spiti district of Himachal Pradesh. It lies between 32°11’ to 32°17’N Latitudes and 77°30’ to 77°32’E Longitudes and extends in the altitudinal range of 4,000 to >5,600 m. Chhota Shigri Glacier is 9 km long and its width varies from 0.5 to 1.5 km. The Chhota Shigri Glacier drains into the Chandra River. The total drainage area of the Chhota Shigri Glacier basin is about 45 km^2 and the glacier occupies about 20 % of the drainage area (Vohra *et al.,* 1970). Chhota Shigri lies on northern slopes of the main ridge of Pir-Panjal Range of Inner Himalaya, just across Bara Shigri. As the name suggest, it is comparatively smaller glacier than Bara Shigri. It does not reach down to the bed of Chenab but, it is much steeper, slippery and difficult to cross.

(c) Samudra Tapu

The Samundra Tapu Glacier is another large glacier in the upper Chandra basin after the Bara Shigri glacier. The snout of glacier is located at 32°30’ N Latitude and 77°32’ E Longitude, at an altitude of 4,200 m about 10 km SW of Chander Tal Lake.

(d) Chandra Glacier

It is located on the slopes of the main Himalayan ranges in the Lahaul and Spiti district. It is responsible for the formation of Chader Tal Lake and was originally part of the Bara Shingri glacier and feeds Chandra River.

(e) Bhaga Glacier

It lies in the main Himalayan range in Lahaul and Spiti district. It is the source of Bhaga River which later merges with Chandra River.

(f) Sonapani Glacier

The glacier is located in the Chandra valley of Himachal Pradesh. It is about 11 km long. The dried Glacier Lake and the old terminal moraine are noticeable from the Rohtang Pass. The dried lake, about 2.5 km in length, is a narrow meandering plain following the contours of bounding slopes and contains such fluvial-glacial deposits as mud, fine sand, pebbles and angular gravels, through which the glacier stream runs.

(g) Mukila and Miyar Glaciers

Mukila and Miyar glaciers lie in Lahaul valley of Lahaul and Spiti district. They are about 12 km in length and feed Bhaga and Miyar Rivers, respectively.

(h) Gangstang Glacier

The Gangstang glacier is located at the western border of the Lahaul region at an altitude of about 5,480 m streaming into Shahsha *Nallah* which joins the Chandra Bhaga River at about 13 km to the south.

(i) Nun-Barashigri Glacier

The southern flank of the Nun-Barashigri range forms the northern portion of the Chenab River basin, north and east of Kishtwar. It is one of the most highly glacierized areas of the Indian Himalaya (Fig. 2.2).

Snow Cover

Snow is a type of precipitation in the form of crystalline ice, consisting of a magnitude of snowflakes that fall from clouds. The process of this precipitation is called snowfall. There are three major classes of snow cover i.e., temporary, seasonal and permanent. Temporary and seasonal snow cover occurs in winters while permanent snow cover is retained for many years. Snow is an essential resource present in the Himalaya. Therefore, monitoring of snowfall changes over a time period is important for hydrological and climatological purposes. Many studies have been carried out in the past to assess the total area under snow cover in Chenab River Basin. Snow cover area of the Chenab River Basin was evaluated between the period October 1982 to September 1992, which discloses maximum snow cover in March/April i.e., 70%, and only 24.3% remains covered by perpetual snow and glaciers in September/October (Kour *et al.*, 2016). Singh *et al.*, (1997) has also investigated the behaviour of snow distribution with elevation in the Chenab River Basin. Himachal Pradesh State Centre on Climate Change (HPSCCC) has also assessed the snow cover area of Chenab

River Basin during the years 2017-18 and 2018-19. Table 2.4 and Fig. 2.3 provide illustrative insight of this study.

Table: 2. 4- Area under Snow in Chenab River Basin during 2017-18 and 2018-19

Observation Month	Area under Snow (Monthly Average) (2017-18) km^2	Area under Snow (km^2) 2018-19	Area under snow cover (% change)
October	2,121.00	6,007.65	183.2
November	5,377.32	7,800.24	45.1
December	6,339.70	7,440.82	17.4
January	7,679.00	8,001.01	4.2
February	7,988.40	8,567.05	7.2
March	8,111.00	8,548.59	5.3

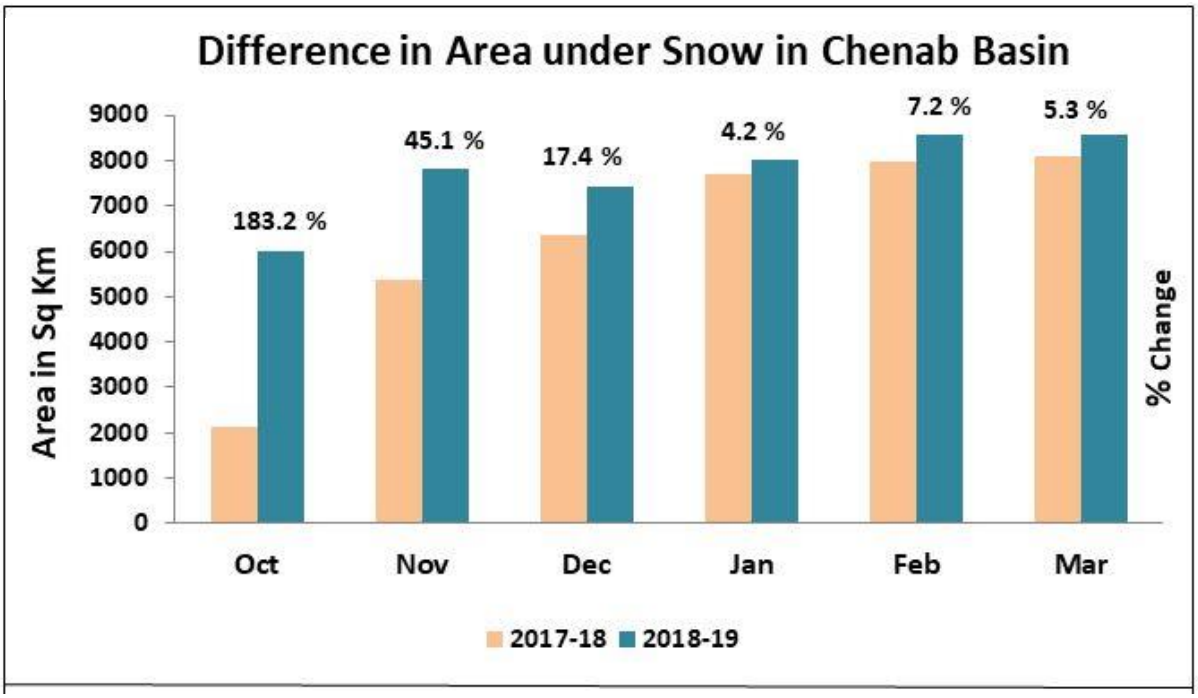


Fig. 2.2- Difference in Area under Snow in Chenab River Basin

(Source: HPSCCC, 2019)

Glacial Hazards

Glacial lake outburst floods (GLOFs) are a serious and potentially increasing threat to livelihoods and infrastructure in most high mountain regions of the world. GLOFs refer to the sudden discharge of a water reservoir that has formed either underneath, at the side, in front, within, or on the surface of a glacier, and related dam structures can be composed of ice, moraine, or bedrock. GLOFs can be produced by water reservoirs existing in front, or at the surface, base, or margins of glaciers. These floods can cause extensive damage to the natural environment and human property as they can drain extremely rapidly and small lakes can cause dramatic floods (Govindha Raj, 2010). In the Indian Himalayan region, the first glacial

lake outburst flood occurred in the year 1926 when flood caused by the Shyok glacier in Jammu and Kashmir UT destroyed Abudan village and the surrounding land which were at a distance of 400 km from the burst site (Basu Soma, 2015). Therefore, in Himalaya, as elsewhere in the world, considerable focus has been on flood hazards associated with the catastrophic failure of moraine dammed lakes (Vuichard and Zimmermann 1987; Richardson and Reynolds 2000; Liu *et al.*, 2013; Allen *et al.*, 2015). The glaciated regions of Chenab River in Himachal Pradesh falls between 31°00' to 38°00' N Latitudes and from 76°00’ to 78°00' E Longitudes. The Chenab River is one of the major rivers in the Indus system. The shape of the Chenab sub-basin is elongated and the gradient is very steep at upper region and eventually decreases in the lower part of the region. The total number of glacial lakes and water bodies present in the Chenab River Basin are 168 which 33 are glacial lakes and 135 are water bodies. The State/UT wise glacial lakes and water bodies are presented in Table 2.5. The density of glacial lakes is more at the north and southeast sides of the basin (Fig. 2.4).

Table: 2. 5- State and Union Territory wise Glacial Lakes and Water Bodies in Chenab Riverscape

State/UT	Type	Number
Himachal Pradesh	Glacial Lakes	20
	Water Bodies	52
Jammu and Kashmir UT	Glacial Lakes	13
	Water Bodies	83
Total Number		**168**

Both Himachal Pradesh and Jammu and Kashmir UT are surrounded by about 200 potentially dangerous glacial lakes formed by glacial melt. Randhawa *et al.* (2005) studied the moraine dammed glacial lakes in Chenab River Basin. Based on the minimum and maximum extent of area (in hectares) occupied by the glacier lakes and water bodies, the Chenab River Basin have been classified into five categories *viz*., 0-0.5ha, 0.5-1ha, 1-2ha, 2-5ha, and >5ha. Most of the water bodies in Chenab River Basin are under 0-0.5 ha category (Table 2.6).

Table: 2. 6- Extent of area (in hectares) occupied by the Glacial Lakes and Water Bodies in the Chenab River Basin

Area (ha)	No. of Glacial Lakes	No. of Water Bodies
0-0.5	9	63
0.5-1	9	27
1-2	4	13
2-5	2	9
>5	8	15

Vulnerability

The concept of vulnerability has recently emerged as a key topic in the field of climate change science. There exist large variations of interpretation of vulnerability in different contexts. The ‘vulnerability’ of any system to ongoing environmental variability and future

environmental changes depend on the level of anticipated and unanticipated risks. The assessment of vulnerability of natural systems constitutes significant part of the management plans. The vulnerability of the geologically young and fragile Himalayan ranges has been increasing rapidly due to inappropriate human activity like deforestation, road cutting, terracing and changes in agriculture crops, etc. The hills and mountains of Himachal Pradesh are liable to landslides during monsoons. Various forms of landslides are slumps, debris or rock slides, debris falls or rock falls. Various factors like steepness of slopes, melting snow, rocks vibrations, excess load from embankments, fills and waste dumps, changes in water content, weathering of rocks, effect of ground water, and change in vegetal cover cause the landslides. The higher hills comprising the districts of Lahaul and Spiti and Chamba are vulnerable to the hazards of avalanches. Himalaya being a nascent mountain range is still rising and vulnerable to earthquake due to movement of tectonic plates. The whole area of Himachal Pradesh falls into two earthquake zones *viz*., Zone IV and Zone V and Chenab Riverscape lies in seismic zone IV (Kaur *et al*., 2015). Similarly, the Kisthwar, Doda, Bhadarwah belt in Jammu and Kashmir UT is vulnerable to earthquakes due its geological and tectonic setting. As the topography of Chenab River Basin is predominantly mountainous with fragile slopes and high tectonic activity and course of Chenab River is through the fault zones. Therefore, the development of hydropower projects in the basin is also a source of rise in the vulnerability.

2.3.3 Hydrology–Surface and Groundwater Resources, Sedimentation, Environmental Flows and Water Quality

Hydrology is the science of water occurrence, movement and transport in nature. It deals with hydrological process such as evapo-transpiration, snowpack, surface runoff, base flow, rainfall, flood and runoff, drought, groundwater occurrences, etc. On the application side, hydrology provides basic equations, algorithms, procedures, and modelling of these events for the practical use. Hydrological modeling is a better tool to gain an understanding of the dynamics of hydrological systems, importantly the drivers of the river discharge. Studies indicate that elevation dependency of temperature and precipitation greatly affects the perennial water storage and river flow (Giorgi, 1997). The Chenab River is one of the major tributary of Indus River Basin which originates from the snow covered slopes of Great Himalaya in district Lahaul and Spiti and a large portion of upper Chenab River Basin remains under snow cover for long periods of the year. Temperature and precipitation over mountainous regions vary in accordance with the elevation, which also have large impact on snow accumulation and ablation processes. Like other Himalayan Rivers, the river flow of Chenab River is greatly affected by glacial melt, snow melt and rainfall (Zhang *et al.*, 2013). Hydrological data about the river flow, river water level and discharge are the most important and of immense use as it provides baseline data in planning, design, and operation of water projects, and are also used in designing of bridges and culverts, flood forecasting systems, flood plain delineation, and water resource management (Jain *et al.*, 2007).

Annual Flows Characteristics of the Chenab River and Water Balance

Scientific studies conducted in the past have revealed the spatial and seasonal variations in precipitation of Chenab River and its different sub-catchments. The upper catchments falling in the Greater Himalaya experiences more than 75% precipitation in the form of snowfall during winters. In Middle Himalaya, about 65% precipitation occurs in pre-monsoon and monsoon periods and about 26% in winter. In Outer Himalaya, about 36% precipitation occurs in winter and forms a major source of contribution to river flow during winter season in the form of seasonal winter rains. Generally, the catchment areas where elevation is > 4500 m, glaciers and snow-melt have major contributions to flows, whereas downstream areas representing the western side of catchment with elevations < 1500 m, have high contributions to flows in the form of heavy monsoon rainfalls. Bookhagen and Burbank (2010) reported 43% melt water contribution to annual discharge of Chenab River. Snowmelt runoff starts contributing to river flows in the mid or late summer season, while during monsoon season, the flow is further enhanced by monsoon rains producing higher discharges and occasional peak floods. Due to combination of rain and snow and glacier melt runoff, about 84% of annual river flows occur in pre-monsoon and monsoon seasons (i.e., April–September), particularly in the months of June-September (Singh *et al.*, 1995).

The hydrologic modeling is an important tool for the investigation of hydrological response of a river flow regime and catchment characteristics. Shahid *et al.* (2014) has developed and evaluated a hydrologic model for predicting flows of Chenab River based on rainfall data. The model was calibrated and validated for summer/rainy months (June-September) for 2006 and 2007, respectively. There was found consistency between simulated and observed flows with percent difference in volume to be 5.49% and 6.61% for calibration and validation periods, respectively.

Water Use of Chenab River Basin

Directorate of Energy, Government of Himachal Pradesh has assessed the total potential of Chenab River Basin as 3,510.95 MW as per CEIAS study undertaken by RS Environlink Technologies Pvt. Ltd. (RSET, 2019). Three Hydro Electric Projects (HEPs) are located on Chandra River, one on Bhaga, six on Chenab River, two on Miyar *Nallah*, three on Saichu *Nallah* and one on Lujai *Nallah* which also is a right bank tributary of Chenab River. HIMURJA, Himachal Pradesh Energy Development Agency has identified 21 Small HEPs (less than or equal to 5 MW) on various tributaries of the Chenab River. Equally, Chenab River has been extensively harnessed for hydro-power development in Jammu and Kashmir UT by constructing Hydro projects *viz.*, Salal, Dul Hasti, and Baglihar. About 16% of the area under Chenab River Basin in Jammu and Kashmir UT is sown mostly with wheat, maize, rice, onion, fruits, vegetables and beans. The area in Chenab River Basin in Jammu region is mostly irrigated by gravity canals. In Jammu district, land is generally flat and two major canal systems *viz.*, Ranbir Canal and Pratap Canal were constructed way back during 1903-04 to irrigate vast track of land on either side of river. Similarly, many medium irrigation schemes and canals have been constructed on Chenab River and its tributaries in Doda, Udhampur and Rajouri districts.

Ground Water Availability

Water is a most valuable resource to human and living things covering almost three quarters of earth's surface. According to Nace (1971), 94% of earth's water exists in the oceans and seas, 2% are stored in icecaps and glaciers and 4% is reserved as groundwater. Groundwater is a valuable resource that needs to be used sustainably in order to meet the growing demands in domestic, agricultural, and industrial sectors (Gupta and Deshpande, 2004; Kumar *et al*., 2005). It is estimated that approximately one third of the world's population use groundwater for drinking (Nickson *et al*., 2005). The groundwater resources have two components, *viz*., static and dynamic. The static component is represented by fresh reserves called aquifers. Central Ground Water Board (CGWB), the apex organization under the Jal Shakti Mantralaya, Government of India, monitors the behavior of the ground water regime through a network of ground water monitoring wells spread across the country. In case of Chenab River Basin, snowfall/rainfall is the major source of groundwater recharge apart from the influent seepage from the rivers and irrigated fields in upland areas. The deep, narrow and isolated valley areas have discontinuous aquifer system (CGWB, 2013).

In the plain areas, the ground water occurs in piedmont deposits. These deposits comprised of unconsolidated sediments in the form of terraces and coalescent alluvial fans developed by the streams debauching out of Shiwalik Hills (Ground Water Year Book, 2016-17).

Environmental Flows

The 'Environmental Flows' or (e-flow) defines the quality and quantity of water flows required to sustain freshwater ecosystems like rivers for the human well-being and livelihoods (Arthington, 2012). Iyer (2005) suggested that environmental flow imply allocating water for different uses and for nature as well. An environmental flow describes water regime within a river to maintain the ecosystems. It is critical to river health and ecological balance. The failure to meet environmental flow requirements has disastrous consequences for many users of the river water (Dyson *et al.*, 2008).

Undoubtedly, rivers are the most important freshwater sources supporting diverse organisms and ecosystems. A river is the only ecosystem that connects different ecosystems on its way like glaciers, forests, riparian zones, flood plains, mangroves, etc. Besides, it carries water, transports dissolved minerals, sediments and nutrients to maximum places. Flowing rivers also create flood plains, sand deposits, deltas, etc. Rivers while draining the land carry out groundwater recharge by percolating into deeper aquifers. The various ecological functions of rivers are driven by e-flows and depend on the frequency of flows (Table 2.7).

Table: 2. 7- Ecological Functions of Different River flow levels

Low (base) flows	**Normal Level** • Provide adequate habitat space for aquatic animals. • Maintain suitable water temperature, dissolved oxygen and water chemistry. • Maintain water table levels in the floodplains and soil moisture for plants. • Provide drinking water for terrestrial animals. • Keep fish and amphibians eggs suspended. • Enable fish to move to breeding and spawning areas. • Support hyporheic organism (those living in saturated sediments. **Drought level** • Enables recruitments of floodplains plants. • Purge invasive introduced species from aquatic and riparian communities. • Concentrate prey into limited areas to benefit predators.
High Pulse flows	• Shape physical charter of river channel, including pools and riffles. • Determine size of stream bed substrates (i.e., sand, gravel and cobble). • Prevent riparian vegetation from encroaching into channels. • Restore normal water quality conditions after prolonged low flows, flushing away waste products and pollutants. • Aerate eggs in spawning gravels and prevent siltation. • Maintain suitable salinity conditions in estuaries.
Large floods	• Provide migration and spawning cues for fish. • Trigger new phase in life cycle (e.g., in insects). • Enables fish to spawn on floodplains, provides nursery area for juvenile fish. • Provide new feeding opportunities for fish and waterfowl. • Recharge floodplains water table. • Maintain diversity in floodplains forest types through prolonged inundation (different plant species have different tolerances). • Control distribution and abundance of plants on floodplains. • Deposit nutrients on flood plains. • Maintain balance of species in aquatic and riparian communities. • Create sites for recruitment of colonizing plants. • Shape physical habitats of floodplains. • Deposit gravels and cobbles in spawning areas. • Flush organic materials (flood) and woody debris (habitat structures) into channel. • Purge invasive introduced species from aquatic and riparian communities. • Disburse seeds and fruits of riparian plants. • Drive lateral movement of river channel, forming new habitats (secondary channel and oxbow lakes). • Provide plant seedlings with prolonged access to soil moisture.

(Source: Postel and Richter, 2003)

A flowing river is a beautiful natural entity on earth and the flows of different frequency are important for channel maintenance, bird breeding, algae control, wetland flooding and maintenance of riparian vegetation, cycling of organic matter, fish migration, fish spawning, water quality maintenance, etc. Reckless damming and diversion of river water for human benefits alter the e-flows and affect the ecology and aquatic biodiversity adversely by hampering important ecological processes. Alteration in the natural flow of river modifies channel and floodplain habitats, desynchronize the reproductive cycle of aquatic species, breaks the lateral and longitudinal hydraulic connectivity and favours the invasion of exotic and introduced species in river systems and (Richter and Thomas, 2007. Over and above, it plays havoc with riverine and riparian ecosystems. It is obvious that, out of all human interventions, dams have direct and often irreversible impacts on river flows. Globally, over half of the large river systems are affected by dams. India, is third largest dam builder in the world, has >5,000 dams. Environmental flows estimation has been recently introduced in the purview of Cumulative Impact Assessment (CIA) of hydro-electric projects in India. More than 200 methodologies have been developed across the world for the assessment of e-flows. The Expert Appraisal Committee (EAC), Ministry of Environment, Forest and Climate Change, Government of India (GoI) has accepted the Building Block Methodology (BBM) as a preferred methodology for prescribing e-flows. According to the current norm adopted by the EAC, the minimum continuous release from the barrage as environmental flow during the lean season will be 20% of the 90% dependable flow. During other seasons, the release is to be higher and during monsoon season, the release is to be 30% of the 90% dependable flow (Anantha and Dandekar, 2012).

In fact, it is a challenge to arrive at a uniform standard flow regime as flow is based on the climatic, hydrological and ecological peculiarities of river basin e.g., Himalayan Rivers like Chenab is ecologically and hydrologically different river system. It has larger flows during summer when the snow melts. Apart from the big projects on the main stem of the river, there are several mini and micro hydro-electric projects which are planned on the tributaries. Assessment of effect of changed flow regime on river bank, river bed ecology and establishment of environmental flows has become a critical constraint in development of Hydro Electric Projects. Release of environmental flow is to be confirmed immediately downstream of the diversion structure at all times to sustain the ecology and environment of project area. RSET (2019) provides consolidated environment flow release recommendations for the 20 hydro-electric projects (HEPs) in Chenab River Basin with installed capacity of 25MW or higher in terms of percentages of average values of corresponding period based on 10 daily discharge series of 90% dependable year (DY) (Table 2.8).

Table: 2. 8- Project-wise Environment flows release recommendations in Chenab River Basin

Project	Average discharge (%) of low flow period in 90% DY	Average discharge (%) of high flow period in 90% DY	Average discharge (%) of intermediate period in 90% DY
Chhatru	25	20	25
Shagling	25	15	20
Teling	20	20	20
Tandi	20	20	20
Rashil	20	20	20
Bardang	20	20	20
Seli	15	20	20
Reoli Dugli	25	20	25
Purthi	Environment flow released from Reoli Dugli along with contribution of intermediate catchment and 20% untapped release from Reoli Dugli tailrace at all the time.		
Sach Khas	25	20	25
Dugar	15	20	25
Miyar	25	20	15
Tinget	20	20	20
Patam	20	20	20
Gyspa	30	20	25
Stingiri	25	20	25
Chiroti Saichu	20	30	25
Saichu	20	30	25
Saichu Sach Khas	20	30	25
Lujai	20	30	25

(Source: RSET, 2019)

Hon'ble High Court, Himachal Pradesh has a directive in place for all dams to release 15% of mean flow of the respective rivers downstream at all times as minimum flows. Article 51A (g) of Indian Constitution imposes obligation on State and individual to protect and improve terrestrial and aquatic environments. Acts like The Water (Prevention and Control of Pollution) Act, 1974, The Wildlife (Protection) Act, 1972, The Forest Conservation Act, 1980 and the Environment Protection Act, 1986 can also be used effectively to demand for e-flows in the river (Anantha and Dandeka, 2012).

Erosion Process

The river or stream erosion is the detachment of material from the sides of channel or river bed. Flowing water of a river or stream erodes land resources from the sides of the channel; transports the eroded material to a new location, and then deposits it. Material deposited by streams is called alluvium. This geologic action of the river or stream is a function of its velocity and discharge. Erosion and deposition are important processes of a river/stream and it completes its geo-morphologic cycle from young, mature to old age. Erosion takes place in upstream and deposition in downstream (Survey Document, Government of Himachal Pradesh). Globally, rates of soil loss are increasing owing to natural and anthropogenic

factors, which have important economic implications relating to on-site loss of soil productivity and to the off-site, downstream impact of mobilized sediments (Walling and Webb, 1996). In India, about 5,334 Mt of soil is removed and carried away by the rivers into the sea and 10% is deposited in reservoirs resulting in the considerable loss of the water storage capacity (Narayan and Babu, 1983).

Mountainous region of the Himalaya are characterized by a high rate of denudation (Shroder, 1993) and with river systems like Chenab acts as the export mechanisms for sediments. The large quantity of sediment produced and transported downstream creates a number of major water resources management problems such as siltation of reservoirs, damage to turbines, reduction in quality of water supplies, and transport of chemical pollutants (Johnson *et al.*, 1998). The part of Chenab River falling in Jammu and Kashmir UT is covered by brown hill and sub-montane soils in Doda district, mountain meadows in Udhampur district while in Jammu district, it is covered by brown hill and alluvial soils. The soils of the high Himalaya in the north are subject to continuous erosion and a thick silt sediment layers are deposited to form a wide valley plain. The entire tract of Chenab River, Shiwalik region is a rugged terrain with steep slopes. The soil erosion is severe and water shortage is common. The slope in most of the compartments is > 20% and gully formation is prominent.



Landslidenear Doda(J&K UT)

Sediment Transport and Sediment Budget

There is a serious problem of soil erosion and sedimentation in river reaches downstream in the young Himalayan regions. The natural rates of denudation in Himalaya have also been reportedly high (Rawat and Rawat, 1994). The steep slopes in the Himalaya and high seismicity have been major factors in soil erosion and sedimentation in river reaches (Varsheney *et al.*, 1986). The suspended sediment load of a river exerts a key impact on its aquatic ecology, its morphology and the exploitation of its water resources. The river gradient is very steep at its source and gradually reduces downstream. The Chenab River has the

general character of terrain with a gradient of 10m/km in the higher reaches and 3 – 4m/km in the lower reaches (Rao *et al*., 1997). The sedimentation transport of Chenab River is governed by precipitation, run off characteristics, geology, landuse and soils, etc. The Central Water Commission has been collecting sediment related data in the Chenab River Basin, since 1967. Sediment yield characteristic in the Chenab River Basin depends on the season. During the winter season (i.e., October-March) the sediment yield is minimal, and is <5-10% of the annual yield. During premonsoon season (i.e., April-June) the seasonal snow cover melts in the intermediate and upper reaches. During this period, the lower reaches receive rain and the intermediate reaches experience rain and snow causing occasional floods. The sediment yield during the premonsoon is significant. During the monsoon season (i.e., July-September) rainfall contribution to flows is very high in the lower reaches and gradually tapers at elevations of about 4,000 m (Singh *et al.,* 1995).

Air temperatures are also at their highest during the season resulting in snow and glacier melts from permanent snow covered zones. Consequently, a major part of the sediment yield is received during the monsoon season. Average sediment yields for annual and monsoon season periods in terms of coarse medium and fine sediments are given in Table 2.9.

Table: 2.9- Average sediment yield (t/km^2) in the Chenab River Basin and their composition during the Monsoon period (July- September)

Site	No. of years	Annual average (t/km^2)	Monsoon			Total
			Coarse	Medium	Fine	
Akhnoor	24	1,029	85.9	180.8	455.9	722.7
Benzwar	23	1,597	169.6	360.9	694.5	1225.0
Dhamkund	27	1,900	314.3	386.4	533.5	1234.3
Ghoshal	17	513	69.7	90.3	221.2	381.3
Kuriya	20	878	138.9	152.4	300.9	592.3
Premnagar	27	1,363	102.9	112.9	222.9	438.7
Sirshi	27	939	146.7	186.6	221.4	554.8
Tandi	18	371	51.3	70.6	164.0	286.0
Tillar	20	373	40.7	62.2	92.4	195.4

The precipitation and runoff characteristics in the Chenab River Basin influence sediment yield to a large extent. Snow melt glacier contribution increases with elevation, while rainfall decreases with elevation in the upper reaches (Rao *et al*., 1996; Singh and Jain, 1993). Consequently, rainfall has little to do with the sediment yield in the upper reaches of Chenab catchment. Besides this, construction of dams on the Chenab River also affects the sediment transport.

Water Quality

The term ‘Water quality’ indicates the suitability of water for various uses or processes. It expresses the physical, chemical and biological characteristics of water. Water quality is affected by a wide range of natural and human influences. The most important natural influences are geological, hydrological and climatic. Although the natural ecosystem is in

harmony with natural water quality, any significant changes to water quality will usually be disruptive to the ecosystem. There is increasing recognition that natural ecosystems have a legitimate place in the consideration of options for water quality management (Meybeck *et al.*, 1996).

In India, the Central Water Commission (CWC) monitors water quality of all the major river basins by maintaining a three tier laboratory system for analysis of 41 water quality parameters. The Level-II Laboratories under Chenab Division, CWC, and Jammu monitors physical and chemical parameters on a monthly basis at sites *viz*., Tandi, Udaipur, Premnagar, Dhamkund, Akhnoor, Jammu and Benzoor (Table 2.10 and 2.11).

Table: 2. 10- Water quality data at Tandi

Parameter	Unit	Analysis of Data from 1999-2000 to 2008-09 (10 Yrs)					
		Maximum Observed		Average		Minimum Observed	
		Monsoon	Non-monsoon	Monsoon	Non-monsoon	Monsoon	Non-monsoon
Q	(Cu.)	198	61	120.7	29.17	89	13
Physical							
pH		7.7	7.8	7.53	7.08	7.1	6.3
Electric Conductivity	mho/c.m	214	256	141.2	162.76	96	109
Temperature	mg/l	17.1	16	7.36	2.03	4	4.7
Chemical							
Boron	mg/l	0.62	0.07	0.32	0.33	0.01	0
Calcium	mg/l	42	33	30.4	24.4	20	12
Magnesium	mg/l	9.8	13.5	8.34	7.82	7.3	3.4
Chloride	mg/l	17.4	13.7	7.39	5.48	2	2
Carbonate	mg/l	0	0	0	0	0	0
Bicarbonate	mg/l	125	90	85.4	69.1	57	32
Sodium	mg/l	3.5	3.9	2.7	2.13	1.9	12
Potassium	mg/l	1.8	1.5	1.55	0.77	1.3	0.2
Fluoride	mg/l	0.27	0.36	0.27	0.09	0.27	0
Iron	mg/l	1.4	0.2	0.85	0.15	0.3	0.1
NO_2+NO_3	(MgN/L)	0.19	0.03	0.0625	0.018	0.01	0.01
Ammonia	N(mg N/L)	0.04	0.04	0.014	0.024	0	0.01
Total –P	Mg/l	0.06	0.186	0.0295	0.071	0.015	0.034
Nitrite	N(mg N/l)	0.01	0	0.01	--	0.01	0
Nitrate	N(mg N/l)	0.73	0.36	0.5	0.36	0.27	0.36
Phosphate	mg/l	0.066	0.075	0.066	0.075	0.066	0.075
Silicate	mg/l	28.6	3.4	15.65	1.95	2.7	0.5
Sulphate	mg/l	65	35.6	39.225	24.45	29.2	14.8
Turbidity	NTU	2.5	5.6	1.275	1.94	0.7	0.3
Manganese	mg/l	0	0	0	0	0	0
COD	mg/l						
BOD	mg/l						
D.O.	mg/l	7.8	8.3	6.1	6.775	4.3	4.9
Biological/ Bacteriological							
Total Coliform	MPN/100ml	-	-	-	-	-	-
Fecal Coliform	MPN/100ml	-	-	-	-	-	-
Pesticides	-	-	-	-	-	-	-
DOT	ppb		169.57		169.57		169.57
Endosultan	ppb	-	-	-	-	-	-
TOC		1.309		1.309	1.28	1.309	1.28

(Source: www.indiawaterportal.org)

Table: 2. 11- Water quality data at Akhnoor

Parameter	Unit	Anlaysis of Data from 1999-2000 to 2008-09 (10 Yrs)					
		Maximum Observed		Average		Minimum Observed	
		Monsoon	Non-monsoon	Monsoon	Non-monsoon	Monsoon	Non-monsoon
Q	(Cu.)	1790	964	1160	411.4	527	131
Physical							
pH		8.10	8.70	7.90	7.90	7.60	7.40
Elec. Conduc.	mho/c.m	232.00	265.00	164.45	180.22	110.00	106.00
Temp.	mg/l	23.50	20.90	17.53	13.13	12.00	8.80
Chemical							
Boron	mg/l	0.42	0.29	0.22	0.07	0.01	0.02
Calcium	mg/l	43.00	58.00	30.40	32.00	20.00	21.00
Magnesium	mg/l	10.80	14.20	8.68	8.13	7.20	2.70
Chloride	mg/l	17.20	15.90	7.87	8.55	2.0	2.50
Carbonate	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
Bicarbonate	mg/l	118.00	157.00	85.40	88.13	57.00	48.00
Sodium	mg/l	3.10	8.10	2.55	3.68	2.00	1.60
Potassium	mg/l	2.70	3.00	2.45	1.49	2.20	0.30
Fluoride	mg/l	0.22	0.31	0.22	0.11	0.22	0.00
Iron	mg/l	1.10	0.40	0.77	0.14	0.40	0.00
NO_2+NO_3	(MgN/L)	0.21	0.22	0.07	0.08	0.02	0.02
Ammonia	N(mg N/L)	0.53	0.18	0.11	0.04	0.00	0.00
Total –P	Mg/l	0.05	0.24	0.04	0.06	0.02	0.02
Nitrite	N(mg N/l)	0.01	0.01	0.01	0.01	0.01	0.00
Nitrate	N(mg N/l)	0.77	0.86	0.27	0.36	0.01	0.05
Phosphate	mg/l	0.09	0.08	0.08	0.04	0.04	0.01
Silicate	mg/l	61.30	46.60	32.20	18.03	3.10	0.60
Sulphate	mg/l	36.70	37.70	28.50	26.15	19.10	19.60
Turbidity	NTU	5.60	4.30	2.08	1.37	0.40	0.30
Manganese	mg/l	0.44	0.06	0.22	0.01	0.00	0.00
COD	mg/l	21.80	34.20	12.03	13.13	7.80	5.90
BOD	mg/l	2.50	2.50	1.00	1.16	0.50	0.60
D.O.	mg/l	10.60	11.30	8.98	9.79	5.00	8.40
Biological/ Bacteriological							
Total Coliform	MPN/100 ml	3.00		3.00		3.00	0.00
Fecal Coliform	MPN/100 ml	0.00				0.00	0.00
Pesticides							
DDT	Ppb		143.03			0.00	143.03

(Source: www.indiawaterportal.org)

The Water Quality Index (WQI) of Chenab River has also been assessed scientifically. In general, WQI varies from 80 to 93 which specify that water quality is good to excellent. At number of sampling sites, WQI was > 90 most of time representing excellent water quality (Fotedar *et al.*, 2010). The analysis of water quality showed pH 8.2. Alkalinity is in the range of 40 to 64 mg/L. Total solid ranged between 66 to 84 mg/L, total hardness ranged between

88 to 104 mg/L, and chloride ranged between 6 to 14 mg/L. Sulphate, nitrate and phosphate contents were found in the range of 34 to 36, 6 to 8 and 0.16 to 0.29 mg/L. Sodium and potassium of water ranged between 1.8 to 4.1 and 1.7 to 2.2 mg/L, respectively. Cloudiness ranged between 27 to 178 NTU (Nephrological Turbidity Unit). Cloudiness is followed to be higher as the river flow is fast and higher rate of weathering in the catchment area due to steep incline (Khadse *et al.,* 2016). Turbidity values of Chenab River water ranged between 6.1to8.2 units. The higher values of turbidity can be linked to high index of weathering.

Water Quality Assessment

The aquatic biological communities act as bio-indicators of assessment of stream or river water quality. The use of biological communities for the assessment of water quality is widely accepted. It is relatively inexpensive, and provides reliable results as it reflects the cumulative effect of different stressors (Georgudaki *et al*., 2003).

Macro-invertebrates are one of the indicators of water quality of freshwater streams. In biological assessment of water quality, various Biotic indices *viz*., The Biological Monitoring Working Party (BMWP) score, the Average Score Per Taxa (ASPT), the Lincoln Quality Index, the Iberian BMWP, and the Iberian ASPT are commonly used to assess the quality of surface waters. RSET (2019) during the CEIA studies has assessed the water quality of Chenab River during pre-monsoon, monsoon and post monsoon seasons by calculating BMWP and ASPT values. BMWP score calculated during pre-monsoon season varied from 24 to 58, during monsoon from 19 to 71 and in post- monsoon from 24 to 51. Therefore, on an average, water quality of Chenab River is poor to moderate and somewhere good. In general, the average BMWP scores during monsoon were good as it ranged from 19 to 71 and pre-monsoon, it ranged between 24 to 58. The ASPT score varied from 5.1 to 10.2. ASPT indicates good and moderate water quality of Chenab River.

2.3.4 The Alluvial Plains

The alluvial plains of Chenab River in Jammu and Kashmir UT are a part of Great Plains of India. The alluvial plains of Chenab River and its tributaries are 7 to 30 km in width and height of these well drained plains varies between 325 to 350m. These very fertile and well drained tracts are mainly the alluvial deposition of Chenab River and its tributaries. These plains are located in the south of Shiwalik Hills. The outer plains of Jammu Division are traversed by numerous hill torrents. The plains are deeply dissected by series of deep and shallow ravines which carry off the seasonal flood waters of monsoon rains, exposing the sand, gravels, pebbles and boulders of river beds. Apart from the parched, stony and brown wilderness of the ravines, the Jammu plains comprise large expanses of cropland with deep, fertile alluvial soils. This productive agricultural tract is locally referred to as Anderwah and Bajwat. Largest hectarage of this arable land is present in Jammu and Akhnoor. Main crops sown in Kharif are rice and wheat in Rabi seasons (Qazi, 2005).

2.3.5 The Climate

The upper portion of the Chenab River Basin is largely mountainous and located between the Zanskar and the Pir-Panjal ranges, and the lower portion lies in the plain areas (Rao *et al.*, 1997). The climate of the Chenab Riverscape can be broadly divided into following zones.

(a) Cold Arid Zone: This zone covers high altitude area of Greater Himalaya, Lahaul and Spiti region, characterized by severe cold, dry winter, moderately hot and dry summer.

(b) Temperate Zone: This covers Pir-Panjal region and is characterized by wet and cold winter, relatively dry and moderately hot summer.

(c) Sub-Tropical Temperate Transitional Zone: It represents mid to high altitude intimated zones like Bhadarwah and Kishtwar characterized by colder winter, high annual rainfall, and low mean annual temperature as associated to low altitude sub-tropical zone.

(d) Low Altitude Sub-Tropical Zone: Foot hill plains and Shiwalik Hills of Jammu region fall under this zone, and are considered by monsoon precipitation, hot summer, relatively dry but pronounced winter.

The climate of the upper catchment of Chenab River is arid and cold especially in Lahaul and Spiti region of Himachal Pradesh, which experiences light rainfall albeit very heavy snow fall in winter season. The average maximum temperature in Keylong area ranges from 0.7^{o} C in February to 23.1^{o} C in August and the normal minimum temperature from -10^{o} C in February to 10^{o} C in July. Average annual rainfall in Lahaul and Pangi valley is about 450 mm and 30 mm, respectively. The high-altitude uplands in Doda and Kishtwar *viz.,* Bhadarwah, Banihal, Kishtwar and Batote also experience cold climate and heavy snowfall takes place in the area during winter months (EIA Report, 2016).

2.4 The Biological Environment

Human-beings live in the realm of natural environment consisting of atmosphere, hydrosphere, lithosphere and biosphere. Biological Environment in its widest sense is represented by diverse terrestrial and aquatic ecosystems embracing living organisms, plants, animals, aquatic biota, vegetation and habitat types, wildlife, micro-organisms and other components of environment (Adesiyan, 2005). The scope of biological environment is very large and it is by far the most important due to complex interplay of interactions between mankind and biological environment. Various natural ecological processes e.g., nutrient cycling, biotic interactions ensure the dynamic functioning of ecosystem and helps to maintain the ecological resilience. Conversely, multiple human activities include deforestation, road construction and expansion, hydro-power development, quarrying, and mining impacts the natural environment severely and give rise to a number of adverse environmental consequences.

Rivers create a series of tangentially linked ecosystems and habitats all along its length (Dudgeon, 2006). The unidirectional flow of water in rivers also contributes to determine their biota and biological characteristics. The biological environment of *lotic systems* like

river encompasses various ecosystems and diversity of organisms varying from microbes to higher plants, and from protozoans to vertebrates, such as fishes and mammals along the main course of the river, its tributaries and catchments. The following description brings forth the uniqueness and diversity of biological environment of Chenab Riverscape in the Himachal Pradesh and Jammu and Kashmir UT.

2.4.1 Bio geographic Representation

Indian mainland is divided into twelve bio-geographic zones which are further sub-divided into 25 ecological provinces (Rodgers and Panwar 1988). These zones and provinces cover large areas, unique ecology, biomes, communities and species. The Chenab Riverscape delineated in the Himachal Pradesh and Jammu and Kashmir UT is mainly represented by three bio-geographic zones: (i) 1A- Trans Himalaya (ii) 2A- North West Himalaya (ii) 2A- Semi-arid zone.

a) **1A- Trans Himalaya**: The Trans Himalaya constitutes a distinct bio-geographic unit with very harsh climatic conditions having diurnal fluctuation in temperature, erratic rainfall, intense winds and heavy snowfall. The area lies north of Baralacha range in Lahaul valley of Himachal Pradesh with limited natural vegetation representation in this zone under the riverscape.

b) **2A- North West Himalaya**: This biotic province is characterized by high snow capped peaks, steep slopes, unconsolidated soils, and intense rainfall. The principal mountain ranges include the Great Himalaya and Lesser or Middle Himalaya. The major portion of Chenab Riverscape in Lahaul and Pangi valleys of Himachal Pradesh and hilly/plain areas of Jammu province falls in these ranges. There are varied landforms, notable altitudinal gradient, and wide-ranging climatic variations from cold, sub-tropical, temperate to alpine types.

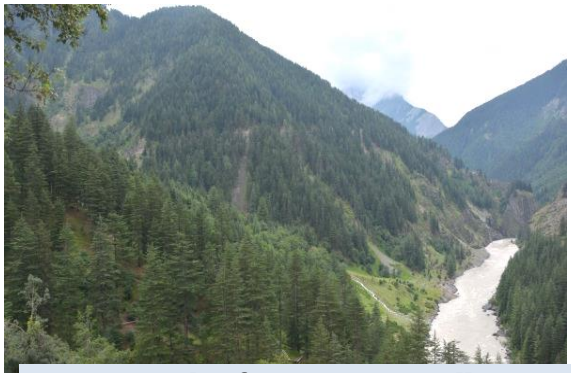
c) **2A- Semi-arid zone**: The biotic province includes the Shiwalik Hills system and plain areas of Chenab Riverscape. There is predominance of dry deciduous type of vegetation. The forest cover has been severely eroded and reforestation has largely used exotic tree species.

The distinct physiographic and climatic factors prevailing in these zones have given rise to many diverse natural ecosystems *viz*., forests, grasslands and pastures, riverine glaciers, lakes and wetlands. All these ecosystems are structurally different and functionally dynamic and support bountiful biodiversity. The contextual description of different ecosystems has been encapsulated in the following sections.

2.4.2 Diversity of Forests

Forests are a unique ecosystem which provides us various goods and services. They are not only the rich repository of numerable varieties of plants, animals and microorganisms, but also play a major role in soil and water conservation, reducing siltation, controlling floods,

carbon sequestration, and regulating fresh water flows (Fig. 2.3). Although, the forests cover only about one third of Earth's surface, but it holds immense ecological value due to numerous inherent functions. The UN Sustainable Development Goal (SDG- 13) makes explicit reference to the value of forests for clean air and water (Ellison *et al.*, 2017).



-Deodar forest, Pangi Valley



Low Level Blue Pine Forest, Batote

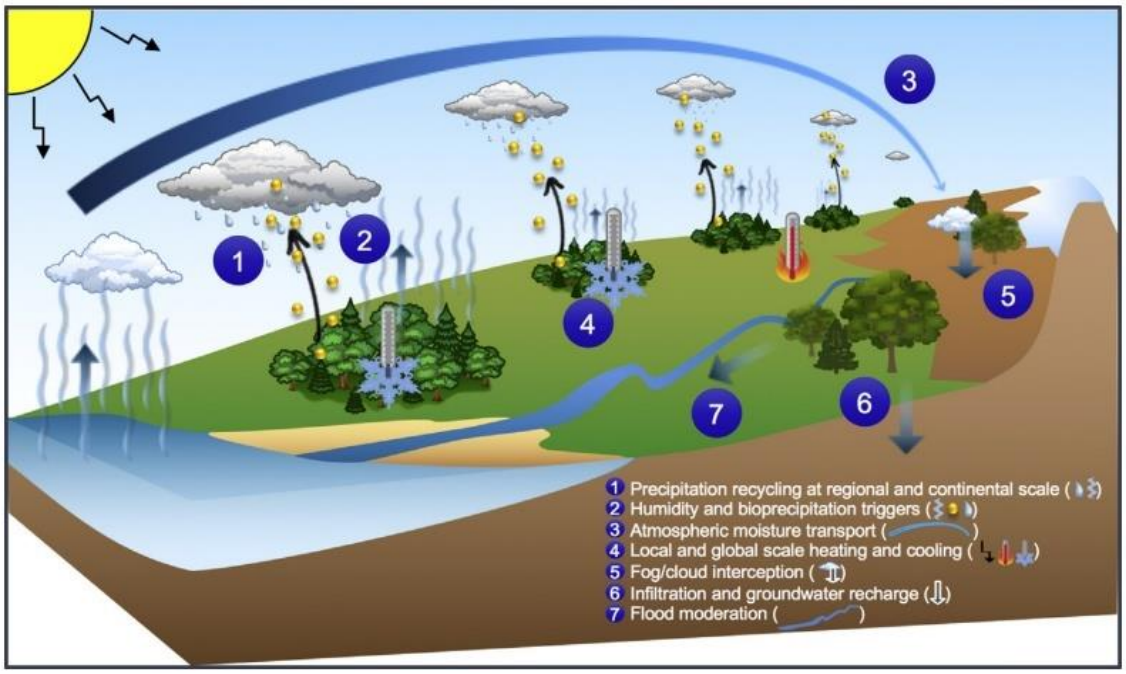


Fig. 2.3- Multiple intrinsic functions of Forests

(Source: Ellisona *et al.*, 2017)

Terrain, climate, latitude, soil and water conditions determine the type of forests/vegetation existing on particular landscape. The vast stretch of Chenab River Basin spreads across Himachal Pradesh and Jammu and Kashmir UT has distinct topographic characteristics and it is adorned with diverse forests (Kumar *et al*., 2018). It is quite befitting to provide an insight about the diversity of forests existing along the different altitudinal gradient within the Chenab Riverscape in Himachal Pradesh and Jammu and Kashmir UT. The detailing has been provided on the basis of synthesis of existing information from different sources of

literature (Kumar *et al*., 2018; Joshi *et al.*, 2001; Ellison *et al.*, 2017; ISFR Report, 2018 ; Jee, 2020; Envis centre J&K, 2018; etc.)

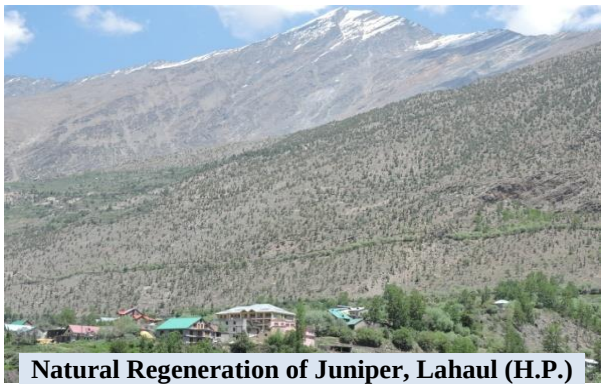
2.4.3 Forests in Himachal Pradesh

Himachal Pradesh is a predominantly mountainous state and the climate is more congenial to the growth of forests. The state has profuse wealth of forest resources and biodiversity. Forests are the most important natural resource of the state, legally comprising nearly 66 % of the geographical area. In this total forest area, 46% of land is covered by the coniferous and broad-leaved forests and the remaining 54% include high altitude areas above the tree line, snow peaks, alpine pastures, and river beds. Vascular flora dominates the forests of Himachal Pradesh and forms the conspicuous vegetation cover. The forest ecosystems are crucial for the environmental, ecological and economic well-being of local communities. Due to large differences in altitude and precipitation, the forest vegetation types in this region range from tropical to alpine types. The forests of Himachal Pradesh are characterized by tropical moist deciduous, sub-tropical pine forests and broad leaved forests (tropical dry deciduous and sub-tropical dry evergreen forests, temperate conifers, mixed forests (Himalayan moist and dry temperate forests), and sub-alpine forests (Joshi *et al.*, 2001). The main forest types predominant within Chenab Riverscape in Himachal Pradesh, as per the classification of forest types by Champion and Seth (1968) is given in Table 2.12.

Table: 2. 12– Forest Types of Chenab Riverscape in Himachal Pradesh

Groups	Forest Types
Himalayan Dry Temperate Forests (13)	C1 Dry broad-leaved and coniferous forests
	C2 Dry temperate coniferous forests
	C2a Neoza pine (*Pinus gerardiana*) forests
	C2b Dry deodar forests
	C2/DS1 Pohu Scrubs (*Parrotiopsis jacquemontiana*)
	C3 West Himalayan dry temperate deciduous forests
	C4 West Himalayan high-level dry blue pine forests (*Pinus wallichiana*)
	C4 West Himalayan dry juniper forests
Sub-Alpine Forests (14)	C1a West Himalayan sub-alpine high level fir forests
	C1b West Himalayan birch/fir forests
Moist Alpine Scrub (15)	C1 Betula-Rhododendron scrub forests
	C3 Alpine pastures
Dry Alpine Scrub (16)	C1 Dry alpine scrubs

(Source: ISFR Report, 2018)



Natural Regeneration of Juniper, Lahaul (H.P.)



Betula Forests, Lahaul (H.P.)

2.4.4 Forests in Jammu and Kashmir UT

The erstwhile state and now Jammu and Kashmir UT is a gift of nature and the vegetation of the region reflects considerable Himalayan impact (Jee, 2020). The geology, soils, height and climate are the determining factors in the distribution of forest types. Out of the total 26,293 km^2 area of Jammu province nearly 12,066 km^2 (45.89%) area is covered under forests (Envis J&K, 2018). As per Champion and Seth (1968), the major forests types of Jammu and Kashmir UT are; (i) Sub-tropical pine forest (ii) Sub-tropical dry ever green forest (iii) Himalayan moist temperate forests (iv)Himalayan dry temperate forests (v) Sub-alpine forests (vi) Moist alpine forest (vii) Dry alpine scrubs. The Chenab riverscape covers fourteen forest divisions in Jammu and Kashmir UT. The main forests types existing within the riverscape has been depicted in Table 2.13 followed by brief description of each type.

Table: 2. 13- Forest Types of Chenab Riverscape in Jammu and Kashmir UT

Groups	Types	Subtypes
Subtropical dry evergreen forests (10)	10/C1: Sub-tropical dry evergreen forest	10/C1a: *Olea ferruginea* scrub forest
Himalayan moist temperate forests (12)	12/C1: Lower Western Himalayan temperate forests	12/C1a: Ban Oak forests
		12/C1b: Moru Oak forests
		12/C1c: Moist deodar forests
		12/C1d: Western Himalayan mixed coniferous forests
		12/C1f: Low level blue pine forest:
	12/C2: Upper Western Himalayan temperate forests	12/C2a: Kharsu Oak forests
Himalayan dry temperate forests (13)	13/C1: Dry broadleaved and coniferous forests	
Moist alpine scrub (15)	15/C1: Betula/Rhododendron scrub forests	
Dry alpine scrub (16)	16/E1: Dwarf Juniper scrubs	

Division-wise Representation of Forest Types: The Chenab Riverscape is represented by fourteen Forest Divisions in Jammu and Kashmir UT. The brief description of existing forest types of different divisions is given below:

Northern Dry Mixed Deciduous Forests (5B/C2): These types of forest are characterized by the presence of *Anogeissus latifolia, Albizia chinensis, A. lebbek, Cassia fistula* and *Acacia catechu*. The upper canopy is light and continuous in the climax form. The forest type is found in Jammu, Rajouri and Udhampur Forest Divisions.

Khair-sissu Forests (5/1S2): These type of forest typically and conspicuously occur on fresh sandy and gravelly alluvium of river bed. *Dalbergia sissoo* and *Acacia catechu* are the main species of this type and are mixed by other deciduous species in varying proportions depending on the extent of ecological succession in the area. It is mainly found in the Doda and Udhampur division.

Dry Deciduous Scrubs (5/DS1): These forest types are marked by low broken soil cover and shrub growth of 3 to 6m height including some tree species reduced to similar conditions. The main tree species are *Acacia catechu*, *Butea monosperma*, *Lannea coromandelica* etc, and the bushes include*Nyctanthes arbortrists*, *Dodonaea viscosa*, *Woodfordia fruticosa, Murraya koengii*, *Justicia adhatoda*, etc. This forest type is found in Jammu and Udhampur districts.

Dry Bamboo Brake (5/E9): Only one species, *Dendrocalamus strictus* occurs and forms relatively low, but often dense brakes. It is found in Jammu Division.

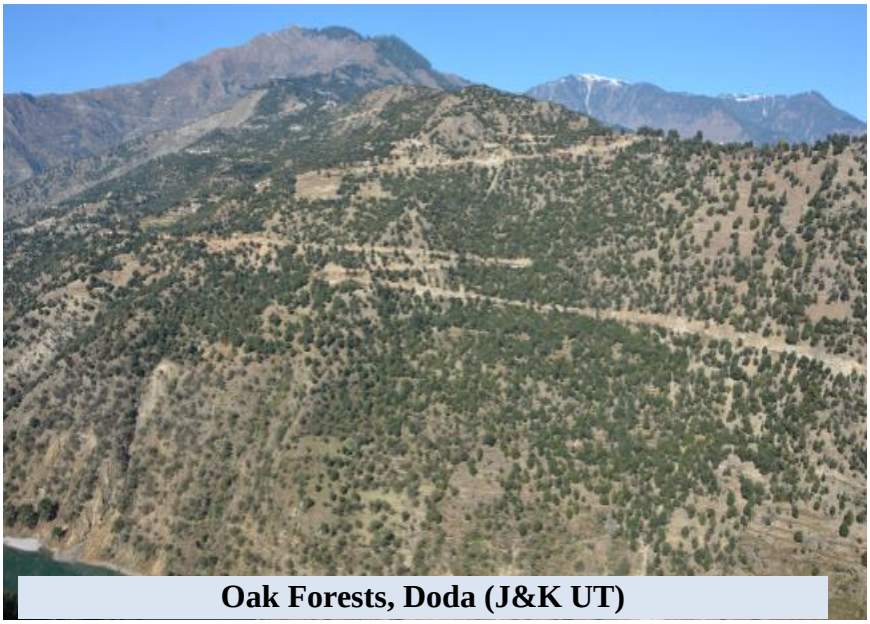
Lower or Shiwalik Chir Pine Forests (9/C1a): The *Pinus roxburghii* stands singly or in groups with a scattered lower deciduous tree storey. These forests occur between 800 to 1,700m amsl. At lower elevations, it confines itself more to the cooler northern and shelter aspects while on higher elevations, it occurs all over, preferring ridges. This type occurs mainly on Shiwalik conglomerates and sand stones. It is found in Jammu, Rajouri and Udhampur districts.

Upper or Himalayan Chir Pine Forest (9/C1b): This type occurs mainly between 1,200 to 1,700m amsl. Main species are *Pinus roxburghii* sometimes associated with *Quercus oblongata*, *Syzygium cumini*, *Pyrus pashia*, *Rhododendron arboreum*, etc. This forest type is found in Doda, Kishtwar, Rajouri and Udhampur Forest Divisions.

Himalayan Sub-tropical Scrubs (9/DS1): This forest type is found over considerable areas in the Shiwalik chir zone, extending up to Himalayan chir forest and down to the mixed deciduous forests. *Carissaopaca*, *Dodonaeaviscosa*, *Rhus parviflora*, *Murraya koenigii*, etc. scrubs are quite common in this forest type. This forest type is found in Doda, Rajouri and Udhampur Forest Divisions.

***Olea ferruginea* Forest (10/C1a):** *Olea ferruginea* is the main species. This type of forest occurs along the lower limits near river and extends up to *Quercus* forest. It is common only to the drier southern slopes along the river. Common associates are *Punica granatum*, *Pistacia integerrima*, *Myrsine africana*, *Daphne oleoides* and *Plectranthus coesta*, etc. This forest type is mainly found in Kishtwar, Doda and Udhampur Forest Divisions.

Ban Oak (*Q. oblongata*) Forest (12/C1a): This forest type occurs between 1,600 – 2,300 m amsl on fairly deep, fertile loam soils. *Quercus oblongata, Rhododendon arboreum, Cornus macrophylla, Pyrus pashia*, etc. are quite common species in this forest type. It is mainly found in Doda, Rajouri and Udhampur Forest Divisions.



Oak Forests, Doda (J&K UT)

Moru Oak forest (*Quercus floribunda*) (12/C1b): This type occurs between 1,200 – 2,250 m amsl. Moru is chief constituent present abundantly, forming almost pure stands. Spruce is the main associate and often the Moru forms second storey of scattered spruce trees. This forest type is found in Kishtwar and Doda Forest Divisions.

Moist Deodar (*Cedrus deodara*) Forest (12/C1c): *Cedrus deodara* is the dominant species found between 1,700 – 2,500m amsl. This forest type is found in Doda and Mahore Forest Divisions.

Western Mixed (Spruce, Blue pine, Silver fir) Coniferous Forest (12/C1d): These forests occur at between 2,100 – 3,000 m amsl. Dominant species are *Picea smithiana*, *Abies pindrow*, *Pinus wallichiana*, *Cedrus deodara*, etc. Sometimes any one species may be found as pure forest. This forest type is mainly found in Bhaderwah, Doda, Kishtwar, Rajouri, and Reasi Forest Divisions.

Moist Temperate Deciduous Forests (12/C1e): These are commonly found between 1,800 to 2,750 m amsl in moist depressions often as strips along the hill streams and also on the gentler slopes. Locally, there may be gregarious growth of bamboos. Main species are *Acer caesium*, *A. pictum*, *Betula alnoides*, *Ulmus wallichiana*, *Abies pindrow*, etc. It is mainly found in Doda and Kishtwar Forest Divisions.

Low Level Blue Pine Forests (*Pinus wallichiana*) (12/C1f): *Pinus wallichiana* is the universal colonizer of vacant sites. More or less Kail forest occurs in the Ban Oak (*Quercus oblongata*), Moru Oak (*Quercus floribunda*) and mixed coniferous zone as a separate type. This forest type is mainly found in Doda, Ramban Forest Divisions.

Oak Scrubs (12/C1/DS1): Due to excessive lopping and felling the oak and associated species are reduced to low stunted scrub like structures trees with bushes like *Berberis lycium*, *Berberis aristata*, *Crataegus crenulata*, *Prinsepia utilis*, etc. This forest type is mainly found in Doda, Rajouri and Udhampur Forest Divisions.

Himalayan Temperate Secondary Scrubs (12/C1/DS2): They are usually found throughout the temperate forests on burnt and degraded areas especially in southern aspects. Main species of the scrubs are *Plectranthus rugosus*, *Berberis asiatica*, *Berberis lycium*, *Rubus ellipticus*, *Colebrookea oppositifolia*, *Indigofera heterantha*, *Desmodium elegans*, etc. This forest type is found mainly in Doda, and Reasi Forest Divisions.

Kharsu Oak (*Quercus semicarpifolia*) Forests (12/C2a): Kharsu forests occur in the high elevations ranging from 2,700 – 3,300 m amsl on northern aspect and 2,600 – 3,500 m amsl on southern and east-west aspects. This forest type is found mainly in Kishtwar, Batote, Doda and Mahore Forest Divisions.

West Himalayan Upper Oak/Fir Forests (12/C2b): These forests occur between 2,600 - 3,000 m amsl. The characteristic feature is presence of Kharsu and fir. Spruce together as stand mixture and the forests look like two storied forests. Main species in this type are *Abies pindrow*, *Picea smithiana*, *Quercus floribunda* and *Quercus semecarpifolia*. This forest type is mainly found in Kishtwar, Batote and Bhaderwah Forest Divisions.

Dry Broadleaved and Coniferous Forests (*Q. ilex & P. wallichiana*) (13(i)/C1): An open forest of Blue Pine mixed with evergreen Oaks and a few other xerophytic trees which together form a fairly complete cover at least on sheltered sites and cool aspects. This type occurs between 2,000 – 2,440 m amsl sometimes extending 300 m below, on cool aspects and 300 m above this range on southern exposures. Main species are *Pinus wallichiana*, *Cedrus deodara*, *Quercus ilex*, etc. This forest type is found in Reasi and Doda Forest Divisions.

Dry Deodar Forests (13(i)/C2b): These forests occur between 2,100 – 3,250 m amsl. The rainfall rarely exceeds 1000 mm. The main species under this type are *Cedrus deodara*, *Pinus wallichiana*, *Picea smithiana*, etc. This forest type is mainly found in Doda Forest Division.

West Himalayan High-Level Dry Blue Pine (*Pinus wallichiana*) Forests (13(i)/C4): These forests occur in the arid zone of the inner western Himalaya between 3,000 - 3,600 m amsl with rainfall below 500 mm. Main species are *Pinus wallichiana*, *Pinus gerardiana*, *Abies pindrow*, *Abies spectabilis*, etc. This forest type is found in Kishtwar and Marwah Forest Division.

West Himalayan Sub-Alpine Fir Forests (14/C1a): These occur between 2,900 – 3,050 m amsl on the northern aspect. Main species are *Abies spectabilis*, *Pinus wallichiana*, *Picea smithiana*, etc. These are mainly found in Kishtwar and Marwah Forest Divisions.

West Himalayan Sub-Alpine Birch/Fir Forests (14/C1b): These are mainly dominated by *Betula utilis*, but in some areas irregular forest consisting largely of Fir, Birch and *Rhododendron* species in varying proportions. The overwood is often absent especially in hollows, leaving more or less pure *Rhododendron*. In the moist zone, *Quercus semecarpifolia* also occur in association. This forest type is found in Kishtwar and Doda Forest Divisions.

Sub-Alpine Blue Pine Forests (14/2S1): These forests of pure *Pinus wallichiana* are distributed in the form of belt above mixed coniferous forests and extend up to the tree line. This type is seral in character and mainly found in Kishtwar and Mahore Forest Divisions.

***Rhododendron* Scrub forests (15/C1):** This type forms low evergreen forest almost entirely of *Rhododendron companulatum* and *R. anthopogon*. A thick layer of black humus is typically present and the soil is generally wet. These are found in Doda and Kistwar Forest Divisions.

Dwarf *Rhododendron* Scrubs (15/E1): This type is found on very cold regions, also in rocks at higher elevations. The dense *Rhododendron anthopogon*are found thickets between 3,350 – 4,600 m amsl; dominant between 4,600 – 4,900 m amsl and ascending upto 5,500 m amsl on dry southern slopes, Average precipitation varies from 250 – 2,000mm, mostly as snow. These are mainly found in Kishtwar and Doda Forest Divisions.

Dwarf Juniper Scrubs (15/E2): These forest types are found on very dry slopes having annual precipitation 250 mm or below. Soil is dry sandy and loose, and easily transported by wind. Main species are *Juniperus indica, Juniperus communis*, etc. between and above. These are mainly found in Kishtwar and Marwah Forest Divisions.

Dry Alpine Scrubs (16/C1): These are often xerophytic formation in which dwarf scrubs predominate. Rainfall is little. *Hippophae* spp., *Juniperus indica*, *J. communis*, *Rosa* spp., *Lonicera* spp., etc. are quite common. This forest type is found in Kishtwar Forest Division.

The forests cover nearly 31% of the land on Earth and holds more than two-thirds of the terrestrial biodiversity. The forests of the Chenab River Basin are biologically rich and display unique flora and fauna consisting of a variety of birds, butterflies, animals, and plants. In fact, the vast forested catchments of the Chenab River are store house of plant diversity, medicinal plants, NTFPs, rare, endangered and threatened plants. The following section attempts to highlight various aspects of biodiversity in context with the Chenab Riverscape on the basis of review of secondary information (Samant *et al.,* 2007;Singh *et al*., 2009; Singh and Samant, 2010; Dawa *et al.*, 2018; Numata, 1986; Ram *et al*., 1989; Kumar and Puniya, 2018; Nayar and Sastry 1987-1990; ZSI, Kolkata; Stirling and Wilsey, 2001; etc.)

Floral Diversity of Chenab River Basin

The Chandra, Bhaga, Pattan, Miyar, Udaipur and Pangi valleys within Chenab Riverscape in Himachal Pradesh represent an emporium of flowering plants, gymnosperms, shrubby vegetation and herbaceous flora. The vegetation mainly consists of temperate, sub-alpine, and alpine types. The temperate vegetation is dominated by evergreen conifers i.e., *Pinus gerardiana, Pinus wallichiana, Juniperus polycarpos, Abies pindrow* and broad leaved deciduous i.e., *Corylus jacquemontii, Juglans regia*, *Hippophae salicifolia, Fraxinus xanthoxyloides* and *Crategus songarica* forests. The sub-alpine vegetation is dominated by broad-leaved deciduous species e.g., *Betula utilis* and evergreen coniferous i.e. *Pinus wallichiana, Abies pindrow*, *Juniperus polycarpos* and mixed coniferous forests (Samant *et al*., 2011). The alpine vegetation is mainly dominated by alpine scrub species of *Rosa, Hippophae*, *Caragana, Lonicera, Salix, Myricaria*, *etc*. and herbaceous species.

Temperate to alpine types of vegetation can be seen along the Chenab River in Pangi valley. The forest have tree species *viz*., Deodar (*Cedrus deodara*), Fir (*Abies pindrow*), Spruce (*Picea smithiana*), Kail (*Pinus wallichiana*), Hazel-nut (*Corylus jacquemontii),* Willow (*Salix* sp.), Maples (*Acer* spp.) and Ash (*Fraxinus* spp.), Walnut (*Jugalans regia*), Horse Chestnut (*Aesculus* sp.) and Elm (*Ulmus* sp.); etc. Hazel-nut (*Corylus jacquemontii)* has a common occurrence in Pangi Valley. The seeds of this species are very nutritive and it is locally famous as '**Pangi -ki-Thangi.**'

The alpine meadows and glacial moraines within the Chenab Riverscape have distinctive floristic composition comprising of herbaceous elements e.g.,*Anemone rupicola, Androsace sempervivoides, Arabidopsis* sp., *Aster flaccidus, Corydalis meifolia; Achillea* sp., *Anemone* spp., *Cynoglossum* sp., *Origanum* sp., *Pedicularis* sp., *Silene* sp., *Taraxacum officinale;* etc.

Medicinal and Aromatic plants (MAPs) Wealth

Himachal Pradesh and Jammu and Kashmir UT are endowed with variety of Medicinal and Aromatic Plants. The representative Medicinal and Aromatic plants(MAPs) of the NW Himalayan State and UT are given in Table 2.14 and 2.15.

Table: 2. 14- The representative medicinal plants in different altitudinal zones of Himachal Pradesh.

Altitudinal zones	Representative species
Tropical and Sub-tropical < 1,800 m	*Justicia adhatoda, Achyranthes aspera, Mangifera indica, Apium graveolens, Rauwolfia serpentina, Acorus calamus, Calotropis gigantea, Asparagus adscendens, A. racemosus, Azardirachta indica, Artemisia absinthium, A. japonica, Tagetes minuta, Berberis asiatica, Rorippa indica, Bauhinia variegata, B. vahlii, Caesalpinia decapitala, Cassia fistula, Terminalia atata, T. arjuna, T. chebula, Cyperus rotundus, Dioscorea bulbifera, Phyllanthus emblica, Swertia angustifolia, Hypericum perforatum, Curculigo orchioides, Ajuga parviflora, Mentha arvensis, M. piperata, Ocimum canum, O. sanctum, Salvia plebeia, S. lanata, Cinnamomum tamala, Aloe barbadensis, Woodfordia fruticosa, Tinospora cordifolia, Syzygium cumini, Malaxis acuminata, Ziziphus mauritiana, Prinsepia utilis, Rubia manjith, Zanthoxylum armatum, Sapindus mukorossi, Bergenia ligulata, Bacopa monnierii, Withania somnifera, Atropa belladonna, Urtica parviflora, Hedychium spicatum,* and *Elaeagnus conferta.*
Temperate 1,801–2,800 m	*Ferula jaeschkeana, Heracleum candicans, Asparagus filicinus, Ainsliaea aptera, Berberis aristata, Betula alnoides, Sagina saginoides, Corylus jacquemontii, Rosularia rosulata, Gentiana kurroo, Skimmia laureola, Geranium nepalense, Elsholtzia fruticosa, Rhododendron arboreum, Malva verticillata, Oxalis*

	corniculata, Phytolacca acinosa, Polygala sibirica and *Taxus wallichiana*
Sub-alpine 2,801–3,800 m	*Allium humile, Bunium persicum, Malaxis muscifera, Carum carvii, Geranium wallichianum, Angelica glauca, Archangelica himalaica, Bupleurum falcatum, Heracleum lanatum, Arisaema flavum, Saussurea auriculata, S. costus, Tanacetum gracile, T. tenuifolium, T. tomentosum, Impatiens gladulifera, Arnebia benthamii, Eritrichium canum, Rhododendron campanulatum, Ribes orientale, Polygonatum multiflorum, P. verticillatum, Plantago depressa, Aconitum ferox, A. leave, A. heterophyllum, A. falconeri, Pedicularis pectinata, Dactylorhiza hatagirea* and *Picrorhiza kurroa*
Alpine > 3,800 m	*Cortia depressa, Selinum tenuifolium, Heracleum wallichii, Inula royleana, Saussurea graminifolia, S. obvallata, S. simsoniana, S. gossypiphora, Arnebia euchroma, Corydalis meifolia, C. govaniana, Iris kumaonensis, Fritillaria roylei, Polygonum affine, Rhododendron anthopogon, Rheum australe, R. moorcroftianum, R. webbianum, Dactylorhiza hatagirea, Picrorhiza kurroa, Aconitum heterophyllum, A. rotundifolium, A. violaceum, A. spicatum, Delphinium cashmerianum, D. vestitum* and *Nardostachys grandiflora*

Source:(Samant *et al.,* 2007)

Table: 2. 15- The representative medicinal plants of Jammu and Kashmir UT

Jammu region	Kashmir region
*Cymbogon flexuosus, C. winterianus, C. maritinii, Vetiveria zizanoides, Pelargonia graveolens, Eucalyptus citriodora, Argemone graveolens, Allium stoliczka, A. victoralis, Withania somnifera, Matricaria chamomilla, Bacopa monnieri,*and *Andrographis paniculata.*	*Aconitum heterophyllum, A. violaceum, Acorus calamus, Adiantum capillus veneris, Allium victoralis, Amaranthus caudatus, Arnebia benthamii, Artemisia maritima, Berberis aristata, Calendula officinalis, Crataegus oxyacantha, Custuca reflexa, Cyperus rotundus, Datura oleiodes, Dioscorea deltoidea, Euphorbia helioscopia, E. wallichii, Euphrasia officinalis, Fagopyrum esculentum, Geranium wallichianum, Hyoscyamus niger, Malva sylvestris, Menyanthes trifoliata, Mirabilis jalapa, Nymphea stellata, Origanum vulgare, Papaver rhoeas, Peganum harmala, Picrorhiza kurroa, Plantago major, Sinopodophyllum hexandrum, Polygonum*

	alpinum, P. amplexicaule, Portulaca oleracea, Prunella vulgaris, Pyrus cydonia, Rheum australe, Rhododendron campanulatum, Rumex acetosa, Salvia spp., *Saussurea costus, S. sacra, Solanum nigrum, Taraxacum officinalis, Tribulus terrestris, Viola odorata, Valeriana jatamansi, Crocus sativus, Descurainea sophia, Daphne oleiodes* and *Euryale ferox.*

(Source: Dawa *et al.*, 2018)

The Chenab River Basin has a significant contribution to the Medicinal Wealth of Himachal Pradesh and Jammu and Kashmir UT. It is a trove of many medicinal and rare plants *viz.,Tanacetum himachalensis, Thalictrum reniforme, Ferula jaeschkeana, Heracleum thomsonii, Cypripedium cordigerum, Eremurus himalaicus, Aconitum ferox, Aconitum heterophyllum, Allium stracheyi, Gentiana kurroo, Meconopsis aculeata, Picrorhiza kurroa, Dactylorhiza hatagirea, Lilium polyphyllum, Aconitum violaceum, Valeriana jatamansi, Allium stracheyi, Berberis aristata, Rheum spiciforme* and *Selinum vaginatum* (Singh *et al*., 2009; RSET, 2019). Thirteen (13) plant species under Rare, Endangered and Threatened (RET) categories as per Red Data Book of India have also been reported from various ecological zones of Chenab River basin (Nayar and Sastry 1987, 1988, 1990).

Faunal Diversity of Chenab River Basin

The Chenab River Basin is dominated by beautiful forests, mountain spurs, slopes, natural streams and lakes. The range of topographical variations and diversity of habitats creates a great variety of macro and micro climates needed for the existence of different faunal elements. The Chenab River Basin possesses a plenty of Mammalian, Avian, Reptile, Amphibian and Invertebrate fauna (Wildlife Publication, Jammu).

Mammals

The high altitude region of Chenab River Basin harbours diverse, representative and unique mammals. Ibex (*Capra sibirica*), Snow leopard (*Panthera uncia*), Musk Deer (*Moschus*



Blue Sheep (*Pseudois nayaur*)



Brown Bear (*Ursus arctos*)

moschiferus), Himalayan Black Bear (*Ursus thibetanuslaniger*), Himlayan Blue

Sheep(***Pseudois nayaur***), Himalayan Thar (*Hemitragus jemlahicus*), Marmots (*Marmota himalayan*), Brown bear (*Ursus arctos*), *etc*. are found in the temperate region (Parvez, 2007). The lower reaches of the Riverscape have presence of Sambar deer (*Rusa unicolor*), Barking Deer (*Muntiacus muntjak*), Wild boar (*Sus scrofa*), Ghoral (*Naemorhedus goral*),etc.

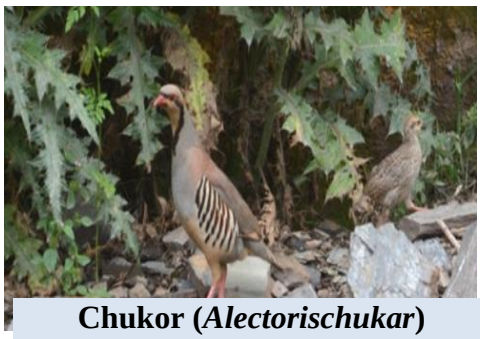


Himalayan tahr (*Hemitragus jemlahicus*)

The ghoral (*Nemorhaedus goral*), Himalayan musk deer (*Moschus chrysogaster*), Himalayan tahr (*Hemitragus jemlahicus*), barking deer (*Muntiacus muntjak*), wild boar (*Sus scrofa*), sambar (*Cervus unicolor*), serow (*Capricornis sumatraensis*), Himalayan ibex (*Capra ibex sibirica*) and blue sheep or bharal (*Pseudois nayaur*) are the ungulate animals, which serve as important prey base for the large mammalian predators such as leopard (Vinod and Sathyakumar, 1999).

The mammals found throughout the Jammu Region include Common Leopard (*Panther pardus*), Jackal (*Canis aureus*), Common Fox (*Vulpes bengalensis*), Rhesus monkey (*Innuus rhesus*), Common Indian Hare (*Lepus nigricaulis*),Mangoose (*Herpestes edwardsi*), Nilgai (*Boselaphus tragocamelus*), Wild boar (*Sus scrofa*), Fox (*Vulpes vulpes*), Monkey (*Macaca mulatta*), Jackal (*Canis aureus*), Barking deer (*Muntiacus muntjak*), etc.

Avian fauna



Chukor (*Alectorischukar*)

Birds play dynamic roles in an ecosystem as they control pest populations through predation and scavenging, pollinate, and disperse seeds. The Lahual and Pangi region under Chenab River Basin in Himachal Pradesh has profuse diversity of birds. Important birds of the region include Cheer Pheasant (*Catreuswallichii*), Western Tragopan (*Tragopan melanocephalus*), Himalayan Monal (*Lophophorus impejanus*), Kaleej Pheasant (*Lophura leucomelanos*), Snow-cock (*Tetraogallus himalayensis*), Hill Pigeon (*Columba rupestris*), Sparrows (*Passeridae sp*) and Chukor (*Alectoris chukar*) Partridge. Systemic studies of birds in Pangi Valley have reported the presence of 62 species belonging to 19 families (Saikia *et al.*, 2008). This include bird species *viz.,Tachybaptus ruficollis* (Little Grebe), *Phalacrocorax carbo* (Great Cormorant), *Ardea cinerea* (Grey Heron), *Anser indicus* (Bar-headed Goose), *Anas crecca* (Commmon Teal), *Milvus migrans* (Black kite), *Spizaetus nipalensis* (Mountain Hawk Eagle), *Aquila chrysaetos* (Golden Eagle), *Ictinaetus malayensis* (Black Eagle), *Sarcogyps calvus* (Red-headed Vulture), *Falco tinnunculus* (Common kestrel), etc.

In Jammu region, the common birds are Sparrow (*Passer domesticus*), Fowl Crow (*Corvus brachyrhynchos*), Blue Heron (*Ardea cinerea*), Parrot (*Psittaci formes*), Nightingle (*Luscinia magarhynchos*), Vulture (*Gyps bengalensis*) and Eagle (*Haliaeetus leucocephalus*), Peafowl (*Pavo cristatus*), Jungle Bush Quail (*Perdicula asiatica*), Black Partridge (*Francolinus francolinus*), Grey Partridge (*Perdix perdix*), Common Myna (*Acridotheres tristis*),

Himalayan Jungle Crow (*Corvus macrorhynchos*), Griffon Vulture (*Gyps fulvus*), Bearded Vulture (*Gypaetus barbatus*), Golden Oriole (*Oriolus kundoo*), Paradise Flyculture (*Diphyllodes magnificus*), Tree Creeper (*Certhia himalayana*), Neelkanth (*Coracias garrulous*); etc.

Reptiles

The commonly found reptiles in the tropical and sub-tropical areas of Chenab River Basin include chameleon (*Chamaeleo chamaeleon*), cobra (*Ophiophagus hannah*), pit viper (*Trimeresurus gramineus*), Krait (*Bungarus caeruleus*) and Russel's Viper (*Daboia russelii*), monitor lizard (*Varanus salvator*), Garden lizard (*Calotes versicolor*), Common wall lizard (*Podarcis muralis*), spiny-tailed lizard (*Saara hardwickii*), etc.

Aquatic and Amphibian biodiversity

The fish and amphibian fauna have not been reported from Lahaul and Pangi regions of the Riverscape due to torrential nature of river in these areas. But, many important species of fishes have been found in Jammu region e.g., Carp (*Cyprinus carpio*), Mahseers (*Cyprinus tor*), Brown Trout (*Salmo trutta*), Rainbow Trout (*Oncorhynchus mykiss*), Mirror Carp (*Salmo trutta*), Kalbose (*Labeo calbasu*), Mirgal (*Cirrhinus mrigala*), Rohu (*Labeo rohita*), Grass Crap (*Ctenopharyngodon idella*), Silver Crap (*Hypopthalamichthyes molitrix*) and Common Crap (*Cyprinus carpio*), Channa (*Channap punctatus*), Rasbora (*Trigonostigma Heteromorpha*), Rosy Barb (*Punctius Conchonius*), Zebra fish (*Danio Rerio*), etc. (Parvez,2007). Apart from that important species of turtles *viz*., Indian Flapshell Turtle (*Lessemis punctata*) and Softshell Turtle (*Trionyx gangeticus*) have also been reported (Kapoor, 1992).

Butterflies

Butterflies constitute conspicuously attractive group of organisms. The butterfly diversity in an ecosystem indicates the health of ecosystem. About 288 species of butterflies have been reported from Himachal Pradesh. The Lahaul and Pangi valleys of the State have abundance of butterfly fauna. Many species belonging to important butterfly families *viz*., Lycaenidae and Nymphaliadae have been reported from upper reaches of Chenab River Basin in Lahaul valley and about 36 species of five butterfly families have been inventoried from the Pangi area (Arora *et al*., 1995, 2005).

Diverse Habitats and Unique Fauna

The Chenab River Basin constitutes a range of intact, serene and diverse habitats all across the spatial extent and supports lot of Fauna. But, the Pangi valley within Chenab Riverscape exhibits unique amalgamation of faunal elements. Pangi valley is a remote and isolated area in Himachal Pradesh. It is the transition zone located between Pir-Panjal and Zaskar ranges. Due to this, the valley represents mixing of Trans-Himalayan and Himalayan faunal elements. The High Altitude Regional Centre, Solan under Zoological Survey of India (ZSI) has developed an excellent database of different faunal groups of Pangi Valley. About 41 species of Protozoa, 16 species of Orthoptera, 20 species of Moths, 5 species of Heteroptera,

7 species of reptiles, 75 species of birds and 19 species of mammals have been reported from this region (Source: ZSI, Kolkata).

Terrestrial and Aquatic Weeds

The higher hills of temperate and alpine zones and the lower hills of tropical and sub-tropical zones under the Chenab Riverscape harbour a wide range of terrestrial and aquatic weed flora (Gurevitch and Padilla, 2004). Due to their exotic origins, the weeds are threat to the endemic species and biodiversity. The presence of the weeds in pastures and grasslands reduce the productivity of grasses (Rana and Badiyala, 2015; Negi *et al.,* 2016). The typical examples of weeds include *Lantana camara, Ageratum conyzoides* and *Parthenium hysterophorus*. The other major problematic weeds in these areas are *Oxalis latifolia, Oxalis corniculata, Chromolaena adenophorum, Imperata cylindrica, Sorghum halepense, Cyperus rotundus, Cuscuta* sp., *Urtica dioica, Xanthium strumarium, Sisymbrium loeselii, Bupleurum lanceolatum, Galinsoga parviflora, Marrubium vulgare, Cousinia microcarpa, Centaurea iberica, Digitaria marginata, Setaria verticillata* and *Eragrostis nigra*. The weeds of moist localities include *Coronopus didymus, Tribulus terrestris* and species of *Oxalis, Herniaria, Geranium* and *Veronica* (Kumar and Puniya, 2018).

Threatened and Endangered Fauna

The IUCN Red List of Threatened Species is the most authoritative guide for finding out the extinction risk of thousands of animal and plant species across different regions of the world. The IUCN Red list recognizes several categories for threat assessment on strong scientific basis. The three broad categories are Critically Endangered, Endangered, and Vulnerable. A taxon facing extremely high risk of extinction in wild having 80-90% decline in its population is called Critically Endangered. Endangered (EN), species are those which possess a high risk of extinction with 50-70 % decline in population. Vulnerable species also face risk of extinction and likely to become endangered unless the circumstances threatening its survival and reproduction improve. In the context with Chenab River Basin, the important threatened and endangered fauna include Himlayan Brown Bear(*Ursus arctos*), Himalayan Black Bear (*Ursus arctos*), Himalayan Langur (*Semnopithecus ajax*), Himalayan Tahr (*Hemitragus jemlahicus*), Makhor (*Capra falconeri cashmiriensis*) and Musk Deer (*Moschus chrysogaster*), etc.

Himalayan Brown Bear (*Ursus arctos*) – T**he largest Ominvore**

It belongs to family ursidae. It is found in the high-altitude areas above tree line in alpine scrubs and meadows of Jammu and Kashmir UT, Ladakh UT, Himachal Pradesh and Uttarakhand. It has small head, a pointed snout and small rounded ears. The stocky limbs end in flat paws with long straight claws. It is agile animal and can run at speeds of 50 km/h. More scientific information is required for the conservation and management of this species and its habitats.

Himalayan Langur (*Semnopithecus ajax*)

It is least known species of langurs and occupies an important position in the food chains of forest ecosystems. It is a leaf eating primate and inhabits the steep and rugged mountains of

north western Himalaya. The threat to its survival has increased due to expansion of agricultural and developmental activities and this species is placed in the Endangered category of the IUCN red list. In India, it is restricted to the States of Himachal Pradesh, Uttarakhand and Jammu and Kashmir UT. In Himachal Pradesh, it is found in Great Himalayan National Park while in Jammu and Kashmir UT, its presence has been recorded from Wadwan area of Kishtwar National Park and upper Bhaderwah region within Chenab River Basin (Sharma and Ahmed, 2017).

Markhor- The Largest Goat

Markhor (*Capra falconeri cashmiriensis*) is a medium sized, sexually dimorphic, Endangered moutain ungulate. Markhor is the largest goat but also a globally threatened species. It is an endangered species under IUCN Red List. In India, markhor is found only in Jammu and Kashmir UT. The potential predators of markhor are Common leopard (*Panthera pardus*), Himalayan brown bear (*Ursus arctos*), Himalayan black bear (*Ursus thibetanus*), and the Golden eagle (*Aquila chrysaetus*) (Peerzada *et al.*, 2010).

Himalayan Tahr (*Hemitragus jemlahicus*) – **The Moutain Goat**

It is copper brown colured mountain goat which belongs to bovidae family. It occurs in inaccessible areas, precipitous slopes and prefers to inhibit the oak forests. It has heavy body and tough limbs. The body is covered with tangled masses of hairs. The horns are solid, keeled and furrowed.

Flagship Species

These are the species that play a significant role in the ecological functioning of entire biological community of a region. Flagship species act as catalyst for the continued productivity, and structure and function of the ecosystem. Snow Leopard is such a high profile charismatic species that is found in upper reaches of Chenab River Basin in Trans and Greater Himalayan zones.

Snow Leopard

Snow leopard (*Panthera uncia*) belongs to the Cat family Felidae. It is an attractive and elusive animal having remarkable ability to camouflage with the surrounding landscape of rocks, sparse low vegetation, and snow. The species is perfectly adapted to live in the high altitude environment and found in Kullu, Kinnaur, Chamba, Lahaul and Spiti districts of Himachal Pradesh (Jackson *et al*., 2008). Snow leopards are important for the dynamics of Himalayan ecosystems and their presence indicates healthy wild ecosystems (Animal Diversity Web, 2008). Snow leopard symbolizes the rich natural and cultural heritage of the Himalayan high-altitudes and it is a flagship species for conservation. The Government of India launched a landscape level participatory conservation program for the Indian high-altitudes called the 'Project Snow Leopard' (PSL) in 2009. The framework of PSL allows conservation of multiple-use large landscapes and to develop National and Trans-boundary conservation initiatives in the form of National Snow Leopard Ecosystem Priority Protection (NSLEP), Snow Leopard Survival Strategy (SLSS), and Global Snow Leopard and Ecosystem Protection Program (GSLEP) (Snow Leopard Network, 2014). As part of GSLEP,

large landscapes have been identified in India across Himachal Pradesh and Jammu and KashmirUT to secure breeding populations of Snow leopard. In Ladakh UT, the scope of the Project Snow Leopard is confined to Ladakh, Zanskar, and Karakoram. But, surveys need to be conducted in other parts such as Pir-Panjal, Doda, Bhaderwah, Rajouri, etc. (Anonymous, 2008). Himachal Pradesh Forest Department is also executing a collaborative project with the National Conservation Foundation (NCF) to estimate the population of snow leopard. Three landscapes in context of Chenab River Basin in Lahaul Valley *viz*., Bhaga, Chandra, Miyar and Thirot have been confirmed for the occurrence of Snow leopard during the initial findings of this project.

Management practices and human interferences have strong influence on the physical and biological (terrestrial and aquatic) environments. Tran-Himalayan and North Western Himalayan bio-geographic zones face the major threats from tourism, extraction of medicinal plants and NTFPs, poaching, human-animal conflicts, climate change, deforestation, invasive species, land use change, etc.

SECURE Himalaya project is major initiative by Government of India to ensure the conservation of significant biodiversity, land and forest resources of high Himalayan ecosystems present in Himachal Pradesh and Ladakh Union Territory. The project is joint venture between MoEF&CC and UNDP with support from the Global Environment Facility Trust. The project aims at securing livelihoods, conservation, sustainable use and restoration of high range Himalayan ecosystems. The project is meant for specific landscapes Changthang in Ladakh Union Territory and Lahaul, Pangi, and Kinnaur in Himachal Pradesh. The key focus areas of the project are protection of Snow leopard and other Endangered species, their habitats and also securing livelihoods of people in the region.

2.5 Grasslands, Pastures and Alpine Meadows

Grasslands are structurally different and functionally dynamic ecosystems which support lot of flora, fauna, livestock and human populations. Grasslands cover pasturelands, rangelands, and alpine meadows (Singh *et al.*, 2018). These ecosystems are dominated by the Poaceae, Cyperaceae, Fabaceae and Asteraceae families. Globally, grasslands constitute about one quarter of earth's surface and occur in well defined climatic zones i.e., tropical, sub-tropical, temperate, sub-alpine, alpine (Curry-Lindahl, 1981; Brown, 1989). Indian Himalayan region has many temperate grasslands, pastures and alpine meadows. The grasslands vegetation present in the Indian Himalayanregion occupies nearly 35% of the geographical area and includes temperate grasslands, sub-alpine and alpine meadows, and steppe formations of cold arid regions or alpine dry scrubs. The temperate and alpine grasslands of the Himalayanregion have been studied by a large number of ecologists (Numata, 1986; Ram *et al*., 1989; Rikhari *et al.*, 1992; Sundriyal, 1989, 1995; Bawa, 1995; Bhat and Kaul, 1989). In the Himalayan region, alpine meadows are phenologically distinct and well adapted to harsh climatic conditions. These alpine pastures are ecologically very significant as they play a major role in ecosystem functioning by controlling the soil erosion of catchments areas and hold importance in aesthetic aspects (Stirling and Wilsey, 2001). Himalayan temperate

grasslands and alpine meadows are also a rich repository of the large number medicinal herbs.

Temperate Pastures and Alpine Meadows of Chenab River Basin

The Chenab River Basin in Indian Territory covers the State of Himachal Pradesh and Jammu division of J&K UT. Due to the peculiar topographical features and varied climatic factors, a number of grasslands are found both in Himachal Pradesh and Jammu and Kashmir UT (Table 2.16)

Table: 2. 16- Grasslands of Himachal Pradesh and Jammu and Kashmir UT including Ladakh

State/ Union Territory	Geographical Area (km^2)	Temperate Grassland/ Pastures
Himachal Pradesh	55,673	10,240
Jammu and Kashmir UT including Ladakh UT	2,22,236	1,240

The Lahaul and Pangi valleys of Himachal Pradesh under the Chenab River Basin fall under the semi arid zones of inner Himalaya. The rain shadow areas of the valley have characteristic trans- Himalayan 'steppe' grasslands dominated by short grasses. The major species contain *Elymus nutans*, species of *Danthonia*, *Stipa*, *Agropyron*, *Poa*, *Calamagrostis*, *Bromus* and *Festuca* along with thorny bushes such as *Caragana*, *Astragalus*, *Lonicera* and also *Juniperus*, *Ephedra*, etc. (Rawat, 1998). Himalayan grasslands are called as Bahaks/Margs or dhars in Jammu and Kashmir UT and thatches in Himachal Pradesh. *Danthonia cachemyriana* is found as dominant species on the slopes of these Alpine meadows along with other major grasses e.g., *Festuca, Poa, Bromus, Agrostis*, etc. (Table 2.17). Apart from grasses, species of *Carex, Cobresia, Medicago, Potentilla, Primula, Delphinium, Aconitum, Medicago, Cicer, Arnebia, Arabidopsis, Ephrasia, Doronicum, Sinopodophyllum, Arabis, Rheum, Danthonia, Lloydia, Allium, Thermopsis, Allium, Arenaria, Eremurus, Caltha, Anemone, Heracleum, Pleurospermum, Thalictrum, Sausurrea,Aquilegia, Sibbaldia, Bistorta*, etc. also form the major part of the alpine meadow (Samant *et al*., 2011).

Table: 2. 17- Diversity of important grasses and legumes of Jammu and Kashmir UT

Zone	Grasses
Temperate zone	*Dactylis glomerata, Bothriochloa* spp., *Alocopis paleacea, Festuca arundinacea, Calamogrostis emodensis, Arundinella nepalensis, A. pumila, Chrysopogon gryllus, Digitaria* spp., *Saccharum spontaneum, Erianthus rufipilus, Lolium perenne, Phleum pratense, Bromus unioloides, Phalaris* minor, *Poa pratensis, Lolium multiflorum, Agrostis*

	spp., and *Avena sativa.*
Intermediate zone	*Dactylis glomerata, Festuca arundinacea, Lolium perenne, Cymbopogon martini, Dicanthium annulatum, Chloris gayana, Chrysopogon serrulatus, C. gryllus,Heteropogon contortus, Setaria* spp., *Avena sativa, Cymbopogon distans, Neyraudia arundinacea, Phragmitis* sp., *Polypogon fugax, Arthraxon compositus, Sachharum spontanum,* and *Themeda anathera*.
Sub-tropical zone	*Dicanthium annulatum, Chloris gayana, Chrysopogon fulvus, Heteropogon contortus, Cenchrus ciliaris, C. setigerus, Paspalum notatum,* and *Avena sativa*
Cold arid zone	*Festuca arundinacea, Avena sativa, Phalaris* spp., *Dactylis glomerata, Danthonia cachymiriana, Brachypodium sylysaticum*.

(Source: Modified after Singh and Ahmad, 2018).

Sacred Groves

These are traditionally protected natural areas of native vegetation or particular forests that have been given sacred status on religious and ethinic beliefs and protected by local communities since long (Gadgil and Vartak, 1976; Chandrakanth *et al.,* 1990; Ramakrishnan, 1996). The concordness between human and nature exists since ages and practiced by showing reverence, recognition and appreciation for nature and natural resources. The traditional communities have marked landscapes with mythological importance as sacred groves. They are widely distributed all over the world (Ramakrishnan, 1998). Sacred Groves are commonly known as 'Devban' in Himachal Pradesh. A variety of plant species (e.g., Bael-*Aegle marmelos*, Deodar- *Cedrus deodara, Buxus wallichiana, Ulmus wallichiana*, *Ficus* spp., and Oak-*Quercus* spp.) are considered as sacred and felling a tree from the sacred groves is considered a taboo (Gupta, 2006). In Jammu and Kashmir UT, the sacred groves are called as Banis and these are present all over the places. Some of the species commonly found in the sacred groves include Mango(*Mangifera indica*), Banyan (*Ficus benghalensis*), Mountain ebony (*Bauhinia variegata*), pipal (*Ficus religiosa*), white fig (*Ficusvirens*), and Neem (*Azadirachta indica*) (Amirthalingam, 2016).

2.6 Wetlands- The Interface Ecosystems

The wetlands are important landscape features which represent the intermediatary ecosystems between the aquatic and terrestrial environments. Primarily the word 'Wetland' provides an idea about the land saturated with water and inhabited with plants and animals as well (Hashemi*et al.,* 2012). Water is the main factor monitoring the environment and associated

plant and animal life in a wetland. The wetlands are generally interfaced between a terrestrial ecosystem and an open water system and include areas *viz*., marshes, swamps, temporary ponds, riverbanks, estuaries, deltas, bogs, streams, reservoirs, and mangroves (Attri *et al*., 2010).

Technically, the wetlands are defined as areas of marsh, fen, peat land static or flowing water and brackish or salt including areas of marine water. The wetlands are most productive and diverse ecosystems of earth like the rain forests and coral reefs and supports a variety of Plants and animals i.e., amphibians, reptiles, mammals, insects, birds, fish and microbes (Ghermandi, 2008). They perform numerous vital functions *viz*., protect and improve water quality, provide habitats for fish and wildlife, store flood waters and maintain surface water flows, etc. These valuable functions are result of the unique natural characteristics of wetlands (HIMCOSTE, 2017). The wetlands are also ecologically sensitive (Turner *et al*., 2000). As per the Ramsar Convention, the natural water bodies such as lakes, coastal lagoons, mangroves, peat lands, coral reefs and man-made structures such as ponds, farm ponds, irrigated fields, reservoirs, sewage farms and canals constitute the wetland ecosystem.

Wetlands of Chenab River Basin: The geographical extent of Chenab River Basin across the Himachal Pradesh and Jammu and Kashmir UT has a plentiful inland wetlands and lakes due to varied physiographic terrain, climatic conditions and extensive water resource (Table 2.18, 2.19).

Table: 2. 18- Wetlands under Chenab Riverscape in Himachal Pradesh and Jammu and Kashmir UT

S. No.	District	Geographical area (km^2)	Lake/Pond (ha)	High Altitude Wetland (ha)	Riverine Wetland (ha)	River/ Stream (ha)	Reservoir/ Barriage (ha)	Tank/ Pond (ha)	Wetland (< 2.25 ha)	Total
Jammu and Kashmir UT										
1	Jammu	3,017	31	-	-	19,372	-	-	235	19,638
3	Doda	11,683	-	79	-	5,567	-	-	21	5,667
4	Rajauri	2,628	-	37	-	4,835	-	-	38	4,910
5	Udhampur	4,580	58	13	45	7,591	576	-	43	8,326
Himachal Pradesh										
1	Chamba	6,528	2	30	-	3,631	991	-	13	4,667
2	Lahaul & Spiti	13,835	-	184	8	10,368	111	8	87	10,766

(Source: ISFR 2019)

Table: 2.19– Type wise Details of Wetland in State of Himachal Pradesh and Jammu and KashmirUT

S. No.	Wetland Category	Himachal Pradesh			Jammu and Kashmir UT including Ladakh UT		
		Number of Wetlands	Wetland Area (ha)	% of Wetland Area	Number of Wetlands	Wetland Area (ha)	% of Wetland Area
A	**Inland Wetlands – Natural**						
1	Lakes/ Ponds	1	2	0.04	36	13762	3.52
2	Oxbow Lakes/ Cut-off Meanders	-	-	-	-	-	-
3	High Altitude Wetlands	20	214	2.35	1143	109170	27.88
4	Riverine Wetlands	-	-	-	88	9594	2.45
5	Waterlogged	2	8	0.07	-	-	
6	River/ Stream	14	13999	174.1	138	231597	59.16
B	**Inland Wetlands – Man-made**						
7	Reservoir/ Barrages	3	1102	22.26	4	25132	6.42
8	Tanks/ Ponds	2	8	-	2	6	0.00
9	Waterlogged	-	-	-	-	-	-
C	**Total Inland Wetlands**	**142**	**15443**	**200**	**3651**	**391501**	**100.00**
D	**Wetlands (<2.25 ha)**	**100**	**100**	**0.545**	**2240**	**2240**	**0.57**
E	**Grand Total**	**284**	**30876**	**399.365**	**7302**	**783002**	**200**

(Source: SAC, 2010)

Chander Tal Wetland - The Origin Point of Chandra River

It is a high altitude wetland situated in the cold desert area of Trans Himalaya. The Chandra tributary of Chenab River originates from Chander Tal. The wetland is situated in Chander

Tal Wildlife Sanctuary. The total wetland area is about 1.53 km^2 and circumference of the Lake is 4 km^2. The Chander Tal catchment is an area of meadows, rugged rocks, snow and scree. The catchment is dominated by alpine scrubs and dry alpine steppe vegetation consisting of grasses and sedges e.g., *Stipa* sp., *Leymus* spp., *Carex* spp., *Kobresia* spp., *Danthonia* spp., *Agrostis* spp., etc.

Surinsar-Mansar: The Twin Lakes of Chenab Basin in Jammu Region

The Surinsar-Mansar freshwater composite Lake system is a major natural resource in the Jammu region. The twin lakes have high religious significance owning to their origin in Mahabharata period. The Surinsar Mansar Wildlife Sanctuary is nestled in the middle of the lakes. The two lakes separated by an aerial distance of 10 km, represent the typical micro-climate and it forms an ideal habitat and breeding ground for many avifauna and aquatic species (Singh and Sharma, 1999). Important native and migratory bird fauna include *Fulica atra atra* (Coot), *Gallinula chloropus indicus* (Indian moorhen), *Podiceps nigricollis*, *Podiceps cristatus* (Great Crested Grebe), *Podiceps ruficollis* (Dabchick), *Podiceps cristatus* (Great crested Grebe), *Aythya fuligula* (Pochard), *Netta rufina* (Red Crested Pochard), *Anas acuta* (Pintail), *Anas crecca* (Common Teal), *Phalacrocorax niger* (Little Cormorant), *Ardea alba* (Large egret), *Ardeola grayii* (Pond heron), *A. cinerea* (Grey heron), *Ceryle lugubris guttulata* (Pied Kingfisher) and *Alcedo atthis* (Small blue kingfisher).

Gharana Wetland: The Gharana wetland is situated about 27 km away from Jammu City. It has been the winter destination for Siberian birds. It is an abode for about 170 species of resident and migratory birds, and known as 'The bird- Watcher's Paradise'. Few flagship species include Bar Headed Geese (*Anser indicus*), Grey Lag Goose (*Anser anser*), Shelduck (*Tadorna sp.*), Pochard (*Aythya ferina*), Gadwill (*Marecas trepera*), Pintail duck (*Anasacuta sp.*), Mallard (*Anasplatrhynchos*), Spoonbills (*Platalea sp*), Common cranes (*Grus grus*), Wooly necked storks (*Ciconia episcopus*), Wigeon (*Mareca sp.*), Whistling Teals (*Dendrocygna javanica*), etc. (Gupta *et al.,* 2017).

Pargwal Wetland: The Pargwal wetland is a group of islands and small streams located downstream of Chenab River near Akhnoor. About 3,000 to 5,000 Bar Headed Geese (*Anser indicus*) and other migratory birds visit this wetland every year (Gupta *et al.,* 2017).

2.7 Forest Cover and Change

The deforestation of forest land as natural resource occurred on a large scale during recent decades. This rapid deforestation made great changes on the ecology, environment, health and economy of the country. Keeping all these features in view, it was necessary to carry out forest cover change detection by focusing on the monitoring of present and past status of forest cover and other related objects using Remote Sensing and GIS techniques.

The ISFR-2019 reported that there is a complete increase of 6,678 km^2 (0.96%) forest cover during two consecutive assessments in 2017 and 2019 (ISFR, 2019). The state of Himachal Pradesh indicated a net increase of 393 km^2 in 2 years in comparison to 14,707 km^2 forest cover in previous assessment of 2017. The main reason for net increase of 393 km^2 in forest

cover in the State can be recognized to plantation and conservation activities both within and outside the forest cover area. The Jammu and KashmirUT registered net increase of 253 km^2 in the forest cover over the 2 years period and much of this was in Open Forest (OF) category. The main reason for net increase of 253 km^2 in forest cover in the State can be attributed to plantation and conservation (ISFR, 2019).

(a) Forest Cover

According to the ISFR-2019 (FSI, 2019), India had Recorded Forest Area (RFA) of 7,67,419 km^2 representing 23.34% of the country's geographical area. This RFA included 56.6%, 28.5%, and 14.8% proportion under the legally defined Reserved Forests (RFs), Protected Forests (PFs), and Unclassed Forests (UFs), respectively (Table 2.20). The values of RFAs in the State of Himachal Pradesh and Jammu and KashmirUT along the course of Chenab River were 37,033 km^2 and 20,230 km^2, respectively. The mountainous State has nearly 67% area as the recorded forest area while the agriculture dominated territory of Jammu and Kashmir had a meager recorded forest area of just 6.76% of its geographical area. The proportion of reserved forests in both was substantially low as bulk RFA was in the legal category of protected forests. The State of Himachal Pradesh with it's nearly 67% RFA contributes 4.82% of the country's RFA while the Jammu and Kashmir UT contributes a minuscule proportion of country's RFA. The factual information provided in Table 2.20 amply revealed that the hilly State of Himachal Pradesh wherein the Chenab River not only originates but, also have catchment of some of its major tributaries still has considerable RFA. However, the bulk RFA is under the relatively lower category of PFs. The factual insight about the current forest cover in Himachal Pradesh and Jammu and Kashmir UT and the historical information on the considerable loss of forests in HP and J&K UT in the past century or so warrants intensive Forestry Interventions in the riverscape by way of plantations as well as strict protection to the existing limited extent of forests. (Table 2.20)

Table: 2. 20- Recorded Forest Areas (RFAs) in India, and Himachal Pradesh and Jammu and Kashmir UT represented in the Chenab Riverscape

S. No.	India/ State/UT	Geogra-phical Area	Reserved Forests (km^2)	Protected Forests (km^2)	Unclass-ed Forests (km^2)	Forests Recorded Area (km^2)	Country/ State Geographical Area (%)	% of India's Forests Area
1	**All India**	**32,87,263**	**4,34,705**	**2,19,432**	**1,13,881**	**7,67,419**	**23.34**	**23.34**
2	Himachal Pradesh	55,673	1,898	33,130	2,005	37,033	66.52	4.82
3	Jammu and Kashmir UT	2,22,236	17,643	2,551	36	20,230	6.76%	2.64
4	**Total of HP and J&K UT**	**2,77,909**	**19,541**	**35,681**	**2,041**	**57,263**	**73.28**	**7.46**

(Source: ISFR, 2019)

Further, the close scrutiny of information on forest cover on canopy density provided by the FSI in its ISFR-2019 in concerned States/UT depicts almost similar trends (Table 2.21)

Table: 2. 21- Forest Cover in India, Himachal Pradesh and Jammu and Kashmir UT

S. No.	India/ State/UT	Geo-graphical Area (km^2)	VDF (km^2)	MDF (km^2)	OF (km^2)	Total Forests (km^2)	Geo-graphical area (%)	Tree Cover (km^2)	Total Forests and Tree Cover (km^2)	Scrub (km^2)
1	**India**	**3,287,469**	**99,278**	**3,08,472**	**3,04,499**	**7,12,249**	**21.67**	**95,027**	**8,07276**	**46,297**
2	Himachal Pradesh	55,673	3,113	7,126	5,195	15,434	27.72	829	16,263	315
3	Jammu and Kashmir UT	2,22,236	4,281	8,612	10,719	23,612	10.62	7,944	31,556	548
4.	**Total of HP and J&K UT**	**2,77,909**	**7,394**	**15,738**	**15,914**	**39,046**	**38.34**	**8,823**	**47,819**	**863**

(b) Tree Outside Forests (TOFs)

Trees Outside Forests (TOF) are defined by FAO as "trees on land not defined as forest or other wooded land". Consequently TOF are defined in relation to the two other tree resources and these three categories should therefore be discussed at a landscape level. In India, TOF is defined as all those trees, which have accomplished 10cm or more dbh (diameter at breast height) and are available on lands, is not notified as 'forests' or 'other wooded land'. Trees Outside Forests contain trees on agricultural lands, in urban and settlement areas, along roads, in home gardens, in hedge rows, scattered in the landscape and on pasture and rangelands. In the 1990s, FAO recognized that TOF are typically splintered among the components of agro-forestry, urban and rural forestry, and other disciplines. TOF tend to be left out of forest statistics, natural resource assessments, policy, and legislation.

Trees outside Forests (TOF) play a very important role in national economies, ecosystems and international efforts for sustainability and in many places they already do. At the local level, people have long relied on TOF in various land-use settings for food security, income and biological diversity. Forest professionals in many countries support local use of trees for these purposes, outside forest as well as in forest settings. More recently, international programmes build on trees' roles in providing essential environmental services to encourage sustainable land management, carbon sequestration to alleviate climate change, and local economic development.

The entire country had tree cover outside RFAs to the extent of 93,815 km^2 while HP and J&K UT including Ladakh UT together had 8,637 km^2 tree cover outside RFAs. In total, tree

cover of 822 km^2 was recorded in Himachal Pradesh while the tree cover was 7,815 km^2 recorded in Jammu and Kashmir (ISFR, 2019).

(c) Growing stock

The exact information on growing stock which is the measure of the substance of its trees wealth and contains distribution of stems in different diameter class, volume, biomass, carbon stock, etc. both within and outside forest area is required for strategic planning of the forestry sector at various levels. Traditionally, growing stock is considered as a main indicator of forest health and productivity. The growing stock is assessed through forest inventory under which both qualitative and quantitative parameters are recorded to know overall health of growing forests. In working plan exercise also, assessment of growing stock is an important and integral component for local level management of forest resources.

Table: 2. 22- Growing Stock (ISFR, 2019)

S. No	Country/ State/ UT	Geographical Area (km^2)	Forest Recorded Area in TOF (km^2)	% of India's Forest Area	Country/ State/ UT' Geographical Area (%)	Growing Stock in RFAM (m^3)	Growing Stock M (m^3)
1	All India	32,87,469	5,915.76	23.34	21.67	4218.4	1604
2	Himachal Pradesh	55,673	372.26	4.83	27.72	315.6	23.2
3	Jammu and Kashmir UT	222,236	416.77	2.64	10.62	232.8	146.1
4	**Total of HP and J&K UT**	2,77,909	789.03	7.46	38.34	548.4	169.3

For the entire country, the growing stock in the RFA was computed to the amount of 4218 million m^3 while the growing stock in TOFs was 1604 million m^3 (ISFR, 2019). Collectively, diverse forests in Himachal Pradesh, UTs of Jammu and Kashmir and Ladakh had growing stock in RFA to the tune of 548 million m^3 and this established 13% growing stock of the country in RFA. These contributed 7.46% growing stock of the country in TOF. The state of Himachal Pradesh contributed 316 million m^3 or 7.5% growing stock of RFA of the whole country while Jammu and Kashmir UT including Ladakh UT was contributor of the growing stock in TOF, being 233 million m^3 or 5.5% growing stock in TOF of whole country (ISFR, 2019)(Table 2.22).

(d) Spatial pattern of forest cover and fragmentation in different patch size

Forests offer a wide range of services as, they protect soils from erosion, regulate the water regime, capture and store carbon, produce oxygen, provide fresh water and habitat, help decrease fire risk (in the tropics), and produce wood and non-wood forest products. Forest degradation, therefore, adversely affects millions of people who depend, wholly or partially, on forests goods and services at a local scale, and billions of people who benefit from forest services at a regional or global scale. Specifically, for forest owners and managers, forest degradation is a direct threat to their livelihoods as it decreases a forest's productivity and profitability, and it is a clear indication of unsustainable practices in the forests under their supervision. Forests fragmentation refers to any process that results in the conversion of formerly continuous forest into patches of forests separated by non-forested lands. The definitions of fragmentation are as diverse as the subject itself. In one definition, "Fragmentation has been clear as the conversion of large areas of contiguous native forest to other types of vegetation and /or land use leaving remnant patches of forest that vary in size and isolation". Thus, the FSI for the first time has evaluated the number and size of patches with regard to the forest cover of the whole Country/ States as well as different forest types (ISFR, 2019). Accordingly, it was observed that the country's total forest cover (708,273 km^2) was fragmented in 746,386 patches under varying size classes ($\geq$0.01 km^2 to >10,000 km^2) and as much as 97.45 patches (7,27,380) were of the lowest size class ($\geq$0.01 km^2 to $\leq$ 1 km^2); together, they contribute just 7.64% of the forest cover of the country, just 379 patches under higher patch size class (>100km^2 to >10,000 km^2)(ISFR, 2019).

In case of Himachal Pradesh, 33.83% of forest cover was made up by just one patch of > 5000 - >10,000 km^2 while, 97.15% forest patches were of the lowest forest size category ($\geq$0.01km^2 to $\leq$ 1km^2) and contributed 1,578 km^2 or 10.45% of forest cover of the state. The situation of forest fragmentation and distribution of forest patches in different size classes inJammu and Kashmir UT, 40.98 % of forest cover of the whole State and UT was formed by just one patch of > 5000 - >10,000 km^2 while 97.85% forest patches in Jammu and Kashmir UT were of the lowest forest size category ($\geq$0.01 km^2 to $\leq$ 1 km^2) and contributed 2900 km^2 or 12.48% of the forest cover (Table 2.23).

Table: 2. 23- Forest Cover Informatics in Different Patch Size Class (ISFR, 2019)

S. No.	Patch Size Range (km^2)	No.of Patches	Area (km^2)	Percentage (km^2)
All India				
1	$\geq$ 0.01 - $\leq$ 1.0	7, 27,380	54,082	7.64
2	>1.0 - $\leq$ 10	16,444	43,639	6.16
3	>10 - $\leq$ 100	2,183	58,052	8.20
4	>100 - $\leq$ 500	257	51,298	7.24
5	>500 - $\leq$ 1000	57	39,628	5.59

6	>1000 - ≤ 5000	42	85,407	12.06
7	>5000 - ≤10000	14	90,028	12.71
8	>10000	9	2, 86,139	40.40
	Total	**7, 46,386**	**7, 08,273**	**100**
Himachal Pradesh				
1	≥0.01 - ≤1.0	22,082	1,578	10.45
2	>1.0 - ≤10	554	1,482	9.82
3	>10 - ≤100	76	2,276	15.07
4	>100 - ≤500	9	1,635	10.83
5	>500 - ≤ 1000	4	3,020	20.00
6	>1000 - ≤ 5000	4	5,109	33.83
7	**Total**	**22,729**	**15,100**	**100**
Jammu and Kashmir UT including Ladakh UT				
1	≥ 0.01 - ≤ 1.0	41,872	2,900	12.48
2	>1.0 - ≤ 10	798	2,067	8.89
3	>10 - ≤ 100	97	2,754	11.85
4	>100 - ≤ 500	15	3,120	13.42
5	>500 - ≤ 1000	4	2,874	12.37
6	>1000 - ≤ 5000	5	9,526	40.99
7	**Total**	**42,791**	**23,241**	**100.00**

(d) Changes in Forest Cover

As stated earlier, FSI has been carrying out biennial assessment on forest cover for the entire country and each of the State, Union Territory since 1987. Thus, in past 15 consecutive assessments until 2019, valuable results on changes in forest cover have been obtained. The same has been summarized in Table 3.14 for the entire country, Himachal Pradesh and Jammu and Kashmir UT relevant to the Chenab Riverscape. Accordingly, in general, the country has shown the continuous gain in the extent of forest cover from 1987 to 2019, except in 1991 assessment. The forest cover increased from 6,40,819 km^2 in 1987 to 7,12,249 km^2 in the intervening period of 30 years. Hence, there was an overall gain in forest cover to the extent of 10.5%. Like India, Himachal Pradesh and Jammu and Kashmir UT also showed gradual increase in forest cover since 1987 except an aberration between 2001 and 2005 in the case of Jammu and Kashmir UT (Table 2.24).

Table: 2. 24- Comparison of Forest Cover in India, Himachal Pradesh and J&K UT between 1987 and 2019

India/ State/ UT	Geo-graphical Area (km^2)	Change in Total Forest Cover Since 1987 (km^2)							
		Assessment Year							
		1987	1991	1995	2001	2005	2011	2017	2019
India	**3,287,263**	**6,40,819**	**6,39,879**	**6,38,879**	**6,75,538**	**6,77,088**	**6,92,027**	**7,08,273**	**7,12,249**
Himachal Pradesh	55,673	12,480	12,480	12,502	14,360	14,369	14,669	15,100	15,434
Jammu and Kashmir UT	2,22,236	20,905	20,449	20,443	21,237	21,273	22,539	23,241	23,612
Total of HP and J&K UT	**2,77,909**	**33,385**	**32,929**	**32,945**	**35,597**	**35,642**	**37,208**	**38,341**	**39,046**

(Source: ISFR, 2015 and 2019)

Undoubtedly, the country as well as concerned State and UT showed gradual increase in forest cover in past 30 years. However, such increase in forest cover has to be seen with caution in connotation with the valuable insight on various forest canopy density classes, growing stock, spatial patterns of forest cover, patch characterization, and the pace of fragmentation, particularly loss of smaller forest patches at a very fast pace. The foregoing description on changes in forest cover, the condition of the growing stock and the alarming rate of forest fragmentation warrants extensive as well as intensive Forestry Interventions so as to ensure healthy forests, efficient catchments, and sustainability of river ecosystems.

2.8 Carbon Stock in Forest

Forests store carbon and contain approximately 80% of the total aboveground organic carbon and 40% of the total below ground organic carbon worldwide. Deforestation and forest degradation add 15-20% of global carbon emissions, and most of this contribution comes from tropical regions. Approximately 60% of the carbon sequestered by the forests is free back into the atmosphere via deforestation. Forest biomass is an indicator of carbon sequestration. The amount of carbon sequestered by a forest can be conditional from its biomass accumulation because approximately 50% of forests dry biomass is carbon. The majority of biomass assessments are performed for the above-ground biomass (AGB) of trees because this biomass generally signifies the greatest fraction of the total living biomass in a forest and does not pose significant logistical problems during field measurements. Estimating above-ground forests biomass is the most important step in calculating the carbon stocks and fluxes from tropical forests and helps to control the contribution of forests to the global carbon cycle (Vicharnakorn *et al.*, 2014).

(a) Carbon Cycle and Global Warming

Carbon is a rich element that is necessary for life on Earth. "The carbon cycle is the exchange of carbon between all of the Earth's components- the atmosphere, oceans and rivers, rocks, sediments and living things". The processes of photosynthesis and respiration are the basis of the carbon cycle. In photosynthesis, plants use energy from the sun and carbon dioxide (CO_2) gas from the atmosphere to produce carbohydrates (sugars) and oxygen (O_2). Carbohydrates are then stored (or sequestered) in their biomass (living parts, such as leaves, stems and roots) as plants live and grow. Stored carbohydrates can be used as energy. To use the energy, carbohydrates are essential to be broken down in respiration and CO_2 is released back into the atmosphere. The rate at which CO_2 formed is variable. For example, decomposition- where fungi and microorganisms break down carbohydrates to gather energy, is a slow but important way that carbon is returned to the atmosphere. The carbon cycle involves the flux, or flow of carbon between different earth systems. An object or process that absorbs and stores carbon is called a sink, while one that releases carbon faster than it is absorbed is termed as source. For example, a healthy plant is a carbon sink because it is taking in CO_2 from the atmosphere and storing it in new leaves and roots and a larger stem. However, a plant can become a source of carbon if the amount of CO_2 going out exceeds the amount taken in. This might happen if a plant is eaten and an animal utilizes its carbon for energy or if CO_2 is sent back into the atmosphere through decomposition or fire.

Humans have a large influence on the worldwide carbon cycle. Fossil fuels, including coal, oil, and natural gas, all contain large amounts of carbon that was formed during the decomposition of plants and animals over millions of years. Burning fossil fuels breaks large amounts of CO_2 and other greenhouse gases into the atmosphere faster than natural processes. Changes in land use, especially deforestation, also contribute to elevated levels of atmospheric CO_2. Although, plants fascinate some of the additional CO_2, most of the greenhouse gases remain in the atmosphere and contribute to climate change/ global warming (NIACS, 2007) (Table. 2.25).

Table: 2. 25- Forest Carbon Stock in Different Carbon Pools (values in '000 t) in India, Himachal Pradesh and Jammu and Kashmir UTalong the Course of Chenab River (values in parentheses are of per ha of a stock in tonnes)

India/ State/UT	Area of forest land (km^2)	AGB	BGB	Dead wood	Litter	SOC	Total
India	**7,12,249**	**22,56,533**	**7,00,824**	**35,842**	**1,27,902**	**40,63,575**	**71,24,676**
Himachal Pradesh	15,434	1,10,045	30,745	2,559	2,711	1,06,300	2,52,360
Jammu and Kashmir UT	23,612	1,70,222	47,806	3,813	3,706	1,64,648	3,90195
Total	**39,046**	**280,267**	**78,551**	**6,372**	**6,417**	**270,948**	**642,555**

(Source: ISFR, 2019)

(b) Carbon Stock of Forests in Himachal Pradesh and Jammu and Kashmir UT

Diverse forests along the altitudinal gradient, riverine and other forests in hills of Himachal Pradesh and Jammu and Kashmir UT contribute about 6.4% carbon stock of the country. The carbon is sequestered/stored by forests in various forms. It contains the Above Ground Biomass (AGB), Below Ground Biomass (BGB), Dead wood, Litter and Soil Organic Matter (SOC). The health of forests in terms of density and growing stock will matter in the process of carbon sequestration. Hence, diverse forests in Jammu and Kashmir UT have maximum carbon stock, followed by forests in Himachal Pradesh.

2.9 Conservation Initiatives and Challenges

Most of the rivers originate from the Himalayan glaciers and support various ecosystems *viz*., forests, grasslands and wetlands (Sathyakumar and Bhatnagar, 2002). The Himalaya is well known for its rich biological, ecological and hydrological values (Sathyakumar, 1994). As described earlier, there is a very rich repository of niche-specific wild fauna and flora in Chenab River Basin due to various altitudinal range, topography, rugged terrain and distinct physiographic zones (Ghosh, 1996). A large population of the region lives in close proximity with the forests and wildlife is seriously threatened due to human interferences. In order to conserve the entire range of biodiversity, a Protected Area Network(PAN) consisting of Biosphere Reserves, National Parks and Wildlife Sanctuaries has been established in Himachal Pradesh and Jammu and Kashmir UT.

Protected Area Network

The Protected areas are those in which human interferences and exploitation of resources is restricted or limited. They vary by level of protection depending on the enabling laws of each country or the regulations of the international organizations involved. Biosphere Reserves are notified for the conservation of ecosystems, National Parks for the conservation of habitat and Wildlife Sanctuaries for the protection of a particular species of flora and fauna. Some of the Protected Areas under Chenab River Basin in Himachal Pradesh and Jammu and Kashmir UTare described below:

Chandratal Wildlife Sanctuary

The Chandratal Wildlife Sanctuary is located in Lahaul valley. It was notified on 7th June, 2013. This Wildlife Sanctuary has an area of about 38.56 km^2.This area is situated between 32°31' to 32°23' N Latitudes and 77°38' to 77°34' E Longitudes. Important species of mammals found in the sanctuary include Snow Leopard (*Panthera uncia*), Ibex (*Capra sibirica*), Tahr (*Hemitragus jemlahicus*), Tibetan Wolf (*Canis himalayensis*) and Blue Sheep (*Pseudois nayaur*) (Singh and Thakur, 2019; Samant *et al.,* 2012). The notable floral elements of Chandertal Wildlife Sanctuary are *Hippophae rhamnoides*ssp. *turkestanica, Caragana* sp., *Rosa webbiana, Lonicera* sp., *Ephedra gerardiana* andherbaceous species i.e., *Sinopodophyllum hexandrum, Ranunculus* sp., *Thymus linearis, Delphinium* sp., *Geranium* sp., *Rosularia* sp., *Stellaria*sp., and *Bistorta affinis,* etc.

Sechu Tuan Nalla Wildlife Sanctuary

Sechu Tuan Nalla Wildlife Sanctuary is in Pangi valley of Chamba district with an area of 390.29 km^2. It was established in 1974 and finally notified on 7th June, 2013. This Sanctuary is located between 32°49' to 33° 10' N Latitudesand 76°38' to 76°46' E Longitudes. Important faunal species of the sanctuary are Himalayan Ibex (*Capra sibirica*), Musk deer (*Moschus chrysogaster*) and Snow Leopard (*Panthera uncia*) (Singh *et al*., 1990). The floral species found in the Sanctuary include *Ephedra geradiana*, *Jurinea macrocephala*, *Acontium heterphyllum, Sinopodophyllum hexandrum, Berberis* spp., *Angelica glauca*, *Bergenia ligulata*, etc.



Ibex (*Capra ibex*)

Nandini Wildlife Sanctuary

This is one of the very popular Wildlife Sanctuary in Jammu Division of Jammu and Kashmir UT. It covers an area of 33.34 km^2. It was notified as sanctuary by Jammu and Kashmir UT (Government notification vide SRO.137 dated 10-4-1990). This Sanctuary is acclaimed worldwide due to the significant pheasant's dominance. Apart from that, the Sanctuary also provides shelter to a huge number of rare and endangered species of mammals. The main species are Common Indian leopard (*Panthera pardus*), barking deer (*Muntiacus muntjak*), wild boar (*Sus scrofa*), nilgai (*Boselephus tragocamelus*), porcupine (*Hystrix indica*), red jungle fowl (*Gallus gallus*), peafowl (*Pavo cristatus*), python (*Python spp.*), russell viper (*Daboia russelii*), cobra (*Ophiophagus hannah*), mongoose (*Herpestes edwardsi*), etc. The trees, shrubs and herbaceous flora found in the wildlife sanctuary are *Mallotus philippensis*, *Pinus roxburghii*, *Justicia adhatoda*, *Carissa opaca*, *Malvastrum coromandelianum*, *Desmodium* sp., *Cassia* sp., *Crotolaria* sp.,*Medicago* sp., *Oxalis corniculata* and *Cynodon dactylon* (Singh *et al*., 2018).

Ramnagar Wildlife Sanctuary

The Ramnagar Wildlife Sanctuary is situated on the outskirts of Jammu City. The Sanctuary area is about 31.50 km^2. It was declared as Wildlife Sanctuary in 1987, the catchment zone of Kar Nalla of the Tawi River. The faunal species found in the Sanctuary are Common Indian leopard (*Panthera pardus*), barking deer (*Muntiacus muntjak*), wild boar (*Sus scrofa*), nilgai (*Boselephus tragocamelus*), porcupine (*Hystrix indica*), red jungle fowl (*Gallus gallus*), peafowl (*Pavo cristatus*), python (*Python* spp.), russell viper (*Daboia russelii*), cobra (*Ophiophagus hannah*), mongoose (*Herpestes edwardsi*). The Sanctuary area is covered by dense mixed scrub and Chir pine forests. Other floral elements of the Sanctuary are *Acacia catechu*, *Bombax ceiba*, *Cassia fistula*, *Acacia arabica*, *Dalbergia sissoo*, *Mallotus philippensis* and *Grewia optiva*.

Surinsar Mansar Wildlife Sanctuary

This Sanctuary is of one the most popular Wildlife Sanctuaries, which has been christened so due to the influence of two lakes, located on the periphery of this Sanctuary. A vast area of 97.82 km^2 forms the existence of this Sanctuary. It was notified in the 1990. The vegetation comprised of the *Pinus gerardiana* and has a lush spread of mixed scrub forests and the broad leaved trees and shrubs. The broad leaved species are *Bauhinia variegata*, *Ficus religiosa*, *Dalbergia sissoo*, *Mallotus philippensis*, *Acacia* spp., *Dalbergia sissoo*, *Bauhinia variegata*, and *Ficus religiosa*. Prominent fauna of this sanctuary are Goral (*Nemorhaedus goral*), leopard(*Panthera pardus*), barking deer(*Muntiacus muntjak*), wild boar (*Sus scrofa*), etc.; important bird species found in the sanctuary are Rufus turtle dove(*Streptopelia orientalis*), Red jungle fowl(*Gallus gallus*), Gray partridge (*Perdex perdex*), Peafowl (*Pavo cristatus*), Black partridge (*Melanoperdix niger*), Blue rock pigeon(*Columba livia*) and Green pigeon (*Treron sp*.).

Kishtwar High Altitude Natioanl Park

The Kishtwar High Altitude National Park is located on the northern side of the Kishtwar town in Jammu province. It was notified in the year 1990. The National Park spreads between 33° 27’ to 33° 59’ N Latitudes and 75° 40’ to 76° 17' E Longitudes and lies between 2,300-6,000 m amsl. It covers 2,191.50 km^2area. It comprises of grass lands, bushy vegetation, marshy land, glacial lakes and varied types of forests *viz*., Himalayan moist temperate forests, sub-alpine forests, moist alpine scrub, western mixed coniferous forests, moist temperate deciduous forests, temperate pastures and high level dry blue pine forests. Due to the availability of varied vegetation and variety of habitats, the area is highly suitable for the wildlife. The prominent fauna are Hangul (*Cervus elaphus*), Snow Leopard (*Panthera uncia*), Leopard (*Panthera pardus*), Himalayan Black Bear (*Ursus thibetanus*), Brown Bear (*Uusus arctos*), Common Langur (*Semnopithecus entellus*), Musk Deer (*Moschus chrysogaster*), etc. The principal tree species are *Pinus gerardiana*, *Cedrus deodara*, *Quercus* spp., *Pinus wallichiana*, *Juglans regia*, *Ulmus* spp., etc. The main shrub associates are *Viburnum* spp., *Parrotiopsis jacquemontiana*, *Rosa* spp., and *Desmodium tiliaefolium*. The National Park harbours a wide range of medicinal plants *viz*., Hillu (*Impatiens glandulifera*), Bankakdi (*Sinopodophyllum hexandrum*), Mulam (*Inula royleana*), Guggal (*Jurinea dolomiaea*), Postul (*Taxus wallichiana***),** Mori (*Delphinium roylei*), Tatnu (*Caltha palustris*), Kuth (*Saussurea costus*), etc. (J&K Govt. Gazette, 2015). Besides this, the National Park supports a large local and nomadic population. The inhabitants are largely dependent on the wild resources of National Park.

2.11 Socio-Economic Environment

The natural streams of water including rivers are most important components for the functioning of society and play important role for the well- being of the individuals and communities. Rivers provides a range of services which are utilized for the benefit of human society. The society derives a whole range of benefits from the rivers *viz*., freshwater,

livelihoods, commercial production, energy generation, transport, tourism, etc. (Emerton and Bos, 2004; TEEB, 2013). Apart from these, riverine ecosystems support biodiversity, transport sediment and nutrients, dilute pollutants and waste, and regulate floods and droughts. These attributes of the rivers have helped in establishing the linkage between the society and river ecosystems (Fig.2.4)

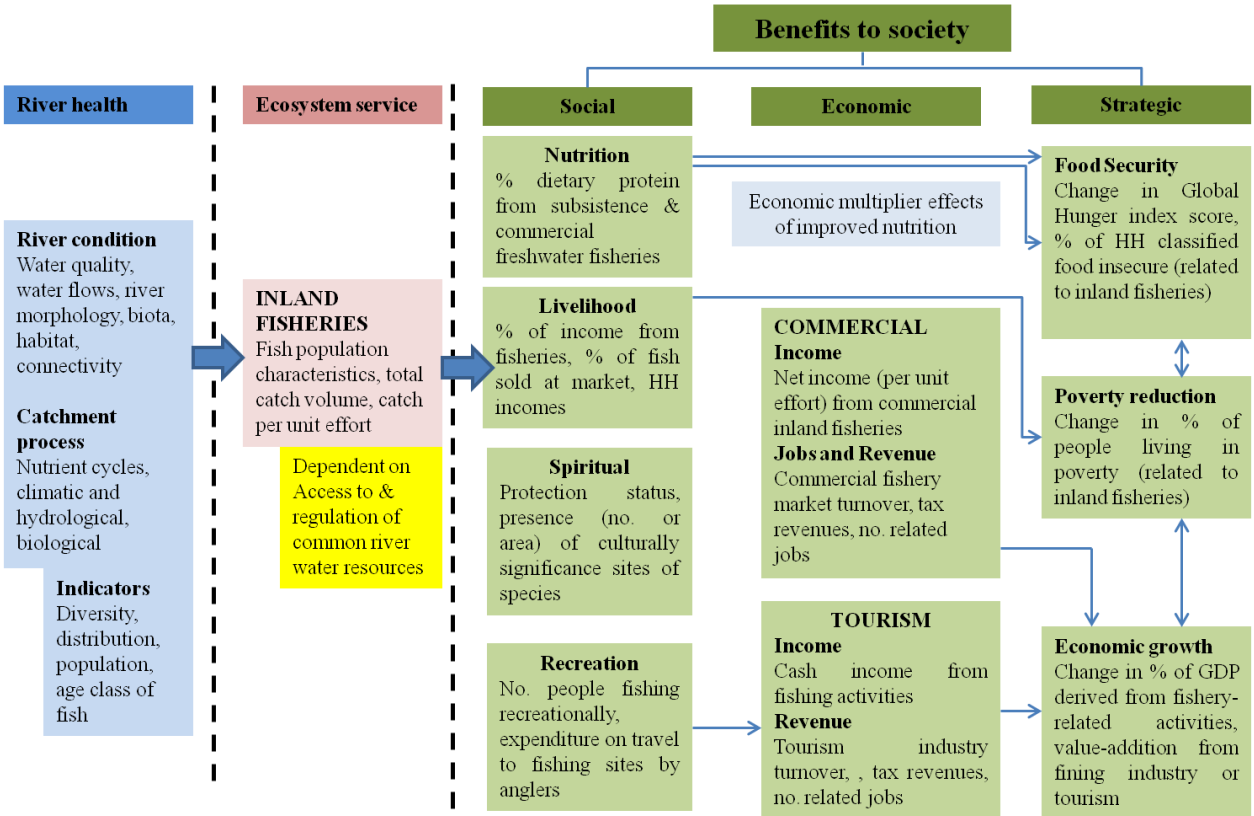


Fig. 2.4- Attributes of the rivers between the society and river ecosystems

(Source: Adopted and Modified Parker and Oates, 2016)

The dynamics of socio economic environment, drivers of human development and various bio-physical factors such as climate change, population growth and other demographic changes, industrialization or economic transformation, land use change and urbanization impacts the riverine ecosystems directly and alters the processes and functioning of rivers resulting in over-exploitation, pollution, proliferation of invasive species, and disruptions of natural flow regimes, etc. Ramsar Convention underlines the concept of 'Wise Use' as the need to secure benefits for society over the long-term through the protection of ecosystems (Ramsar Convention Secretariat, 2010). The potential impacts of socio-economic change on flow and water quality in rivers is a key area of interest.

2.12 Historical Perspective – Creation of Forest Reserves, Timber extraction, Commercialization of Forests and Deforestation

Forests are great natural wealth and the Indian landmass is gifted with rich forest resources. The historical legacy of Indian forests is closely linked with the political, demographic and

economic development, and social set up of the country. Factors such as population pressures, socio-economic matrixes, topographic and climatic variables and social and religious conditions have led to the changes in management and utilization of forests in India over the years. The utility of forests was well known to the people even in the ancient times (Biswas, 1998). Forests play a great role during the advent and development of Dravadian civilization as early as 2000 B.C. The early Aryans cleared large areas of forests to establish their settlements. Beautiful description *viz*., Dandakaranya, Nandanvan, Khandavan, etc., are given in Ramayana and Mahabharata scriptures. The ancient Hindu culture also originated in Ashrams located in forests. Himalayan forests are extensive, diverse and structurally, phenologically and functionally different (Zobel and Singh, 1997). The forests of Indian Himalayan Region constitute major land use and land cover category. These provide subsistence and livelihoods to large number of people in and around their periphery, and are very important for survival of humankind. The wide range of altitudes and climatic conditions in the Chenab Riverscape across Himachal Pradesh and Jammu and Kashmir UT sustain a variety of forest types namely, moist tropical, dry tropical, montane subtropical, montane temperate, sub-alpine, and alpine scrubs (Champion and Seth, 1968). These forests play a vital role in conserving the integrity of the upper watersheds of Chenab River and sustaining the agro-pastoral livelihoods of hill people. In 1855, Sir J. Lawrence under the colonial government framed and issued General Rules for the conservancy of forests and jungles in the hill regions. These rules marked the first systematic effort to exert state rights over the management of forests. Following this, forest settlements were conducted in almost all the forested regions of Himachal Pradesh between 1855 and 1934. Like most parts of India, Local Forest Rights in Himachal Pradesh are based on colonial forest settlements conducted by British Forest Officers in the last century. Forest settlements clearly recognized and legalized local forest uses, which are very significant today for community forestry. Under the extant, Forest Rights in Himachal Pradesh, villagers living in the fringes of forests can sell Non-Timber Forest Products (NTFPs) and earn financial benefits. Thus, although, almost all the forests belong to the state in terms of ownership, villagers enjoy extensive user rights to forests near their villages (Vasan, 2001). The practice of keeping local forest guard or '*Rakha*' was prevalent in Himachal Pradesh. The *rakha* was engaged to protect forests from illegal uses. He received the remuneration for this from all the households of the villages usually in the form of grains. This practice indicates the importance of forests as livelihood resource and perception of ownership and responsibility for forest management among villagers of the region. The colonial Forest Department institutionalized the *rakha* system and paid a nominal cash salary to the *rakha* in addition to the grains. He was expected to report to the Forest Department in addition to his traditional duties. The *rakha* was responsible for the every day management of both government forests as well as common and private forests and grasslands. In Lahaul Forest Division, the presence of *rakhas*, has been documented (Singh, 1998). Similarly, sacred groves or *devban* are a unique socio-ecological resource. These groves also present excellent examples of local management of resources. Observance of the rules of the *devban* constitutes religious practice, and no separate enforcement organization is necessary. Many sacred groves are spread across Pangi valley in Himachal Pradesh and Jammu Division of Jammu and Kashmir UT under Chenab riverscape.

The forests in Jammu and Kashmir UT were utilized since long with no regulation on management of forests. The setting up of section called 'Mahal Mawera' in the Revenue Department is considered as the first step in forest management. Even then, the objective was to obtain more revenue and no heed was given to conservation of forests (Negi, 1994). The forests regulations in case of Jammu and Kashmir UT were promulgated in 1913 and after that working plan are framed for managing the forest resources. In 1982, MC Donnel, an officer of Indian Forest Services organized the forest department and consolidated the work of demarcation of forest, organized the beats and ranges, initiated the construction of roads and buildings, etc. An introductory regulation called 'Aim-i- Janglat' for controlling forest working was introduced in 1983. Jammu and Kashmir Forest Poicy, 2010 emphasized to enhance the aesthetic value of forests and optimize the productive potential of forests by scientific management according to the working plan prescription. The Jammu Division comprises of Kishtwar, Doda, Udhampur, Jammu, Reasi and Rajouri district under Chenab Riverscape, has a vast forest stretches providing many benefits to the local communities since generations mainly timber for construction of houses and manufacturing of furniture,besides, they provide also medicinal herbs for use in the ayurvedic health care sytsems. Among the wild edible species, *Morchella esculenta* is very well known in trade, and is the source of income generation for the poor people residing in the temperate and sub-alpine regions. But at the same time, commercialization of forests of Jammu Division had contributed significantly to the loss of biodiversity. Deforestation had threatened the ecological security and accelerated soil erosion due to floods.

2.13 Land and the People

The tribal belt of the Lahaul and Pangi valleys in Himachal Pradesh and different physiographic areas of Jammu Division of Jammu and Kashmir UT including Kishtwar, Doda, Udhampur, Reasi and Rajouri districts under the Chenab Riverscape are enormously unique and diverse in terms of natural resources *viz*., forests, alpine pastures, grasslands, wetlands and lakes and also presents an attractive matrix of socio-economic profile. The people of Lahaul and Pangi valleys preserve some interesting remnants of great historical value, and have innumerable vestiges of ancient Vedic civilization right from the Mahabharata period onwards (Chauhan,1998). Chenab Valley which is also known as Pattan valley extends from Tandi to Tindi and downstream of Tindi, approximately after 10 km it is known as the Pangi Valley. The Lahaulis comprising of Hindu and Budhishts ehinic groups, are basically honest, hospitable and peace loving Tribes. Agriculture is the main occupation although; growing season is short and limited. Dress in Lahauli, tribes consists of loose trousers and coarse woolen coat, like a gown, which is tied at the waist. Pula or straw shoes are commonly used. Female dress consists of churridar pyjama, a gown (dugpo), that hangs below the knees. Woolen shawl is used in winter. The Pangwals of the Pangi valley purely belong to Hindu community. They are straight-forward, honest religious and hard working. Their main occupation is agriculture; some of them also rear sheep and goats. The Jammu region has both plain as well as mountainous physiography and spread from Shiwalik hills, mid Himalayan Mountains up to Pir-Panjal range. The region represents an intricate mosaic

of mountain ranges and hills characterized with river terraces valleys and gorges. More than two-third residents of the area are classified as Hindu. The people of this region belong to Hindu and Muslim communities. Several pastoral communities e.g., Gujjars and Bakerwals also reside in the region. Thus, the upper areas of Chenab Riverscape are sparsely populated and the lower areas are quite densely inhabited. The details of land, land use and people in context with Himachal Pradesh and Jammu and Kashmir UT are given below:

2.13.1 Land and Land Use

The Lahaul and Pangi valleys of Himachal Pradesh and Kishtwar, Doda, Udhampur, Jammu, Ramban, Reasi, Rajouri districts constituting the Jammu province of Jammu and Kashmir UT largely fall under Chenab Riverscape area. Collectively, both these geo-political entities cover 2,77,909 km^2 area (Table 2.23). The Himachal Pradesh is predominantly mountainous with 1.7% geographical area of the country while Jammu and Kashmir UT represents 6.93% area of the country. The Himachal Pradesh and Jammu and Kashmir UT display topographic features and considerable altitudinal variations. There are various land use categories *viz*., forests, net area sown, permanent pastures and other grazing lands, and area not available for cultivation in Himachal Pradesh and Jammu and Kashmir UT. The extent of forests as land use category represents 24.21% area in Himachal Pradesh and 56.24% area in Jammu and Kashmir UT including Ladakh UT. The extent of permanent pastures and other grazing lands covers relatively large area. A larger proportion of geographical extent (24.82%) in Himachal Pradesh is represented by the area not available for cultivation while 14.29% of Jammu and Kashmir UT falls in this land use category. Thus, it is very clear that the Chenab River Basin is rich in forests and permanent pastures and other grazing lands (Table 2.26).

Table: 2. 26– Land Use Pattern in Himachal Pradesh and Jammu and Kashmir UT

Land Use					
S. No.	**Land Use**	**Himachal Pradesh**		**Jammu and Kashmir UT including Ladakh UT**	
		Area (km^2)	**Per cent Geographical Area of Country/ State**	**Area (km^2)**	**Per cent Geographical Area of Country/ State**
1	Total Geographical Area	55,673	1.70	50,360	1.53
2	Reporting Area for Land Utilization	45,490	100.00	50,330	100.00
3	Forests	11,010	24.21	2,950	5.86
4	Non-Cultivable Land	11,290	24.82	5,160	10.25
5	Permanent Pastures and other Grazing Lands	14,960	32.89	70	0.14
6	Land Under	650	1.43	50	0.10

	Miscellaneous Tree Crops and Groves				
7	Culturable Waste Land	1,380	3.03	30	0.06
8	Fallow Lands other than Current Fallows	150	0.33	0	0.00
9	Current Fallows	640	1.41	370	0.74
10	Net Area Sown	5,410	11.90	41,690	82.83

(b) Culture and Religion

Culture is the admixture of various tangible and intangible elements including belief systems, ethics, values, knowledge, taboos, traditions, folklore, attires and dresses, dance, cuisines, art, artefacts, architecture, monuments, etc. It is the assemblage of basic values of society and expresses the specific way of life practised and preserved by people and passed from generation to generation (Gandhian Studies, 2014). In broader context, culture includes different aspects and it is the reflection of social behaviour, learning and experiences.

The North Indian hilly state, Himachal Pradesh, popularly known as *dev bhomi,* has very rich and unique culture. This mountainous state boasts of varied cultural aspects i.e., fairs, festivals, dance forms (nati), songs and cuisines (Kumar, 2017). The Himachali culture is traditionally very rich and consists of varied and exclusive elements i.e., the traditional attires, rhythmic dance forms, music, religious institutions, folk songs, life- styles, arts and handicrafts, etc. The culture of the state is known for its simplicity and exuberance. It reflects unity in diversity. Fairs and local festivals of the state have exceptional attraction. The local deities (*devta*) are located in almost every village and during fairs and festivals; they are pleased by enchanting music and dance. Different dialects *viz*., Mahasui, Pahari, Kangri, Bilaspuri, Kehluri, Lahauli and Kinnauri are spoken in the state. Local cuisines are essential and integral cultural aspect of Himachal Pradesh. Some of the traditional dishes include Siddu, Sepu-vadi, Madra, Guchhi-mutter, Patande, Bhaturu, Babru, Badana, Mithdoo, Seera, Lasurae ki sabji, Bhruni ki sabji, Patrode, etc; (Kumar, 2017). Majority of the people follow Hinduism. Besides, a small population of Muslims, Sikhs and Buddhists also occur in the State.

Jammu and Kashmir UT, popularly known as the crown of India, is a beautiful landscape dotted with many scenic places, beautiful valleys, rivers, lakes, springs, and dense forests. Since long, the region has reeled under militancy, religious conflicts, turmoils, and upheavals due to various political and strategic reasons. Despite of all this, Jammu and Kashmir UT present a unique blend of rich culture which is reflected in its colourful costumes, delicious cuisines, music, dance, arts, handicrafts, embroidery, fairs, festivals, etc. Many fairs and festivals are orgainsed and celebrated by various socio-ethinic groups. These include Baishakhi, Lohri, Eid-ul-Fitr, Tulip Festival, Shikara Festival, Gurez Festival, Sindu Darshan, Bahu Mela, Jhiri Mela, Craft Mela, etc. Vegetarian and non- vegetarian dishes *viz.*, Hak, Rajmah, Zarda, Tursh, Shree Pulao, Nadeir Yakhaen, Rogan Josh, Yakhni, Pasanda, Syun Alu and Methi Keema constitute important part of the cuisines. The traditional costumes are

beautifully decorated with attractive embroidery. There is presence of diverse social and religious practices. The traces and traditions of Hinduism and Budhism in the region are older than the advent of Islam. There are temples, gurudwaras, mosques, forts, palaces, havelis, serais, baolis, etc. at many places. By and large, Jammu and Kashmir UT comprise of three distinct regions *viz.*, Jammu province, Kashmir, and Ladakh. The three regions are greatly different and diverse in terms of culture, customs, language and religion (Midlaj). The culture of Jammu region is dominated by Dogri culture. This culture is prevalent in the areas along the Shivalik mountain ranges. Folk dances, basholi style of miniature painting and sculptures portraying the images of Hindu Gods and Goddesses are the main features of this culture (Qazi, 2005).

The Chenab valley spread between Doda- Kishtwar stretch of Jammu province, has religiously and linguiustically amalgated culture displaying various connections and dimensions of Hindu- Muslim communities. This belt is dominated by Muslim population. Muslim and Hindu inhabitants speak different languages and dialects e.g. Kashmiri, Bhaderwahi, Siraji, Kishtwari, Pogli, Padderi, Gojri, Dogri, Pahari, Punjabi, etc. Their dressing and cuisines have similarity and they participate in intercommunal rituals and regligous ceremonies. Machail Devi Yatra and Kailash Yatra are the popular Hindu pilgrimage in which Muslims also participate enthusiastically. The Muslims of the region follow the Sufian convention of Islam. The holy shrine of Sufi Saint Hazrat Shah Fariduddin Baghdadi is visited both by Hindu and Muslims. Thus, this region shows the communal harmony and inter-mixing of culture.

(c) Tourism and Allied Activities

Both Himachal Pradesh and Jammu & Kashnmir UT are the favorite tourist destinations due to the spectacular kaleidoscope of nature and grandeur of natural beauty existing at various places. Tourists from the different parts of country and abroad visit these places quite frequently for adventure, culture and pilgrimage tourism. Undoubtedly, tourism provides a fillip to the economy of Himachal Pradesh and Jammu & Kashnmir UT. But, conversely the pressure on the natural resources has increased due to these activities.

2.14 Development Programmes, Implications and Conservation Issues

During past few years, the State of Himachal Pradesh and Jammu and Kashmir UT have witnessed many developmental activities. Construction of big dams, creation of long tunnels, widening of highways, real estate activities, mining activities, settlements, irrigation network, agriculture and horticulture expansion, fishery, tourism, urbanization, industrialization, etc. In general, these developmental activities have put adverse impacts on the vital natural resources *viz.*, soil, forests, rivers, streams and aquifers. In addition to this, the increasing dependence of people for meeting out the needs of water, food, fuel, timber, fodder, and fibre is compounding the pressure on natural resources. Resultantly, these resources are becoming scarce and there are phenomenon of bio-diversity loss, habitat fragmentation, pollution, degradation of land and freshwater resources including the rivers.

In nutshell, the preceding description given in this Chapter delineates the Chenab Riverscape alongwith its various sub-environments. It also provides a general account about the prevailing situation, terrestrial and aquatic ecosystems, unique flora and fauna, and ecology of Chenab River. Definitely, the varied anthropogenic activities/processes and their implications have brought enormous and multi-dimensional losses to the river ecology and its associated environments. Consequently, the continuous deterioration of important freshwater resources has reached to the irreversible extent.

2.15 SWOT Analysis of Chenab River Ecosystem and its Environment

After the extensive consultative exercises undertaken for the present task and simultaneous exhaustive review of available published literature, technical reports and websites carried out to find out the existing situation of the Chenab River and its environment, its past trends, and implications, the Strength, Weakness, Opportunities, Threats (SWOT) Analysis was performed. The outcomes of the SWOT Analysis are briefly presented in Table 2.27

Table: 2.27- Summary of SWOT Analysis in the Context of Chenab Riverscape and its Environment

Strength
i) Chenab River is one of the major tributary of Indus River Basin. It originates from Chandertal in Lahaul and Spiti district of Himachal Pradesh. After the confluence of Chandra and Bhaga at Tandi, the Chandrabhaga or Chenab River flows through Lahaul and Pangi valleys in Himachal Pradesh and then enters in Padder valley of the Kishtwar district of Jammu and Kashmir UT. It flows up to Akhnoor within Indian Territory. The total catchment area of Chenab River is spread over India and Pakistan. The upper drainage basin of Chenab River situated in Himachal Pradesh and Jammu and Kashmir UT is mainly fed by glaciers.
ii) The Chenab Riverscape has very complex physiographic characteristics and it reveals rugged topographic attributes, peculiar relief features, steep cliffs, deep gorges, large altitudinal gradient and distinct climatic conditions which in turn supports diverse forests, high altitude grasslands and alpine pastures, lakes and wetlands. All these habitats across the riverscape harbour rich faunal and floral elements including many rare, endangered, endemic and threatened species. These diverse natural ecosystems entail huge biodiversity values, maintain the ecological integrity, overall health and sustained environmental flows of the Chenab River and its tributaries.
iii) The drainage network of the Chenab River is the result of fluvio-glacial activity. The Chenab River Basin is mainly characterized by presence of a wide ranging snow clad peaks, glaciated lakes and large glaciers which keeps recurrent water flow in the river throughout the year.
iv) There are array of Protected Areas *viz*., Wildlife Sanctuaries and National Park under the Chenab Riverscape. The Chandertal Wildlife Sanctuary in the Himachal Pradesh and Kishtwar High Altitude National Park in Jammu Province of Jammu

and Kashmir UT support unique and socio-economically important flora and fauna besides serving as important tourist destinations.

v) The Chenab riverscape also supports unique mammals and birds.

vi) The Chenab River has huge hydro-power generation potential and provides irrigation to the vast stretches of plains in Jammu region of Jammu and Kashmir UT.

vii) Many places of immense historical, cultural and religious values *viz.*, Tandi, Trilokinath, Udaipur, Killar, Bahu Fort, Akhnoor Fort, etc., are under the Chenab Riverscape.

Weakness

i) The terrain of Chenab River Basin is ecologically very fragile and loose, prone to landslides and high seismicity. A variety of physical, hydrological, climatic and socio-economic factors e.g., dumping of excavated muck, erosion due to anthropogenic activities (i.e., deforestation, road construction/ clearing, overgrazing, and farmland cultivation), increased sedimentation and silt load, reckless exploitation of resources (i.e., medicinal and aromatic plants) from the river basin have changed the status, health and functionality of the Chenab River adversely and drastically over the years.

ii) The Chenab River Basin is a major river basin of Himalaya which exhibits the phenomenon of deglaciation and moraine dammed lakes in its upper reaches. Moreover, the fragile ecology of mountainous terrain having the varied physico-climatic conditions makes it even more susceptible to the vagaries of nature.

iii) The majestic forests resources, wetlands, alpine meadows and pastures are under constant anthropogenic pressures.

iv) Despite of so many legislative frameworks, regulatory mechanisms and authorities instituted for ensuring the sustainable use of forests, environment, wildlife, pollution control, waste management, etc., the challenges for enforcement of these acts and laws still perisits. Most of the agencies and organisations in context with the conservation of Chenab River are working in isolated and fragmented manner and there is lack of coordination and synergy.

v) Chenab River is the largest tributary of the Indus River Basin. It is a major river of India and Pakistan and volume wise bulkiest river of Himachal Pradesh. The clauses of Indus Water Treaty (IWT, 1960) render Chenab River of limited and disproportionate use for India.

vi) The harnessing of Chenab River Basin for cascade development of hydro-power has resulted in increased deforestation, landslide, soil erosion, disappearing of aquifers and springs causing irreversible detrimental effect to the overall river environment.

vii) The main stem of the River and its tributaries in Jammu region face the problem of pollution due to disposal of untreated sewage waste, unabated disposal of municipal solid waste, dumping of wastes of commercial

establishment, pesticides, chemicals fertilizers and industrial wastes. All these factors are degrading the quality of the Chenab River day by day.

Opportunities

i) The transboundary extent of Chenab River and vast spatial spread of Chenab River Basin across two countries provides ample scope of research and development on its enormous resources having high potential of providing wide range of goods and services to the well-being of dependent human population.
ii) Significant involvement and realistic interventions are required on the part of various scientific organizations, environment protection agencies, government sector departments, non-governmental organizations, law enforcement agencies, civil society organizations and other stakeholders to explore various resources of Chenab River Basin and devise viable mechanisms for sustainable use, strategies for conservation of unique biodiversity and maintenance of the ecological integrity of the Chenab River ecosystem.
iii) The provisions of the legal enactments/ treaties can be revised for proportionate use of the water of Chenab River by two riparian countries.
iv) The Chenab River has huge ability to reverse and reduce bad effects of different disturbances and pollution. Therefore, the ecological problem which has damaged the structure and functionality of Chenab River provides opportunities for restoring the dynamic natural ecosystem to meet the needs of human survival and development sustainably.

Threats

i) The fragile terrain, sensitive seismotectonic setup, proneness to landslides and glacial lakes outbursts are the major threats of the Chenab River Basin.
ii) The various anthropogenic activities in the form of hydro-power generation, construction and widening of roads, riverbed mining, deforestation and urbanization, industrialization, unregulated tourism and the emerging problem of climate change are posing threats to the Chenab Riverscape ecology, altering the intact and inherent nature of river and as a whole impacting the ecosystem of the area.
iii) The expansion of agriculture and horticulture activities leading to increased demand of water for irrigation has caused depletion of groundwater resources at many places in the Chenab Riverscape and affected flow regime of the river.
iv) The inter-governmental involvement, complexities and pitfalls of IWT, 1960 in context with Chenab River sometimes give rise to conflicting interest between the riparian State/UT and countries.

2.16 Research and Monitoring

The major cross cutting issues and challenges of natural resource management, environment degradation, and other developmental sectors require research and monitoring at various levels and scales. Essentially, research and monitoring are important and corresponding

activities which are widely practiced for natural management, addressing the water resource degradation, sedimentation of rivers, fragmentation of forest resources and biodiversity loss etc,. These vital activities help to appreciate the existing situation, generate comprehensive knowledge base, identification of major problems and areas of concerns, setting up priorities and devising the suitable redress strategies and mechanisms. Apart from this, research and monitoring also helps in the formulation of long term all embracing policy framework for the appropriate management of natural resources.

The detailed description about the Chenab River, its lateral and longitudinal connectivity, varied land features, associated bio-physical sub-environments given in the preceding sections and Chapters elaborately underscored the multi-dimensional, dynamic and integrated nature of the river ecosystem and also provides insight about the initiatives of different organizations/ agencies, scientists and researchers from different areas and arenas (i.e., forestry, biodiversity, hydrology, glaciology, fishery, agriculture, pedology, wildlife, environment science, geology, engineering, social sciences, etc.) to know the intricacies of the Chenab River ecosystem from its origin to confluence besides providing the impacts and influences of various anthropogenic activities on the fragile and susceptible environment of river environment as a whole. It is evident that the existing information on the river ecosystem and surrounding environment is found in archaic, isolated, disjointed, piecemeal, and inconsistent forms. It lacks uniformity, consistency and coherence. Obviously, the information is sparsely available and largely asymmetric which do not provide the systematic understanding of Chenab River and its surrounding environments. This suggests that different implementing agencies require to work with better coordination and synergy to develop through exhaustive and complete understanding of the river environment and its linkages with the terrestrial ecology. It necessitates the dire need to envisage, support, speed up, integrate and coordinate the initiatives/actions, consider all aspects and implications simultaneously for developing a complete understanding of river, its ecology and environment or more precisely river science discipline as a whole.

Evidently, the analysis of available information reflects the fact that so far the research and monitoring activities have not given required heed to the importance of forests/vegetation and their vital role in governing ecology, environment and flow regime of major river systems of India. It is equally true that perennial Himalayan Rivers of the country are gifted natural freshwater resources which not only support a large highland population but, also brings prosperity to regions situated downstream. In view of the emerging water crisis and large population of the country, water security has become one of the overriding priorities of the nation. It is the right time and highly pertinent to understand the significance of seamless interconnectedness between the forests and river hydrology. In developed countries, the discipline of river science is well recognized and institutional setups and mechanisms are already in place for the restoration of rivers. In Indian context, the scenario is quite dismal because rivers and fresh water resources have been neglected since long. Therefore, research and monitoring between various cross-linking areas/disciplines assumes immense importance to serve the concerns of rivers and fresh water resources all across the country. Consequently, the Detailed Project Report (DPR) for rejuvenation of Chenab River through Forestry Interventions has been conceptualized to supplement and enhance the research and

monitoring framework for the improvement of river ecology including hydrology and environment.

Table: 2. 28- Types of Researches and Monitoring Efforts in the context of Chenab Riverscape

Sr. No.	Type of Inventory and Monitoring	Implementing Agencies	Periodicity	References	Remarks
1.	State/ UT and Fate of Himalayan Glaciers	Geological Survey of India ICIMOD SAC, ISRO	Broad based baseline information on glaciers exists and study/ monitoring protocols standardized. No specific periodicity or consistency in procedures evident. Mostly, one time project based outputs. Longer gaps in monitoring. Appears as no single authority designated for monitoring and keeping long term database. Several piecemeal, sporadic monitoring efforts by individual Scientist or group of Scientists for specific glacier or a basin level monitoring.	Govinda Raj, 2010; Cuffy and Paderson, 2010; Benn and Evens, 2010; Sain, 1946; Immerzeel *et al.*,2010; Kaser *et al*., 2010; Pritchard, 2017; Bajracharya and Shrestha, 2011; Miller *et al.*, 2012; Vohra *et al*., 1970	Broad based insight on the State/ UT and fate of Himalayan Glaciers and Glacial Lakes region/basin-wise exists. Monitoring of glaciers in different basins during 2000-2011 undertaken. Inventory of glaciers and glacial lakes by ICIMOD during 2002-2015 provided.

Sr. No.	Type of Inventory and Monitoring	Implementing Agencies	Periodicity	References	Remarks
2.	Cryosphere, Snow Cover, Glacial Lakes and Permafrost	National Institute of Hydrology (NIH) SAC, ISRO Wadia Institute of Himalayan Geology (WIHG) H.P. State Centre on Climate Change (HPSCC) HIMCOSTE	Probably no specific designated agency. Sporadic and *adhoc* initiatives by different agencies/ group of scientists. Lack of uniformity in procedures/ protocols, monitoring sites and even periodicity.	Kour *et al*., 2016; Singh *et al*., 1997; HPSCCC; Randhawa *et al*., 2005	Mostly piecemeal efforts. SAC, ISRO carried out probably one time study on snow cover in different basins during 2000-2011. It was difficult to comprehend precise information on snow cover, GLOFs, etc. specific to the Chenab River Basin.
3.	Surface and groundwater Resources and E-Flows	Central Water Commission (CWC) Central Ground Water Board (CGWB) – States Units State Council for Science and Technology Department of Irrigation National Institute of Hydrology (NIH) Wadia Institute of Himalayan Geology (WIHG) Indian Institute of Technology (IIT), Roorkee International Water Management Institute (IWMI)	Valuable information on the State/ UT-wise and District-wise ground water resources on annual basis is being provided by CGWB. Information on surface water, estimation of snow/ glacier melts contribution on *adhoc* basis-fragmentary studies. Evaluation of water Budget – river specific studies/ monitoring. Monitoring in specific stretches of river. Information on e-flows for Indian River basins based on longer stretches of time periods by IWMI.	Giorgi, 1997; Zhang *et al.*, 2013; Jain *et al.*, 2005; Singh *et al.*, 1995; Shahid *et al*., 1995; Ground water year Book, 2016-17; RSET, 2019; HIMURJA; CGWB, 2013; Kumar *et al.*, 2005; Nikson *et al*., 2005; Iyer, 2005; Dyson *et al*., 2008; Gupta and Despande, 2004.	Desired information on ground water and surface water being provided on regular basis for each of the State/ UT, District and prominent rivers. Likewise, valuable information on e-flow in case of prominent rivers and hydroelectric projects (HEPs) being generated. However, there is a need to organize large datasets for optimal use by various user agencies. Insight on e-flows for smaller streams/ tributaries of major rivers is desirable.
4.	Sediment Transport and Sediment	Various international and national	Methods to assess sediment fluxes in reservoirs have been	Rawat and Rawat, 1994;	Review revealed that probably no specific national

Sr. No.	Type of Inventory and Monitoring	Implementing Agencies	Periodicity	References	Remarks
	Budget and Flooding	agencies carry out the studies on sediments load in major rivers. National Institute of Hydrology (NIH) Indian Institute of Technology (IIT), Roorkee and Bombay Scientific studies on assessment of sedimentation in different reservoirs and role of mega dams in reducing sediment fluxes.	improved using RS and GIS technologies. Piecemeal and fragmentary studies. No specific periodicity.	Varsheney *et al*., 1986; Rao *et al*., 1997; Singh *et al*., 1995; Singh and Jain, 1993;	level agency responsible for comprehensive and adequate monitoring of sediment transport through various rivers, tributaries, and confluences.
5.	Water quality	Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) are the agencies for monitoring water quality in rivers and other water bodies. State and Central Government Institutions, Universities, and Scientists.	Regular monitoring of water quality on select permanent monitoring stations in different seasons relevant to prominent rivers and water bodies. Individual efforts are predominantly piecemeal or specific to a river/ tributary stretch or a wetland.	HPSPCB, 2019; Khadse *et al*., 2016	Standard guidelines for monitoring of water quality (parameters, tolerable range and periodicity) by MoEF&CC, CPCB and BIS are available. However, water monitoring in various rivers, tributaries and confluence points needs intensification.
6.	Forest Cover,Tree Cover, Forest Types, TOFs, Growing Stock and Carbon	Forest Survey of India (FSI)	FSI undertakes biennial assessment on overall forest cover – entire country, State /UT and District-wise since 1987. Situation	Biennial ISFRs by FSI; NIACS, 2007	Much reliable, authentic and institutionalized process. Considering the significance of prominent rivers

Sr. No.	Type of Inventory and Monitoring	Implementing Agencies	Periodicity	References	Remarks
	Sequestration		of forests including temporal changes in TOFs being provided on regular basis. Valuable insight on growing stock, carbon sequestration, forest fires, bamboos, etc. is also made available.		and their tributaries, it would be desirable that basin-wise information is also generated at least on a periodical interval of five years to start with the available data Considering the threat of weeds/ Invasive Alien species(IAS).
7.	Carnivores (Snow leopard, bears) and Herbivores	State Forest Department (SFD), Wildlife Wing WII ZSI NCF Snow Leopard Trust Local Universities/ State level Institutions Individual Experts/ Scientists	The Wildlife Wing of the State Forest Department organizes periodic/ annual assessments on population estimation of select species i.e., carnivores, ungulates and primates in select PAs. In recent years, NCF and HPFD have collaborated to monitor the population of snow leopard and its prey. WII and ZSI have also intensified activities on field surveys/ assessments of faunal species in project mode.	Animal Diversity Web, 2008; Peerzada *et al*., 2010; Parvez, 2007; Vinod and Satyakumar, 1999	Efforts so far have been made mainly to standardized methods/ protocols for field surveys/ assessments/ monitoring of elusive snow leopard and its prey in vast rugged terrain and harsh climatic conditions. Concerted efforts, collaborations are required to develop comprehensive scientific protocols to assess high altitude fauna and their habitat on periodic basis on the lines of All India Monitoring of Tiger, its Prey and Habitat as implemented by NTCA in all tiger range States/ UTs. Replication of similar efforts in the Himalayan States/ UT or the Project Snow Leopard States is desired.

Sr. No.	Type of Inventory and Monitoring	Implementing Agencies	Periodicity	References	Remarks
8.	Fish Fauna	State Fishery Department National Bureau of Fish Genetic Resources (NBFGR) ZSI WII SANDRP WWF - India	Several institutions/ experts have carried out fragmentary/ isolated studies on the diversity, abundance and distribution of fish fauna in different rivers/ stretches or other water bodies. By and large, most efforts are in the form of surveys/ research studies or one time initiative.	Kapoor, 1992	Considering the significance of fish fauna in river ecology, there is an urgent requirement to develop and adopt standard protocol for long term monitoring of fish fauna in the Chenab River Basin/ Riverscape or relevant, prominent rivers and tributaries in a State/UT on the lines of Sarkar *et al*., 2012 as adopted in the case of Ganga River.
9.	Herpetofauna	State Forest Department (SFD) ZSI WII WWF - India	So far, ZSI has made efforts to provide comprehensive insight on the diversity of herpetofauna in the concerned States. Sporadic studies have been carried out by experts from WII and WWF – India	Kapoor, 1992	In general, the review of available information on herpetofauna in the context of Chenab River and two concerned State/UT revealed that there is highly inadequate information, particularly on their status, distribution and efforts to monitor them were conspicuously absent.
10.	Avifauna in general and waterfowls	State Forest Department (SFD), Wildlife Wing BNHS, Bird International WII WWF, ZSI India	The focus of avifaunal surveys, research studies and *ad.hoc* fragmentary monitoring efforts have been restricted to preparation of checklists, galliforms and pheasants, water birds, particularly migratory in prominent wetlands.	Saikia *et al*., 2008; Gupta *et al*., 2012, SAC, 2010; HPFD, 2018a, b and c	As such planned long term monitoring of avifauna in the Chenab River Basin or concerned State and UT is missing, except comprehensive and institutionalized monitoring of avifauna

Sr. No.	Type of Inventory and Monitoring	Implementing Agencies	Periodicity	References	Remarks
					particularly migratory waterfowls in select wetlands/ Ramsar sites or even some PAs.
11.	Socio-economic: Demography; Floristic Biodiversity; resource dependence on forests, grasslands, wetlands and river; ecosystem services collection of NTFPs including medicinal and aromatic plants; alternate income generation options.	Census of India Various Universities and Scientific Organizations (GBPIHE, HFRI, WII, WWF-India, FRI, BSF, CSIR-IHBT, etc.)	Insight on socio-economic situation in the State and UT and District-wise is primarily available from decadal census. In addition, various agencies, departments and scientific institutions are contributing on the socio-economic theme and its different related aspects.	Census India, 2011 Samant *et al*., 2007; Dawa *et al*., 2018; RSET, 2019; Nayer and Sastri, 1987-1990	There is an urgency to design and develop a comprehensive and well institutionalized monitoring covering various aspects of socio-economics, particularly resource dependence, collection of NTFPs, , community participation, access and benefit sharing, conflict, etc.
12.	Social and Village Level Institutions; Community Participation; Sustainable Livelihoods; and Vulnerability.	Disaster Management Cell, State Government	Only a handful studies provide insight on village level institutions, sustainable livelihoods and vulnerability. However, the approach is largely fragmentary and widespread. In recent years, a large number of studies have come up with regard to hazards, vulnerability and risk analysis relevant to mountain hazard susceptibility, livelihood security	GoI, 2003; GoHP, 2012	Both concerned State and UT are having several types of village level institutions created for various purposes. While some old, traditional village institutions are dying, several new institutions at village/ panchayat level are being created. There is an urgent need to have detailed study on such institution, their roles and contributions in natural resource

Sr. No.	Type of Inventory and Monitoring	Implementing Agencies	Periodicity	References	Remarks
			and climate change implications.		management, particularly rivers and their tributaries.
13.	Impact of developmental projects (e.g., HEPs and road network), mass pilgrimage/ congregation and tourism.	Organizations under the MoEF&CC (e.g., FRI, WII, GBPNIHE, HFRI, NIC, Department of Energy, Govt. of H.P., etc.) Universities, Non-Governmental Organizations and individual Experts.	Most EIA studies are project specific and often focusing either on limited components/ themes or specific aspects.	RSET, 2019; Himdhara, 2019	Information on various developmental projects and their monitoring is widely distributed among several Organizations/ Agencies. Recently, on the behest of the MoEF&CC, RSET (2019) carried out a cumulative impact and carrying capacity study of Chenab River Basin. No institutional mechanism and appropriate databases are available.

Chapter 3

Approach and Methodologies

3.1 River Management – Emerging Concept of Planning Areas

With the emergence, integration and amalgation of different approaches and after considering the wide range of stakes, issues and interests, the concept of river management has undergone drastic changes for the overall improvement of the river environment and its health. This approach involves altogether different practises both direct and indirect strategies, including the perspectives of planning, assessment, management and conservations of river ecosystems. Integrated River Basin Management (IRBM) involves the full range of implements and approaches with numerous sectors working collectively, rather than at cross-purposes, to organize and preserve freshwater resources sustainably. It is the process of organizing management, conservation and improvement of water, land and associated resources within a given river basin, in order to maximize the economic and social remuneration derived from stream resources in an unbiased manner while conserving, and where necessary, re-establishing freshwater ecosystems. It works on the principle that naturally functioning river basin ecosystems including associated wetlands and groundwater resources are the main source of freshwater. Therefore, management of river basin must include maintaining ecosystem implementation as a vital goal. River basins shows tremendous spatio- temporal variabilities and any particular management intervention must have some key fundamentals *viz.*, a) A long-term vision for the river basin, approved by all the major stakeholders involved in project; b) Amalgamation of policies, pronouncement and budget across sectoral interests such as forestry intervention, river rejuvenation, agriculture, urban development, navigation, fisheries management and wildlife conservation, including poverty decline approaches; c) Strategic decision-making at the river basin scale, which guides actions at sub-basin or local levels; d) Efficient timing, taking advantage of opportunities as they crop up while working within a strategic agenda; e) Active participation by all relevant stakeholders in well-informed and transparent planning and management; f) Adequate assets by Governments, the Private Sector, and Civil Society Organizations in competence for river basin development and involvement processes; and g) A solid establishment of awareness of the river basin and the natural and socio-economic forces (Williams, 2003).

The concept of river basin as a component of water resource management was prompted at the beginning of this century and revolved around the following four aspects: i) improved technology in Forestry Interventions and cleaning of rivers ii) the reckless depletion of many natural resources; iii) Industrial pollution of rivers and lakes; iv) Construction of large dams endorsed the harnessing of water courses for several different purposes consecutively; and power production, water supply and irrigation utilized the natural interconnectedness of waters within a river basin more economically (Teclaff, 1991).

Basically, watersheds are the vastly spread large mass of land which forms rivers, lakes and enrich aquifer through drainage and inflow of water. Watersheds retain the rain water through trees, bushes and grassland which infiltrate to sub-surface and the surface. Degradation of watersheds due to natural and anthropogenic factors hinders the infiltration process and finally weakens the recurrent flow in the rivers and streams downstream. Clearly, the change in the physical and climatic characteristics (i.e., precipitation, temperature, topography, vegetation, etc.) of river basins drastically affects the hydrology of the rivers. Any river rejuvenation plan must envisage the ecologically sustainable and economically viable management including afforestation and combination of vegetative and other traditional measures to ameliorate the degraded basins.

Watersheds of entire river basin, also known as the drainage basin or catchment areas where all the water coming into, goes to a common outlet/ stream. People and livestock of the area form an integral part of catchment and their deeds affect the productive status of catchment area and vice versa. From the hydrological point of view, the diverse phases of hydrological cycle in a catchment are dependent on the diverse natural features and human activities. Catchment area of the river is not simply the hydrological unit, but also socio-political-ecological entity which plays a decisive role in influential food, social, and economical security and also provides life support services to local people. River basin is an area from which the runoff flows to a common point on drainage system. Every stream, tributary, or river has a connected watershed, and small watersheds combined together to become larger watershed. Water travels from its origin to the mouth location and meets with similar potency of stream and then it forms one order higher stream (Wani and Garg, 2009).

Any river management programme hence essentially requires the knowledge of overall environment of the river and its structure must reflect the combination of physical, biological and socio-economic factors which are vital for the rejuvenation of river ecosystems.

3.1.1 Global Insight on Riparian Corridors or Riparian Buffers

Riparian Buffers or Corridors of the river basin can be explained in numerous ways, but is fundamentally the narrow strip of intermediary land between upland habitats and perennial or alternating bodies of water, comprising creeks, streams, rivers, wetlands and lakes. A healthy riparian system supports an immense diversity of upland and wetland-adapted plant species and endows with habitat for wildlife, forest and aquatic organisms. Although, they frequently cover only a small percentage of total forest land area, riparian zones symbolize an essential element in the overall landscape, acting as both a buffer and an ecological link between water-based and land-based ecosystems (DNR, 2004).

Malanson (1993) explained the river corridors as ‘The ecosystems adjacent to the river’. Natural riparian corridors are the most diverse, dynamic and complex biophysical habitats on the terrestrial portion of the river catchment area. Riparian corridors, an interlink between terrestrial and aquatic ecosystems, cover sharp environmental ascents, ecological processes, and communities. Riparian corridors consist of diverse variety of landforms, communities, and environments within the larger landscape. As such these unique and distinct ecological

entities serve as a structure for understanding the organization, diversity and dynamics of communities linked with fluvial ecosystem (Naiman *et al.*, 1993). Riparian zones or corridors in fact, are a type of ecotone, or frontier between two closely linked ecosystems. Similarly, too many other ecotones, riparian buffer zones are exceptionally rich in biodiversity. It is well established that ecotones display a larger variation in features than either of the systems they connect. By and large, ecotones are considerably different from two interconnected systems. Due to these reasons single riparian zones can be considered valuable ecological asset. In addition, riparian zones perform a wide range of functions from ecological, economic, social and aesthetic perspectives and some of them are; a) Trapping/removing sediment from runoff; b) Stabilizing stream banks and reducing channel erosion; c) Trapping/removing phosphorus, nitrogen, and other nutrients that can lead to eutrophication of aquatic ecosystems; d) Trapping/removing other contaminants, such as pesticides; e) Storing flood waters, thereby decreasing damage to property; f) Maintaining habitat for fish and other aquatic organisms by moderating water temperature; g) Providing habitat for terrestrial organisms; h) Improving the aesthetics of stream corridors, and i) Offering recreational and educational opportunities (Wenger, 1999).

The riparian zones have frequently been eliminated or degraded and substituted by cropping pattern, pasture, and urban development. The loss of riparian buffers regularly results in soil erosion, increased water pollution, sedimentation or silt, flooding, loss of forest vegetation and valuable wildlife habitat. Every related effort hence, should be made to restore, develop or enhance riparian zones. There are two methods that can be commonly used to restore degraded riparian systems: a) Natural regeneration and/or planting; Natural regeneration is the easiest and least expensive method; and b) Second method for restoring a degraded riparian system is by planting. This method is more labour intensive and costly to implement, though it allows the landowner to directly persuade the plant species composition (DNR, 2004).

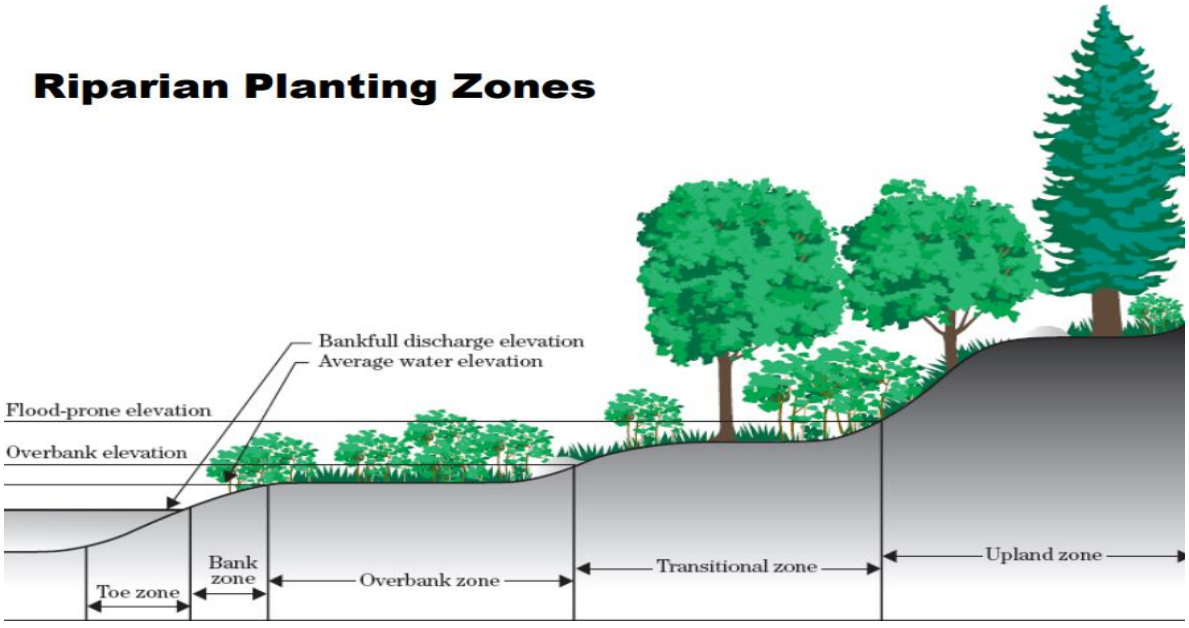


Fig.3. 1- Different Vegetation Forms in the Riparian Planting Zones
(Source: USDA, 2011).

3.1.2 Issues with Maintaining a Riparian Corridor or Buffer Zone

Both natural and human induced activities have adverse effect on riparian zone and its functions. Past practices may have left areas that cannot provide full riparian functions for several centuries. Current harvest activities quite infrequently may harm the riparian management zones even with better planning and technology. Natural disasters, such as floods or fires, may also craft degraded riparian circumstance. Though, natural disaster is desirable, yet they spoil the riparian areas containing significant resources. These disasters at times may even get benefitted from man's assistance. Silviculture land geomorphic techniques may be quite valuable while carrying out rehabilitation of degraded riparian wealth (Gregory and Ashkenas, 1990).

In many cases the riparian buffer zone approach fail and the possible causes of failure in the implementation of the buffer zone concept then revolve around; a) Ecological causes where local environmental surroundings, Soil and climatic conditions, and the role of the riparian buffer zone in relative to particular species was not sufficiently taken into account. Besides, the objectives of nature management were often found inconsistent with developmental objectives whereas; b) Social and Economic causes include inadequate examination of the social limitations, proposed activities not in line with local people's aspirations and unenthusiastic implementation of the perception of community; c) Institutional Causes: When institutional aspects are taken into consideration lack of harmony on objectives, location, shape and legalized uses come into play; d) Lack of legal authority to establish or manage riparian zones; and e) Other Causes: Local awareness also contribute towards failure. Sometimes, buffer zones are not distinct, and stakeholder cannot utilize the resources sustainably (Ebregt and Greve, 2000).

3.1.3 River Ecology Concepts and the Riparian Buffers

Several studies on river ecology had been carried out in the past those were based upon the zonation pattern, stream hydraulics, river continuum, nutrient spiraling, serial discontinuity, flood pulse, riverine productivity and catchment hierarchy. Few other concepts highlight the hydro-geomorphic conditions in rivers. However, it is quite evident that the most of the concepts developed so far have many points in common and they emphasize the role of physical processes in regulating biological systems at spatial and temporal scales (Bouewman *et al.,* 2013).

While few studies have scrutinized the values of buffer zones in provisions of their ecological buffering utilities and a number of them have focus on the socio-economic aspects. Ecological functions of buffer zones include: (i) the enhanced protection of species with high mobility or of high ecological significance; (ii) their functioning as substantial barriers to human encroachment; (iii) lessening of the edge effects; and (iv) enhancement of the ecological services. However, some more studies have reflected that local people do not obtain economic reimbursement from the establishment of riparian buffer zones. For instance, establishment of ecological corridors for forest/ wildlife may rivet relocation of

communities with economic reward, but the reimbursement was normally irrelevant compared to the social, cultural, and economic harm caused by the translocation (Atsri *et al.,* 2019).

3.1.4 Rationale for Selection of Reasonable River - Forest Buffer or Riparian Corridor

The riparian zones are the interface between aquatic and terrestrial environments. The Research demonstrates that intact riparian zones are critical to aquatic-terrestrial ecosystem function and ultimately, to waterway health. The riparian zone (riparia) represents the boundary between aquatic and terrestrial environments (Naiman *et al.* 1993). They influence the rivers/streams by mediating the bi-directional flow of matter and energy. Evidently, as the riparian zone represents the environments of exceptionally high diversity, the boundaries of riparian zones are typically diffused, and dynamic, determination of a fixed standard width for delineating riparian zones is inherently difficult. Most importantly, a single fixed width for all riparian zones is not logical.

Width of a buffer zone depends mainly on; a) Erosion control - erodibility of soil type is a key factor when assessing adequate buffer widths; b) Water quality - Nutrients - Nitrogen and phosphorous can be reserved in buffers and will be able to provide long-term storage; c) Aquatic habitat, - *Wildlife* – The minimum width of riparian buffers to protect aquatic wildlife, including trout and invertebrates, *Litter and debris input* – suggestions for buffer widths to afford an adequate amount of debris for stream habitat; d) Terrestrial habitat - The River watershed contains a large number of forest area, the river and its tributaries has remained mostly intact, supporting a lot of biodiversity as well as control water quality (Hawes and Smith, 2005).

The Himalayan Rivers initially meanders through the rocky and precipitous mountainous tracts and finally enters the plains. In recent past, the incidences and intensity of landslides and erodability in high altitude Himalayan Mountains have increased many times mainly because of different natural and anthropogenic factors. In such areas, vast consultative process was planned for consideration of viewpoints of different stakeholders in selection of reasonable Riparian Corridor. On the basis of consensus emerged, the whole catchment was taken as Riverscape for planning, assessment, and proposed Forestry Interventions and rationale of 5 km and 2 km width/ buffer was applied on the main river for the plains (Ganga DPR, 2016).

3.2 Planning and Assessment Area–Preparation of DPR on Forestry Interventions

The ecosystem approach and Riverscape level planning has been recognized widely for the rejuvenation of river ecosystems. The DPR emphasizes the need of adopting a holistic and complete multi-pronged method focus on the entire Chenab River Basin for its control and various proposed interventions. This method embraces a thorough review of the literature in the context of earlier successful major river conservation programmes. The Chenab River traverses through Himachal Pradesh and Jammu and Kashmir UT. Chenab River is the most

important river of Indus River Basin. Its Riverscape area delineated for the purpose of planning, assessment and proposed Forestry Interventionsrepresenting entire catchment including all the micro-sheds has been given in Table 3.1.

Table: 3. 1– State and UT wise Spatial Extent of the Riverscape

State/UT		**Himachal Pradesh**	**Jammu and Kashmir UT**
Geographical Area (km^2)		55,673	53,258
Geographical Coordinates (from-to)	**N Lat**	$30^o22'$to $33^o12'$ N	32°17' to 36° 58' N
	E Long	$75^o45'$ to $79^o04'$ E	73° 26' to 80° 30' E
Riverscape Coordinates of Chenab (from -to)	**N Lat**	$32^o05'$ to $34^o15'$ N	32°26' to 34°12' N
	E Long	$76^o13'$ to $77^o48'$ E	$74^o03'$ to $76^o46'$ E
Area in Riverscape (km^2)		7,755.44	21,571.03
Percent area of Riverscape		26.45	73.55

(Source: Statistical Abstract of HP, 2017-18; Ground Water Year Book, 2015-16; ISFR, 2019)

Himachal Pradesh has geographical area of 55,673 km^2 which represents 1.69% geographical area of the country. Out of this, the spatial extent covered by in the Chenab Riverscape in the State is 7,755.44 km^2 which represents 26.45% area of the delineated Riverscape (Table-3.1). The select area of the Riverscape falls in two administrative districts i.e., Lahaul & Spiti and Chamba of the state forming the upper reaches of Chenab River Basin. The Jammu and Kashmir UT including Ladakh UT is having a geographical area of 53,258 km^2 (IFSR, 2019). Out of its total area, spatial extent included in the Chenab Riverscape of Jammu and Kashmir UT is 21,571.03 km^2 which contributes 73.55% area of the delineated Riverscape (Table-3.1). The select area of the Riverscape falls in 14 administrative Forest divisions of Jammu and Kashmir UT. Chenab River and its 17 major tributaries i.e., Saichu Nala**,** Chandra River, Bhaga River, Thirot, Miyar Nala, Bhut Nalla, Marusudar River, Kal Nai River, Neeru, Lidar River, Manawar Tawi River, Raggi, Bichlari River, Ans River, Mihari Tawi River, and Naoshara Tawi River falling in 3,657 micro-watersheds, have been included in the river-scape. Out of 17 tributaries, 5 originate in different parts of Himachal Pradesh and 12 of the remaining tributaries originate in different parts of Jammu and Kashmir UT from Pir-Panjal, Great Himalayan and Zanskar Ranges.

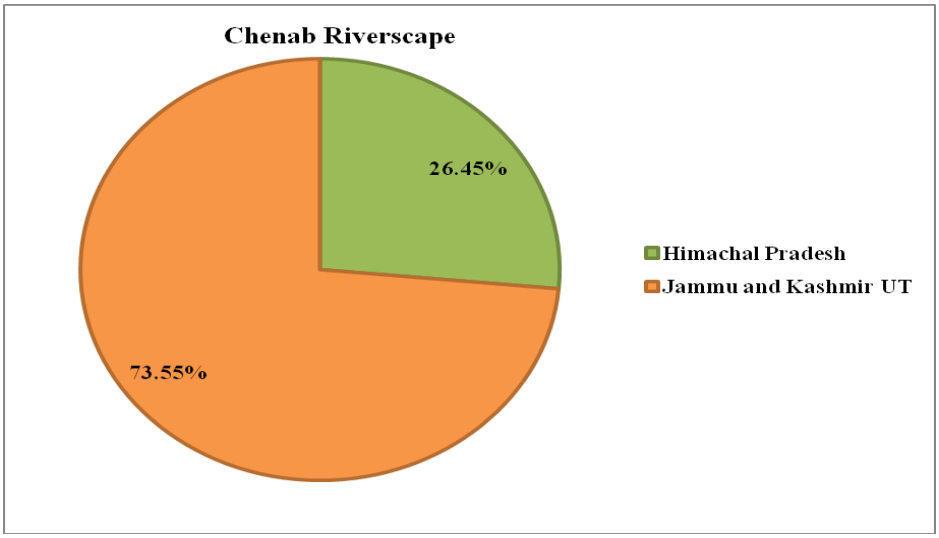


Fig.3. 2– Riverscape Area in Himachal Pradesh and Jammu and Kashmir UT

3.3 Approach for Preparation of DPR through Forestry Interventions

Himalayan Forest Research Institute (HFRI), followed a multi prolonged and multi-stakeholder oriented consultative approach for preparing the DPRs of the five tributaries of Indus River Basin (i.e., Chenab, Jhelum, Ravi, Beas and Sutlej). The preparatory phase included review of literature, primary and secondary data collection and analysis. Expert consultations and inputs from the wide range of stakeholders (i.e., policy and decision makers; relevant authorities; scientific organizations dealing with environment, forestry, wildlife; civil society; non-governmental organizations, etc. were recorded (Fig.3.3).

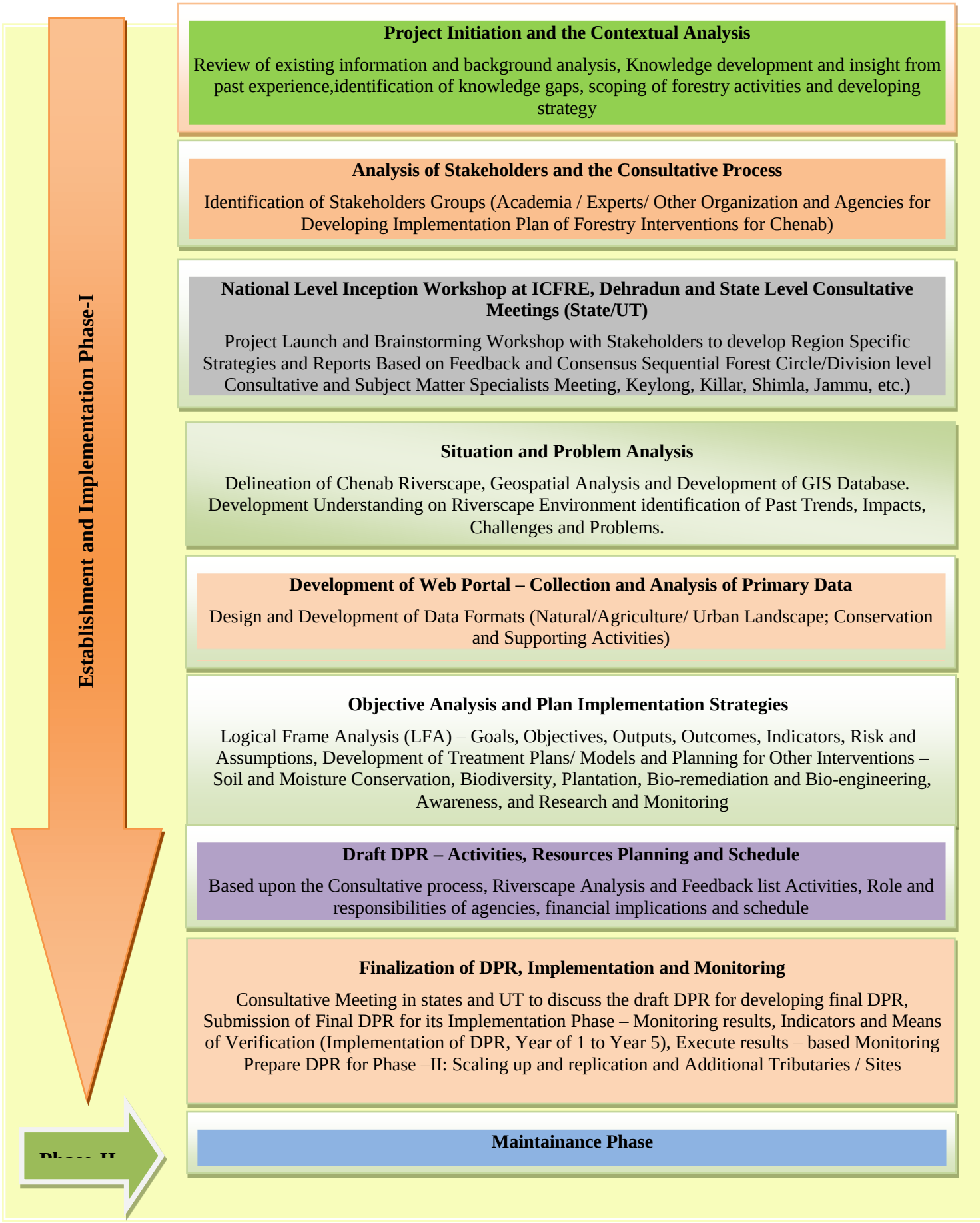


Fig.3. 3- Approach for Preparation of DPR for Carrying out Forestry Interventions in Chenab River

3.4 Project Initiation - Background Analysis/ Contextual Analysis

All 'Change processes 'of the exercise formed a part of wider context impinging upon the very objectives of the project itself. The project on Preparation of DPR for rejuvenation of Chenab River is constantly influenced by economic, social and political processes otherwise forming an integral part of the society. The project planners and implementers sought inputs/information about the overall environment, including technical national and sectoral information. Activities under the said project started with an overall preliminary study (*pre-study*), feasibility study forming its inception phase. The pre-study involved the understanding and assessment of project's external environment by collecting information about various related Sectors, States and Organizations involved as well as the primary data that existed about the target disciplines, sectors, themes, etc.

Further, it was also realized that understanding the complex and dynamic nature of a river ecosystem and its linkages with the forests and other surrounding lands requires adequate knowledge of relevant multi-disciplinary subjects and application of various technologies. It is beyond any doubt that there is a lot of literature on the wider subject of river ecology and management besides a long historical perspective on the management of the each of the major river including the Chenab River. Thus, the foremost and key step in the present planning exercise on the preparation of DPR was a systematic review of vast available literature on the subject through internet surfing and library consultations. The websites of prominent international, national, state level agencies and organizations dealing with any of the aspects related to river resources and conservation approaches were extensively searched and required information was downloaded for developing the desired insight. The relevant secondary information from related organizations was also collected. The combined effort on the review of literature and collection of background information immensely helped in the contextual analysis. The contextual analysis also provided desired insight on the Chenab Riverscape and its physical, biological and socio-economic sub-environments.

3.4.1 Identification of Knowledge Gaps

Considering the immense historical, cultural, social, environmental significance and vastness of Chenab River and its basin, there is constant development of knowledge for restoration efforts and many endeavours have been made for improvement of the Chenab River ecosystem in terms of reduction of siltation and checking the pollution. Some of the past efforts/ interventions in connection with Chenab river are as follows.

Integrated Watershed Management Programme (IWMP) - The State Level Nodal Agency (SLNA, HP) under the Department of Rural Development, GoHP has implemented several watershed management schemes in different blocks of Lahaul Valley.

Central Pollution Control Board (CPCB) has also identified stretches of Chenab River and its tributaries *viz.*, Tawi and Devika highly polluted (CPCB, 2018). The Jammu and Kashmir Government has prepared a comprehensive plan with the involvement of Urban Environment

Engineering Department (UEED), Directorate of Urban Local Bodies and Municipal Committees for checking pollution in Chenab River

The harsh terrain, remoteness of the area and other extremities of the climate have invariably posed challenges and there has been limited interventions in terms of forestry and conservation measures. Moreover, the earlier efforts made to address river ecosystem issues, were isolated and lacked systematic approach. The gaps can be enlisted as below.

i) The site specific strategies and state specific policies for water related issues lack the holistic plan and methodology for the entire River Basin.

ii) The earlier management practices for conservation of Chenab River made little or no endeavors for community participation.

iii) Lack of coordination among different agencies is also evident.

iv) Lack of suitable monitoring indicators for finding out the success/failure of the projects.

v) Legal policies/ perspective governing the conservation of river are not well articulated and uniform.

3.5 Analysis of Stakeholders and Consultative Process

The second vital step for successful planning and implementation required broader participation of stakeholders at all stages of planning of the project activities. Hence, it was essential to first identify which individuals and stakeholders affect and are affected by the project and which ones should be involved in the planning process. Likewise, it was critical to identify which stakeholders should be informed and involved during and after the project implementation. In the context of present assignment, broad five groups of stakeholders were identified as a part of the Step 1 on the contextual analysis. These five stakeholder groups included: (a) Target Group (i.e., primary and secondary target groups and beneficiaries); (b) Project Owners and Project Groups; (c) Decision Makers (i.e., Organizations, Authorities and Agencies, Local Politicians); (d) Experts and Subject Matter Specialists; and (e) Financing Agencies (i.e., State, National and International) (Ganga DPR, 2016; Ortengren, 2016). The preparatory phase included the extensive consultative process with identified groups of stakeholder right from the beginning. Table 3.2 provides a broad-based list of stakeholders in five identified groups, highlighting the prominent Central/ State Governments Ministries, Departments, Agencies, Organizations besides Civil Agencies and NGOs that were consulted or their representatives participated in Project Launch and Brainstorming Workshop and subsequent sequential Consultative Meetings organized for the purpose at the Forest Circle/ Division level in stakeholder State/UT. Details of the consultative process and sequential meetings are presented in Table 3.3.

Table: 3. 2- Group of Stakeholders involved in the Consultation Process

Central Government Ministries/ Departments/ Agencies/ Organisations
Ministry of Environment, Forest and Climate Change (MoEF& CC), New Delhi
Ministry of AYUSH (Ayurveda, Yoga, and Neuropathy, Unani, Sidha and Homoeopathy), New Delhi
Ministry of Youth Affairs and Sports (MoYA&S), New Delhi
Ministry of Rural Development (MoRD), New Delhi
Ministry of Panchayati Raj (MoPR), New Delhi
Ministry of Defence (MoD), New Delhi
Central Water Commission (CWC), Jammu
National River Conservation Directorate (NRCD), New Delhi
Central Pollution Control Board (CPCB), New Delhi
National Medicinal Plant Board (NMPB), New Delhi
Indian Council of Forestry Research and Education (ICFRE), Dehradun, Uttarakhand
Himalayan Forest Research Institute (HFRI), Shimla, Himachal Pradesh
National Institute of Hydrology (NIH), Jammu, Jammu and Kashmir UT
Forest Survey of India (FSI), Dehradun, Uttarakhand
Indian Institute for Soil and Water Conservation (IIS&WC), Dehradun, Uttarakhand
Council of Scientific and Industrial Research – Institute of Himalayan Bio-resources Technology (CSIR-IHBT), Palampur, Himachal Pradesh
Botanical Survey of India (BSI), Regional Centre, Solan, Himachal Pradesh
Zoological Survey of India (ZSI), High Altitude Regional Centre, Solan
Border Road Organisation (BRO), New Delhi
Indian Agriculture Research Institute (IARI), New Delhi
Central University of Himachal Pradesh, District Kangra, Himachal Pradesh

Indian Institute of Technology (IIT), Mandi, Himachal Pradesh
State/ UT Government Ministries/ Department/ Agencies/ Organisation in State of Himachal Pradesh and Jammu and Kashmir
State Governments (Hon'ble Chief Minister and Hon'ble Forest Minister)
State Administration (Chief Secretary, Principal Secretary-E&F, District Magistrates/ Collector, Municipal Commissioner and BDOs)
State Forest Department (PCCF HoFF, PCCFs, Addl. PCCFs, CCFs, CFs, DFOs, RFOs), Himachal Pradesh and Jammu and Kashmir UT
State Forest Department Corporation, Himachal Pradesh
State Biodiversity Board, Himachal Pradesh
State Pollution Control Board (SPCB), Shimla, Himachal Pradesh
Himachal Pradesh Council for Science Technology and Environment (HIMCOSTE), Shimla, Himachal Pradesh
Himachal Pradesh State Electricity Board Limited (HPSEBL), Shimla, Himachal Pradesh
Directorate of Energy (DoE), Shimla, Himachal Pradesh
Himachal Pradesh Power Corporation Limited (HPPCL), Shimla, Himachal Pradesh
Department of Economics and Statistics, Shimla, Himachal Pradesh
Municipal Corporation (MC), Shimla, Himachal Pradesh
Municipal Corporation (MC), Jammu, Jammu and Kashmir UT
Sher-e-Kashmir University of Agriculture, Science and Technology (SKUAST), Jammu, Jammu and Kashmir UT
Directorate of Soil and Water Conservation, Jammu, Jammu and Kashmir UT
University of Jammu, Jammu, Jammu and Kashmir UT
Dr.Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh
Himachal Pradesh University (HPU), Shimla, Himachal Pradesh
Chandertal Wetland, Lahaul and Spiti, Himachal Pradesh

Govind Ballabh Pant National Institute of Himalayan Environment and Sustainable Development, Himachal Regional Centre, Mohal-Kullu, Himachal Pradesh
Pin Valley National Park, Lahaul and Spiti, Himachal Pradesh
Animal Husbandry Department, Jammu, Jammu and Kashmir UT
Directorate of Animal Husbandry, Shimla, Himachal Pradesh
Department of Horticulture, Jammu, Jammu and Kashmir UT
Department of Horticulture, Shimla, Himachal Pradesh
Western Himalayan Research Centre, Jammu, Jammu and Kashmir UT
Civil Society
Pangi-welfare Association, Chamba, Himachal Pradesh
Lahaul Environmental Protection Committee, Lahaul and Spiti, Himachal Pradesh

Table: 3. 3– Different Consultative Meetings held at the State and National Levels for the Preparation of DPR

S. No.	Consultation Event	Date and Venue	No. of Participants
1	National Level Inception Workshop on Preparation of DPRs of Indian Major Rivers	24-25 April, 2019; ICFRE, Dehradun, UK	61
2	State Level Project Launch Workshop and Brainstorming	28-29 June, 2019; Hotel Holiday Home, Shimla, HP	178
3	Consultative Meeting for stakeholders of Himachal Pradesh	6 August, 2019; Keylong, Lahaul and Spiti	53
4	Consultative Meeting for stakeholders of Himachal Pradesh	8August, 2019; Killar, Chamba, HP	46
5	Consultation Meeting for stakeholders	12 October, 2019 ; Forest Information	50

	of Jammu and Kashmir UT	Centre, Vikram Chowk, Jammu Jammu and Kashmir UT	
6	Final Consultative Meeting for stakeholders of Jammu and Kashmir UT	25 February, 2020; Jammu, Jammu and KashmirUT	116

The following section provides the chronological summary of sequential Consultative Meetings at the National/ State/ Forest Circle levels and provides a gist of deliberations, recommendations, decisions and outcomes.

3.6 National Level Inception Workshop on Preparation of DPRs of Indian Major Rivers (ICFRE, Dehra Dun; 24-25 April, 2019)

The ICFRE, Dehradun, being the Nodal and Coordinating Agency was entrusted with the task for preparation of DPR for major Indian rivers by the MoEF&CC, New Delhi with special emphasis on Forestry Interventions. To accomplish this important assignment, the Council had organized the Inception Workshop at its Headquarters based at Dehradun on 24-25 April, 2019 under the Chairmanship of Director General, ICFRE. The Directors and Members of the Core Team from all the Research Institutes of ICFRE those were directly involved in the preparation of the DPRs and Resource Persons/ Representatives from Forest Research Institute, (FRI), Indian Institute of Soil and Water Conservation (IISWC), Dehradun; Forest Survey of India (FSI), Dehradun; State Forest Department, Uttarakhand; *Namami Gange* - State Project Management Group, Dehradun besides professional agencies connected with RS and GIS; IT and Development of Web Portal; and select Resource Persons were present in the Workshop. Altogether, 61 participants including 04 from HFRI, Shimla were present, in the Workshop to held discussions on; (a) the familiarization with the goals of the entrusted task, expected outputs and timelines; (b) development of an acquaintance with the related approaches and framework pertaining to the preparation of DPR adopted in the case of Ganga River during 2015-16; (c) creating awareness about the emerging concepts and strategies related to river ecology, linkages between forests and river, complex and dynamic nature of rivers, human disturbances in the context of river fragmentation, availability of water (e-flow), and water quality; (d) sharing of experiences and lesson learnt during preparation of DPR on Ganga River; (e) emphasizing upon the need for adopting holistic and participatory approach based on the extensive consultations and the use of 'Riverscape approach'; and (f) highlighting the need of knowledge management and sharing, science and results-based planning, monitoring, development of appropriate strategies for assessment and implementation.

The Resource Persons associated with the preparation of DPR on Ganga River made presentations and acquainted the participants with the emerging concepts in the context of river conservation, broad framework and approach to be adopted during preparation of DPRs.

The Resource Persons also elaborated upon the key steps and components involved, formats to be used for field data collection and incorporation of the related strategies on Forestry Interventions. The concepts of Riverscape, its RS and GIS based geo-spatial analysis and the requirement of describing the Riverscape environment was shared with the participants. During the Workshop intensive deliberations were held to work out the modalities and mechanisms for implementation of this time bound project involving nine major Indian River Basin Systems.

3.7 Project Launch and Brainstorming Workshop (Hotel Holiday Home, Shimla; 28-29 June, 2019)

After the Inception Workshop at ICFRE, Dehradun, HFRI organized the State Level Project Launch and Brainstorming Workshop primarily involving participants from concerned States/ UT (i.e., Himachal Pradesh, Jammu and Kashmir UT, and Punjab) those are associated with the preparation of DPRs of five tributaries of the Indus River besides a large number of experts, Resource Persons and representatives from the State Forest Department and specialized National/ State Level Scientific Organisations *viz*., the Forest Research Institute (FRI), Indian Institute of Soil and Water Conservation (IISWC), Indian Institute of Remote Sensing (IIRS), Forest Survey of India (FSI), Zoological Survey of India (ZSI), Botanical Survey of India (BSI), Central Water Commission (CWC), National Institute of Hydrology (NIH), and State Pollution Control Board (SPCB). Representatives of wide range of line agencies (i.e., Agriculture, Animal Husbandry, Horticulture, Medicinal Plants, Irrigation, Mining, Power, Rural Development, Hydroelectric Projects, Tourism, etc.) also attended Workshop and actively participated in the deliberations. Further, Experts and Subject Matter Specialists representing various universities based in above two States and one UT were also invited. Two Day Workshop was organized at Hotel Holiday Home (HHH), Shimla on 28-29 June, 2019.

The Workshop was inaugurated by the Hon'ble Forest Minister, Himachal Pradesh. In his Inaugural Address, he highlighted the need of water security, livelihoods, sustainable development and the priority agenda on rejuvenation of five rivers in Himachal Pradesh, Jammu and Kashmir UT and Punjab, those are are important tributaries of the Indus River. He suggested adopting the approach/ framework on the lines of DPR on Ganga River and the efforts made under the National Mission for Clean Ganga (NMCG) and the *Namami Gange* program initiated by the Government of India (GoI). The Hon'ble Minister emphasized that the proposed plantation models should take into consideration the topography, geology and forest types of the concerned areas keeping in view the varied landforms, climatic and edaphic conditions in the mountainous states of H.P. and Jammu and Kashmir UT. The PCCF and HoFFs of two States - H.P. and Punjab were the



Guest of Honour on the occasion and in their address they emphasized on reduction of soil erosion in the hilly tract by appropriate soil and moisture conservation and Forestry Interventions and assured full cooperation of their department(s) in the preparation of DPRs. The PCCF (Wildlife) and CWLW, Himachal Pradesh was the Keynote Speaker of the Workshop and she not only introduced the concepts of river conservation and the approach adopted for the preparation of DPR on Ganga River in her earlier capacity as the Director, FRI, Dehradun, but also shared her experience and lessons learnt in the process of preparation of DPR with the workshop participants. The Lead Speaker on the occasion who was also associated with the preparation of DPR on Ganga emphasized on global challenges, particularly the water crisis, the vital aspect of connectivity in the context of complex and dynamic river ecosystems besides the important aspects of ecological integrity and river health. The Director, HFRI, Shimla in his address informed the participants about the assigned task on five rivers and sought support of SFDs and other stakeholders.



Altogether, in the Inaugural and five Technical Sessions, there were 20 presentations by various resource persons and experts. The Technical Session I included presentations by senior forest officials representing Himachal Pradesh and Jammu and Kashmir UT. They shared information on current efforts towards implementation of catchment area treatment plans, particularly soil and moisture conservation activities, development of appropriate technologies for afforestation including suitable nursery and plantation techniques. They emphasized on the micro-watershed treatment plans, snow water harvesting techniques, avalanche prone treatment area plans, selection of water efficient plant species, need for replenishment of medicinal plants, and a review of existing nursery techniques especially for plants relevant to cold arid zone.

The Technical Session II included multiple presentations from the representative of the Universities, Scientific Organisations and NGOs. These presentations highlighted that in Himachal Pradesh, nearly 30% area is under heavy erosion and about 50% area has medium soil erosion, causing displacement of around 280 MT of soil through water erosion every year losing 5.4 to 8.4 MT NPK per year and hence, enormous loss in productivity. This heavy loss of soil by erosion calls for urgent mechanical and vegetative measures for effective control of erosion and improving soil moisture condition. The representative from IISWC, Chandigarh informed that maps on soil erosion for Himachal Pradesh and Punjab by his Institute will help HFRI in the assigned task on the preparation of DPR. A senior expert in the field of soil and water conservation/ watershed management shared his experiences on the earlier efforts of watershed management programs carried out in the catchment of Swan River, Una, Himachal Pradesh wherein the approach of treating whole watershed from top to bottom by adopting appropriate Forestry Interventions, pollution control measures, sewage treatment activities and allied actions for river rejuvenation was adopted. Based on experience gained, recommendations for treating the entire catchment with brushwood, bamboo plantations,

stone check dams, and silt retention structures were made. Illustrating on the lessons learnt from the implementation of the World Bank supported 'Mid-Himalayan Watershed Project', the Resource Person informed the Workshop participants that the project covered in 10 Districts, 710 Panchayats, and 45 Development Blocks has constructed check dams and water harvesting structures and as a result there was reduction and discharge from 40 to 20%, promotion of crop diversification, and increase in crop productivity and horticulture produce. The Resource Person from NERIL while highlighting the issues and concerns in preparation of DPR for rejuvenation of river emphasized for a need to collect primary as well secondary data with regard to topography, soil conditions and climatic patterns and advocated for identification of critical areas, development of site specific plantation models, and selection of suitable native species in proposed plantation program.

During the Technical Session III, the Resource Person from the CWC, Shimla recommended for effective management of factors responsible for degradation and deterioration of environmental flow and water quality. A priority need for treating solid waste and sewage disposal; and checking soil erosion, land mining, sedimentation flux, unsustainable land use, and industrial effluents was emphasized so as to seek uninterrupted flow and clean water in rivers under consideration. The Technical Session IV covered multiple presentations from specialized institutes and the State Pollution Control Board. The Experts from National Institute of Hydrology (NIH), Western Himalayan Regional Centre, Jammu (Jammu and Kashmir UT) broadly discussed the role of springs in the Himalayan Mountains and voiced concerns about their drying up, resulting in migration of as high as 200 million people living around those springs and traditionally dependent upon them. The house was informed about the structural, vegetative, and social measures for rejuvenation of springs. The experts from Indian Institute of Remote Sensing (IIRS), Dehradun emphasized on the geospatial support needed for the preparation of DPR and informed that a wide range of data on snow cover dynamics land use change, socio-economic and climatic changes, hydrological and geospatial modeling, discharge data, forest fragmentation, vegetation and disturbance mapping, and biodiversity characterization are available with his institute besides similar information/ data can be availed from NRSC, WRIS and Bhuvan Portal of ISRO. Likewise, the Resource Person from Forest Survey of India (FSI), Dehra Dun informed about the availability of varied information *viz*., forest cover and forest type mapping, and extent and intensity of forest fires. He suggested to optimally using the information from the Web Map Service (WMS), and Digital Elevation Model (DEM) available with FSI while information on soil types can be obtained from BHUMI Portal of the NBSS, Nagpur. The Resource Person from the Punjab State Pollution Control Board informed about the high pollution level of Sutlej River due to sewage, industrial effluents and the major pollution/ impact by Buddha *Nallah* of Ludhiana and recommended for appropriate measures like phyto-remediation and installation of bio-reactors in the Buddha *Nallah*.

The second day of the Workshop was devoted to deliberate on the Way Forward and the session was Chaired by Dr. Savita, PCCF (Wildlife) and CWLW, Himachal Pradesh Forest Department. During the deliberations, the following pertinent points and recommendations relevant to the proposed assignment on DPR emerged.

3.7.1 Area of Consideration

The issue of delineation of riverscape was discussed at length and the participants were informed about the approach adopted for delineating Ganga Riverscape. Forest Research Institute (FRI), Dehradun has earlier incorporated the entire catchment of Ganga River in hilly areas while a buffer of 5 km on either side from main stem and 2 km buffer on either side in the case of selected tributaries in the plains were included in Riverscape. Initially, some of participants were of the opinion to either consider the whole catchment or focus on the watershed approach. However, after considerable deliberations, the unanimous consensus was built to consider the entire catchment of a river in the mountainous Himalayan State as a major part of the riverscape while in the case of plains, a buffer of 5 km and 2 km for main stem and tributaries, was considered adequate for inclusion in the riverscape. It was also decided that selection of tributaries in the riverscape should be on the basis of silt load and water flow. It was also considered that DPRs should not only be for the treatment of Government lands but also for the private and agriculture land along the rivers.

3.7.2 Selection of Planting Material

Some participants were of the opinion that careful selection of suitable species for plantation/ treatment models is prerequisite for effective recharge and rejuvenation of groundwater as in several instances nallahs and streams were dried up due to plantations of Poplar and Eucalyptus. Finally, the consensus was built around selecting native and fast growing species those can provide multiple benefits and to avoid exotics and species those have high water requirement.

3.7.3 Cryosphere and its Significance

The term ‘Cryosphere’ is used to describe the areas where water exists in solid form e.g., glaciers, ice caps, ice sheets, and frozen ground (Allison *et al.,* 2001). It plays a significant role for regulating the climate and various processes of water, energy, and material exchange on different spatial and temporal scales (Qin and Ding, 2010; Marshall, 2011). The cryosphere is an important component of ecosystem services and it maintains and preserves the vitality of the general ecosystem (De *et al.*, 2015).

The concerns about receding glaciers and declining of glaciated areas in River Basin (i.e., Jhelum, Chenab, Ravi, Beas and Sutlej), changing climatic and glacio-hydrological regimes of the Himalaya and effect of glacier recession on runoff were stressed upon during the Launch Workshop. Implications of depleting cryosphere under changing climate on water, energy and food security particularly in Indus River Basin were highlighted and an urgent need for estimating the snow and glacier melts, rainfall runoff, permafrost contribution and base flow at each of the sub-basin scale in the Indus River Basin was highlighted. The significance of protecting high altitude wetlands in the fore fields of glaciers in the upper

Indus River Basin that plays a vital role in maintaining the hydrological regimes of rivers was also emphasized.

3.7.4 Planning Process

The Chairperson in her concluding remarks strongly advocated the adoption of riverscape concept on the lines of DPR on Ganga River and also emphasized upon the proper utilization of the outcome of two days extensive and exhaustive consultative process involving various stakeholders. In view of the short time of one year for the preparation of DPR, she stressed upon the need to review the progress after every two months so as to identify gaps and constraints in accomplishment of the targets and objectives. Contributions by the stakeholders, especially from the specialized organization must be on priority during the process of preparation of DPR.

The two-Day Workshop was successfully concluded and it was felt across that the workshop could achieve its various objectives. Participants applauded the efforts of HFRI in bringing together various stakeholders for discussion on the priority agenda of river rejuvenation through Forestry Interventions by providing opportunity to the participants and stakeholders for sharing their experiences and interactions. The Workshop concluded with a vote of thanks to the Chair, Resource Persons and the participants for their significant contributions.

3.8 Consultative Meeting for Stakeholders of Himachal Pradesh (Keylong, Lahaul & Spiti; 6 August, 2019)

The Himalayan Forest Research Institute, Shimla organized First Consultative Meeting for preparation of DPR of Chenab River on 6 August, 2019 at Keylong, the Head Quarter of Lahaul and Spiti district, Himachal Pradesh. Smt. Smritika Negi (Himachal Pradesh Administrative Services) and Integrated Tribal Development Project Officer (ITDPO) of Lahaul & Spiti was the Chief Guest. About 53 participants representing Line Departments and Members of Civil Society Organisations were present in the Meeting. Chief Guest in her address highlighted that Lahaul and Spiti district is very fragile geographically, and it lies in the most sensitive zone of Himalayan region. She reiterated that Forestry Interventions in the catchment areas of Chenab River will definitely stabilize the loose strata and also improve the quality of water in river. She urged the representatives of all the Line Departments to extend their full cooperation and contribution for this task of Local, Regional and National significance. Various stakeholders present during the meeting focused mainly on the areas like agriculture, horticulture and public health. Issues like soil erosion, land degradation and pollution were discussed in details and it was emphasized that suitable measures should be adopted to check the loss of fertile soil and protecting the agriculture fields from degradation and reduce the silt load in the river. Representatives from Horticulture highlighted the importance of horticulture as a potential income generating occupation and proposed to include the horticulture crops in the plantation models. Serious concerns on the deterioration of the water resources and decline in the level of ground water were raised by representatives

from IPH Department. It was also stressed that plantation in the traditional wisdom, community participation and active involvement of the residents of valley should be taken into consideration during rejuvenation of Chenab River.



3.8.1 Main Reccomedations of Keylong Meeting

The thoughtful discussions of stakeholders brought forth a number of recommendations to be taken into consideration in the DPR preparation of Chenab River. The specific recommendations/ suggestions are summarized below.

i) The proposed Forestry Interventions in the catchment of Chenab River should achieve the objective of stabilization of the loose strata and also improve quality of the water in river.

ii) The project proponents should identify the main causes responsible for the deterioration of Chenab River and degradation of the riverine ecosystem. Some sustainable models should be proposed in DPR for agriculture and horticultural landscapes, and potential avenues of livelihood generation should also be identified.

iii) There should be incorporation of suitable measures and interventions in the form of revetments, embankments and spurs all along the bunds and edges of the river to check the problem of soil erosion and degradation in agriculture landscapes along the river bank.

iv) Provisions of Forestry Interventions in the DPR should be broad and ample space should be given to the potential income generating horticulture crops in the plantation models.

v) There should be efforts for checking the deterioration of the water resources and continuous decline in the level of ground water.

3.9 Consultative Meeting for Stakeholders of Himachal Pradesh (Killar, Chamba; 8 August, 2019)

One Day Consultative Meeting was organized by the Institute on 8th August, 2019 at Killar – the Head Quarter of Pangi Valley in Chamba district. About 46 representatives from various Departments and NGOs participated in the Meeting. Block Development Officer (BDO) of Pangi presided over the Meeting as Chief Guest. In his address, he asserted that the geographical location of Pangi valley is very remote and isolated and Chenab River and its catchment forests play important role in the life of people in Pangi valley. He was of opinion that the upcoming project of DPR preparation of Chenab River is a timely initiative and participation of the surrounding inhabitants should also be ensured in this task.



It was emphasized by the stakeholders that project proponents should incorporate the eco-tourism aspect from livelihood point of view and also stressed upon the need for conservation of rare floral and faunal attributes found in the meadows, pastures and high altitude areas of the Pangi Valley. Ample provisions and effective measures in the DPR should be made for managing the soil erosion from agricultural landscapes and run-off from catchment areas and micro-sheds of the Valley. Since, Pangi Valley is a rich repository of medicinal plants and hence, efforts should be made to take necessary steps for preservation of unique wealth of the valley. It was also deliberated that there is need for carrying out plantations of nutritive fodder yielding and high calorific value species in the farmlands to meet the requirements of the livestock and local people that will reduce the pressure on the forests. Practices for strengthening of traditional agriculture mixed with livestock production was stressed upon in view of the fact that it is the mainstay of the livelihoods of the tribal people and the Pangi Valley is favorable for cultivation of the stone fruits and this sector has immense potential for socio-economic upliftment of the people.

3.9.1 Main Recommendations of Consultative Meeting at Killar

The participants of the Consultative Meeting discussed many issues at length related to the importance of Chenab River to Pangi valley. The following core recommendations emerged in the Meeting.

i) The proposed DPR project on Chenab River Basin should focus the need of plantations of some nutritive fodder yielding and high calorific value species in the farmlands to meet the requirements of the livestock and people. It will also reduce the pressure on the natural forests.

ii) The plantation models should include the common plants of the region in the plantation models for agricultural landscapes e.g. *Corylus jacquemontii* (Hazel nut) locally known as 'Pangi - ki -Thangi' is a common plant of the region and its seeds are very nutritive.

iii) The proponents of DPR should also incorporate the eco-tourism aspect in proposal and implement it from livelihood point of view.

iv) Pangi valley is a rich repository of Rare, Endangered and Threatened (RET) plant species and unique floral elements. Therefore**,** there should be adequate provisions for the conservation of plants growing in the high altitude meadows and pastures.

v) The DPR must include the ample provisions and effective measures to reduce soil erosion from Agricultural Landscapes and run-off from catchment areas and micro-sheds.

vi) The DPR should identify the promise and potential of cultivation of the stone fruits in Pangi valley and models should be devised in the DPR on the lines of Agri-Horti-Silvi (AHS) and Horti- Silvi (HS) land use systems.

vii) There should be provisions in the DPR for wildlife habitat management

3.10 Consultation Meeting for Stakeholders of Jammu and Kashmir UT (Erstwhile State) (Forest Information Centre, Vikram Chowk, Jammu; 12 October, 2019)

One Day Consultative Meeting for stakeholders of Jammu and Kashmir UT organized by Himalayan Forest Research Institute (HFRI), Shimla at Forest Information Centre, Vikram Chowk, Jammu, on 12October, 2019to discuss various issues and concerns for their subsequent consideration and inclusion in the DPRs of Chenab, Jhelum and Ravi Rivers flowing entirely or partially through Jammu and Kashmir UT. Dr. Mohit Gera, PCCF and HoFF (J&K UT) presided over the Meeting as the Chief Guest. In his address, the Chief Guest emphasized upon the close and intricate linkages between forests, rivers and catchment areas. He underscored the fact that forests by virtue of its different attributes like canopy cover, density and thick layer of humus trap the energy of precipitation and reduces runoff from catchment and improve the water regime.



Proper and effective treatment on the scientific lines of the catchment areas holds the key to increase the quality and quantity of water in the rivers, he added and suggested for drawing a distinct line for Forestry Interventions, identification of exact locations and development of best models for plantations with native species. He elaborated that treatment of catchment areas holds the key to increase the quality and quantity of water in the rivers. About 50 participants from various Line Departments including Forest,

Agriculture, Horticulture, Soil and Water Conservation, Animal Husbandry, Photo Interpretations Division of Forest Department, Jammu Municipal Corporation and representatives of various Research Institutes of repute and Universities like Sher-e-Kashmir University of Agriculture, Science and Technology- Jammu (SKUAST-J) and National Institute of Hydrology (NIH) participated in the Meeting. During this Meeting, the stakeholders and participants mainly deliberated upon various areas e.g., methodology and approach of DPR preparation, riverscape planning, zonation of river connectivity, river ecology, e-flow, biodiversity and habitat management, drain line treatment, *nallah* treatment, proper delineation of the micro-sheds, emphasis on micro-irrigation and drought prone areas, agroforestry and integrated plantations models, provision of livestock development and importance of cryosphere.



3.10.1 Key Recommendations of Consultative Meeting at Jammu

Many issues were raised, discussed by the diverse group of stakeholders and subsequently recommendations were made. Some of the key recommendations of the Consultative Meeting include.,

i) Detailed Project Report (DPR) of Chenab, Ravi and Jhelum rivers should draw a distinct line for Forestry Interventions, identification of exact locations and development of best models for plantations with native species.

ii) The emphasis should be given on the drain line treatment, *nallah* treatment, and minor engineering in the DPR.

iii) There should be provisions of more water for cropping, proper delineation of the micro- sheds, emphasis on micro- irrigation, ways and means for the drought prone

areas and agro-forestry and integrated models for plantations in the Agricultural Landscapes.

iv) There should be provisions for the capacity building and livelihood enhancement in the DPR.

v) There should be provision for the treatment of polluted stretches of the rivers and the tributaries like Tawi River and Biological Oxygen Demand (B.O.D.) levels should be taken as benchmark for the treatment of the selected sites across the riverscape

vi) There should be models for landscaping and avenue plantation to add aesthetic beauty and reduce pollution.

vii) There should be provisions for the production of the quality planting material and plantation of the varieties of apricot and seabuckthorn (SBT).

viii) DPR document must incorporate some proposals for the revival of the dried up springs particularly in the Kandi areas.

ix) The high altitude wetlands should be included for management in case of Chenab River.

x) The slaughter houses located alongside the Tawi River should be shifted and creation of composite zones should be created to deal with the solid wastes.

xi) There should be provisions of livestock development and wood based industries in the DPR.

xii) Focused approach for the treatment of most polluted stretches of the Tawi River which is a trans-boundary tributary of Chenab River and devising effective measures for resuscitation of the dysfunctional or partially operative sewage treatment plants (STPs) with adequate backup mechanism and replacement of the obsolete systems by new and more efficient systems.

xiii) Status and extent of the springs should be exhaustively studied and provisions should be made for the revival of the springs.

xiv) The sites should be proposed and prioritized for Forestry Interventions on the basis of various parameters in the context of respective River basins e.g., soil characteristics, slope, gradient, forest canopy, forest density, land use land cover patterns, and hydrological and hydrometrological data.

xv) Role of various land management agencies like Soil & Water Conservation Department, Agriculture Department and Horticulture Department must be clearly identified and integrated approach in the DPR should be followed.

xvi) Suitable clones of the fast growing wood species should be suggested in the plantations models for natural landscapes.

xvii) Urban bodies like Municipal corporations and Municipal Committees should be actively involved in the formulation of the DPR.

xviii) Provisions should be made primarily for the treatment of most polluted stretches where BOD is >3.

xix) Recommendations of the River Rejuvenations Committee (RRC) must be considered and incorporated in the DPR of the Chenab, Ravi and Jhelum Rivers.

3.10.2 Training of Field Staff



After the Consultative Meetings, the Technical Team of HFRI, associated in the preparation of DPR of Chenab River approached field functionaries of the Forest Department of Himachal Pradesh and Jammu and Kashmir UT for imparting trainings for the collection of field data in the prescribed formats. During these trainings all the formats were elaborately discussed with the participants and doubts were addressed. For Natural Landscape, participants were informed that information/data for selected sites need to be provided in the format–I, along with current status of land, current photograph, and sketch of the site, elevation and GPS location. Similarly, for 'Agriculture Landscape' the format-II has to be filled. The formats for Urban Landscapes and other interventions were also discussed with the participants in details.

3.11 Final Consultative Meeting of Detailed Project Report (DPR) for Rejuvenation of Chenab, Jhelum and Ravi River Basins through Forestry Interventions' (Convention Centre, Jammu; 25 February 2020)

The Himalayan Forest Research Institute (HFRI), Shimla, Himachal Pradesh in collaboration with Jammu and Kashmir Forest Department organized 'Final Consultative Meeting for the Finalization of Detailed Project Reports for Rejuvenation of Chenab, Jhelum and Ravi River Basins through Forestry Interventions' on 25 February 2020 at Convention Centre, Jammu, Jammu and Kashmir UT. About 116 participants from Central and State Government, R&D





Organizations, Jammu and Kashmir UT State Forest Department and various other Departments like SPCB; SKUAST – Srinagar, SKUAST- Jammu, University of Jammu, Central University - Jammu; CGWB, NIH, Jammu, Municipal Corporation, Agriculture Department and various other stakeholders actively participated in the Consultative Meeting. Dr. Mohit Gera, PCCF and HoFF (Jammu and Kashmir UT) presided over the Meeting as the Chief Guest. In his address, Dr. Gera appreciated the efforts of HFRI in preparation of DPRs and hoped that HFRI has incorporated the suggestions of stakeholders given during the first Consultative Meetings in the Draft DPR.

3.11.1 Recommendations of Final Consultative Meeting

During the final Consultative Meeting, meticulous and articulate deliberations were held on the forestry intervention models prepared by HFRI, Shimla. There was general agreement in the proposed activities, however, few suggestions provided by some of the participants, were;

i) More emphasis should be given to those forestry species which will provide livelihood options to the local populace, besides conservation of the soil and moisture works.

ii) High quality improved grass species and high value medicinal plants should be preferred in the plantation models. Indigenous species should be preferred while carrying out plantations in the sites suggested for Forestry Interventions.

3.12 Chenab Riverscape – Situation and Problem Analysis

The third key step in the process of preparation of DPR was to delineate the Chenab Riverscape for the purpose of planning, situation and problem analysis thereby, developing an insight on the riverscape environment and prioritization of areas for proposed Forestry Interventions. The background analysis/ contextual analysis and the consultative process adopted at the National, State and Forest Circle Levels provided the much desired insight on the issues pertaining to Chenab River, its Basin and tributaries, terrestrial and aquatic biodiversity, past management, associated states, and developmental activities. A riverscape within the larger river basin was delineated. Detailed geospatial analysis of the riverscape using remote sensing and GIS technologies was carried out. It provided an understanding on the situation of physical attributes i.e., land use and land cover, altitudinal variation, slope, aspect, soil, erosion, forest types and forest cover, fragmentation, etc. The review of secondary information from a variety of sources (i.e., National/ State Level Agencies/ Departments, Scientific Organizations and Universities) allowed developing an understanding on the river-scape environment (i.e., physical, biological, and socio-economic) and identification of challenges, constraints, problems, and threats in river conservation. The situation analysis facilitated developing an insight on state specific challenges and threats for Himachal Pradesh and Jammu and Kashmir wherein the river flows which depicted contrasting situation owing to large variations in the physical, biological and socio-economic sub-environments. In fact, the consultative process and the sequential meetings with varied

stakeholders definitely helped in the identification and zeroing upon the focal problems in concerned State and UT, along with understanding of reasons/causes of degradation, and effects or implications on the river and surrounding lands.

3.13 Design of Field Data Formats

The Project team at HFRI, Shimla designed and developed a set of different types of elaborate formats for field data collection. Separate formats were provided to collect data from proposed sites for the Forestry Interventions on Natural, Agricultural, Urban landscapes and other interventions. These formats were also sent to the State and UT Forest Departments for collection of actual field information for the proposed Forestry Interventions and other conservation activities. Basically, it was intended to collect the requisite information from the field functionaries of the concerned State and UT about the name of the site for forestry intervention, area, geographical details, rough sketch and photograph of the site (Annexure: 2 – Annexure:5).

3.13.1 Development of Web Portal - Collection and Analysis of Primary Field Data

The sequential consultative process helped to develop an insight into the hierarchical organizational structure of the State and UT, river basin, and the Forest Department being identified as the Nodal Agency for the purpose of planning and implementation of DPR. The present project has envisaged collection of primary field data for the entire Chenab Riverscape of course with the support of State Forest Department (SFD), Agriculture Department and other Line Agencies. Prior to the collection of primary field data, the essential requirements revolved around the development of plantation and treatment models, design of field data formats and software for analysis of the field data.

3.13.2 Development of Software and Web Portal

A large variety of duly filled up field data formats were received from the SFDs of respective State and UT. Altogether, 1169 field record sheets had been acquired reflecting a huge database/ voluminous statistics. Out of this, almost 224 records sheets have been for proposed interventions in Natural Landscapes and 96 records sheets for plantation activities and other treatment in Agriculture Landscapes. Remaining 849 statistics sheets had been meant for Urban Landscapes, Conservation Interventions and supporting activities. In order to effectively collate, examine, synthesize, interpret and retrieval of desired statistics, HFRI Shimla obtained the services of a commercial vendor – M/s Reckon Web Solutions, Dehradun to develop a web based software (Fig. 3.4).

The firm developed software in PHP/ Mysql, server Linux based and that works on Codeigniter Framework basis. It is a web based and easily accessed via internet. The software can compute cost calculations according to selected specified models for unlimited created models and is password protected. In the software, field data was entered as per the five

specified models, namely, natural, agriculture, and urban landscape, conservation interventions and supporting activities, and can be saved in digital format. The software is capable of generating reports in the desired formats i.e., State-wise, District-wise, Division-wise, Model-wise and Activity-wise, and Annual Consolidated Reports can be generated to obtain insight on year-wise areas under different landscapes to be treated and corresponding costs.

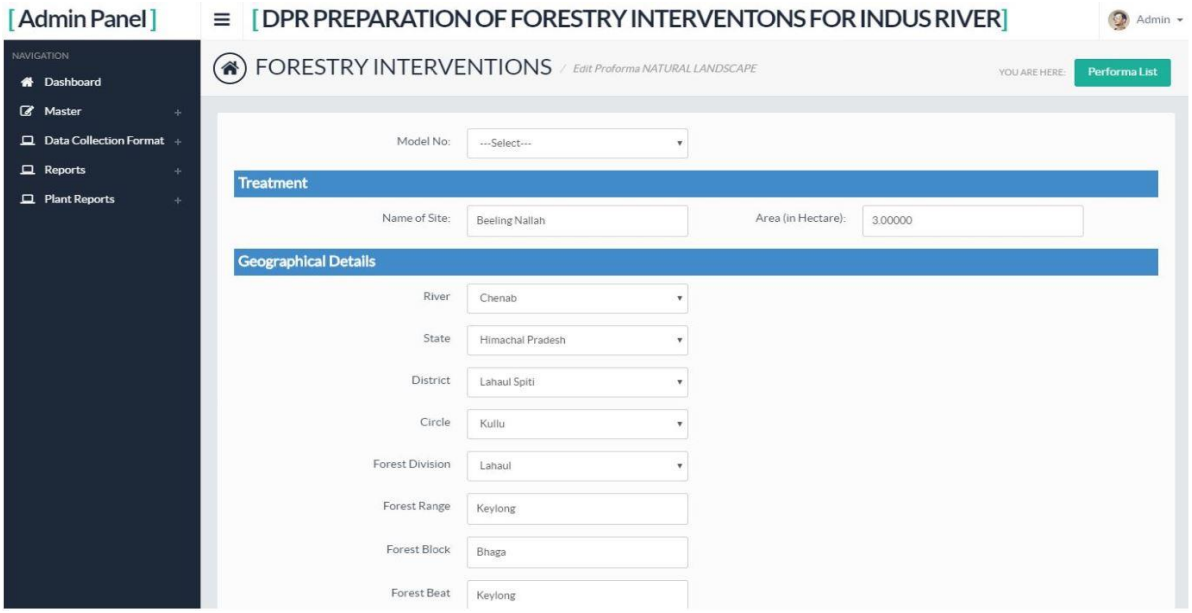


Fig.3. 4– Software developed for data entry of filled formats

3.14 Objective Analysis and Strategic Planning

Consultative process with the stakeholders paved the way for developing long term vision and goals and also emphasized upon the desired direction or pathways for relevant actions and activities. In the process, a clear picture of the changes the project can bring once launched, emerged along with its contribution on the long term basis. A clear picture of the project significance and of the outcome for the society, biodiversity and the river ecosystem was also understood in a much better and refined way. The multi-disciplinary team from HFRI with resource inputs from widerange of stakeholders was able to pin point objectives, outputs and outcomes that need to be attained including refining the strategy to be adopted. Desired insight of the problems those can be faced while achieving various objectives and identification of priority actions for rejuvenation of the river were defined/made easy after the Consultative Meetings. In fact, the process immensely helped in firming up the strategies for implementation of the project. Accordingly, it was decided that the programme implementation should revolve around the Natural, Agriculture and Urban Landscapes and also within the Riverscape. Further, a variety of conservation and supporting activities would also be required for effective implementation, knowledge management and sharing, capacity development, monitoring, and adaptive management.

3.15 Suggested Plantation and Treatment Models

The Multi-disciplinary expertise available at HFRI, Shimla became quite handy to the executing team and was utilized in developing suitable plantation and treatment models for the proposed forestry and other conservation interventions in three types of landscapes visualized in the Chenab Riverscape. These interventions, infact, included the Natural, Agriculture and Urban Landscapes. Considering the kind of natural ecosystems, local flora, soil conditions and agro-climatic zones, ability models of various kinds of plantations had been recognized, designed and developed by the institute's professional for their use. The process behind the various models proposed within the Natural Landscapes primarily revolved around protection, eco-restoration and conservation. Thus, applicable activities have been planned and proposed with equally diverse models.

Details of those potential models on forestry intervention and particular treatment plans were also sent to the concerned State and UT for selection and to propose suitable adjustments, if necessary, based totally on the relevant information, and experience. In all 21 different models applicable to the natural landscapes had been advised to Himachal Pradesh and Jammu and Kashmir UT. Out of which 8 treatment models are for Himachal Pradesh and the remaining 13 models for Jammu and Kashmir UT for their field application in the respective region.

Considering the huge extent of the Chenab Plain in Jammu and Kashmir UT, 13 models of afforestation and treatment plans were proposed to SFDs of concerned UT. In case of agricultural landscapes 4 plantation models, 2 each for Himachal Pradesh and Jammu and Kashmir UT have been suggested. Considering the urban landscapes all along the Chenab and its tributaries, specific models, focusing on: (i) Bio-remediation and Bio-filtration (ii) Riverfront Development, (iii) Eco-park development, (iv) Institutional plantation have been suggested. For urban landscapes, 2 models have been suggested for the state of Himachal Pradesh and 4 models have been suggested for Jammu and Kashmir UT.

3.15.1 Preparation of Draft DPR – Activities, Resource Planning and Schedule

The HFRI followed a multi-pronged and multi-stakeholder consultative approach for preparing the DPR. The preparatory phase of DPR included review of literature, primary and secondary data collection and analysis expert consultations and receiving inputs from the wide range of stakeholders (i.e., policy and decision makers; relevant authorities; Scientific Organizations dealing with environment, forestry, and wildlife; Civil Society; Non-Governmental Organizations and interest groups. The exhaustive process adopted ultimately helped HFRI in the preparation of draft DPR presenting the background information, situation analysis and environment of the delineated Chenab Riverscape, formulation of strategies, planning of specific activities, resource planning (manpower, equipment and the finances), and year-wise schedule of operations. Draft DPR (Vol-I) was shared with the SFDs of concerned State andUT for seeking their feedback and valuable inputs.

3.15.2 Finalization of DPR, Implementation and Monitoring

The draft DPR was finalized incorporating the feedback and specific comments received from SFDs of concerned State and UT and ICFRE. Initially, the implementation during Phase 1 has been planned for duration of five years, starting from the financial year-1 to year-5 by respective State and UT and SFDs as the nodal agencies. It was decided that the first year of the implementation phase of DPR will include the planting work. Nursery raising for subsequent plantation and other related works would be undertaken in the subsequent years. It was also decided that some scope for minor modifications within the proposals can be made possible in the DPRs and the proposal must be supported with ample justification.

A provision for inbuilt, Results-Based Monitoring has been made for continuous monitoring, organizational learning and adaptive management. The maintenance phase after five years implementation would deal with the scaling up of the activities and covering of the left over tributaries. Assessment for selecting the first-rate planting models will also be taken keeping in view the probable benefits those can be derived from such species by the local groups and also considering the usefulness of such species in preserving woodland resources and indigenous biodiversity of the area.

3.16 Spatial Analysis – Application of Remote Sensing and GIS

Two streams, Chandra and Bhaga after originating and meandering from the opposite sides of the Bara Lacha Pass in Lahaul and Spiti of Zanskar Range joins at a place named Tandi falling in Lahaul and Spiti district of Himachal Pradesh and thereafter, known as Chenab which constitutes major part of Indus River Basin. It flows North-west direction through Pangi valley, parallel to Pir-Panjal Range and enters the Jammu and Kashmir UT (Gosal, 2004). The surrounding forests, agriculture and human activities on the banks of Chenab River collectively exert enormous influence on the river, its flow and numerous associated ecological characteristics and processes. Since, vegetation cover in general and forest cover in particular are vital parameters and accordingly, serve as indicators for the quality and functioning of the riverine environment or Riverscape. Thus, the present task for preparation of DPR with special reference to Forestry Interventions on Chenab River requires a better insight and understanding not only of Chenab River and its tributaries, but also of the surrounding lands and expanding human footprints.

3.16.1 Remote Sensing Technology

Use of remote sensing techniques always offer unparallel help and best understanding for monitoring the green and non-green land changes in the surroundings of the river at the regional and local scales besides facilitation in understanding the channel dynamics, particularly channel morphology, changes in the river course, and trends in sedimentation over period of time. Recent advancements in the said field of remote sensing mainly due to satellites with improved temporal frequency of data acquisition and better spatial and spectral resolution have offered unparalleled opportunities for

resource inventory and surveys, planning, management and monitoring of varied natural and man-made resources and objects. New sensors with moderate and high resolution data have enabled evaluation of impacts on biodiversity of specific management policies (Parsad *et al.,* 2015).

Though the term remote sensing is often applied to satellite-borne imaging of the Earth's surface only, yet it may be impressed upon that it is the common name for all methods used to collect data at a distance from the object under study by some kind of recording device (Martensson, 2011).

The accelerated rate of deforestation, forest fragmentation, and forest degradation is not only a threat to continuous supply of forest products for the livelihood of local people, but also has several adverse impacts at multiple levels, particularly the downstream. Further, planning and management for Chenab River management, particularly the proposed Forestry Interventions for Chenab River Basin rejuvenation need a pre-requisite information on the farthest bank lines during the maximum flood period for the main river and its tributaries so as to avoid such areas from the perspective of proposed Forestry Interventions. Furthermore, an insight is essentially required on the distribution and extent of diverse forests, land use, and identification of likely available sites for proposed plantations and Forestry Interventions. Remote sensing technology combined with Geographic Information System (GIS) which excels in storage, manipulation and analysis for geographic information and socio-economic data provides a wider application. Land resources managers and environmental decision makers require quantitative information on the spatial distribution of land use types and their conditions as well as temporal changes for better understanding of the subject (Hughton, 1994).

Remote sensing applications in forestry clearly reflects forest cover types, identify individual species, species composition, forest fire detection, forest fire hazard, detecting forest trees health, assessment of wind damage and other sever climatic condition, forest monitoring, reafforestation and afforestation, timber harvesting planning, forest inventory, forest management, assessment of slope failure and soil erosion, assessing and managing forest recreation resources, including assessment of assessing and managing wildlife habitat (Hussin, 2000).

3.16.2 Geographic Information System (GIS)

Geographic Information System (GIS) refers to a set of theories, methodologies, and computer-based technologies that deal with geography related information. This tool presently is being used widely in many domains including geography, geology, ecology, sociology, urban planning, engineering, business, health studies, public administration, and in many others disciplines for in-depth analysis and interpretation of results. In view of this, emphasis will be laid on the nature of geographic information, spatial data models and structures, data input and editing, spatial query and analysis, computerized cartographic output and presentation, including error analysis (Shi, 2003).

GIS is basically an information system based upon the geographically referenced spatial and non-spatial data for planning, monitoring and effective implementation of the management plans. The role of GIS is invaluable for optimal land use planning and making integrated development plans. A GIS database is a structured collection of digital spatial and non-spatial data that describes map features, spatial relationship and character of features. They may always be linked to GIS through common identifier or other mechanisms. GIS has two distinct utilization capabilities, i) querying and obtaining information, and ii) integrated analytical modeling (Burroughs, 1986). However, both of these capabilities depend upon the GIS database for queried results through a GIS package having the capability of handling both spatial and non-spatial databases.

The evolution of GIS, the Global Positioning System (GPS), and technologies has enabled the collection and analysis of field data in ways that were not possible before the arrival of computers. As indicated earlier, GIS methodologies are used to, make better decision, and improve productivity, so as to save time, money and man power in forest management activities, otherwise essentially required for both location and descriptive inventory data, rather geographic information (Sonti, 2015).

3.16.3 Global Positioning System (GPS)

GPS is basically a system that works on a network of satellites that continuously transmit information pertaining to positioning in the form of code. This precise information transmitted from the satellites can be interpreted by receivers to precisely identify locations on earth by measuring distances from the satellites (NRCS, 2007).

3.17Geospatial Modeling

Geospatial modeling is an analytical process conducted in conjunction with a GIS in order to describe basic processes and properties for a given set of spatial features. The objective of spatial modeling is the ability to study and simulate spatial objects or phenomena that occur in the real world and facilitate problem solving and planning. One of the most important utilities of Geospatial data is its capability of being integrated for decision making through synthesis of spatial and non-spatial information within the framework of an application. Geospatial modeling techniques moves from relatively passive forms of enquiry to more active form of decision making and involves conjunctive analysis of multi-parameter data (i.e., maps and non-spatial data). Towards this, there are two aspects that are of importance; i) a model/criterion that defines the logic for analysis of the composite information set, and ii) relative importance or weightage of each parameter for the end objective.

Subsurface geologic modeling is a complicated venture for Geographic Records System (GRS) technology. However, the spatial nature of geo-items constantly drives GIS to be a part of the modeling structures. The conventional activities wherein GIS is concerned in geo-sciences are information management, visualization, spatial analysis, and selection assist. Current trends allow the entire GIS abilities on a laptop with full integration of the enterprise-

widespread Relational Database Control Machine (RDBMS), geo-statistical capability, 3-D visualization, 3-D geo-processing talents, and Web-based mapping. These make GIS more attractive for complete geo-sciences wishes. Modern GIS is constructed on an open standard era that guarantees GIS can be included with specialized strong 3-D geosciences programs to resolve complex geologic problems (Setijadji, 2003).

3.17.1 Application of RS, GIS and GPS in the Present Assignment

The use of Remote Sensing and Geospatial modeling has much role to play in identification of suitable sites for a particular activity including forest plantations in any area. Accordingly, this methodology is being used in carrying out plantation in Chenab River catchment and its tributaries. Land evaluation analysis which involve the execution and interpretation of basic surveys of climate, soils, vegetation and other technical aspects of land in terms of requirement of alternative forms of land use, land use requirement of land utilization types and the availability of existing land quality and land characteristics is another aspect which require in-depth analysis while preparing such reports. There are many studies highlighting that Remote Sensing Techniques have been highly effective and useful in this regard. The significant inputs can be derived from Remote Sensing Technology in the field of land evaluation are based on all cover type information which is ultimately stratified into different land units containing different land qualities and land characteristics. The ground truth information substantiates the land use requirement of land utilization types *viz*., forest types/individual tree species and management/ silvicultural practices in a particular site condition. It has now been well established that Remote Sensing Techniques have been highly effective and useful in developing a better understanding of land evaluation and land use patterns.

The main objective of the use of RS and GIS technologies in the present assignment was for the identification, selection and delineation of suitable sites for proposed forest plantations and other Forestry Interventions and to relate these with the selection of appropriate plantation species on the basis of their requirements and matching with the existing qualities and characteristics of the available lands/potential sites. This essentially involves several aspects relevant to the technical, social and economic suitability of land along the delineated buffer or influence areas within the Chenab Riverscape, as it is not feasible to manually integrate, analyze and manipulate such vast amount of spatial and non-spatial data and retrieve the desired information for the suitability analysis. Hence, the use of geospatial modeling has been made during selection suitable sites.

3.17.2 Remote Sensing and Geographical Information System Methodology

Image processing and GIS tools used in the present assessment were ERDAS Imagine 2018, Geomedia Professional 2018, ArcGIS, etc. The GIS software infact provided the tools needed to store, analyze and display the required geographic information.

3.17.3 Satellite Data Used

Landsat 8 satellite data for the months of November and December, 2018 was used for the preparation of Land use and Land cover map of the Riverscape under reference. The Row, Path along with Date of Pass of the satellite data used in the current study for the relevant parts of Himachal Pradesh and Jammu and Kashmir UT covering the Chenab Riverscape is presented in (Table 3.4; and Fig.3.5).

Table: 3. 4- Details of the Data Downloaded and used during Present Assessment of Chenab Riverscape

Path	Row	Date of Pass	Satellite
A) Himachal Pradesh			
147	037	10-11-2018	Landsat-8
147	038	10-11-2018	Landsat-8
148	037	03-12-2018	Landsat-8
146	038	21-12-2018	Landsat-8
B) Jammu and Kashmir UT			
147	037	10-11-2018	Landsat-8
148	036	03-12-018	Landsat-8
148	037	03-12-2018	Landsat-8
149	037	24-11-2018	Landsat-8
148	038	17-11-2018	Landsat-8

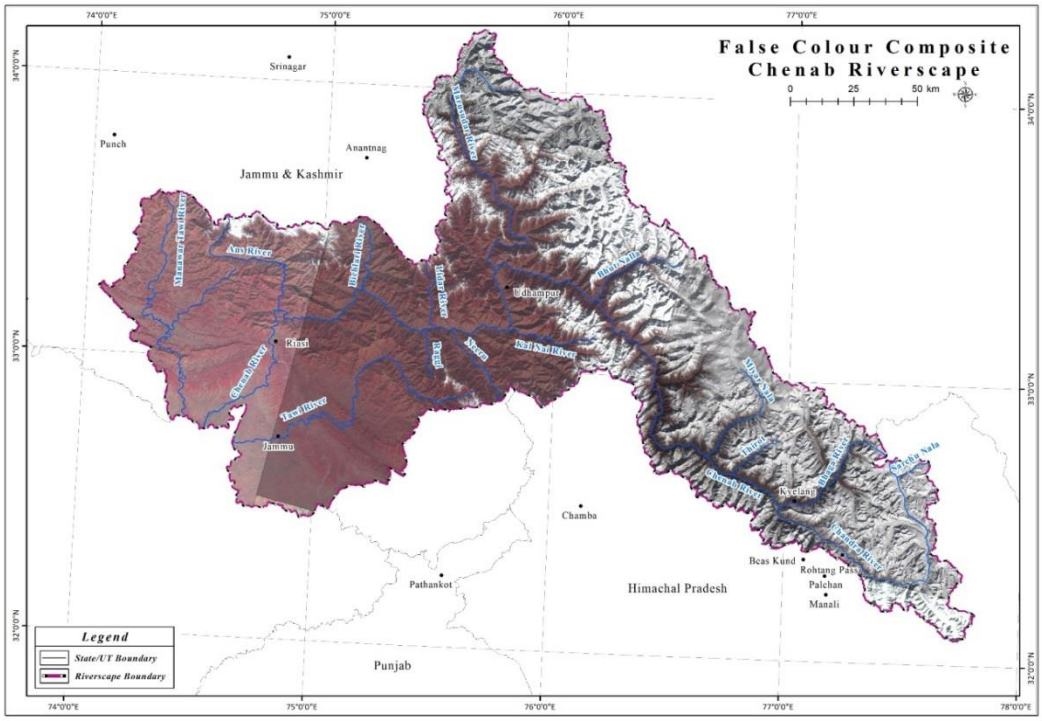


Fig.3. 5- Satellite Map (False Color Composite) of Chenab Riverscape

3.17.4 Ancillary Data

Ancillary information for the present study had been taken from various source of Government of India. Information about the State and UT including district boundaries for the Riverscape taken up for analysis was obtained from Survey of India. Information and the required data pertaining to basin boundary, Catchment boundary, Sub-Catchment boundary, Watershed boundary and Micro-watershed boundaries were obtained from the Soil and Land Use Survey of India, New Delhi. Details of Village and Tehsil boundaries were obtained from the published document of Census of India, Administrative Atlas of Himachal Pradesh and Jammu and Kashmir, 2011. Forest types and forest density data were obtained in digital format from Forest Survey of India, Dehradun whereas, recent soil maps and soil depth information was obtained from the maps of National Bureau of Soil Survey and Land Use Planning, Nagpur. Soil erosion data is the backbone of multi-criterion analysis was obtained in GIS format from the Indian Institute of Soil and Water Conservation, Dehradun. Topographical sheets on 1:50,000 scales as obtained from Survey of India have been used for Geo-reference only. Bhuvan data was also referred, to whenever and wherever required for the preparation of land use map.

3.17.5 Data Downloading

Relevant Landsat-8 satellite datasets specific to Chenab Riverscape were downloaded from www.earthexplorer.usgs.gov. The time frame was selected after keeping in mind

the post-monsoon seasons and maximum differentiation in various land cover features. A list of data downloaded and used for the present study is given in Table 3.4.

3.17.6 Map to Image Registration as per Accepted Projection System

Image registration as per the accepted projection system is one of the important component for area analysis and display of output on definite projection system including integration and modeling of the land-cover parameters. The projection parameters used in the current assessment are given below.

Projection: Lambert Conformal Conic

Spheroid: WGS84

Datum: WGS84

First Standard parallel: 12°28'N

Second Standard Parallel: 35°10'N

Longitude of Central meridian: 82°00' E

Latitude of origin of projection: 20°00' N

False Northing: 20,00000 m

False Easting:2000000 m

3.18Spatial Data Creation and Analysis

Spatial database creation is considered as one of the most important step in Geospatial Modeling and integration of basic layers of this database is of utmost importance from the perspective of present assessment.

3.18.1 Pan sharpening of Landsat Imagery

During the present investigation, pan sharpening of Landsat Imagery was done using 30-m multi-spectral image which was sharpened further having 15-m panchromatic imagery. This exercise was carried out with a specific objective to enhance the spatial resolution of the multi-spectral imagery. The pan sharpening was performed on the Landsat 8 image using the HPF resolution merge algorithm in ERDAS software.

3.18.2 Creation of Riverscape Boundary

Initially, Landsat-8 satellite images, 2018 were used for digitization of main stem and major tributaries of the current DPR and at the same time, Survey of India topographical sheets of 1:50000 scales were used as a reference for the identification of streams. Furthermore, micro-watershed atlas of India was used as the basic tool for delineating the boundaries of Riverscape in Himachal Pradesh and Jammu and KashmirUT

3.18.3 Delineation of Riverscape Boundaries

For the delineation of Chenab Riverscape boundaries, consultative process used for preparation of DPR for Ganga River in the year 2015-16 has been followed. In view of the basic nature of Chenab River and being one of the Himalayan river the criteria adopted for the delineation of Riverscape boundaries by FRI in the case of Ganga River were considered appropriate for Chenab River. In addition, Landsat-8 satellite images of 2018 as also indicated earlier were used to create tentative riverscape boundaries covering 5 km buffer on either side of the river bank line for the main channel of Chenab River and 2 km on either side for the only tributary of Chenab River. After in-depth deliberations in the Consultative Meetings, it was proposed and later finalized to cover all concerned micro-watershed boundaries in the case of Chenab main channel and its tributary as part of the Riverscape for preparation of the present DPR. Accordingly, the entire catchment area of Chenab River including all the tributaries in Himachal Pradesh and Jammu and Kashmir UT were included, thereby, covering an approximate area of 29326.47 km^2 in the Chenab Riverscape.

3.18.4 Selection and Demarcation of Watershed Boundaries up to Micro-watersheds

Sites for the establishment of various treatment models for Forestry Interventions practices have been carefully selected considering the geospatial analysis, modeling and prioritization of the treatment areas. The following section, thus, represents the geo-spatial analysis, and selection of the appropriate model and prioritization of sites for proposed interventions.

3.18.5 Watershed Boundary up to Micro-Watershed

Watershed boundaries up to Micro-watershed level were delineated using source maps of Soil and Land-use Survey of India, New Delhi. Each of the Micro-watershed had been depicted with a code as per the codifications standards comprising of the following stages and have been described below to offer an understanding of the codes.

Stage One – This stage basically emphasizes upon the Water Resource Regions (WRR) and is normally denoted by Arabic Numbers like 1, 2, and 3. etc.

1. Indus drainage
2. Ganges drainage
3. Brahmaputra drainage
4. All drainage flowing in Bay of Bengal except Sl. No. 2 and & 3.
5. All drainage flowing into Arabian Sea except at Sl. No. 1
6. Western Rajasthan mostly ephemeral drainage.

Stage Two – This approach normally revolve around basin – Each WRR since, it appeared for the first time was divided into basins which constitute big Individual river. WPR is

normally denoted by Capital English alphabets suffixed to WRR code for example A, B, C. Thus the basin will be denoted as 1D Chenab

Stage Three – Next step constituting the said process is Catchment. Accordingly, each of the basin was further sub-divided into a number of catchments mainly pertaining to the main tributaries or a group of contiguous small tributaries or individual stream. They are denoted by Arabic number suffixed to Basin Code for example 1, 2, 3 and so on. Thus catchments have been expressed as 1D1.

Stage Four – Next step forms the delineation of sub-catchments which mainly comprises of smaller tributaries or streams. They are denoted by capital English alphabets suffixed to catchment code for example A, B, C thereby expressing the sub-catchment as 1D1A.

Stage Five – Under this stage, each of the sub-catchment has been divided into a number of watersheds which are the smallest hydrological unit delineated in 1: 1 m Watershed Atlas of India in the macro level category. They are denoted by Arabic numbers suffixed to sub-catchment code for example 1, 2, 3, and watershed will be symbolized as 1D1A1.

Stage Six – Delineation of sub-watershed at micro level and its codification forms the next step and is normally done in 1:50,000 Survey of India topography maps. The watersheds are sub-divided in sub watersheds which are either the banks of small tributaries or discreet streamlets. They are denoted by small English alphabets suffixed to code of watershed. However, the use of e, I, o, and l alphabets are avoided. Thus, sub-watershed have been expressed 1D1A1a in the present draft document.

Stage Seven – Micro-watersheds of the river basin have been further divided into the smallest micro-level hydrological unit i.e. micro-watershed which are part of small streams or streamlets. They are denoted by Arabic numbers but restricted to 9 only and suffixed to sub-watersheds code. This completes the delineation and codification at micro-level. Thus, the micro-watershed has been coded as 1D1A1a1, 1D1A1a2, etc. Thus, the micro-watershed code 1D1A1a1 will represent water resource region 1, basin 1D, catchment 1D1, sub-catchment 1D1A, watershed 1D1A1, and sub-watershed 1D1A1a (Source: Micro watershed Atlas of India).

Making use of the data sets as detailed above layers of various catchment of Chenab River followed by Sub-catchment, Watershed and Sub-watershed were derived. The list under each category falling within Riverscape along with the maps is given below (Table 3.5 to 3.6, Fig 3.6 to 3.9).

Table: 3. 5- Riverscape Area and Extent of Distribution Under Various Sub-catchments of Chenab Riverscape

State/UT	Sub-Catchment	Area (km^2)	Area Percentage (%)
Himachal Pradesh	1D1D	1932.66	6.59
	1D1E	5822.78	19.86
Jammu and Kashmir	1D1A	3770.65	12.86
	1D1B	7436.81	25.36
	1D1C	4663.22	15.9
	1D1D	2911.79	9.93
	1D1F	2788.56	9.51
Total (02)		29326.47	100

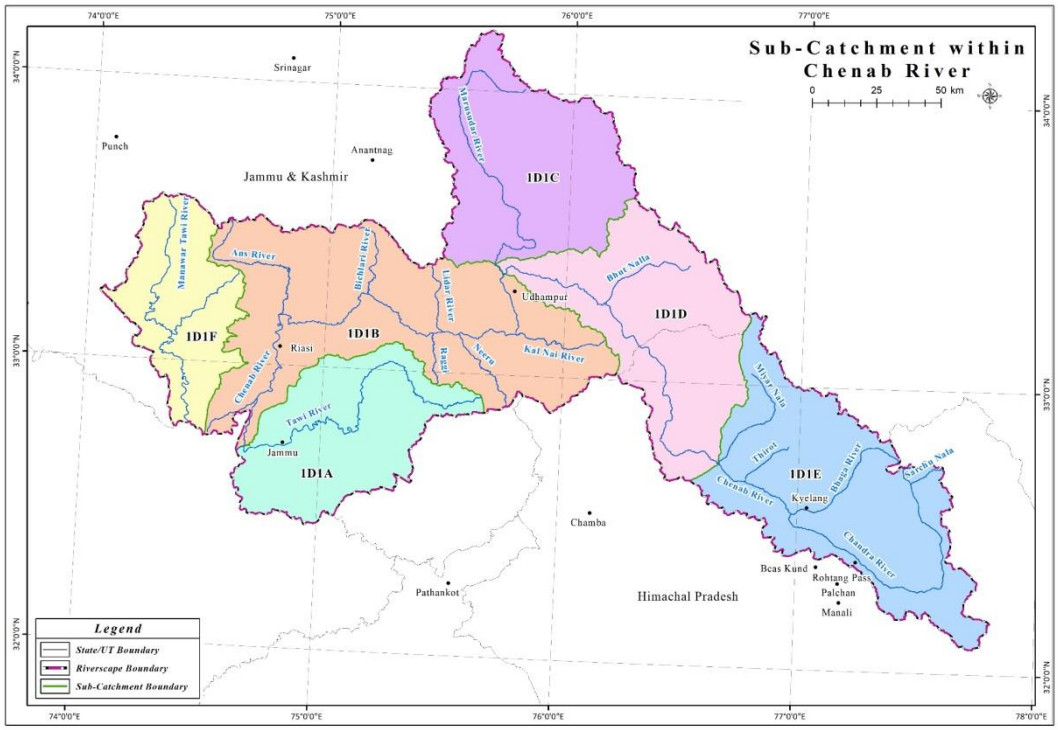


Fig.3. 6– Chenab Riverscape with its Tributaries and Sub-catchments

Table: 3. 6- Under Various Watershed, Extent of Area and Percent Contribution of Riverscape

A) Himachal Pradesh		
Watershed	**Area (km^2)**	**Area Percentage**
1D1D3	10.97	0.04
1D1D4	30.09	0.1
1D1D5	492.73	1.68
1D1D6	670.07	2.28
1D1D7	728.80	2.49
1D1E1	947.11	3.23
1D1E2	822.44	2.8
1D1E3	660.61	2.25
1D1E4	985.80	3.36
1D1E5	1,059.77	3.61
1D1E6	694.65	2.37
1D1E7	652.40	2.22
B) Jammu and Kashmir UT		
1D1A1	613.86	2.09
1D1A2	572.71	1.95
1D1A3	935.69	3.19
1D1A4	665.70	2.27
1D1A5	982.69	3.35
1D1B1	908.61	3.1
1D1B2	726.99	2.48
1D1B3	1337.84	4.56
1D1B4	388.25	1.32
1D1B5	626.36	2.14
1D1B6	850.50	2.9
1D1B7	1,022.10	3.49
1D1B8	584.22	1.99
1D1B9	991.94	3.38
1D1C1	708.21	2.41
1D1C2	1083.84	3.7
1D1C3	565.77	1.93
1D1C4	909.18	3.1
1D1C5	511.28	1.74
1D1C6	884.94	3.02
1D1D1	786.79	2.68
1D1D2	496.09	1.69
1D1D3	971.91	3.31
1D1D4	657.00	2.24

1D1F1	754.16	2.57
1D1F2	751.93	2.56
1D1F3	518.78	1.77
1D1F4	763.69	2.6
Total	**29,326.47**	**100**

Considering all the parameters and also in view of the output to be generated less than 500 sub- watersheds out of 3657 micro-watershed present in Chenab River Basin have been considered for delineation of the Chenab Riverscape Area. Sub-watershed categorized as 1D1B9c is the smallest sub-watershed encompassing 3 micro-sheds whereas Sub-watersheds identified as 1D1B7f and1D1C5k are the largest one with 18 micro-sheds.

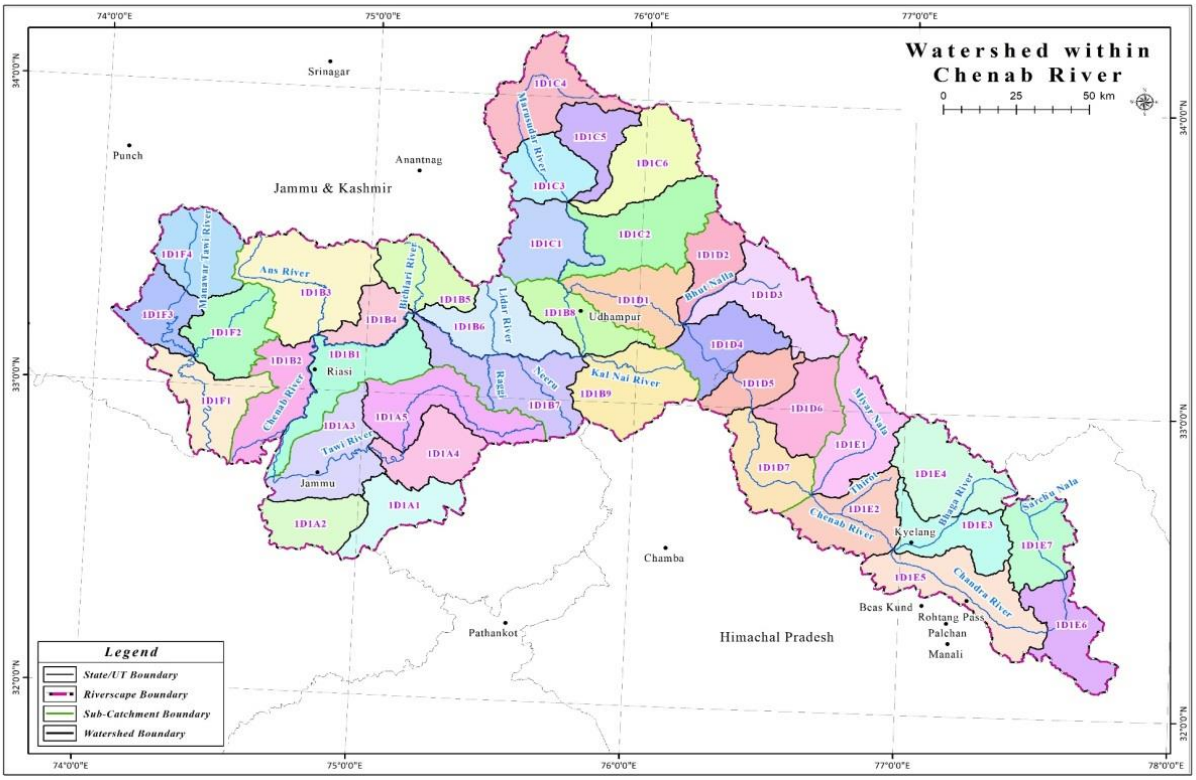


Fig.3. 7– Chenab Riverscape with Tributaries and Watershed

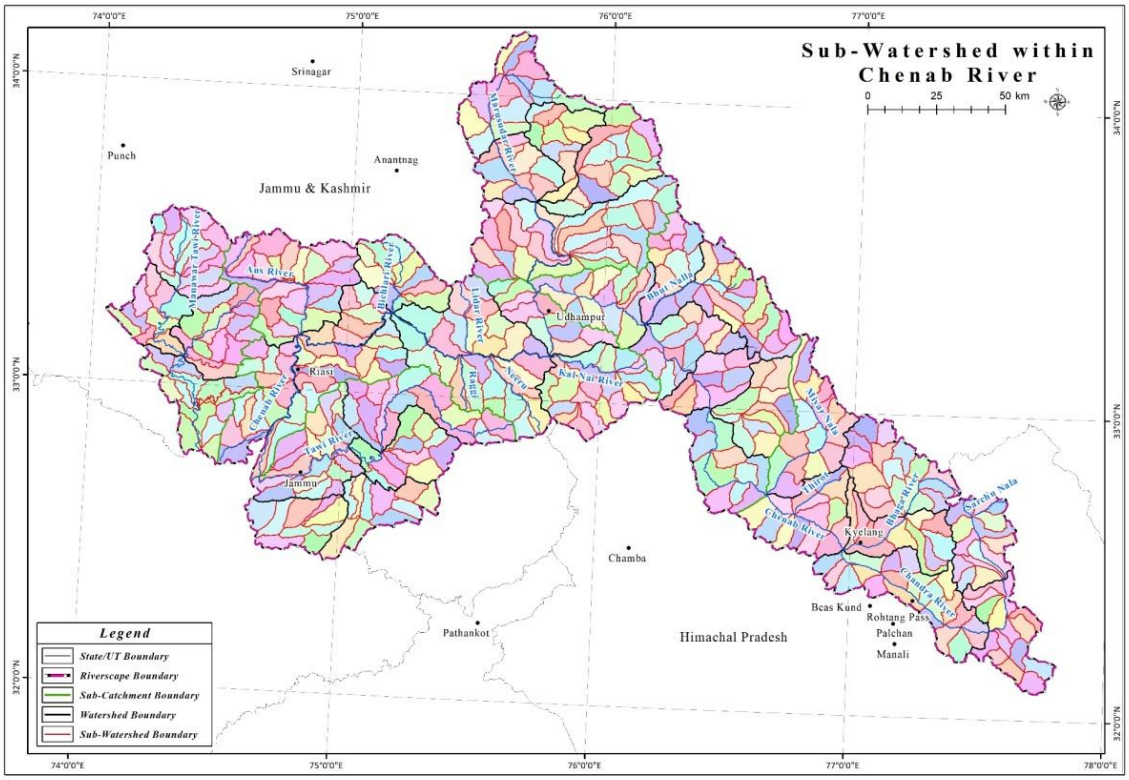


Fig.3. 8– Chenab Riverscape with Tributaries and Sub-watershed

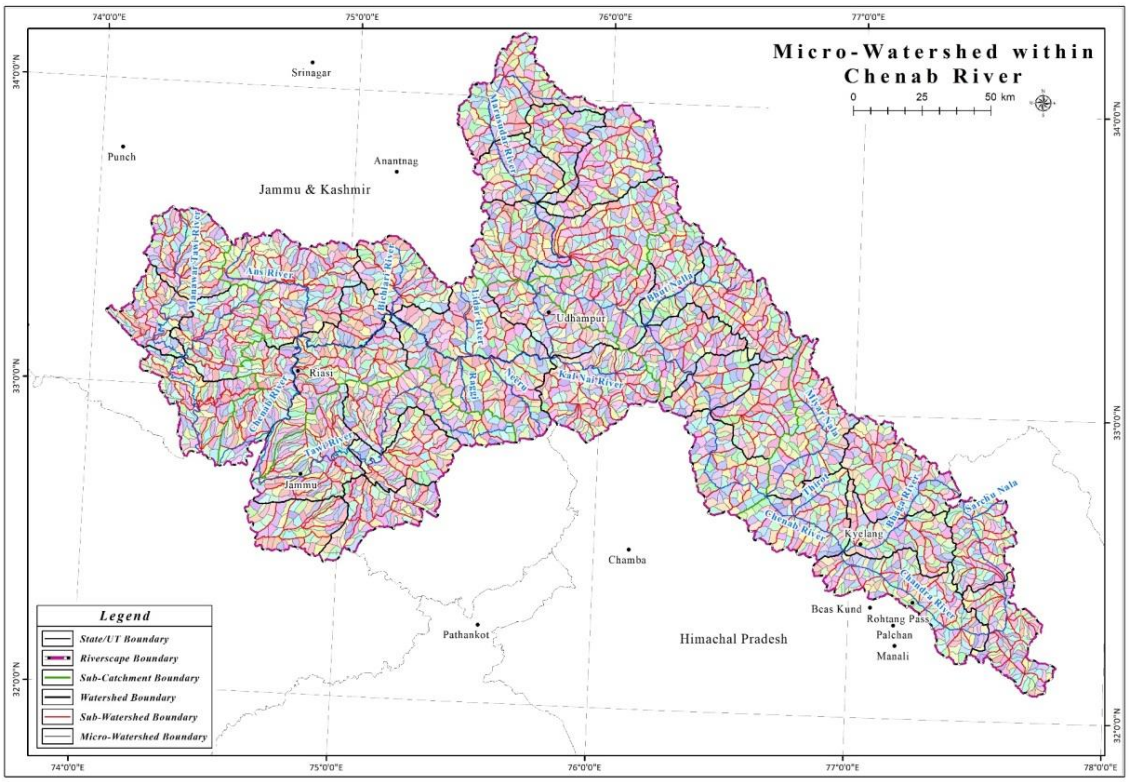


Fig.3. 9– Chenab Riverscape with Tributaries and Micro-watershed

3.19 Geospatial Analysis of the Chenab Riverscape and Modeling for Prioritization of Sites for Forestry Interventions

The previous Chapters provide substantial description of 'Riverscape' concept and suitably laid down the rationale for adopting Riverscape Analysis and Delineation Approach in the present DPR on Forestry Interventions for rejuvenation of Chenab River. This involves the vital steps i.e., delineation the Chenab Riverscape, its geospatial analysis, and basic criteria for prioritization of sites for proposed Forestry Interventions within the delineated riverscape. In addition to this, the preceding section emphasized upon the various attributes of the physical and biological sub-environments of the Chenab Riverscape to gauge the existing situation entirety in its riverscape and also to develop a comprehensive understanding of the past trends, major challenges, issues and factors, factors responsible for the current state of the environment and degradation of natural resources, particularly the Chenab River ecosystem. The following section deals with the geospatial analysis of the Chenab Riverscape and identification of priority sites for the proposed Forestry Interventions. Geospatial technique is a basic tool for mapping and monitoring Land Use Land Cover (LULC) associated with agriculture, urbanization, identification of different sites of human interest and its impact on flora and fauna. In addition, with the remote sensing technique, the complex LULC system of a difficult terrain can be studied and comprehensive management plans can be prepared. Geospatial techniques provide enabling platform to generate space borne multi-spectral data which can be used to generate LULC maps at various levels showing categories of land under different uses both in spatial and statistical form for the entire country at a time. For the Chenab Riverscape, RS and GIS techniques have been used for mapping the LULC and prioritization of sites.

Altitude and Digital Elevation Model (DEM)

Altitude, particularly in the Himalayan region plays a decisive role in the physical characteristics, biological diversity and its distribution, socio-economic uses and consumption patterns. In particular, higher altitudes greatly influence river flow, rate of sedimentation, vegetation, wild animal use and even human settlements and their uses. The Riverscape depicts large altitudinal variation from 195 m amsl to very high altitude of 7,016 m amsl. The altitude plays an important role in the physical characteristics, biological diversity and its distribution and socio economic uses and consumption patterns. In particular, higher altitudes greatly influence river flow, rate of sedimentation, vegetation, wild animal use and even human settlements and their uses. Advanced Land Observing Satellite based Digital Elevation Model (ALOS-DEM) data was downloaded from http://www.asf.alaska.edu/ and used to derive the elevation classes. The different elevation classes were regrouped and a total of 12 elevation classes were derived (Fig 3.10, Fig 3.11). The distribution of areas under different elevation classes within the Chenab Riverscape is given in Table 3.7. The results revealed that the maximum extent of about 6,700.53 km^2 or 22.85% area of the Chenab Riverscape lies between 4,000 to <5,000 m amsl elevation.

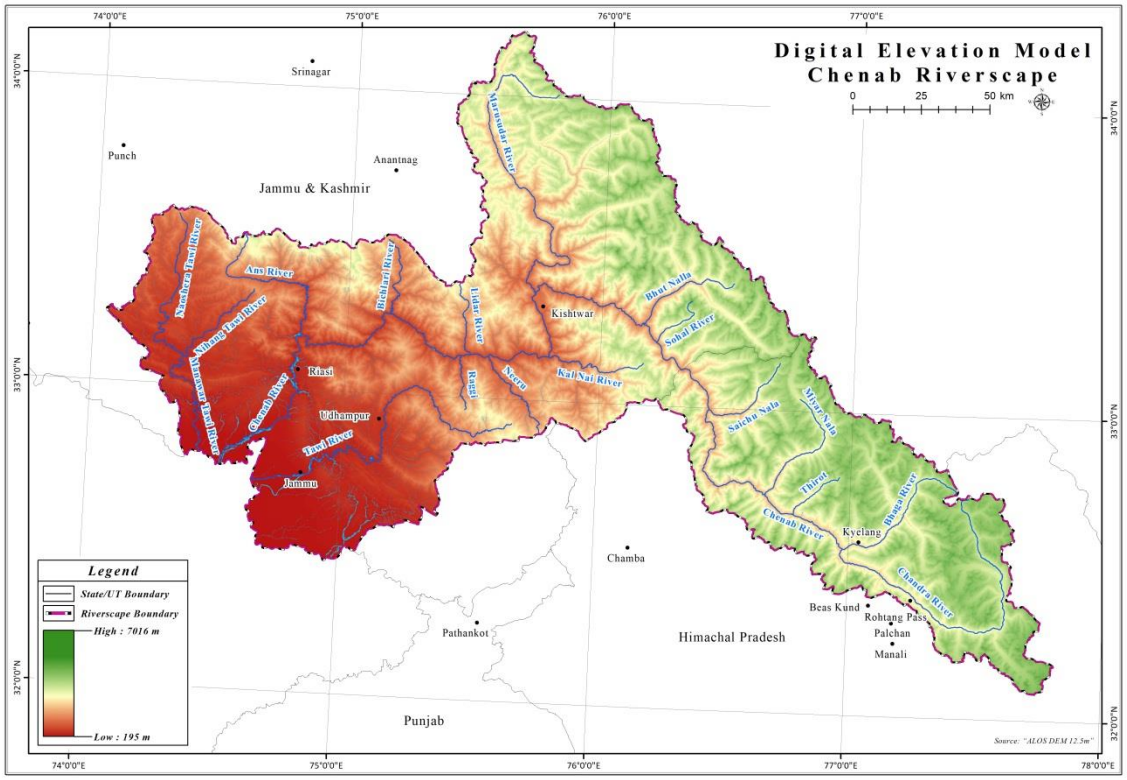


Fig.3. 10– Digital Elevation Model of Chenab Riverscape

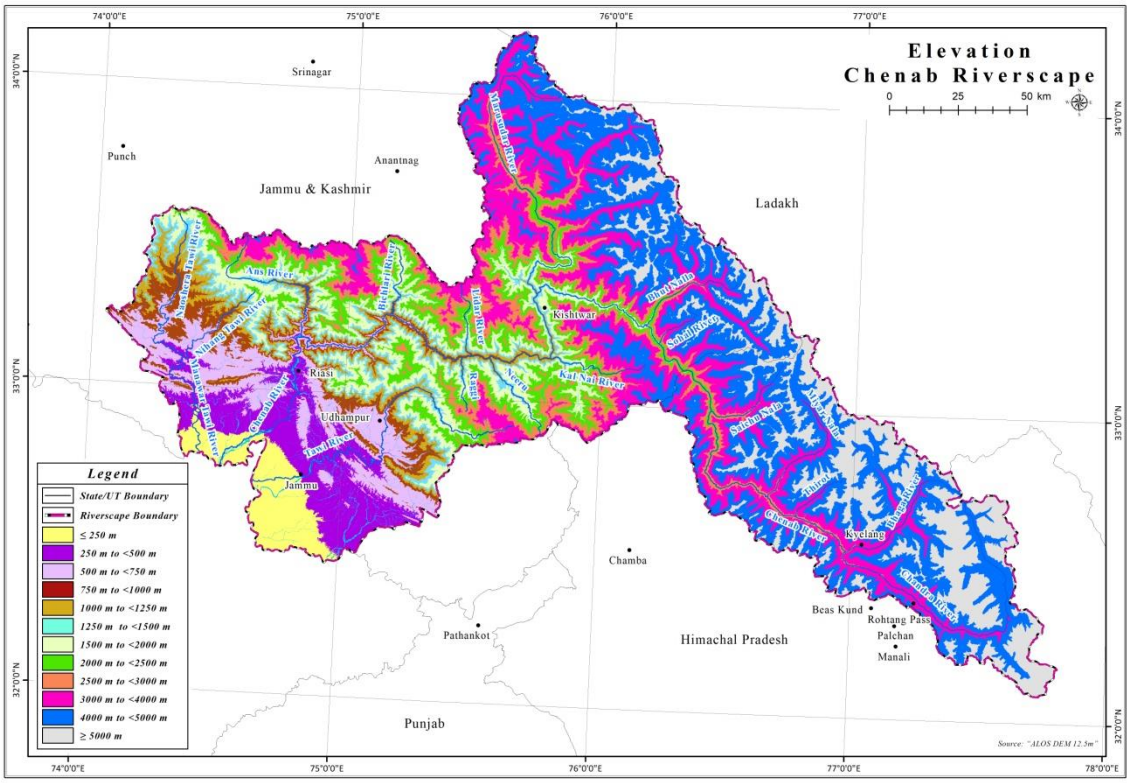


Fig.3. 11– Altitudinal Variation in Chenab Riverscape

Table: 3. 7- Distribution of Area of Chenab Riverscape under Different Elevation Classes

S.No.	Elevation Classes	Area (Km^2)	Representation of the Class (%)
1.	<250 m	1,043.20	3.56
2.	250 -<500 m	1,936.23	6.60
3.	500-<750 m	1,809.89	6.17
4.	750-<1000 m	1,171.76	4.00
5.	1000-<1250 m	1,015.38	3.46
6.	1250-<1500 m	1,024.93	3.49
7.	1500-<2000 m	2,143.18	7.31
8.	2000-<2500 m	2,131.05	7.27
9.	2500-<3000 m	2,079.05	7.09
10.	3000-<4000 m	4,920.57	16.78
11.	4000-<5000 m	6,700.53	22.85
12.	≥5000 m	3,350.70	11.43
	Total	**29,326.47**	**100**

(i) Slope

Slope is considered vital physical feature of the sites while suggesting suitability of areas for Forestry Interventions, particularly plantations. The higher degree of slopes (>30°) usually cause a lot of soil erosion, and are prone to landslides, greater runoff, etc. Thus, areas with slopes 30° to 45° require safeguards from erosion while raising plantations of multiple values (i.e., fuelwood, fodder, timber, etc.). These types of forest resources are in heavy demand all along the Riverscape including higher reaches by increasing pressure of pilgrimage, presence of paramilitary forces, transhumance pastorals and widespread human settlements. A total of 10 classes of slope have been derived in the Riverscape. The distribution of areas under different slope classes is given in Table 3.8.and Fig. 3.12.

Table: 3. 8- Distribution of Area in Chenab Riverscape under Different Slope Categories

S.No.	Slope	Area (Km^2)	Total Area (%)
1	<2.5°	1,688.47	5.76
2	2.5°-<5°	1,279.16	4.36

3	5°-<10°	2,158.08	7.36
4	10°-<15°	2,297.72	7.83
5	15°-< 20°	2,824.11	9.63
6	20°-<25°	3,147.23	10.73
7	25°-<30°	3,868.55	13.19
8	30°-<35°	3,947.55	13.46
9	35°-<40°	3,365.32	11.48
10	≥ 40°	4,750.28	16.2
	Total	**29,326.47**	**100**

Maximum area (16.2%) falls under > 40° followed by 30°to <35° (13.46%), 25°to <30° (13.19%) 35°to <40° (11.48%) and 20°to <25°(10.73%). The total areas under different slope categories will help in developing models accordingly.

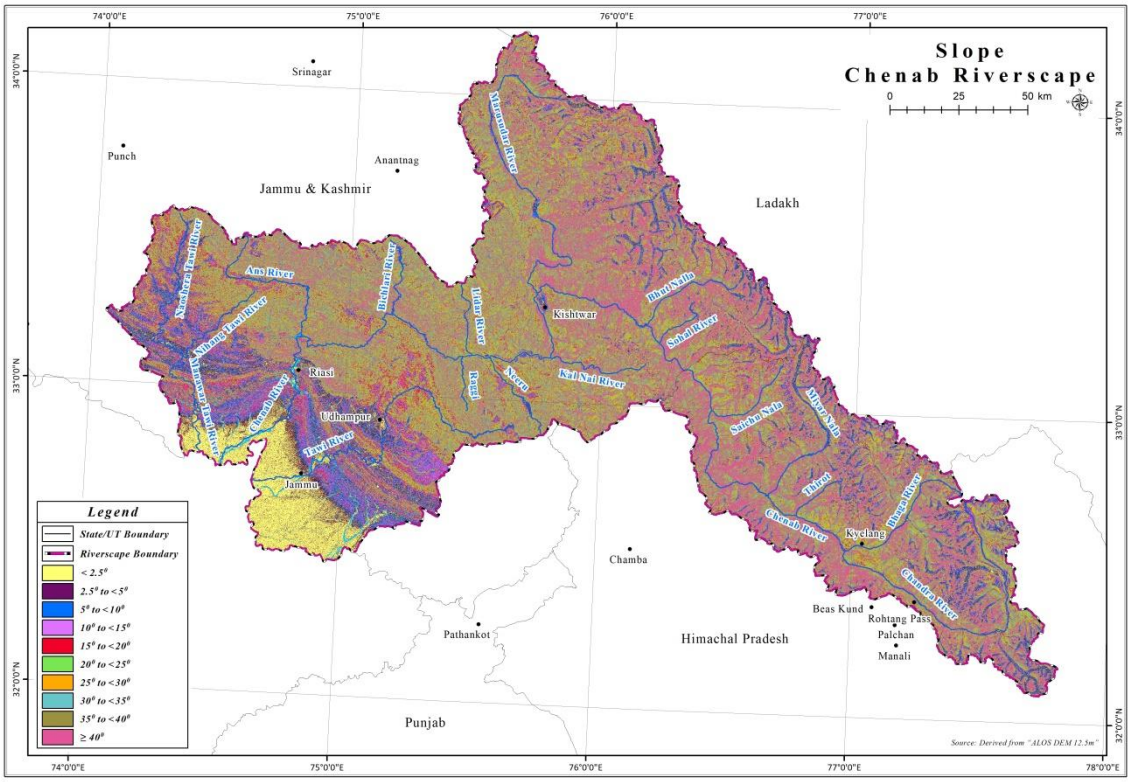


Fig.3. 12- Distribution of Slope within Chenab Riverscape

(ii) Aspect

In the Himalaya, aspect influences the diversity and distribution of vegetation and microclimate. This effect can be seen to an extreme degree in the Himalayan region. North and south aspects vary in their microclimate; light intensity, soil and air temperature, humidity, soil moisture, evaporation and duration of growing periods. These differences are closely associated with differences in vegetation composition and structure. For the DPRs aspect map was derived from the ALOS DEM and a total of nine

categories *viz*., North, North-East, East, South-East, South, South-West, West, North-West and the Flat land were analyzed for the study area.The area distribution under different aspect classes is presented in Table 3.9 and Fig. 3.12.

Table: 3.9- Distribution of Chenab Riverscape Area in Different Aspect Categories

S.No.	Aspect	Area (km^2)	Percentage of Total Area (%)
1.	Flat (-1)	595.33	2.03
2.	North (0-<22.5& 337.5-360)	3,301.47	11.26
3.	Northeast (22.5-<67.5)	3,213.93	10.96
4.	East (67.5-<112.5)	3,189.04	10.87
5.	Southeast (112.5-<157.5)	3,734.24	12.73
6.	South (157.5-<202.5)	3,883.06	13.24
7.	Southwest (202.5-<247.5)	4,271.31	14.56
8.	West (247.5-<292.5)	3,628.59	12.37
9.	Northwest (292.5-<337.5)	3,509.50	11.97
	Total	**29,326.47**	**100**

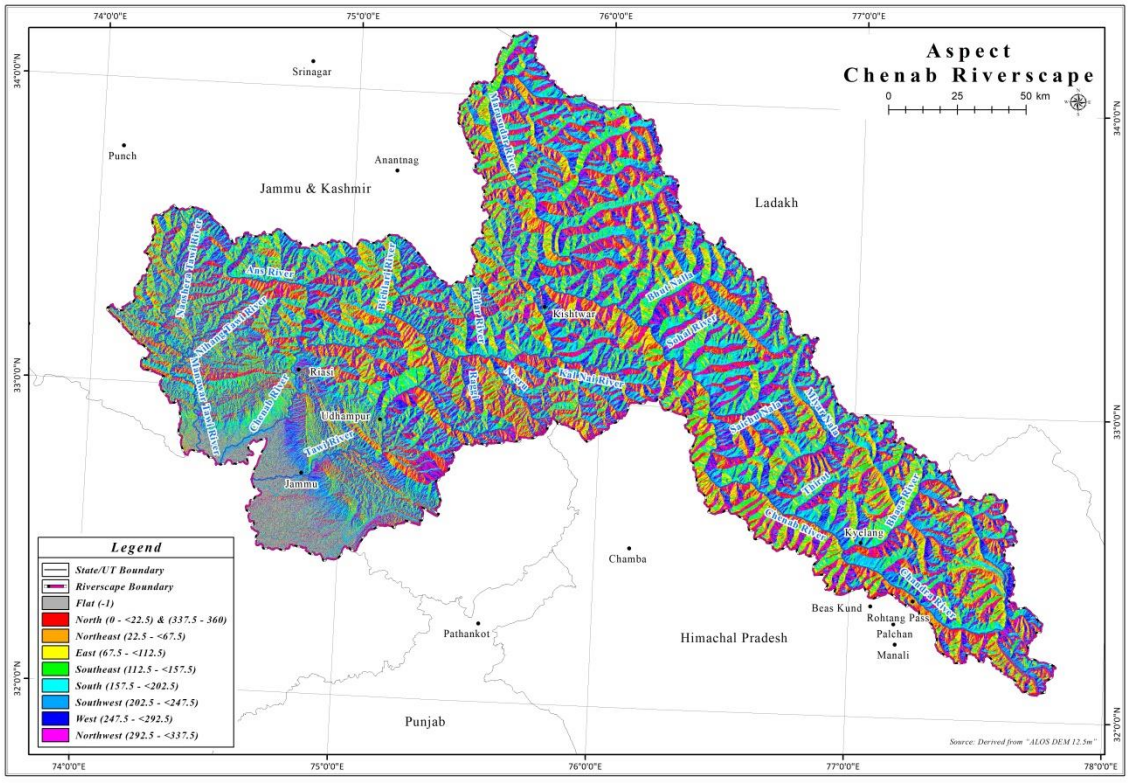


Fig.3. 13- Distribution of Aspects within Chenab Riverscape

(iii) Soil Types

Soil is a mixture of organic matter, minerals, gases, liquids, and organisms that together supports life. The earth's body of soil is called as the pedosphere and has four important functions to perform i.e., (a) provide medium for plant growth, (b) serves as a means of water storage, supply and purification, (c) help as a modifier of earth's atmosphere and

store carbon, and (d) provide habitat for a wide range of organisms including invertebrates, microorganisms, etc. Soil is a product of several factors *viz*., the influence of climate, relief (elevation), orientation, and slope of terrain, organisms, and the soils parent materials (original minerals) interacting over time. Soils continuously undergo development by way of numerous physical, chemical and biological processes including weathering and associated erosion. Natural ecosystems (i.e., forests, grasslands, wetlands and agro ecosystems) are impacted by various processes carried out in the soil. Therefore, understanding of soils in the riverscape is critical from the perspective of present DPR as they form an important biotic variable that determines the suitability of site conditions for proposed Forestry Interventions, mainly trees and other plantations (i.e., grass, herbs, shrubs, medicinal plants, orchards, etc.). Soil is considered as one of the most important parameter for modelling suitability of forest plantation zones. Since, choice of species mainly depends upon the soil type and soil depth, therefore, these parameters were derived from Soil map prepared by NBSS-LUP for further use in modelling. Total soil type classes have been recorded in the Chenab Riverscape (Fig 3.13; Annexure: 6). Various soil types and their proportionate area estimates are given in Table 3.10.

Table: 3. 10- Distribution of Area under Different Soil Types and Other Land Attributes

S.No.	Soil type	Area (Km^2)	Total Area (%)
1.	Aquic Dystric Eutrochrepts	73.03	0.25
2.	Dystric Eutrochrepts	4,759.73	16.23
3.	Dystric Fluventic Eutrochrepts	483.79	1.65
4.	Fluventic Cryochrepts	637.14	2.17
5.	Fluventic Eutrochrepts	66.77	0.23
6.	Fluventic Ustochrepts	114.59	0.39
7.	Fluventic Ustorhents	585.14	2
8.	Lithic Cryorthents	602.20	2.05
9.	Lithic Udorthents	660.35	2.25
10.	Mollic Udorthents	206.11	0.7
11.	Typic Cryochrepts	179.40	0.61
12.	Typic Cryorthents	1,791.68	6.11
13.	Typic Dystrochrepts	8.45	0.03
14.	Typic Eutrochrepts	2,636.95	8.99
15.	Typic Udifluvents	1,022.74	3.49
16.	Typic Udorthents	6,479.69	22.1
17.	Typic Ustifluvents	192.47	0.66
18.	Udic Ustochrepts	210.87	0.72
19.	Udic Ustorthents	134.28	0.46
20.	Non Soil	8,481.09	28.92
	Total	**29,326.47**	**100**

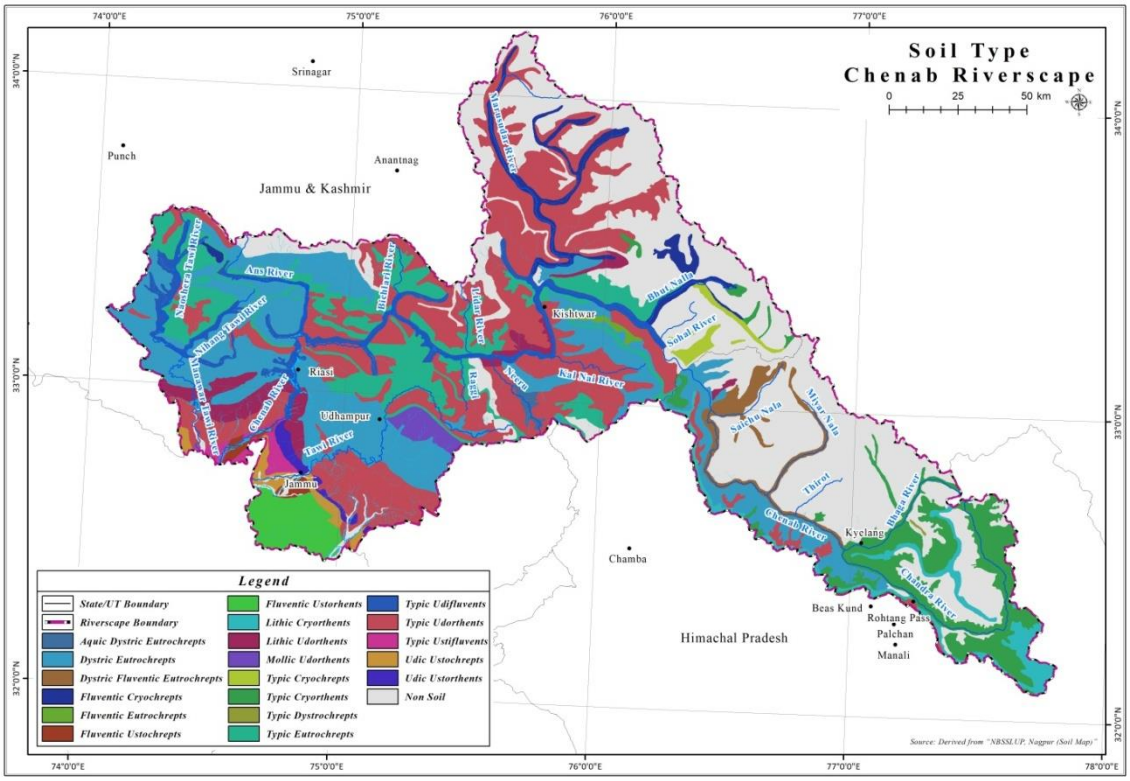


Fig.3. 14– Distribution of Soil Types in Chenab Riverscape

(iv) Soil Depth

In addition to soil type, texture and structure, Soil depth plays important role in water availability, limit root growth and nutrient access. It greatly influences the type of plants that can grow in them. Deeper soils generally provide more water and nutrients to plants than the shallow soils. Thus, soil depth is another important variable for suggesting suitability of tree species for a plantation model as it is important for the penetration of the roots of plants or tree species. Four depth classes *viz*., Very Deep, Moderately Deep, Deep and Shallow have been mapped in the Chenab Riverscape (Fig 3.14). These areas could be suggested as suitable for plantations based on other ground parameters. The distribution of area under different soil depth classes is given in Table 3.11. .

Table: 3.11- Distribution of Area in Chenab Riverscape under different Soil Depth Categories

S.No.	Soil depth	Area (Km^2)	Total Area (%)
1.	Deep	7,039.74	24
2.	Moderately Deep	9,654.02	32.92
3.	Shallow	3,858.27	13.16
4.	Very Shallow	293.35	1
5.	Non Soil	8,481.09	28.92
	Total	**29,326.47**	**100**

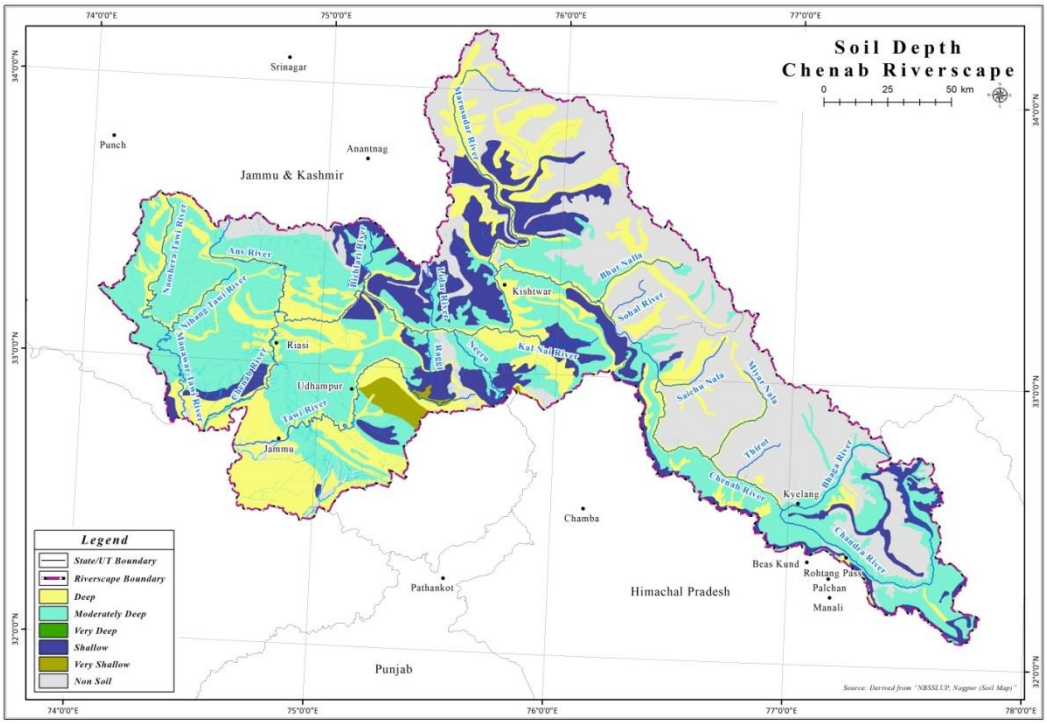


Fig.3. 15- Variation in Soil Depth of the Chenab Riverscape

(v) Soil Erosion

Soil erosion is the displacement of the upper layer of soil and leads to soil degradation. It is a naturally process caused by the dynamic activity of erosive agents namely water, ice, snow, air, plants, animals, and humans that affect all landforms. Soil erosion may be a slow process that may not be continuously noticed, or it may occur at an alarming rate causing a serious loss of top soil. Based on information obtained from the Indian Institute of Soil and Water Conservation (IISWC), Dehra Dun an insight on the status of soil erosion has been developed. A total five categories of erosion classes have been mapped in the Riverscape, *viz*., < 5 tons-ha^{-1}year^{-1}; 5 to < 10 tons-ha^{-1} year^{-1}; 10 to < 20 tons-ha^{-1}year^{-1}; 20 to < 40 tons-ha^{-1}year^{-1}; ≥ 40 tons-ha^{-1} year^{-1} (Fig3.15). An area of 10,920.28km^2 falls under non-soil category. These areas may not be suitable for forestry plantations. The distribution of areas under different erosion classes and their area is given in Table 3.12.

Table: 3. 12- Distribution of Soil Erosion Categories in Chenab Riverscape

S.No.	Soil Erosion (tons/hectare/year)	Area (km^2)	Total Area (%)
1.	<5	5,367.16	18.3
2.	5<10	1,132.50	3.86
3.	10<20	1,693.88	5.78
4.	20 < 40	1,606.83	5.48

5.	≥40	8,605.82	29.34
6.	Non Soil	10,920.28	37.24
	Total	**29,326.47**	**100**

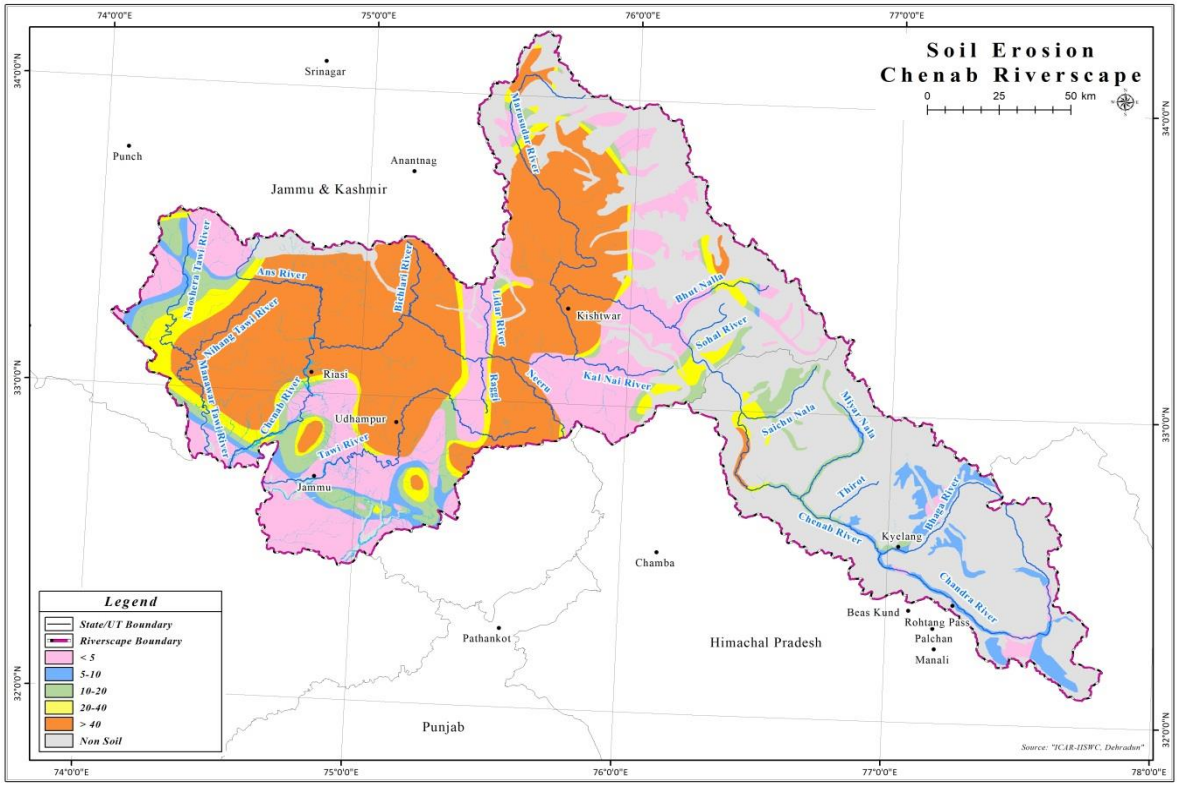


Fig.3. 16– The Status of Soil Erosion in Chenab Riverscape

(vii) Forest Types and Forest Density

The forest types play an important role in regulating the environment of the locality, region, state and country. The information on forest types is most important in suggesting suitable sites for Forestry Interventions based on areas which do not have dense forest cover or which fall in scrub and riverine habitats along the river banks. The forest type and cover map was prepared using the data provided by Forest Survey of India. It is observed that 18,698.49 km^2 area falls under non-forest category. The distribution of area under different forest types and forest cover classes is given in Table 3.13, 3.14, Fig. 3.16, 3.17. The Administrative divisions of forests falling in the Riverscape are given in Table 3.15 and Fig.3.18. However, due to the Beat level data gap for Jammu division in Jammu and Kashmir UT the provided numbers could vary during ground assessment exercise.

Table: 3. 13- Distribution of area under different Forest types categories

S.No.	Forest type	Area (km^2)	Total Area (%)
1.	Dry Alpine Vegetation	355.46	1.21
2.	Himalayan Dry Temperate Forests	731.65	2.49
3.	Himalayan Moist Temperate Forests	2,552.54	8.7

4.	Moist Alpine Vegetation	37.69	0.13
5.	Sub Alpine Forests	420.99	1.44
6.	Sub Tropical Dry Evergreen Forests	85.11	0.29
7.	Sub Tropical Pine Forests	2,049.3	6.99
8.	Tropical Dry Deciduous Forests	1,554.79	5.3
9.	Scrubs	2,840.45	9.69
10.	Non Forest	18,698.49	63.76
	Total	**29,326.47**	**100**

Table: 3. 14- Distribution of area under different Forest Cover categories

S.No.	Forest cover	Area (km^2)	Total Area (%)
1.	Dense Forests	2,180.41	7.43
2.	Moderately Dense Forests	2,472.55	8.43
3.	Open Forests	3,134.58	10.69
4.	Scrubs	2,840.45	9.69
5.	Non Forest	18,698.48	63.76
	Total	**29,326.47**	**100**

Table: 3. 15Administrative divisions of forests in Chenab Riverscape

State/ UT	Number of Divisions	Number of Ranges
Jammu and Kashmir UT	14	45
Himachal Pradesh	2	7
Total	**16**	**52**

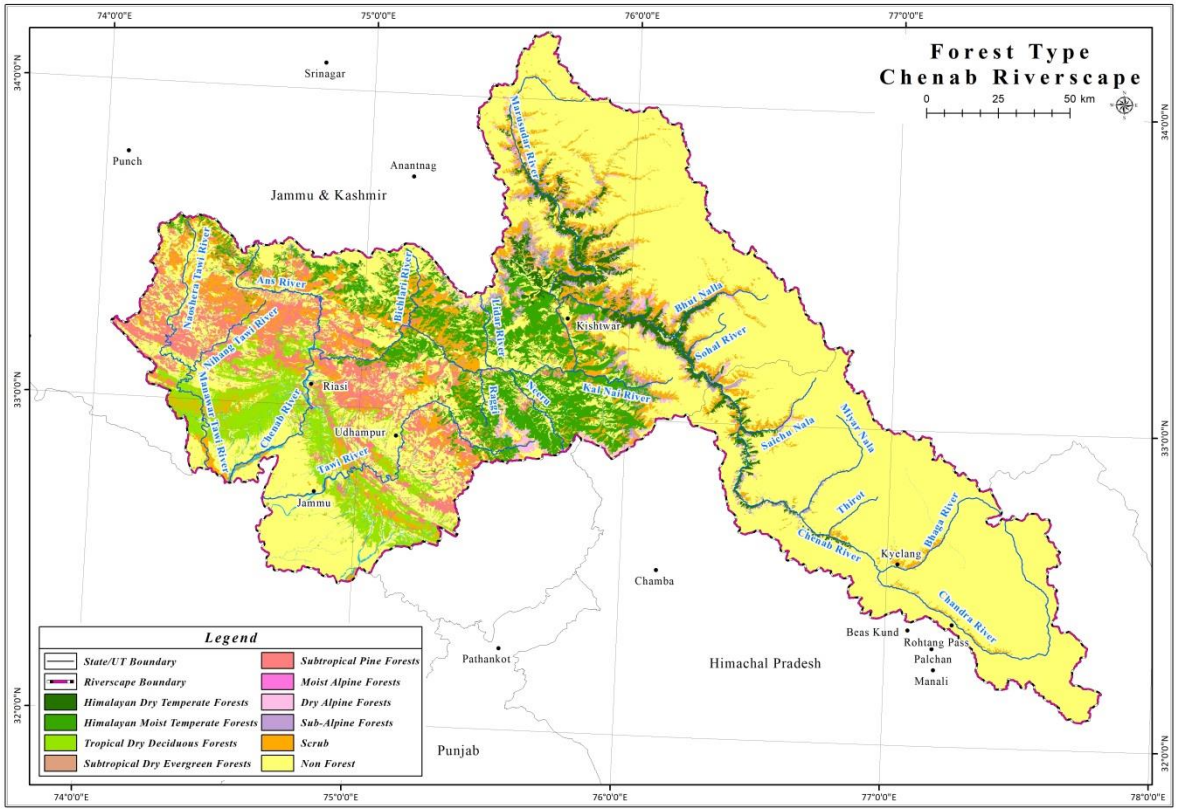


Fig.3. 17- Forest types of the Chenab Riverscape

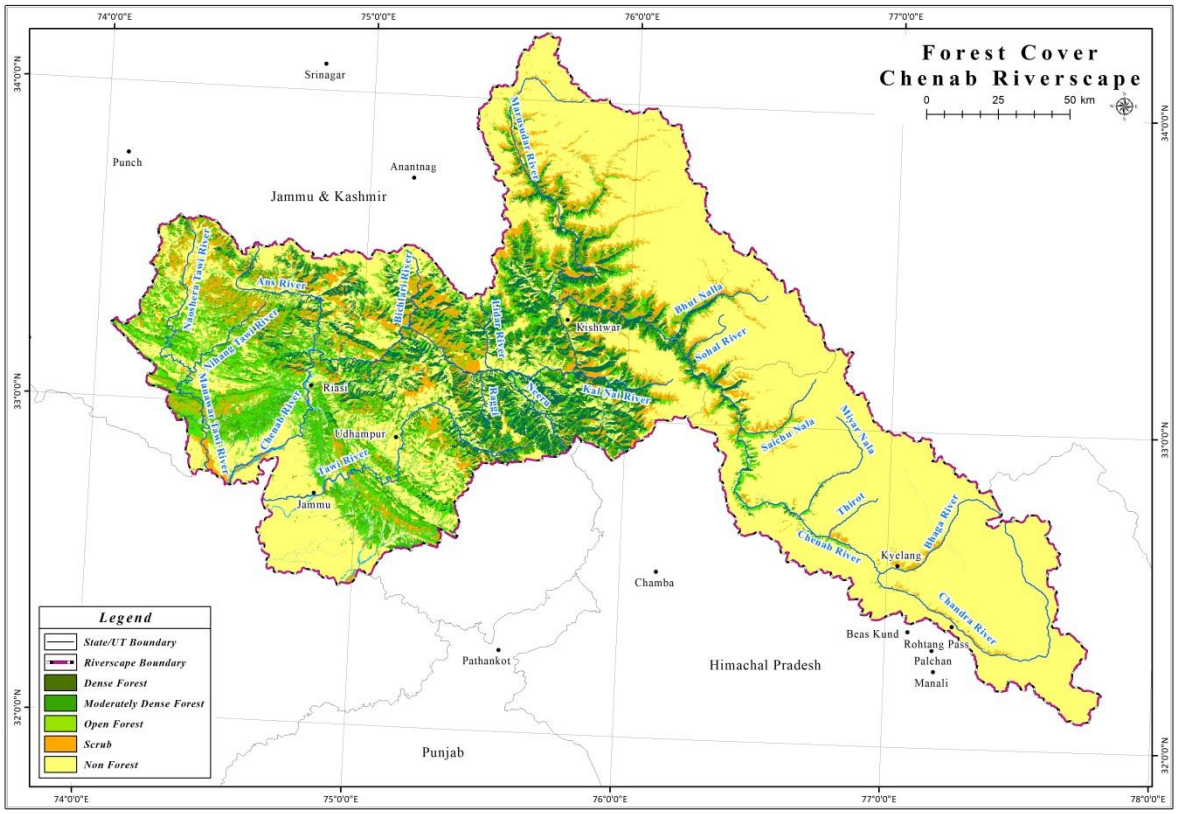


Fig.3. 18- Forests cover of the Chenab Riverscape

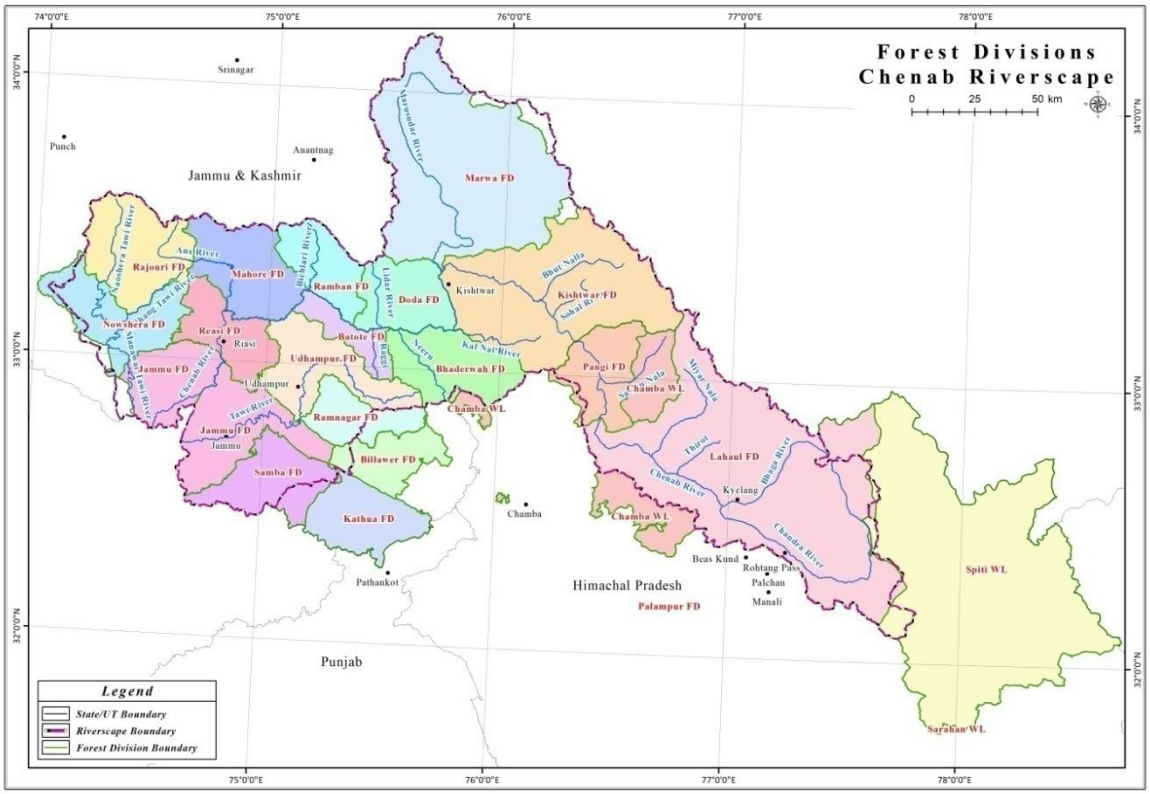


Fig.3. 19- Administrative divisions of forests in Chenab Riverscape

(viii) Land Use and Land Cover

Land Use and Land Coverinformation is important for wide range of human activities such as agriculture, forestry, water resources, and other types of land resource management. The pre-processed geometrically and radio-metrically corrected PAN merged satellite datasets were displayed on screen for attempting visual interpretation of various land use classes. Standard image interpretation keys, *viz*., shape, size, colour, tone, texture, pattern, shadow, site, association, and phenology were used to generate Image Interpretation scheme (Table 3.16and Fig3.19) (NRSA, 2006).

Table: 3. 16- Distribution of area under different land use and land cover categories

S.No.	Land Use and Land Cover	Area (km^2)	Percentage of Total Area (%)
1.	Agriculture	4,470.60	15.24
2.	Alpine Pastures	36.30	0.12
3.	Barren	881.42	3.01
4.	Canals	5.60	0.02
5.	Clouds	79.93	0.27
6.	Dense Forests	2,180.41	7.43
7.	Industrial Area	0.80	0.00
8.	Moderately Dense Forests	2,472.55	8.43

9.	Open Forests	3,134.58	10.69
10.	River (Dry)/River Sand	228.6	0.78
11.	River (Perennial)	109	0.37
12.	Scrubs	2,840.45	9.69
13.	Settlements	226.99	0.77
14.	Snow/Glaciers	12,657.59	43.16
15.	Water bodies	1.65	0.01
	Total	**29,326.47**	**100**

(Source: NRSA; 2006)

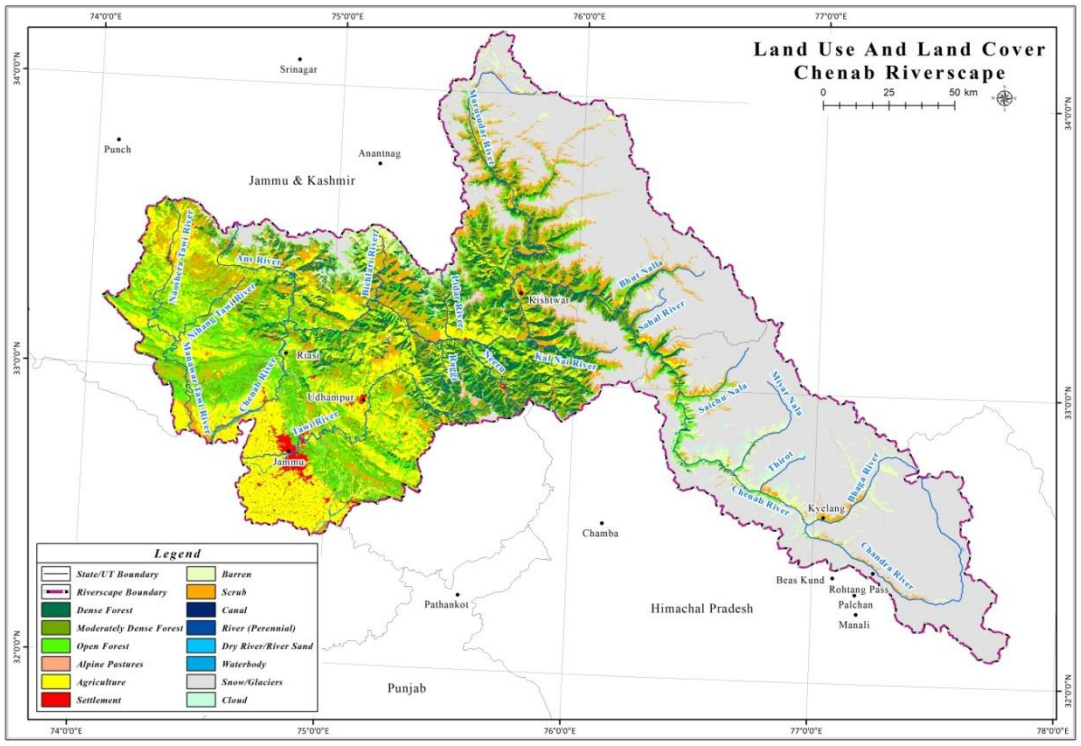


Fig.3. 20- The Chenab Riverscape land use and land cover categories

(xi) Number of Patches in Major Land Use Categories

For the identification of number of patches in Five Land use classes, these classes such as Dense Forests, Moderately Dense Forests, Open Forests, and Scrubs were reclassified according to Geometric interval. After reclassification, number of patches and area of each class were calculated. Maximum number of patches in Open Forests class was 6,488 and minimum number of patches in Barren class was 1164. Table 3.17 shows number of patches in selected categories of natural and man-made land use and land cover (Fig. 3.20 to 3.25).

Table: 3. 17- Distribution of patches in various natural and manmade LULC categories

S.No.	Area (km^2)	Number of Patches	Total Representation (%)
Dense Forests			
1	0.00 - 0.14	413	24.19
2	0.14 - 0.36	430	25.97
3	0.36 - 0.96	422	24.85
4	> 0.96	423	24.98
Total		**1,688**	**100**
Moderate Dense Forests			
1	0.00 - 0.08	1,259	13.83
2	0.08 - 0.18	1,298	11.86
3	0.18 - 0.44	1,292	11.93
4	> 0.44	1,282	62.38
Total		**5,131**	**100**
Open Forests			
1	0.00 - 0.07	1,744	14.84
2	0.07 - 0.15	1,498	11.16
3	0.15 - 0.37	1,631	10.5
4	> 0.37	1,615	63.5
Total		**6,488**	**100**
Scrubs			
1	0.00 - 0.05	1,032	21.47
2	0.05 - 0.12	1,121	33.5
3	0.12 - 0.33	1,000	22.56
4	> 0.33	1,056	22.47
Total		**4,209**	**100**
Agriculture			
1	0.00 - 0.08	671	16.22
2	0.08 - 0.20	650	13.43
3	0.20 - 0.65	639	15.06
4	> 0.65	650	55.28
Total		**2,610**	**100**
Barren			
1	0.00 - 0.06	287	26.55
2	0.06 - 0.15	287	22.5
3	0.15 - 0.53	302	25.83
4	> 0.53	288	25.11
Total		**1,164**	**100**

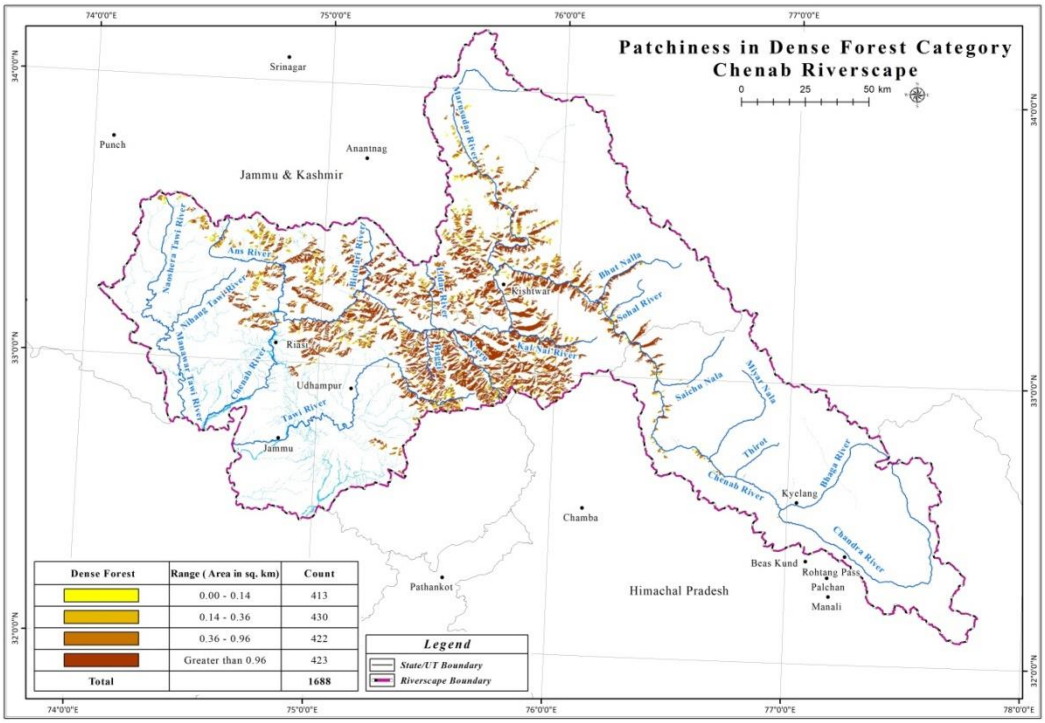


Fig.3. 21- The Chenab Riverscape - Patchiness in Dense Forests

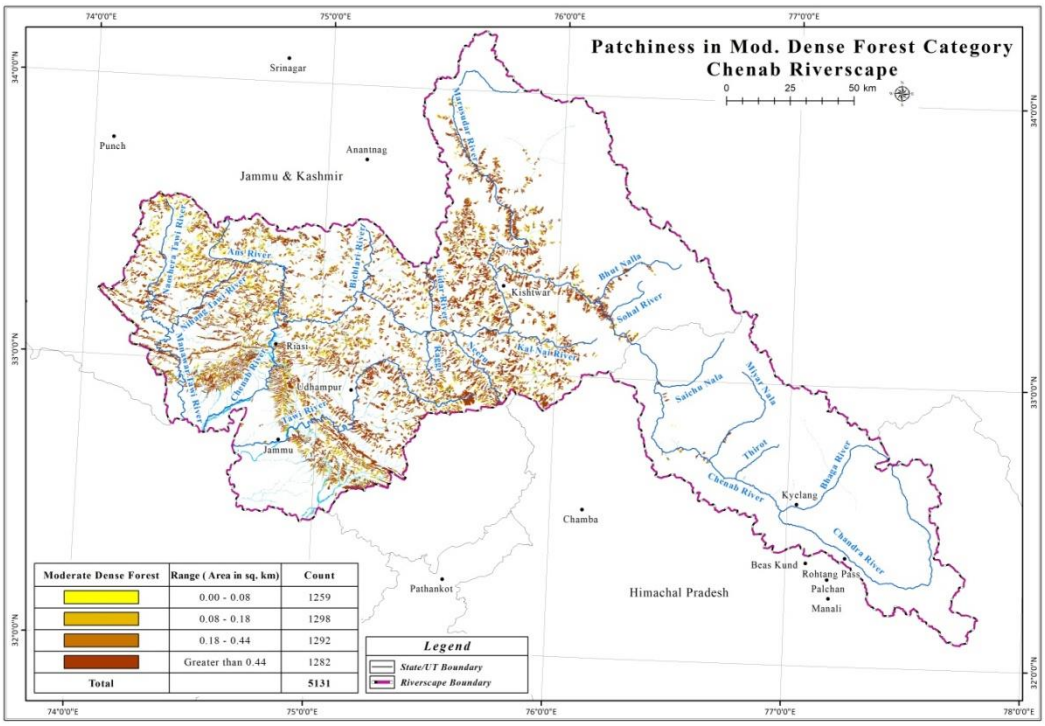


Fig.3. 22- The Chenab Riverscape - Patchiness in Moderately Dense Forests

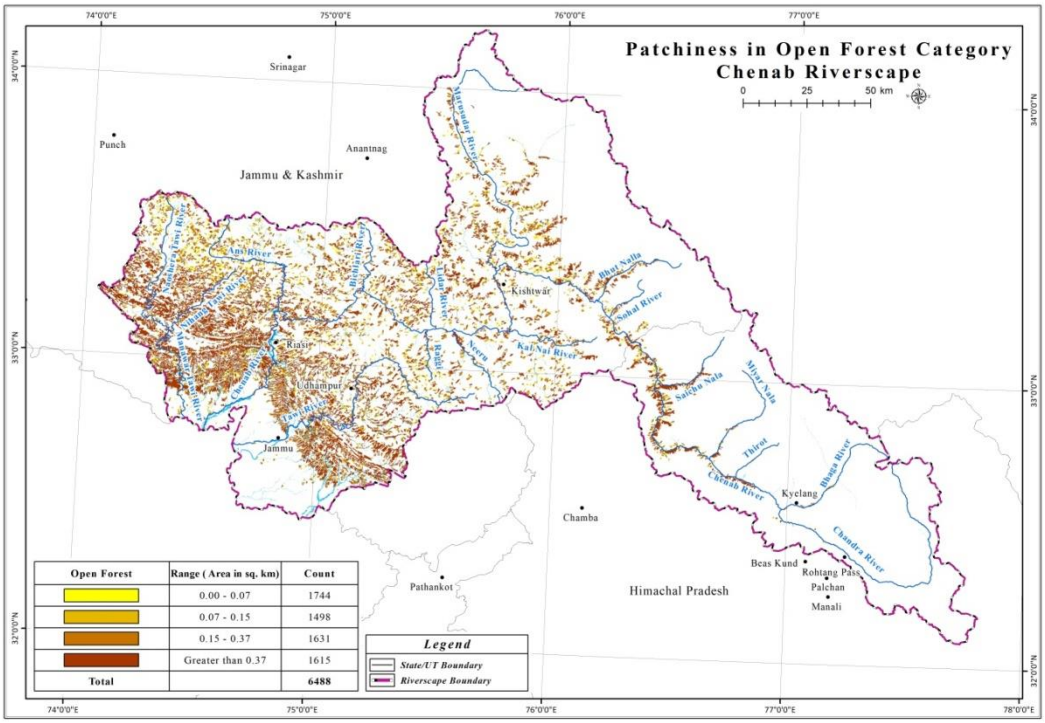


Fig.3. 23- The Chenab Riverscape - Patchiness in Open Forests

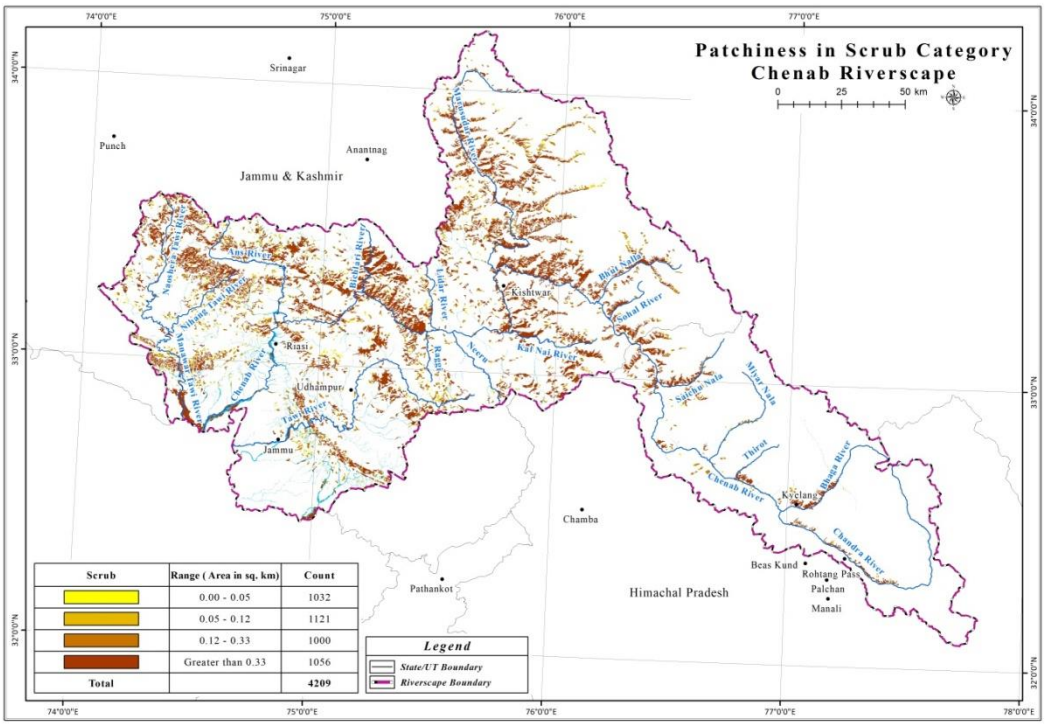


Fig.3. 24- The Chenab Riverscape - Patchiness in Scrub lands

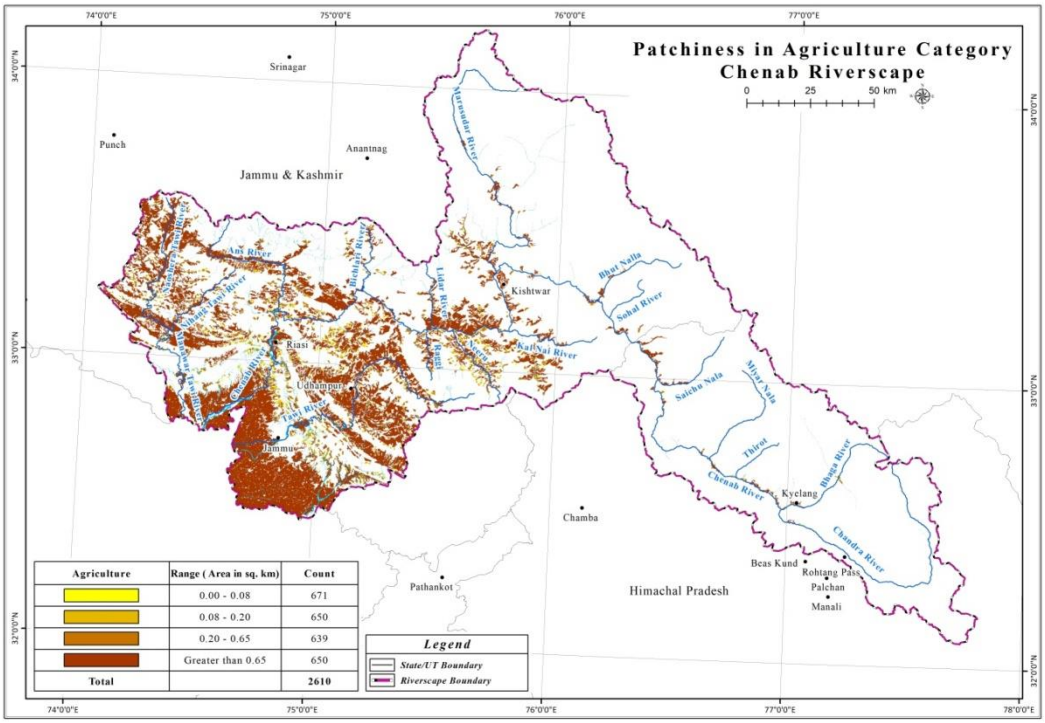


Fig.3. 25- The Chenab Riverscape - Patchiness in Agriculture land

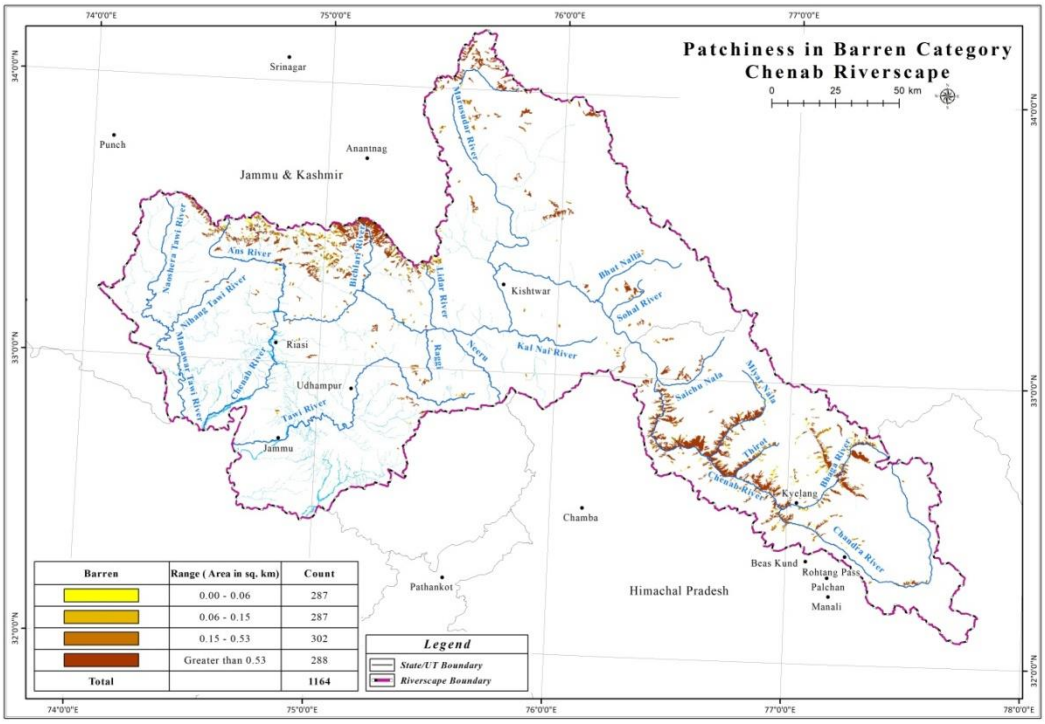


Fig.3. 26- The Chenab Riverscape - Patchiness in Barren land

3.20 Land Use/ Land Cover (LULC) Analysis

The pre-processed geometrically, radio-metrically corrected and resolution merged Landsat - 8 satellite datasets were displayed on the screen for attempting visual interpretation of various land use classes. Standard image interpretation keys, like shape, size, colour, tone, texture, pattern, shadow, site, association and phenology have been used to generate Image Interpretation Scheme. On screen visual interpretation technique has been used for delineating major land use and land cover types i.e., Dense Forest, Moderately Dense Forest, Open Forest, Scrub, Agriculture, Alpine Pastures, Barren, Settlement, Canal, Water body, Wetland, River (Dry)/River Sand, River (Perennial), Snow/Glaciers etc. Thus, the distribution of area under corresponding land cover and land use classes for the entire Riverscape state-wise was computed.

Land information is important to a wide variety of human activities such as agriculture, forestry, water resources, as well as other types of land resource management. The pre-processed geometrically and radio-metrically corrected PAN merged satellite datasets were displayed on screen for attempting visual interpretation of various land use classes. Standard image interpretation keys, *viz.*, shape, size, colour, tone, texture, pattern, shadow, site, association, and phenology have been used to generate Image Interpretation scheme (Fig. 3.26 and 3.27; NRSA, 2006).

Major Land-use and Land-cover classification systems/ keys

A) Forest

These are the areas within the notified forest boundaries having an association predominantly of trees and other vegetation types. The forests can be divided into;

Dense forest: areas those include canopy cover/density of > 70% (Dark red to red color tone).

Moderately Dense forest: areas include the canopy cover/ density of 40-70% (Red to light red in color tone).

Open forest: areas are concerned; these include the canopy cover/density of 10-40% (Light red color tone).

Agricultural Land: These are the lands primarily used for farming and for production of food, fiber, horticulture, etc. They are mainly the lands with standing crops (i.e., cropland; bright red to red color on satellite image), fallow land (i.e., uncropped for one or more season; yellow to greenish blue tone), agriculture plantation (i.e., tea, coffee, etc.), plantation (i.e., herbs, nurseries, orchards, etc; dark red to red and regular sharp edged shapes).

Alpine/ Sub-alpine: These areas are located in between the coniferous forest and permanent snow covered areas. An alpine zone lies between 3,000 - 5,600 m amsl.

Natural/Semi-natural Grassland: These are the areas having grass type (Monocots) vegetation and appear in light red to light brown of varying sizes and irregular shapes.

Scrub lands: are normally prone to erosion generally occupy higher locations excluding mountains and hills. They appear light yellow to brown to greenish blue depending upon the surface moisture and vegetative cover. It varies in sizes from small to large and generally surrounded by agriculture, river area, and forests.

Built-up/Settlement: such areas usually the human habitation developed over a period of time due to non-agricultural use and that has a cover of buildings, transport, and communication utilities associated with water, vegetation and vacant lands. These areas as per the colour reflection appear dark bluish green in the core and bluish in the periphery. The size of such settlement varies from small to big and may be in clustered or scattered form

Barren: The barren area can easily and clearly be delineated on the basis of image having bright white to light blue to yellow to brown colour tone depending upon the rock type. These are located on isolated hill slopes, plateau, etc.

B) Water Bodies

This category comprises areas with surface water (i.e., ponds, lakes, rivers, canals, etc.) and can clearly be seen on a satellite image in blue to dark blue or cyan colour depending on the depth of water.

Rivers (perennial/dry): The rivers form a natural course of water flowing on the land surface along a definite channel/slope regularly or intermittently towards another water body in most cases, sea, another river, lake, marsh, etc. They appear in light to dark blue, irregular shape (non-linear). There are two major categories of rivers, perennial (i.e., flow continuously throughout the year) and dry (i.e., flow only during monsoon period).

Canal: Canal is artificial water course constructed for irrigation purposes, and has a regular linear shape on image.

Snow covered/ glacial area: Another unique land use which normally comes under the category of forest cover is the snow covered/glacial area; these areas are under perpetual snow cover and only confined to the Himalayan region. It appears bright white to white in color depending on the moisture and thickness of snow varies depending upon their location on the mountain peaks.

Wetlands: The wetlands are another type of ecosystem that comes broadly in the ambit of forestry land use. Such areas include all the submerged or water-saturated lands, natural or man-made, inland or coastal, vegetated or non-vegetated areas. They have greenish blue to cyan to brown color depending upon different vegetation cover that these water bodies supports.

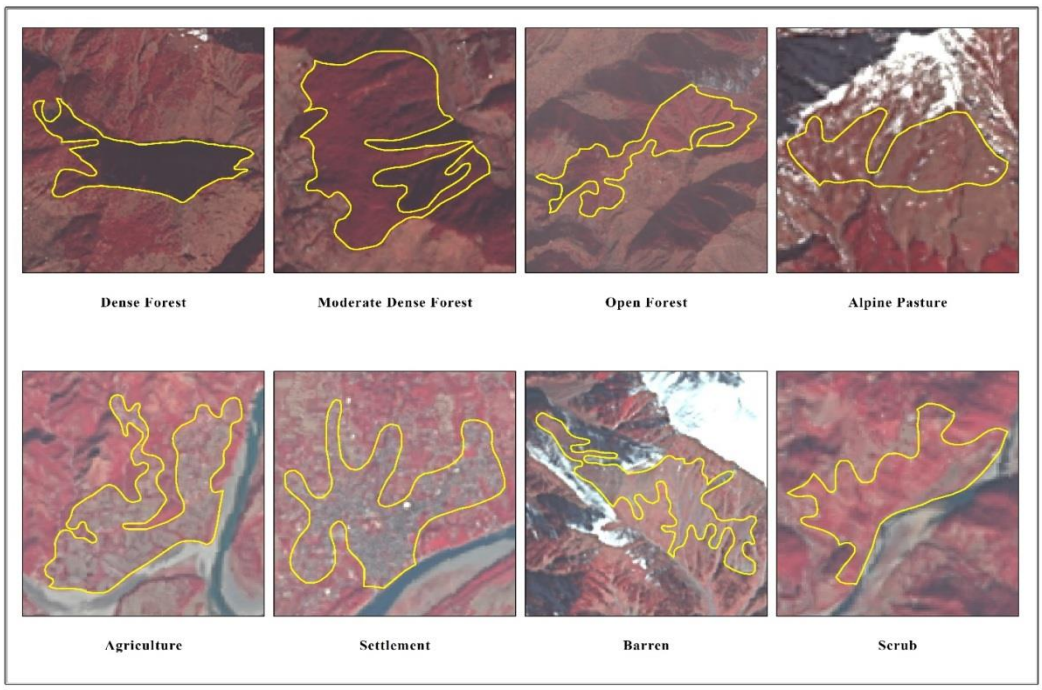


Fig.3. 27-Land Use and Land Cover Classification Key

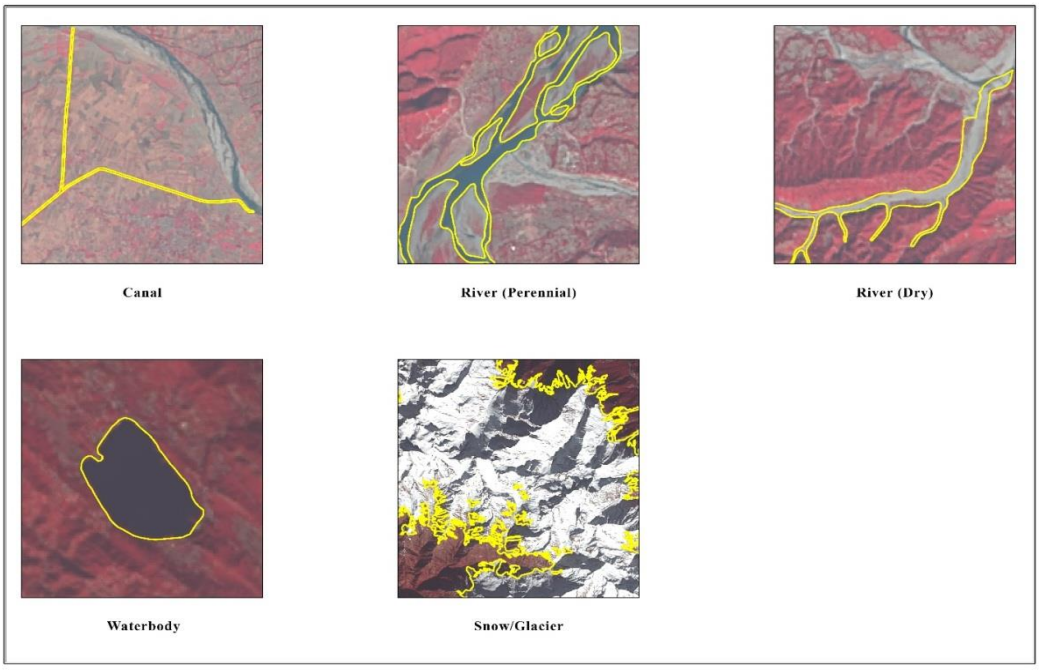


Fig.3. 28- Land Use and Land Cover Classification Key

In the modern context and in view of the techniques being used for identification of land use, etc., presenting the onscreen visual interpretation technique has been used for delineating major land use/ land cover types i.e., Agriculture, Alpine pastures, Barren, Canal, Cloud, Cloud shadow, Dense forest, Moderately dense forest, Open forest, River (Dry)/River Sand,

River (Perennial), Scrub, Settlement, Snow/Glaciers, Water body and Wetland in the Riverscape and presented in Table 3.18 and Fig. 3.38.

Table: 3. 18- Weightage Computed for different Land Use and Land Cover with special reference to Slope and Erosion Categories for Multi Criteria Assessment

Sr. No.	LULC	Weightage	Slope (Degree)	Weightage	Erosion (t/ha/year)	Weightage
1	Dense Forest	6	0^o - 30^o	1	<5	1.5
2	Open Forest	5	30^o - 40^o	2	5-10	3
3	Alpine Pasture/ Scrub	6	> 40^o	3	10-20	4.5
4	Agriculture	4			20-40	6
5	Barren	3			≥40	7.5
6	Wetland	7				
7	Others	1				
	Settlement	2				

3.20.1Prioritization of Suitable Areas for Proposed Forestry Interventions

For the purpose of preparation of DPR and identification of priority areas for the proposed treatment/Forestry Interventions in the Chenab Riverscape, GIS-assisted decision making process by way of geospatial analysis and modelling was used. GIS was used to generate different layers within the Riverscape like land use, soil erosion rates, and slope of the topography. The following shape files were superimposed to obtain a combination-matrix of various layers that revealed the prevalent features of any area within the Riverscape with regard to vegetation, land use, erosion, and degree of slope. The land use and land cover classes were merged in to 8 classes i.e., Dense forest, Alpine Pastures, Open forest, Agriculture, Barren, Wetland, Settlement, and Others. A weightage from 1 to 7 scale was given to the above land use and land cover classes. Further, the slope layer was categorized into three categories and each category was assigned a weightage of 1 to 3 based on the degree of slope. The erosion layer received from Indian Institute of Soil and Water Conservation (IISWC) had 5 major categories of erosion i.e.,<5, 5-10, 10-20, 20-40, and >40(erosion in t/ha/year). Each category of erosion was given a weightage in multiples of 1.5. GIS overlay operations were carried out on the above three layers and the weightages for various combinations were put together by means of addition to arrive at summed weightage for each combination. These values were then categorized in to low medium and high based on statistical quartile. For example, an open forest area is classified as 'High priority' if it has a slope of 15-30 degrees, and erosion 10-20 t/ha/year. Likewise, the same open forest area having slope 0-15 and erosion rate <10 t/ha/year has been classified as 'Low priority'. It is this data which was then depicted on map as low medium and high priority zones (Fig.3.28, Fig 3.29, Table 3.19). The priority information for Chenab River is given in Table 3.19 to 3.21.

Table: 3. 19- Priority zones for forestry intervention in the Chenab Riverscape for different LULC

Slope	Erosion	Weightage (Slope)	Weightage (Erosion)	Weightage (LULC)	Total	Priority
A) Dense Forest						
0º - 30º	10 - 20	1	4.5	6	11.5	High
0º - 30º	5 - 10	1s	3	6	10	Medium
0º - 30º	<5	1	1.5	6	8.5	Medium
0º - 30º	>40	1	7.5	6	14.5	High
0º - 30º	20 - 40	1	6	6	13	High
30º - 40º	10 - 20	2	4.5	6	12.5	High
30º - 40º	5 - 10	2	3	6	11	High
30º - 40º	<5	2	1.5	6	9.5	Medium
30º - 40º	>40	2	7.5	6	15.5	High
30º - 40º	20 - 40	2	6	6	14	High
> 40º	10 - 20	3	4.5	6	13.5	High
> 40º	5 - 10	3	3	6	12	High
> 40º	<5	3	1.5	6	10.5	Medium
> 40º	>40	3	7.5	6	16.5	High
> 40º	20 - 40	3	6	6	15	High
B) Open Forest						
0º - 30º	10 - 20	1	4.5	5	10.5	Medium
0º - 30º	5 - 10	1	3	5	9	Medium
0º - 30º	<5	1	1.5	5	7.5	Medium
0º - 30º	>40	1	7.5	5	13.5	High
0º - 30º	20 - 40	1	6	5	12	High
30º - 40º	10 - 20	2	4.5	5	11.5	High
30º - 40º	5 - 10	2	3	5	10	Medium
30º - 40º	<5	2	1.5	5	8.5	Medium
30º - 40º	>40	2	7.5	5	14.5	High
30º - 40º	20 - 40	2	6	5	13	High
> 40º	10 - 20	3	4.5	5	12.5	High
> 40º	5 - 10	3	3	5	11	High
> 40º	<5	3	1.5	5	9.5	Medium
> 40º	>40	3	7.5	5	15.5	High
> 40º	20 - 40	3	6	5	14	High
C) Alpine Pasture/Scrub						
0º - 30º	10 - 20	1	4.5	6	11.5	High
0º - 30º	5 - 10	1	3	6	10	Medium
0º - 30º	<5	1	1.5	6	8.5	Medium
0º - 30º	>40	1	7.5	6	14.5	High
0º - 30º	20 - 40	1	6	6	13	High

30º - 40º	10 - 20	2	4.5	6	12.5	High
30º - 40º	5 - 10	2	3	6	11	High
30º - 40º	<5	2	1.5	6	9.5	Medium
30º - 40º	>40	2	7.5	6	15.5	High
30º - 40º	20 - 40	2	6	6	14	High
> 40º	10 - 20	3	4.5	6	13.5	High
> 40º	5 - 10	3	3	6	12	High
> 40º	<5	3	1.5	6	10.5	Medium
> 40º	>40	3	7.5	6	16.5	High
> 40º	20 - 40	3	6	6	15	High
D) Agriculture						
0º - 30º	10 – 20	1	4.5	4	9.5	Medium
0º - 30º	5 – 10	1	3	4	8	Medium
0º - 30º	<5	1	1.5	4	6.5	Low
0º - 30º	>40	1	7.5	4	12.5	High
0º - 30º	20 – 40	1	6	4	11	High
30º - 40º	10 – 20	2	4.5	4	10.5	Medium
30º - 40º	5 – 10	2	3	4	9	Medium
30º - 40º	<5	2	1.5	4	7.5	Medium
30º - 40º	>40	2	7.5	4	13.5	High
30º - 40º	20 – 40	2	6	4	12	High
> 40º	10 – 20	3	4.5	4	11.5	High
> 40º	<5	3	1.5	4	8.5	Medium
> 40º	>40	3	7.5	4	14.5	High
> 40º	20 – 40	3	6	4	13	High
E) Barren						
0º - 30º	10 - 20	1	4.5	3	8.5	Medium
0º - 30º	5 - 10	1	3	3	7	Low
0º - 30º	<5	1	1.5	3	5.5	Low
0º - 30º	>40	1	7.5	3	11.5	High
0º - 30º	20 - 40	1	6	3	10	Medium
30º - 40º	10 - 20	2	4.5	3	9.5	Medium
30º - 40º	5 - 10	2	3	3	8	Medium
30º - 40º	<5	2	1.5	3	6.5	Low
30º - 40º	>40	2	7.5	3	12.5	High
30º - 40º	20 - 40	2	6	3	11	High
> 40º	10 - 20	3	4.5	3	10.5	Medium
> 40º	5 - 10	3	3	3	9	Medium
> 40º	<5	3	1.5	3	7.5	Medium
> 40º	>40	3	7.5	3	13.5	High
> 40º	20 - 40	3	6	3	12	High
F) Others						

0º - 30º	10 - 20	1	4.5	1	6.5	Low
0º - 30º	5 - 10	1	3	1	5	Low
0º - 30º	<5	1	1.5	1	3.5	Low
0º - 30º	>40	1	7.5	1	9.5	Medium
0º - 30º	20 - 40	1	6	1	8	Medium
30º - 40º	10 - 20	2	4.5	1	7.5	Medium
30º - 40º	5 - 10	2	3	1	6	Low
30º - 40º	<5	2	1.5	1	4.5	Low
30º - 40º	>40	2	7.5	1	10.5	Medium
30º - 40º	20 - 40	2	6	1	9	Medium
> 40º	10 - 20	3	4.5	1	8.5	Medium
> 40º	5 - 10	3	3	1	7	Low
> 40º	<5	3	1.5	1	5.5	Low
> 40º	>40	3	7.5	1	11.5	High
> 40º	20 - 40	3	6	1	10	Medium
G) Settlement						
0º - 30º	10 - 20	1	4.5	2	7.5	Medium
0º - 30º	5 - 10	1	3	2	6	Low
0º - 30º	<5	1	1.5	2	4.5	Low
0º - 30º	>40	1	7.5	2	10.5	Medium
0º - 30º	20 - 40	1	6	2	9	Medium

Priority Area in Chenab Riverscape: The total Riverscape area of Chenab River in concerned State and UT is 29,326.47 km^2, of which, 9,405.36 km^2 falls in high priority zone, 6,394.71 km^2 in medium priority zone and 13,526.40 km^2 in low priority zone.

Priority Zones for Forestry Interventions: Superimposition of GPS locations of the areas selected for treatment on the basis of various ground based sites provided by Himachal Pradesh and Jammu and Kashmir UT Forest Departments was done to classify area as high, medium and low priority categories. A total of 3,683.00 ha area for Forestry Interventions falls under Natural Landscape. Of which, 2,079.63 ha areas (56.47%) falls under high priority zone, 844.53 ha (22.93%) under medium priority zone and 758.78ha area (20.60%) falls under low priority zone. The division wise details of the area occurring under three different priority zones for natural landscapes in the concerned State and UT is given in Table 3.20.

A total extent for Soil and Moisture Conservation Works falling in Chenab Riverscape in Himachal Pradesh and Jammu and Kashmir UT is6,04,030.00m^3. Of which,3, 54,251.34m^3 (58.65%) falls under high priority zone, 1, 35,658.54 m^3 (22.46%) under medium priority zone and 1, 14,120.12m^3 (18.89 %) under low priority zone. The division wise details of the extent under three different priority zones for soil and moisture conservation works are given in Table 3.21.

Table: 3. 20- Division-wise Priority Treatment Area of Natural Landscape for Forestry Interventions in Chenab Riverscape, Himachal Pradesh and Jammu and Kashmir UT

Sr. No.	Forest Division	Area (ha)*			
		High	Medium	Low	Total
A)	**Himachal Pradesh**				
	Lahaul	3.03	15.37	238.60	257
	Pangi	17.77	47.36	113.86	179
B)	**Jammu and Kashmir UT**				
	Batote	293.30	83.28	16.43	393
	Bhaderwah	89.35	151.71	31.91	273
	Doda	203.68	71.59	28.70	304
	Jammu	60.24	60.08	52.68	173
	Kishtwar	12.12	22.79	45.09	80
	Mahore	418.49	42.44	54.08	515
	Marwah	17.22	12.84	29.94	60
	Nowshera	104.16	20.11	1.73	126
	Rajouri	82.34	82.48	35.18	200
	Ramban	295.27	45.86	18.86	360
	Ramnagar	127.71	107.82	64.47	300
	Reasi	288.44	69.86	24.70	383
	Udhampur	66.50	10.94	2.55	80
Total Area (ha)		**2,079.63**	**844.53**	**758.78**	**3,683.00**

**Excludes sites for natural regenerations and fire protection models.*

Table: 3. 21- Division-wise Priority Treatment Extent for Soil and Moisture Conservation Works in Chenab Riverscape, Jammu and Kashmir UT

Sr. No.	Forest Division	Priority Area Extent (m^3)			
		High	Medium	Low	Total
A.	**Himachal Pradesh**				
1.	Lahaul	574.66	2,912.26	45,213.08	48,700.00
2.	Pangi	4,822.01	12,848.98	30,889.02	48,560.00
B.	**Jammu and Kashmir UT**				
1.	Batote	4,679	1,329	262	6,270
2.	Bhaderwah	18,712	31,769	6,689	57,170
3.	Doda	4,878	1,714	688	7,280
4.	Jammu	6,090	6,074	5,326	17,490
5.	Kishtwar	1,024	1,926	3,810	6,760
6.	Mahore	4,591	466	593	5,650

7.	Marwah	1,624	1,211	2,824	5,660
8.	Nowshera	2,09,461	40,438	3,471	2,53,370
9.	Rajouri	13,759	13,782	5,879	33,420
10.	Ramban	17,216	2,674	1,100	20,990
11.	Ramnagar	4,466	3,770	2,254	10,490
12.	Reasi	57,733	13,983	4,945	76,660
1.	Udhampur	4,622	761	177	5,560
Total Extent (m^3)		**3,54,251.34**	**1,35658.54**	**1,14,120.12**	**6,04,030.00**

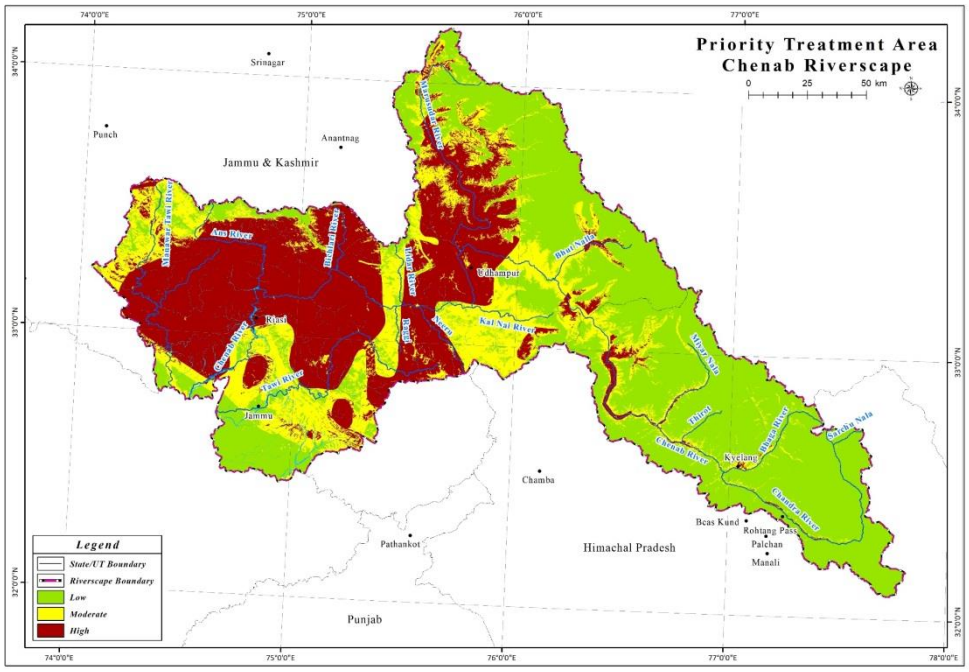


Fig.3. 29-Identification of Priority Zones for Forestry Interventions in the Chenab Riverscape

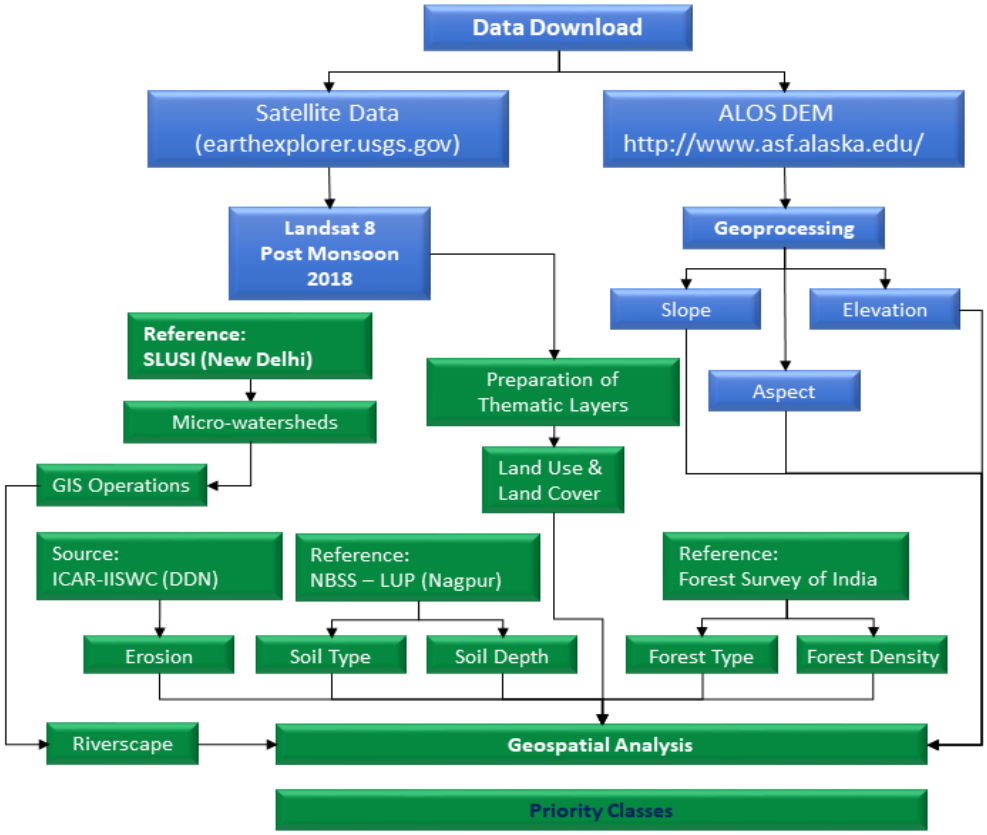


Fig.3. 30–Approach Adopted for Geospatial Analysis and Prioritization of Areas

3.21 Riverscape – Secondary Information, Collation and Synthesis

An understanding of overall environment of the Riverscape from the perspective of its physical, biological and socio-economic environments is invariably considered vital for proposed Forestry Interventions. With this very objective in view and for carrying out Forestry Interventions in Chenab Riverscape, the basic perspectives like physical, biological and socio-economic environment have been kept in mind with special reference to restoration, biodiversity conservation, involvement of local communities and relevant institutions in these efforts including sustainable livelihoods and awareness. Bulk of information on these aspects of Chenab River Basin is generally available in existing literature. Hence, the first step (i.e., background analysis/ contextual analysis) of the broad approach adopted for preparation of the DPR provided much desired and detailed insight on the riverscape environment. The primary sources of relevant information on physical attributes and socio-economic conditions were different agencies/ organisations at the State and National levels. The relevant information was collected from different sources/ departments/ agencies/ websites were also optimally used for the synthesis of an insight on biological sub-environment of the riverscape. Relevant information on demography and socio-economic situation for all regions associated with the riverscape was collected, synchronized and synthesized for better understanding.

Chapter-4

Chenab River – Legislative, Policy and Institutional Context

4.1 Legislative, Policy and Institutional Context

The previous chapters have provided an introductory description of the Chenab River in broader sense with more focus on the multifaceted and lively nature of river ecosystem. The various sections and sub-sections under these chapters explicitly explain the continuous connectivity of river ecosystem with its surrounding environments including the spatially extended large catchments, luxuriant forests, wildlife, physical settings, climatic variables, human resources, anthropogenic activities and processes, etc.

Even so, these chapters developed a deep understanding of the diverse concerns and problems in connection with the Chenab river ecosystem. But, thorough appraisal of the different legal aspects, policies and institutional context is equally important to envision the agenda of rejuvenation of Chenab River. Thus, the present chapter attempts to assess these substantive aspects, their relevance and applicability in the DPR on rejuvenation of Chenab River through Forestry Interventions.

In Indian context, the legal perspectives and policy scenario about the water resources (surface and ground) is complex, perplexing and complicated. The rivers are free flowing trans-boundary entities which pass through many states, cities, towns, forests, polluted strips, agricultural corridors, and country side areas along its entire course. Though, the water and river are inseparably related to each other, and existence of river is attributed to water. But, the stipulated laws classify these terms apart and treat as different subjects. In general, water law is largely state based. Under constitutional statutory framework and provisions, states have the exclusive power to legislate the areas of water supplies, drainage, embankments, hydro-power, fisheries, etc. While the issues of water pollution, inter-state river disputes and navigation on national waterways come under the jurisdiction of union legislation. The rivers are under the realm of State Government, but, as per the clauses of River Board Act, the Union Government can constitute River Boards for providing directions to the state in regulation of various inter-state river disputes, optimum use of water resources, flood control, etc. The Inter-State Water Disputes Act, 1956 laid down the procedure for setting up of various tribunals to resolve the disputes of inter-state rivers, e.g., the Cauvery River Tribunal in context with Cauvery River comes into picture too often. In addition to this, there are international agreements and treaties in place to exercise control over the utilisation of river waters by different states and countries. Moreover, there are separate set of rules for ground water resources and quite enigmatically the land owners enjoy the privilege to use groundwater on their land unrestrictly leading to lowering of ground water table. The rapid development of hydro-power sector has imposed a major concern to the ecological integrity of the rivers.

Rapidly increasing demand for hydro-power based electricity generation requires construction of large dams and weirs on the rivers and their tributaries. These infrastructures brought many changes to river flow, sedimentation load, biodiversity and regulatory functions of the rivers (Nilsson et al., 2005). The controversy around dam planning, construction and operation reflects this. As the already commissioned mega hydro-power projects on the main stem of rivers, different micro and mini- hydro-electric projects on tributaries cause a cumulative adverse impact on the entire river basin and ecosystem. Therefore, the competing interests and controversies always revolve around the planning, construction and commissioning of hydro-power projects. The current concerns and challenges of climate change also need to be construed by the law enacting agencies. The role and responsibility of civil society is invariably imperative in managing the water resources. Clearly, the existing legal arrangements of water regime in the country are a derivative of the pre-colonial and post- colonial era which suffers from many loopholes and lacuna. The important socio-legal aspects have been undermined in its background. Therefore, there is a need to suitably amend legal perspectives and institutional mechanism for better assessment of the susceptibility of water resources to human disturbances, mitigate the impacts of climate change on river ecosystems, and fulfil the requirements of the society in a sustainable manner. By and large, surface and underground water should be considered as single unit resource and uniform law, policies should be laid down in the common interests.

4.2 The Chenab River Perspective

The Chenab River originates from Chandertal in Himachal Pradesh, and then flows into the UT of Jammu and Kashmir before flowing into Pakistan. Thus, the Chenab River is not just an inter-state River, but, also a trans-boundary river whose water is shared between India and Pakistan under the provisions of Indus Water Treaty, 1960.

Rivers provide a wide range of benefits to society e.g., livelihood support, spiritual well-being, aesthetic contentment, food security, water security, hydro-power energy, etc. Rivers have helped the human civilisation and cultures to flourish and grow along its banks. The dynamics of inter-relationship between the river and numerous societal benefits is very intricate as it involves several factors and uncertainties.

Strong River Policy Framework and robust institutional mechanisms have become the need of the hour due to several factors. These include unsustainable and unplanned urbanization, industrialization along the rivers leading to dumping of untreated sewage and toxic effluents into the River. It requires a basin level, decentralized system by involving local communities to revive River. A clean flowing river can be regarded as an indicator of not just a healthy ecosystem but, also of the state of governance. How a Nation or State manages its rivers is a good indicator of how it governs its citizen. A healthy river is not just good for the ecology: it is a key factor that contributes to well-being of the society at large. After all, polluted water has serious health consequences. A flood plain which is destroyed leads to increased flood risk and decline in fishes impact livelihoods and food source. Despite the intrinsic link between river and human well-being, the policy thrust over the last few decades has been to

regard a flowing river as a 'waste' (Iyer, 2001). A river today has to justify its existence by providing electricity to the people, sand and boulder for construction and water for drinking, irrigation and industrial needs. In addition, it is the recipient of all the industrial effluents and domestic sewage. If that was not enough, climate threat has today emerged as the new irreversible threat to the very existence of rivers. The rapidly melting glaciers may give an illusion of an increase in water supply. However, it will not be long before it will be evident that the source for all the water will be gone. The impact of climate change will be all the more visible in Himalayan Rivers which are snow fed.

River governance, in light of the above facts and looming reality of climate change presents a peculiar challenge which has to be met, not only for the sake of the river, but for the sake of human populations. The erratic weather pattern is now a reality and unless the law and policies take this reality into account, developing a plan to govern rivers is going to be a futile exercise.

The Chenab River therefore, poses serious policy challenge. Being a Himalayan River, it is subjected to the impacts of climate change. The flows are not going to be the same. Added to this is the increased human dependence due to industrial and other demands. The flood plains, the areas most important to absorb the 'climate shock' are today seen as prime areas for constructions. The sand and boulders, key materials which reduce the velocity of water, are being removed to meet the demands of building and construction sector. The Himalayas is today the most dammed mountain range in the world. Yet, new dams are being planned across the length and breadth of the Himalayan rivers including the Chenab River.

The last few years have seen some significant developments with respect to river governance. The Uttarakhand High Court had conferred the status of legal personhood on the Ganga River (Uttarakhand High Court, 2014). There can be debate and discussion on both the utility as well as implication of this judgment. However, there is no denial that the Judgment has drawn attention to the need to focus on rivers as something more than just a natural resource to be harnessed for human needs. At another level, the National Ganga Council has been notified by the Central Government as well as State Ganga River Conservation Authority, and District Ganga Committees (MoWR, 2016). The formation of three tiered system is recognition of the need for a basin level governance structure which focuses on the ecology rather than the issue of water distribution.

There needs to be a radical rethink into the manner in which we govern our rivers. The issue is not just between choosing between centralised versus decentralised or between national versus state. The key issue is whether the law, policy and institutions are able to meet the challenges arising out due to the human demands and climate change.These issues have been dealt with in the present Chapter, presenting issue wise relevant legislative, policy and institutional framework in order to achieve the ultimate purpose of present DPR to rejuvenate the Chenab River.

4.3 Mandate under the Constitution of India

Article 48A of the Constitution of India puts an obligation on the State to protect and improve the environment and safeguard the forests and wildlife of the country. The Supreme Court has emphasized on the role of the State in protecting the environment in several cases by bringing it under the ambit of Right to Life under Article 21 of the Constitution (Supreme Court, 2001). In a recent judgment, the Court has taken a strict view on the constitutional mandate on the State under Article 48A by holding that "*in cases pertaining to environmental matter, the State has to act as facilitator and not as obstructionist"*(Supreme Court, 2019) A corresponding duty has also been cast upon every citizen under Article 51 A (g), in the form of "fundamental duties," to protect and improve the natural environment, including forests, lakes, rivers and wildlife, and to have compassion for living creatures. The Supreme Court has invoked Article 48A and intrinsically connecting it with the Public Trust Doctrine while directing for demolition of an illegal hotel construction on the banks of River Periyar in Kerala (Supreme Court, 2013).

With respect to rivers, it is important to locate this subject under the Constitutional scheme, i.e., power to legislate on rivers. The 7th Schedule to the Constitution, drawing on the provisions of Article 246 classifies subjects into three different lists e.g., the Union List, State List and the Concurrent List. Whereas 'regulation and development of inter-state rivers and river valleys' finds mention at Entry 56 of the Union List, the subject of 'water' falls within the State List at Entry 17. This dichotomy in the Constitutional set-up calls for a concerted effort between the Central and State Governments with respect to rejuvenation, especially in the Chenab River context, since it flows through Himachal Pradesh and Jammu region of Jammu and Kashmir UT.

4.3.1 National Forest Policy 1988

The National Forest Policy was developed by the Central Government as a basic document enumerating the principles to be followed while undertaking any activity in forest areas as well as in conservation/rejuvenation efforts of forest areas in the country. Therefore, the National Forest Policy is an important guide to have an effective rejuvenation programme in place. The policy was relied on by the Supreme Court in the *Lafarge Umium* case (Supreme Court, 2011) wherein the Court directed that the National Forest Policy must be read as part of the Environment (Protection) Act, 1986 and the Forest (Conservation) Act, 1980. The directions of the court are noteworthy:-

"The time has come for this Court to declare and we hereby declare that the National Forest Policy, 1988 which lays down far-reaching principles must necessarily govern the grant of permissions under Section 2 of the Forest (Conservation) Act, 1980 as the same provides the road map to ecological protection and improvement under the Environment (Protection) Act, 1986. *The principles/guidelines mentioned in the National Forest Policy, 1988 should be read as part of the provisions of Environment (Protection) Act, 1986 read together with the Forest (Conservation) Act, 1980. This direction is required to be given*

because there is no machinery even today established for the implementation of said National Forest Policy, 1988 read with the Forest (Conservation) Act, 1980. Section 3 of the Environment (Protection) Act, 1986 confers a power coupled with duty and, thus, it is incumbent on the Central Government, as hereinafter indicated, to appoint an appropriate authority, preferably in the form of regulator, at the State and Central levels for ensuring implementation of the National Forest Policy, 1988."

One of the important principles given in the National Forest Policy included checking soil erosion and denudation in the catchment areas of rivers, lakes, reservoirs in the "interest of soil and water conservation, mitigating floods and droughts and the retardation of siltation of reservoirs (National Forest Policy, 1988). The National Forest Policy also emphasises on the need to include community and ensure their active participation in conservation and rejuvenation efforts of the forest areas (National Forest Policy, 1988).

4.3.2 National Water Policy 2012

The Central Government has issued an overarching policy on utilisation and conservation of water resources of the country. The first such policy was issued in 1987 which had laid down the hierarchy of use of water resources for drinking, irrigation, hydro-power, navigation, industrial and other purposes. This policy was revised/demanded in 2002 and again in 2012- which is the policy currently in force (MoWR, 2012). The National Water Policy lists out the guiding principles for implementation of laws relating to sustainable utilisation and conservation of water resource.

"*2.2 Such a framework law must recognize water not only as a scarce resource but also as a sustainer of life and ecology. Therefore, water, particularly, groundwater, needs to be managed as a community resource held by the state, under public trust doctrine to achieve food security, livelihood, and equitable and sustainable development for all. Existing Acts may have to be modified accordingly."*

Therefore, water needs to be managed as a community resource held by the state, under public trust doctrine to achieve food security, livelihood, and equitable and sustainable development for all. The Policy also recognizes the need for encompassing issues relating to climate change while planning and appraising any activity which involves utilisation of water (NWP, 2012). These overarching principles, especially relating to community participation as well as climate adaption become critical when formulating and implementing a rejuvenation scheme for the Chenab River.

4.3.3 Indus Water Treaty 1960

The Indus Water Treaty is one of the oldest trans-boundary river water sharing treaties to be signed in the World. It has been widely accepted as being one of the most successful treaties on trans-boundary water sharing (Hanes, 2017). According to this treaty, India and Pakistan have agreed to demarcate the six rivers which fall within the Indus River Basin for their respective use, management and exploitation of resources. Thus, as per the Agreement, India

has full rights to use and exploit the three eastern rivers, i.e., Beas, Ravi and Sutlej (IWT, 1960); whereas, Pakistan has unfettered rights of exploitation of the Western Rivers, i.e.- Indus, Chenab and Jhelum (IWT, 1960) and India has limited rights on the catchment area of these rivers within Indian territory. Article IV (6) of the Treaty states that each party shall make its best endeavours to maintain the natural channels of the Rivers, and avoid any obstruction as far as applicable to the flow in these channels likely to cause damage to the other party.

As per the provisions of Treaty, if either party wants to exploit resources of a river which has been assigned to the other party, an elaborate mechanism has been laid down-this includes consultations, filing of objections, sharing of data, etc. The Indus Permanent Commission was also set up as per the Treaty which has been tasked with ensuring proper implementation of the Treaty (IWT, 1960). In case of any dispute regarding any activity, the Treaty has specific provisions for dispute resolutions.

Provisions relating to use of waters of Chenab River

Chenab being a western river is governed under the provisions of Article 3 (2) of the Treaty. (See box). Thus, India is obligated to not permit "any interference with these rivers" except for the uses mentioned in the provision. The biggest bone of contention between India and Pakistan is the exception clause which permits generation of hydro-electric power by India in terms with provisions of Annexure D of the Treaty.

Article 3:-

….

(2) **India shall be under an obligation to let flow all the water of the Western Rivers, and shall not permit any interference with these waters**, except for the following uses, restricted (except as provided in item (c) (ii) of Paragraph 5 of Annexure C) in the case of each of the rivers, The Indus, The Jhelum and The Chenab, to the drainage basin thereof:

(a) Domestic Use;

(b) Non-Consumptive Use;

(c) Agricultural Use, as set out in Annexure C; and

(d) Generation of hydro-electric power, as set out in Annexure D.

Annexure-D of the Treaty

This Annexure provides for the conditions to be complied by India while developing hydro-electric power plants on the Western Rivers, including Chenab. The Treaty stipulates that India can construct "Run of the River" plants on the Western Rivers which comply with the conditions given in the said Annexure.

It is also stipulated that India must share the design parameters of a proposed hydro-electric project at least six months prior to the construction. In case, there are any objections, the same must be communicated to India within three months.

Annexure-E of the Treaty:

There is a general prohibition on India to construct storage works on the western rivers, unless it is in compliance with the provisions of Annexure D and E of the Treaty (IWT, 1960). Annexure E of the treaty stipulates a cap on the extent of such projects on the Western Rivers as wells as conditions with respect to the design of such projects (IWT, 1960). The Annexure also permits India to construct such works on the Jhelum Main channel as it may consider necessary for flood control (IWT, 1960). It also stipulates that any such project on any tributary of Chenab would be constructed in such a manner that it does not adversely affect the then existing agricultural or hydro-electric uses by Pakistan on that Tributary (IWT, 1960).

This Annexure also stipulates that India must share the design parameters of a proposed hydro-electric project at least six months prior to the construction. In case there are any objections, the same must be communicated to India within three months.

4.3.4 Hydropower Sector: Need for Cumulative Impact Assessment as well as regulation of State Hydro-electric projects (SHPs)

In Himachal Pradesh, Chenab flows for 130 km which holds a minuscule proportion of the Basin's catchment area i.e. 7500 km^2 of its total 61,000 km^2. In this area, Himachal Pradesh is planning, constructing and implementing 49 hydro-electric projects (SANDRP, 2012). Hydropower generation in the Himachal Pradesh poses a critical threat to the Chenab Sub-Basin. Apart from Jispa a 300 MW project proposed in Lahaul-Spiti (on the Bhaga River), and the 400 MW Seli (Chandrabhaga) hydro-electric projects, a spate of large projects of capacities > 100MW are also currently in the process of getting cleared (Thakur. and Asher, 2015).

Similar to the case of Basins of other Himalayan rivers, the problem is magnified in light of the cascade model of hydro-power development being adopted in Himachal Pradesh. In contrast to a reservoir-based dam, recent trends show a shift towards run of the river hydro-electric power projects in India. This cascade model means that at the tail of one project, the head of the next is located, thereby creating a cascade/series of these projects built bumper to bumper on the streams and rivers to harness the capacity of the rivers to produce power to its maximum. Such projects will lead to the River and its tributaries to flow in tunnels and have adversely impacted aquatic fauna as well as traditional irrigation channels (kuhls) used by local communities (Himdhara).

Hydro-electric projects in J&K UT

With respect to the Sub-Basin in the Union Territory of Jammu and Kashmir ("J&K"), the document also states that there are 23 planned hydropower projects, out of which, 6 are operational. The projects include, Chenani I, II and III and the Bhaderwah HEPs operated by Jammu and Kashmir State Power Development Corporation Ltd., including the contentious Baghlihar Project (Economic and Political Weekly, 2006) (Box 4.1)

Box 4.1 - Baglihar Dam Dispute

This project was conceived in 1992, approved in 1996 and construction began in 1999 as a run-of the river project. The Baglihar Hydro-electric Project (BHP) is located on the river Chenab in Ramban Tehsil of Doda district, Jammu and Kashmir (J and K UT). The project will have an installed capacity of 450 MW during phase I and 900 MW during phase II. The project was objected to by Pakistan under the provisions of the IWT. It was agreed by both India and Pakistan that the World Bank would appoint a Neutral Expert ("NE") to give an opinion on the dispute. In 2005, Prof. Raymond Lafitte was appointed as NE. In 2007, the NE approved the project and gave an opinion that the project does not violate the provisions of the IWT. The NE, however, did suggest some marginal changes in the project design including reductions in freeboard and pondage and increase in the height of the intakes. The project is now operational.

Source: www. mea.gov.in/press release.

Several large dams are already operational, and some are being pursued for clearances in the UT of J&K. These include the following:-

Table:4. 1- Several large dams are already operational, and some are being pursued for clearances in the UT of J&K.

Name of Project	Capacity	District	Status
Salal Dam	690 MW	Reasi	Operational
Dul Hasti	390 MW	Kishtwar	Operational
Pakal Dul	1000MW	Kishtwar	Under construction
Ratle	850 MW	Kishtwar	Under construction
Kiru	624 MW	Kishtwar	Proposed
Kwar	540 MW	Kishtwar	Proposed
Bursar	800 MW	Kishtwar	Proposed
Sawalkote	1,856 MW	Ramban	Proposed
Kirthai I	390 MW	Kishtwar	Proposed
Kirthai II	930 MW	Kishtwar	Proposed

While considering and planning hydro-electric power projects in the UT of J&K, the impact of associated infrastructure such as roads and transmission lines must also be included while assessing impact of the project. The geography of the UT aggravates the energy shortfall issue as the maximum number of places identified for development of hydro-electric projects falls in inaccessible terrain and some of the locations remain cut off from the main cities during winter months. Therefore, laying and maintenance of transmission lines in these

regions are very challenging and uneconomical particularly during winter months (Sharma, 2017).

Thus, it becomes imperative that cumulative impact of these HEPs are assessed properly in terms of impact on the river ecology as well as on the local communities, after consulting the local communities. This becomes even more important in light of the fact that it has been found that around 10 Mega HEPs of Himachal Pradesh are under maximum threat of Landslide followed by large HEPs which fall under medium landslide hazard risk (GoHP, 2015). Other significant impacts of HEPs are the associated impacts of road and other infrastructure development (CWPIL, 2009). Special emphasis on this sector has to be given in light of climate change related discussion.

While regulating HEPs, the following laws become important:-

(a) Environmental Clearance under the EIA Notification, 2006

As per the scheme under the EIA Notification 2006, a HEPs proposing >50 MW power generation would require obtaining prior Environmental Clearance from the Ministry of Environment Forest and Climate Change and if the power generation is 25 MW or more but < 50 MW, clearance has to be obtained from the State Level Impact Assessment Authority (SEIAA). While applying for such clearance, the Project Proponent must undertake an Environment Impact Assessment (EIA) Study and conduct public consultations and submit the report to the Expert Appraisal Committee (EAC) or the State Expert Appraisal Committee (SEAC). Before grant of such clearance, the concerned EAC or SEAC and the regulatory Authority is mandated to conduct a "detailed scrutiny" of the documents submitted and then recommend for grant or rejection of the Environmental Clearance (EIA, 2006). An Environmental Clearance if granted is valid for a period of ten years (EIA, 2006).

It is mandatory for the project proponent to submit six monthly compliance reports of the conditions of Environmental Clearance (EIA, 2006). The Environmental Clearance for HEPs usually has specific conditions with respect to the construction phase of the dam i.e. muck disposal plans, height of the dam, etc. These conditions need to be strictly monitored at the construction stage. During operation phase, the conditions relating to release of minimum environmental flows, Catchment Area Treatment Plan, etc. needs to be visited and monitored. Thus, the Environmental Clearance becomes an important instrument to ensure minimal damage to the river system.

(b) Cumulative Impact Assessment

Cumulative Impact Assessment (CIA) Study for Chenab River Basin is being undertaken by the Government of Himachal Pradesh. As per the Draft Executive Summary of the (CIA (RSET, 2019) in the State of Himachal Pradesh:-

"*Sixteen HEPswith 2951 MW of total installed capacity are at various stages of development. Out of 16, 3 HEPs are located on Chandra River, 1 on Bhaga, 6 on Chenab (Chandrabhaga) river, 2 on Miyar Nallah, a major tributary of Chenab, 3 on Saichu Nallah, another tributary of Chenab and 1 on Lujai Nallah which also is a right bank tributary of Chenab river.*

The Executive Summary states that planned 11 HEPs on main Chenab River will affect 117.76 km of the river length; 41.04 km will be converted to reservoirs and 76.72 km will be travelling through tunnels leading to significant alteration of free flowing riverine ecosystem of Chenab River. Thus, it is clear that not much of the River would be flowing free and such unsustainable development would have serious adverse impacts on the River ecology and Biodiversity.

"Projects proposed on Chandra/Chenab are affecting > 49m river length per MW. Shangling and Teling HEPs in the upper stretch of Chandra River will affect 116m and 132m of river length per MW. Along Bhaga 120m of river stretch per MW is being affected by Stingiri HEP. Patam HEP on Miyar Nallah will affect 134m of river stretch per MW. More than 246m and 106m of Saichu Nallah, an tributary of Chenab River in lower stretches, are being affected by Chiroti and Saichu Sach Khas HEPs".

The residents who are living in this fragile, difficult and hostile environment of the Lahaul valley have opposed the Jispa dam since the day they heard of it. They have seen the condition of the Satluj and Ravi River in their front yards and have vowed to protect the pristine Chenab River for everything it is worth (Himdhara, 2017). Even the executive summary of the CIA for Chenab River (RSET, 2019), clearly records the large scale public protest against the said project.

"*Secretary of the Janjatiya Kalyan Samiti, Lahaul-Spiti and Jispa Bandh Jankalyan Sangharsh Samiti strongly opposed the development of hydro power projects especially Jispa HEP and asserted to keep the valley free from potential destruction as caused by power projects in Kinnaur.*

All the stakeholders were against Gyspa HEP as it involves submergence of villages. They showed/expressed their support to small HEPs instead."

Unlike the CIA study for other Basins, the Draft Executive Summary of Chenab CIA document states that for continuity of the basin study, it is proposed that the scope of present Chenab River basin study should be extended to cover the stretch of Chenab River in J&K UT. It is to be seen what recommendations the study would have with respect to the entire Chenab River Basin.

(c) Forest Clearance under the Forest (Conservation) Act, 1980

In addition to obtaining environmental clearance, in most cases HEPs require prior Forest Clearance under Section 2 of the Forest (Conservation) Act, 1980 for diversion of forest land. Under the Forest Clearance process, what is most critical is the Cost-Benefit Analysis which has to be undertaken by the User-Agency which is to be scrutinised by the Central Government before granting Forest Clearance. As per the Guidelines of the Ministry ofEnvironment, Forest and Climate Change (MoEFCC, 2017), while considering a proposal for diversion of forest land, it is essential that ecological and environmental losses and eco-economic distress caused to the people who are displaced, are weighted against economic and social gains. Thus, the cost ecosystem services and fragmentation of wildlife and economic distress to the displaced communities and cost of settlement of these communities should be added as cost of diversion in addition to the project cost.

(d) Settlement of Forest Rights of forest dwelling communities under the Forest Rights Act, 2006

An important aspect of Forest Clearance process is the mandatory requirement of settling forest rights of tribal communities and obtaining consent from the Gram Sabhas concerned under the provisions of the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006. In this regard, the Ministry has issued letter dated 3.08.2009 wherein the Ministry has listed out the necessary compliances to be undertaken by the User-Agency and State Government before grant of Forest Clearance under Section 2 of the Forest (Conservation) Act, 1980. It is mandatory as per the Forest (Conservation) Rules, 2003, vide amendment dated 06.03.2017 (Forest (Conservation) Rules, 2003). This process becomes crucial in light of the fact that the Lahaul and Spiti district has been notified as a Scheduled District with a high percentage of tribal population who are heavily dependent on the forests for their livelihood and survival. Even in the case of UT of Jammu and Kashmir, tribal communities constitute 11.974 % of the total population (GOI, 2011). In Lahaul and Spiti District there is large scale public opposition to development of HEPs in this highly eco-sensitive and seismic region (Himdhara, 2015).

(e) Dealing with prolific growth of Mini-Hydro Projects

As mentioned earlier, there is a serious need to relook at the issue of mini hydro power projects in the State of Himachal Pradesh. It may be noted that small hydropower projects (SHEPs) (1MW to 25MW) are not included under the purview of the EIA Notification, 2006 of the Environmental Protection Act (1986). Hence all SHEPs are legally exempted from requiring environmental clearances and conducting environment impact assessments and public hearings. Further, the said category of HEPs have also been exempted from the need to obtain consent under the provisions of the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974 (CPC, 2016). This is primarily due to the assumption that small HEPs, on account of being 'small' will have minimal or no adverse environmental and social impacts. Contrary to such assumptions, there is enough documentation to conclude that these SHEPs also have adverse environmental as well as social impacts. In fact, they are also capable of influencing micro-climate as well as spatial distribution of macro invertebrate of the project site and surrounding area of HEPs(Lata *et al*., 2017).

Thus, with respect to SHEPs, the only permissions that are required by the project proponent include the techno-economic clearance and those from the Irrigation and Public Health, Fisheries and Public Works Departments. However, there are no procedures and regulations in place at the state level to ensure a cost benefit analysis with an environment and social impact assessment of these HEPs. Similarly, no CIA is ever conducted (Lata *et al*., 2017).

In the context of the Chenab Sub-Basin, it may be noted that as per the information available on the website of Himurja, Govt. of Himachal Pradesh, there are about 29 approved projects which fall within the category of 0-5MW (Himurja, 2018).

Thus, what has been overlooked is that small projects are coming up not just on the main river channel, but, also on the smaller streams which sustain local livelihoods of remotely

located poor communities and fragile but, bio-diverse ecosystems in numerous ways. Across the state, these streams support the traditional irrigation channels or kuhls. Watermills are run on these and in many places, they even supply drinking water to villages. When looked at from a larger basin perspective, there is a need for assessing the cumulative impacts of SHEPs and bringing the same under a definite legal regime which looks at cumulative impacts of the project and ensures that the project is being permitted with the consent of the local people. It is interesting to note that unlike Satluj and Beas Rivers, the Draft Executive Summary of the CEIA Study for the Chenab River Basin has stated that the study has considered these SHEPs, and has given a list of 21 projects to be included in the study.

(f) Climate Change: Dealing with Adverse Impacts

A recent study has found that over the years, there has been a sharp increase in the number of glacial lakes in the Chenab River Basin in Himachal Pradesh (Randhawa, 2019). In the Chenab River basin (Chandra, Bhaga, Miyar), a total of 254 lakes could be delineated. There are 64 lakes in the Chandra sub-basin, 84 lakes in the Bhaga sub-basin and 106 in the Miyar sub-basin, respectively. The Chenab River basin had 192 lakes in 2015, however, the number had increased to 254 in 2018. Startlingly, the Science Technology Department had only recorded 55 lakes in the Chenab basin in 2001 (Hindustan Times, 2020). Further, it has been found that the loss of glaciers would also be coupled with increased frequency of disaster events such as Glacier Lake Outburst Flood (GLOF).

According to Laghairi, (2013), as the Himalayan glaciers melt, the lack of data for predicting change in river flow patterns is a cause of great concern. It further states that Himalayan nations urgently need to initiate joint funding and strategies, in collaboration with international, environmental and development agencies, to allow research, data collection, evaluation and monitoring of glacial and climate change to take place. The research article also highlights the impact on HEPs due to change in river flow.

In the legislative domain, it may be noted that there is no National Level or State Level legislation which directly deals with Climate Change issues. On the policy level, the Himachal Pradesh has constituted a State Level Governing Council on Climate Change, under the Chairmanship of Chief Minister and a State Level Action Plan on Climate Change was brought out in the year 2012 (www.india.envir.portal). Similarly, the Government of erstwhile Jammu and Kashmir has also prepared a State Action Plan on Climate Change. However, the said policies need to be updated and target based action plan is required to be prepared to deal with the alarming situation as mentioned above. It is highly inadequate in many respects, particularly in terms of capacity and well-designed institutional mechanisms at the stage of implementation and monitoring (Economic and Political Weekly, 2019). The 2012 Policy document derived from the eight missions, identified under the National Action Plan on Climate Change which was adopted in the year 2008 and has not been updated since. There is a critical need for the Himachal Pradesh as well as UT of J&K to take into account the harsh realities of impacts of Climate Change on the Chenab River system, and come out with a more realistic and practical policy document which can be implemented within the current legal framework.

4.3.5 Protecting the "Protected Areas" in the Basin

In the Chenab Sub-Basin in Himachal Pradesh, there are two protected areas, i.e., Sechu Tuan *Nallah* Wildlife Sanctuary and Chandratal Wildlife Sanctuary (RSET, 2019, 2013).The Inderkilla National Park is located adjacent to the Chenab River basin which follows the ridge dividing Chenab and Beas basins near Rohtang Pass. Upper catchment of Chenab river comprised of Bhaga sub-zone and Udaipur Sub-zone is to be included in the proposed Cold Desert Biosphere Reserve. However, it may be noted that there are no Community Reserve or Conservation Reserve notified under the provisions of the Wildlife (Protection) Act, 1972 as well as Biodiversity Heritage Sites under the Biological Diversity Act, 2002 in Himachal Pradesh Sub-Basin.

In the UT of J&K, the Kishtwar National Park and Trikuta and Surinsar-Mansar Widlife Sanctuaries as well as the Jawahar Tunnel Conservation Reserve fall within the Chenab sub-basin.

Under the provisions of the Section 35 (6) of the Wildlife (Protection) Act, 1972, there is a specific prohibition on destroying or damaging or diverting the habitat of any wild animal by any act or diverting, stopping or enhancing the flow of water inside or outside the National Park. Similar provision for protection of Wildlife Sanctuaries has been given in Section 29. These activities are allowed on the exception that a permit is granted by the Chief Wildlife Warden and that no such permit granted unless the State Government is satisfied in consultation with the National Board that such removal of wildlife from the National Park or the change in the flow of water into or outside the National Park is necessary for the improvement and better management of wildlife therein.

4.3.6 Eco-Sensitive Zones: an effective conservation tool for Chenab River

Eco-Sensitive Zones (ESZ) around Protected Areas are declared and notified under section 3(v) of the Environment (Protection) Act, 1986 and Rule 5 (viii) & (x) of the Environment (Protection) Rules. The purpose of notifying Eco-Sensitive Zones around Protected Areas is to create a kind of "shock absorber" for such areas, and they would also act as a transition zone from areas that are highly protected to areas requiring less protection. The status of ESZs around the protected areas in Chenab Sub-Basin is given as in Table 4.2.

Table:4. 2– Protected Area network under Chenab Basin

S. No.	Protected Areas	Area (km^2)	Status of ESZ Notification	Extent of ESZ as per Notification
1.	Sechu-Tuan Nala WLS	390.29	Final Notification (28/09/2017)	Upto 1km from the western boundary of the WLS. NO ESZ on North, South and Eastern sides due to inter-State boundary with Jammu and Kashmir UT and high altitude

				areas.
2.	Chandratal WLS	3856	Draft Notification (03.06.2016)	Upto 5.625 kilometre from the boundary. No ESZ has been proposed on the North-West of Chandertal Wildlife Sanctuary as it forms boundary with their glacier deposits.
3.	Surinsar-Mansar WLS	97.82	Draft Notification (20.07.2017)	0-372 m from South East, 1305 m from South, 1443 m from South-West, 1663 m from West and 940 m from North-West boundary.
4.	Nandini WLS	33.34	Draft Notification (27.04.2016)	Upto 1904 m from the boundary of Nandini Wildlife Sanctuary.

As can be seen from the above Table, most of the Protected Areas do not have a notified ESZ. It is questionable if the extent of the proposed ESZ would be sufficient to act as a "shock absorber". With respect to the proposed prohibited activities, most of the Draft Notifications stipulate a conditional prohibition- for instance "construction of major thermal power project or HEPs" find mention in the list of prohibited activities. However, the Notification states that it is "prohibited (except as "otherwise provided as per applicable law)". Here, it may be noted that otherwise provided as per applicable law" has no legal implication, since the applicable law such as the EIA Notification, 2006 or the Forest (Conservation) Act, 1980 does not protect specific landscapes. There is a definite need to strengthen these provisions and ensure that the activities permitted in this "buffer zone" are minimal. The Chenab River and its tributaries are flowing through these PAs, or its ESZ While the provisions of the Wildlife (Protection) Act, 1972 do provide certain safeguards, ensuring properly demarcated ESZ is a much more effective conservation tool for rejuvenating rivers, since, it covers not only the river and its ecology, but, also the catchment area, in terms of regulation of permissible activities. This is so because the Notification which is issued under the provisions of the Environment (Protection) Act, 1986 have mandatory provisions with respect to activities which are prohibited, and permissible but, with conditions. In most cases, river sand/boulder mining and setting up of stone crusher units within the notified ESZ are prohibited. The State of Himachal Pradesh needs to take proactive steps and consult the Ministry of Environment, Forest and Climate Change for notifying the ESZ Notifications for the protected areas falling within the Basin.

4.3.7 Conservation of Wetlands

Riverine Wetlands are an important component of a river system and plays a critical role in improving flood protection, recharging ground water and increasing the biodiversity, thus

providing several ecological services. The State is under a legal obligation both under the Wetland Rules, 2017 issued under the provisions of the Environment (Protection) Act, 1986 as well as under India's international obligation under the Convention on Migratory Species (CMS), the Ramsar Convention and the Convention on Biological Diversity to protect and preserve wetlands as well as the avian ecology that they support. The Surinsar-Mansar Lake in the Chenab Sub Basin in J&K UT is a notified Ramsar Wetland (Notification, 2005).

Himachal Pradesh has notified the constitution of the State Wetland Authority in 2017 itself (DST, 2017). However, it is not clear as to how much progress there has been with respect to identification and notification of wetlands in the State as per the Wetland Rules, 2017. The timeline as per the Rules for various steps in the identification of wetlands as well as notification is given in the Table 4.3.

Table:4. 3– The Wetland Rules, 2017 - Key Steps and Relevant Timelines

S. No.	Activity	Timeline as per Rules
1	Constitution of Technical Committee to review brief documents, management plans and advise on any technical matter referred by the Wetland Authority; and constitution of Grievance Committee consisting of four members to provide a mechanism for hearing and forwarding the grievances raised by public to the Authority.	3 months from date of publication of Rules.
2	Prepare a list of all wetlands of the State or Union Territory	3 months from date of publication of Rules.
3	Prepare a list of wetlands to be notified,	6 months from date of publication of Rules.
4	Prepare a comprehensive digital inventory of all wetlands	1 year from date of publication of Rules.

From the information available in public domain, it is not clear whether the Himachal Pradesh and of J&K UT are complying with these timelines stipulated under the Wetland Rules, 2017. It is therefore necessary to initiate and complete in a time bound manner, the process of identification and notification of wetlands under the provisions of the Wetland Rules, 2017 so that they come under legal protection. It may be noted that the main river channel is specifically excluded from the legal definition of Wetland under the Rules (Wetlands Rules, 2017). However, the Wetlands which are part of the basin, or which form part of the larger catchment area of the river are important from the perspective of a holistic exercise for river rejuvenation. The States HP and J&K UT can refer to the Guidelines issued by the Ministry of Environment, Forest and Climate Change in this regard (MoEFCC, 2020).

4.3.8 Mineral Extraction and Industrial Land Use

(a) River Sand/Boulder Mining and Associated Industries

The Chenab River and its tributaries are not unknown to the problems of large scale illegal and unscientific mining, especially in Himachal Pradesh. The ill effects of river sand mining have got judicially acknowledged in several cases by the Supreme Court as well as the National Green Tribunal.

The Apex Court had directed that all river sand mining projects irrespective of the area would mandatorily require prior Environmental Clearance under the provisions of the EIA Notification to ensure that impact from such projects is minimized and mitigated to the extent possible. Thus, any rejuvenation efforts for Chenab River and its Basin would necessarily have to concentrate on creating effective mechanism to deal with illegal mining and regulate the mining activities in the river and its basin.

Under the legislative domain, regulation for mining of sand and boulder material falls under the purview of the State Government as per the provisions of the Mines and Minerals (Development and Regulation) Act, 1957 (MMDR Act). In addition to this, mining of minor minerals require prior Environmental Clearance under the provisions of the EIA Notification, 2006 issued by the Ministry of Environment, Forest and Climate Change. As per the scheme under the notification, mining lease area is > 50 ha, such a project would fall within Category A project wherein the clearance has to be obtained from the Ministry. If the lease area is 25 ha or more, but, < 50 ha, the project would fall under Category B and in such cases clearance has to be obtained from the State Level Impact Assessment Authority (SEIAA). If the lease area is < 25 ha, then it would be categorized as B2 projects and require clearance from the district Level Impact Assessment Authority which is headed by the District Collector/Magistrate (EIA, 2016). With respect to B2 category projects, before granting clearance, there is a pre-requisite condition regarding preparation of District Survey Reports with the objective of "*identification of areas of aggradations or deposition where mining can be allowed; and identification of areas of erosion and proximity to infrastructural structures and installations where mining should be prohibited and calculation of annual rate of replenishment and allowing time for replenishment after mining in that area*". The idea is to make a prior assessment of the available reserves in the river and to extract the same in a sustainable manner without adversely impacting the river ecology. These reports are to be updated every five years as per the EIA Notification, 2006. For Himachal Pradesh, DSR Reports are available for Chamba district falling in the Chenab Sub-Basin, however, no such report is available for Lahaul and Spiti district. The Ministry of Environment, Forest and Climate Change has also issued sustainable sand mining guidelines in 2016 which, inter-alia, addresses the issues relating to regulation of sand mining.

(b) Stone Crusher Units

The Himachal Pradesh Government has in 2014 issued mandatory siting criteria under the provisions of the Environment (Protection) Act, 1986 (DST, 2012). The Notification prohibits setting of stone crushers within 500 meters of lakes, wetlands and reservoirs of

irrigation schemes, HEPs and within 100m of a canal or "perennial rivulet". The Notification further mandates a joint inspection by a Committee which includes the Divisional Forest Officer as a Member. The Committee has to ensure that no proposal for setting up of a stone crusher is violating the siting criteria. Interestingly, the National Green Tribunal (NGT) is currently considering the said notification with respect to the distance from rivulets (NGT, 2016a). The issue before the Tribunal is whether the distance of 100m needs to be maintained only with respect to perennial rivulets. In an order dated 29.10.2018, the Tribunal applying the Precautionary Principle held as follows.

*"8. A reference to above Entry shows that there is prohibition for location of a stone crusher within 100 meters from springs, canals, reservoirs or functional water supply schemes and natural water schemes.**The rivulets of perennial nature are specifically included in the said expression but, it cannot be read as excluding non-perennial water bodies**. The object of the regulatory notification issued under the Environment (Protection) Act, 1986 is to protect the ecology from the adverse impact of location of a stone crusher nearby. The intention is not to permit a stone crusher within 100 meters of a water body. Importance of protection of water bodies can hardly be over-emphasized. **Interpretation of a regulatory provision must be consistent with the 'precautionary principle' and 'sustainable development principle'. Location of a stone crusher very close to a water body is against the principle of 'sustainable development' as well as the 'precautionary principle'.** The above Notification cannot be read as meaning that stone crushers can be allowed to be located just on the edge of a water body even if such water body is not perennial. Thus, the stone crushers set up within 100 meters of a water body will be illegal and in violation of Environment (Protection) Act, 1986 and the Notification issued thereunder.*

***9. Accordingly, the consent to operate granted to any stone crusher in the State of Himachal Pradesh within 100 meters of a water body will stand quashed.** The Himachal Pradesh State Pollution Control Board will take steps to stop operation of any such stone crusher and furnish a report to this Tribunal within two months.*

The said order came to be challenged by the State of Himachal Pradesh and several stone crusher units before the Supreme Court on the ground that they were not heard by the Tribunal while passing such orders. The Supreme Court thus remanded the matter back for the Tribunal to consider the submissions of the State as well as the Stone Crushers. The Tribunal by order dated 2.04.2019 constituted an Expert Committee to look into this issue and give recommendations. As per order dated 10.07.2019, the Tribunal had noted the recommendations of the Expert Committee that the minimum distance from any watercourse should be 100 meters irrespective of the nature of the water course-perennial or non-perennial. Thus, any crusher units in violation of the siting criteria must be shut down. The department responsible for such action would be the Pollution Control Board as well as the concerned Deputy Commissioners/District Magistrate. There is another case with respect to pollution caused by stone crushers in Ramban District which falls within the catchment of the River Chenab (NGT, 2019). Ensuring such polluting industries do not have an adverse impact on the river and its catchment area is an important facet of river rejuvenation.

4.3.9 Catchment Area Conservation Measures

While looking at rejuvenating a river, it is important not to just consider the river in isolation. A river is more than just the channel of flowing water, and has to be understood in terms of its catchment, the river bed, bank and floodplain as well as the vegetation on the floodplain. A healthy catchment area is thus integral to ensuring healthy river. In this regard, issues which need to be looked at include floodplain protection measures and measures to ensure efficient retention capacity of rain water in the soil.

Floodplain Protection and Conservation

Floodplain protection is critical to river conservation and ensuring good river health. They also support ecological diversity in a river system by providing carbon and nutrients supply to river channel, which finally governs productivity of the entire river system and by providing geomorphic (habitat) diversity in river space to support biodiversity (Richards *et al.*, 2002; Gurnell and Petts, 2002; Thoms, 2003). It is thus, very important that floodplains are correctly demarcated and protected. The importance of floodplain demarcation has been highlighted in several cases before the National Green Tribunal with regard to rivers in Maharashtra and Yamuna River in Delhi and Agra. Zoning of the floodplain by demarcating prohibited and regulatory zones is an efficient tool for protecting and conserving floodplains. For instance in the State of Maharashtra, as early as 1989, the Government had issued an order directing for demarcation of the flood plain into prohibited zone (blue zone) (GoMH, 1989).

4.3.10 Water Quality-ensuring no untreated sewage/industrial effluent falls into the river

Water Pollution is predominantly dealt with by the Water (Prevention and Control of Pollution) Act, 1974. This is done by mandating a process of regulating discharge of domestic sewage or industrial effluent through a regime of grant of "prior consent" by the State Pollution Control Board (SPCB). Thus, the Act stipulates a mandatory regime for every industry, process, activity etc. to obtain prior consent from the concerned SPCB for such a discharge of sewage or industrial effluent (Water (Prevention and Control of Pollution) Act, 1974). The Central Pollution Control Board has identified different stretches of the Chenab River and its tributaries *viz.*, Banganga, Devika and Tawi polluted in Jammu and Kashmir UT (CPCB, 2018). The detail of identified polluted stretch of Chenab River and its tributaries is given (**Table 4.4**).

Table:4. 4- Identified Polluted Stretches in Chenab River Basin

River /Tributary	Stretch Identified	Town Identified	Approximate Length of the River Stretch (km)
Chenab	Jalpatan (Jio-pota) to Pargawal	Akhnoor	12
Tawi	Surajpur to Belicharana	Jammu	5
Devika	Guru Rabi Dass temple to Nainsu	Udhampur	5
Banganga	Ponyshed to bathing ghat	Katra	3

(Source: CPCB, 2018)

Taking cognisance of the above referred CPCB report, the National Green Tribunal has passed several directions in a suomoto case, wherein the Tribunal has directed for setting up of River Rejuvenation Committees (RRC) in each State (CPCB, 2018).The States are supposed to come out with implementable action plans for rejuvenating the identified polluted river stretches in each State. The matter is being monitored by the Tribunal on a regular basis. Thus, the RRC would be an integral stakeholder while discussing rejuvenation of the Indus River Basin as a whole. In this regard, the Jammu and Kashmir UT has constituted an RRC which has prepared an action plan for the rejuvenation of these identified polluted stretches (RAP, 2019).

4.3.11 Urbanisation/ Infrastructure Development

Floodplains of River Chenab and its tributaries are under major stress due to large scale reclamation for construction or infrastructure development in the form of road construction and other developmental activities. In fact, there is a case pending before the National Green Tribunal (NGT, 2020). Wherein the main issue is with respect to destruction of floodplain due to illegal muck dumping from the ongoing four laning of National Highway from Udhampur to Banihal in Jammu and Kashmir UT by National Highway Authority of India and its sub-contractors. The Chenab sub-basin landscape is witnessing several infrastructure projects. Road construction as well as expansion has led to increasing instances of landslides in the area especially in J&K UT (SANDRP, 2018). In fact, the world's highest railway bridge, Chenab bridge (Part of the larger Udhampur to Baramulla Project) is also being constructed across the Chenab river between Bakkal and Kauri in Jammu and Kashmir UT (Financial Express, 2020). In fact, there are reports of streams and water bodies drying up in Reasi District due to the construction of railway tunnels as part of this project (The Hindu Business Line, 2019). It may be noted that the Railways have consistently taken a stand that Railway projects are not covered under the EIA Notification, 2006 and therefore, do not require any prior environmental impact assessment (Down to Earth, 2016).

With respect to urbanisation and construction along the river, the Town and Country Planning Department as well as concerned Municipal Corporations need to take a proactive role in ensuring that no licenses or permissions are granted under the Municipal laws as well as the

Town and Country Planning Act, 1977. Stringent measures have to be taken against violators and the riverbank and floodplains need to be freed of encroachments.

(a) Tourism woes- how green is "Eco-tourism"

One of the serious challenges threatening the health of Chenab River, especially in State of Himachal Pradesh, is the tremendous impact and stress on the River due to unsustainable tourism activities (Hindustan Times, 2019). It may be noted that there is no legal definition under law for the term "eco-tourism". In the causes of degradation of rivers urbanisation and the heavy inflow of tourists both are emerging as problems because of the disposal of solid waste, encroachment upon the river waterway and water extraction involved (Hindustan Times, 2019).To ensure those tourism activities are sustainable, and achieves the true meaning of "eco-tourism", it is critical that the concerned Authorities- local government, Municipal Corporations as well as the Pollution Control Board take effective steps to comply with laws relating to issuance of construction licenses (TCP, Act, 1977), consents under the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974, compliance with the various Waste Management Rules including the Solid Waste Management Rules, 2016, Plastic Waste Management Rules, 2016, Construction and Demolition Waste Rules, 2016, etc.

Amongst all tourism related activities in the Chenab River Basin, one remains largely unregulated- camping and river rafting, especially in Reasi District. The unsustainable impacts arising out of these activities have received judicial notice in the past with respect to Ganga River in the State of Uttarakhand. The National Green Tribunal has discussed in detail the adverse impacts of unsustainable rafting and camping activities on the River as well as the forest areas along the banks of the River (NGT, 2015). Holding that beach camping would constitute a non-forest activity, the NGT held that the provisions of the Forest (Conservation) Act, 1980 would be applicable to these activities. Further, the State of Uttarakhand was directed to develop a regulatory regime for such activities to ensure minimum damage to the river as well as its floodplains. A similar approach may be adopted by the Himachal Pradesh and UT of J&K in ensuring that such activities have minimal impact on the Chenab River and its floodplains.

4.3.12 Involving Communities in river rejuvenation efforts

Any efforts of rejuvenation would not be successful unless and until local communities, dependent upon the river are actively consulted and involved. There are several legal policy tools which can be referred to and employed to achieve this key process. In fact, the National Forest Policy and the National Water Policy recognises the critical role played by communities in ensuring conservation as well as the rejuvenation of the forest land and water resources in the country.

(a) Panchayats (Extension to the Scheduled Areas) Act, 1996

The Provisions of the Panchayats (Extension to Scheduled Areas) (PESA) legally recognizes the right of tribal communities to govern themselves through their own systems of self-

government and also acknowledges their traditional rights over natural resources. In pursuance of this objective, PESA empowers Gram Sabhas to play a key role in approving development plans, controlling all social sectors including the processes and personnel who implement policies, exercising control over minor (non-timber) forest resources, minor water bodies and minor minerals, managing local markets, preventing land alienation and regulating intoxicants among other things (PESA, 1986). PESA provisions are applicable to the district of Lahaul and Spiti, and therefore development projects/activities in the catchment area of the Chenab River in the district would require clearances from the local communities under the said enactment.

(b) Forest Rights Act, 2006

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 can also be used as an effective tool to empower and engage with tribal communities for participation in the rejuvenation efforts of Chenab River. Forest dwelling tribal communities and traditional forest dwelling communities have community forest rights whereby they are empowered to protect, regenerate, conserve and manage a community forest resource (FRA, 2006). By acknowledging title of communities to the forested areas in the catchment area of the River, the State Government can actively engage in specific conservation and rejuvenation measures for River Chenab basin, both in Himachal Pradesh as well as the UT of Jammu and Kashmir. This becomes even more important in light of several proposed HEPs in this region including Gyspa, Miyar and Seli and the large scale public opposition to the same.

(c) Biological Diversity Act, 2002

As per the Biological Diversity Act, 2002, it is mandatory for every local self-governing institution in both rural and urban areas to constitute Biodiversity Management Committee ("BMC") within their area of jurisdiction. The objective behind BMC constitution is promotion of conservation, sustainable use and documentation of biological diversity. One of the important functions of the BMC is to prepare and maintain the Peoples' Biodiversity Register (PBR) in consultation with the local people. A PBR comprehensively documents information on the availability and knowledge of local biological resources (those falling within the territorial jurisdiction of the BMC), their medicinal or any other use of traditional knowledge associated with them. The PBR thus prepared then serves as a legal document which confirms the sovereign rights of that BMC over the resources documented in the PBR. In addition to preparation of a PBR, the roles and responsibilities of a BMC takes various forms such as eco-restoration of the local biodiversity, management of sacred groves and sacred water bodies, conservation of traditional varieties/breeds of economically important plants and animals. The BMC can be thus actively consulted while undertaking specific measures to rejuvenate the River. Further, the PBRs can be a good source of knowledge of indigenous species of plants and trees which can be considered while undertaking plantation drives, or afforestation measures.

The NGT is also monitoring the implementation of the provisions of the Biological Diversity Act, 2002 (NGT, 2016b). As per the latest report of the MoEF&CC to the NGT as on August

2019, in Himachal Pradesh, BMCs for 3371 local bodies have been constituted and PBRs have also been prepared for the same. In a series of orders, the NGT has issued strict directions to all State Governments and Union Territories to ensure 100% compliance with respect to constitution of BMCs and preparation of PBRs by 31.01.2020. In case of non-compliance, the Tribunal has imposed a hefty penalty of 10 lakhs per month on the defaulting States. The latest Report filed by UT of J&K has claimed that there is 93% compliance with respect to constitution of the BMCs as on 31.01.2020 (NGT, 2020).

(d) Impact of the Jammu and Kashmir Reorganisation Act, 2019

In terms of the Jammu and Kashmir Reorganisation Act, 2019, the erstwhile State of Jammu and Kashmir has ceased to exist and in its place UT of Jammu and Kashmir and UT of Ladakh have been created. Prior to passing of the said Act, the State of Jammu and Kashmir had its own Constitution and most of the laws which were applicable to the rest of the country was not applicable to the State. The State had its own enactments with regard to forests and wildlife. However with the passing of 2019 Act, this legal dichotomy has been removed and several enactments which were not applicable to the State has been made applicable to the UTs of Jammu and Kashmir and Ladakh (Appendix 2 to the Act of 2019). Thus, enactments such as the Forest (Conservation) Act, 1980 as well as the Forest Rights Act, 2006, and Wildlife (Protection) Act, 1972, all have been made applicable to these newly created UTs. The implementation mechanism for these laws needs to be developed effectively in the newly created UTs.

4.3.13 Identifying Stakeholders

This Section identifies the various Govt. Departments and their role in ensuring that the rejuvenation of Chenab River is effective and successful. It is also important to have an active co-ordination between these Departments and ensure that there is no overlapping of functions. Table 4.5 below discusses the role of each of the Department that has been identified on the basis of the discussion in the preceding section.

Table:4. 5– The Govt. Stakeholders and Their Roles

Department	Roles
Forest Department	Ensuring proper implementation of forestry measures including catchment area treatment, compensatory afforestation, etc. Ensuring active synergies and via-media between the communities and other departments in rejuvenation efforts.
Regional Office, Ministry of Environment, Forest and Climate Change	Monitoring of compliance of conditions stipulated in the Environmental Clearance granted under the EIA Notification, especially with respect to e-flow from HEPs.
Biodiversity	Preparation of PBRs and utilising traditional knowledge of

Department	Roles
Management Committees (BMC)	communities for ensuring better catchment area treatment measures in the form of afforestation, etc. Ensuring PBRs are used as an effective tool in terms of documentation of biodiversity and thereby ensuring proper impact assessment of any developmental activity that is proposed in the River Basin.
River Rejuvenation Committees (Constituted under the orders of the National Green Tribunal)	Coordination between all the Govt. departments in ensuring proper and effective rejuvenation efforts. Effective implementation of the action plan submitted to the National Green Tribunal.
State Environment Impact Assessment Authority (SEIAA)	The SEIAA along the SEAC are key bodies for protection of the Beas sub-basin. However, the SEIAA and SEAC grant approvals to project without a thorough assessment of its likely impact on the ecology. No consideration is given as to what impact the proposed project will have on the river and the riverine ecosystem. It is essential that before any project is allowed, the SEAC and SEIAA should conduct a thorough assessment of the proposed site; examine the project along with other projects which have similar effect and take a decision keeping the totality of environmental situation into account. Both, ground truthing and GIS application should be relied on. There is a need to make the SEAC and SEIAA as robust institutions which have both the capacity and ability to take decision that protect the environment rather than favouring destructive projects. Areas which have crossed the threshold in terms of its cumulative impact should have a moratorium in place. Instead of general compliance condition, site specific and project specific conditions should be imposed. Third party monitoring which also involves the local community should be done by SEIAA specifically for those projects which are seeking expansion of the production capacity.
State Pollution Control Board (SPCB)	Not to grant 'Consent to Establish (CTE)' in ecologically sensitive areas. Consent should not be granted as a matter of routine. The practice of granting stand alone Consent should be done away with and should be based on carrying capacity assessment. The renewal of consent to operate should not be a mechanical process but, should be based on proper ground verification. The SPCB should put special focus on the main objective of the Water Act, 1974 i.e., maintaining the wholesomeness of water by any project seeking approval.

Department	Roles
	Projects which are granted Environmental or Forest Clearance should not be granted Consent to Establish as a matter of routine. The SPCB should play a proactive role in examining the impact of the project on the water quality including e-flow. The small HEPs are currently operating under Consent to operate granted by the SPCB under the Water Act, 1974. The condition includes the protection of riparian rights of the people as well as maintaining the flow. There needs to be an objective assessment of the level of compliance with these conditions. Monitoring water quality under the Water (Prevention and Control of Pollution) Act, 1974 and its Rules.
State Water Department/ Sewerage Board	Proper maintenance of Sewage Treatment Plants (STPs) and ensuring that no untreated sewage is discharged into the river or its Tributaries. Ensuring that the treated water is meeting the standards set under the Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Act, 1974.
Irrigation Department/ Revenue Department	Floodplain demarcation once in 25 years and once in hundred years.
Municipal Corporations/ Panchayats	Compliance and monitoring of the Waste Rules, 2016 under the Environment (Protection) Act, 1986, especially segregation of waste at source and ensuring plastic waste is disposed of as per the provisions of the Plastic Waste Rules, 2016 and does not find its way into the River. Ensuring no buildings or construction activities are permitted on the active floodplains or banks of the river.
Town and Country Planning	Ensuring proper safeguards are provided for the river in Development Plans of the cities on banks of the River.
Tourism Department	Preparation of an effective policy on ecotourism which emphasises on mandatory safeguards on the river banks, and prohibits any construction on the river bank, and its active floodplain. To develop proper guidelines/regulatory regime to regulate the river rafting and camping activities in line with the judgment of the National Green Tribunal in SAFE *vs*. Union of India & Others.

4.3.14 Legislative Acts, Bills, Rules, Policies, Authorities, and Definitions

The above description mainly dwelled upon the legal, statutory, institutional and decision making mechanism embodied in the provisions of various laws, rules, policies, definitions, legislation and authorities working for conservation of freshwater resources at national and state levels. Important rulings and judgements promulgated by the honourable NGT and High Courts of different states for protection and environment have also been excerpted.It is appropriate to summarise the broad structure of different extant legislation, laws, by-laws, policies, definitions, authorities and institutions from the perspective of conservation and management of different resources (Table 4.6)

Table:4. 6– Various Legislations, Policies, Authorities and Definitions Relevant in the Context of River Management

A - Legislative Acts			
S. No.	**Applicable Law/ Policy**	**Relevant Provisions**	**Implications in Context of River Management**
1	Constitution of India	Article 21 – Right to life	Interpreted to include the right to water and the right to clean environment.
		Article 48A – Directive Principle of State Policy for protection and improvement of environment	The government should aim to improve the environment and natural resources.
		Schedule VII – Legislative competence of Union and State Governments	The union government has the power of regulation and development of inter-State rivers; and also to implement obligations under international agreements (including agreements for the protection of environment and biodiversity) The state government has the power to

			make laws relating to land use, water and water bodies Forests and the protection of wildlife fall in the Concurrent List.
2	Indian Forest Act, 1927	Establishes the rights and powers of Government Authority over forests and forest products.	Applicable to the Reserved Forests and Protected Forests around the river banks. Also applicable in the context of the use and transportation of forest produce in these areas.
3	Forest (Conservation) Act, 1972	No forest land can be diverted for non-forest purpose by the State Government without the prior approval of the Central Government.	The hydrological impact for the change in land-use; especially for sensitive and vulnerable areas along river banks should be reflected in the decision-making in respect of Forest Clearance. Where granted, adequate management and mitigation measures should be prescribed, and strictly implemented and monitored.
4	National Forest Policy, 1988	Articulates the strategies and principles of forest conservation in India. Objectives include checking soil erosion in catchment areas of rivers; soil and water conservation,	The policies constitute an important recognition of the close relationship between river systems and forests. The

		mitigating floods and droughts and reducing siltation of reservoirs. Recognizes that forest cover should be increased rapidly on hill slopes, in catchment areas of rivers, lakes, etc.	principles and strategies of the Policy should be articulated in legal and executive action
5	Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Right)	The law concerns the rights of forest-dwelling communities to land and other resources, denied to them over decades as a result of the continuance of colonial forest laws in India. Right to hold and live in the forest land under the individual or common occupation for habitation or for self-cultivation for livelihood by a member or members of a forest dwelling Scheduled Tribe or other traditional forest dwellers (Samant *et al*., 2018).	
6	Himachal Pradesh Forest Produce Transit (Land Routes) Rules	To ensure that the forest produce/ species are extracted from the prescribed area in the approved extraction cycle and that the extraction has been done in a sustainable manner and has not caused any ecological or environmental damage (Samant *et al*., 2018).	
7	Establishment of Processing units for NTFP``	Consent for Establishment and Consent for Operation are to be obtained from the State Pollution Control Board prior to establishment and commencement of operations, respectively (Samant *et al*., 2018).	
8	Wildlife (Protection) Act, 1972	Provides for protection to all species of plants and animals with special provisions of higher level of protection for specific species. Also provides for the demarcation of 'Protected Areas' for the protection of wildlife and their habitat.	The definition of 'wildlife' includes not only the identified species, but also any animal and vegetation (aquatic and

			terrestrial) which forms part of any habitat. The provisions of this Act could be used to demarcate and plan critical stretches of the Ganga and its tributaries for the protection of endangered species and their habitats.
9	Biological Diversity Act, 2002	The Central Government can develop strategies / plans for the conservation and sustainable use of biological resources. For areas rich in biological diversity / habitats threatened by overuse, abuse or neglect, the Central Government can direct the State Governments to take appropriate measures. The Act also provides for cross-sectoral plans, programmes and policies. The Act provides for protection of intellectual property rights and appropriated access and benefit sharing mechanisms	The biodiversity of the Ganga riverscape is threatened by over-use and unregulated pollution. The Central Government may utilize the broad mandate under the Act to integrate Forestry Interventions for conserving the riverscape. biodiversity in Ganga Cross-sectoral plans, incorporating the forestry, hydrology, wildlife issues, and other relevant sectors to the basin should be developed. Use of biodiversity resources at different levels (National, State, and Local) must consider aspect of IPR and ABS for

			compliance.
10	Wetlands (Conservation and Management) Rules, 2010	The State Government has to identify the 'protected wetlands' in the state and prepare a 'brief document'. The 'protected wetlands' are ultimately notified by the Central Government on the recommendation of the Central Wetlands Regulatory Authority.	Wetlands form a critical part of river basins and affect the drainage and water quality. The wetlands along the river system should be identified and notified as 'protected wetlands'.
11	Water (Prevention and Control of Pollution) Act, 1974	Powers of the Central Pollution Control Board include providing guidance and technical assistance to states on prevention, control and abatement of water pollution. All industries / operations involving any sewage or waste requires to obtain a consent to establish and Consent to Operate from the State Pollution Control Board.	Forestry Interventions should be recognized as an integral approach for the improvement of water quality. Effluents and discharges from industrial and sewage units should be adequately treated and strictly monitored.
12	National Water Policy, 2012	Acknowledges that characteristics of catchment areas of streams, rivers and recharge zones of aquifers which are affected by land use and land cover changes, affecting water resource availability and quality.	
13	Coastal Regulation Zone Notification, 2011	Restricts activities along the coast, depending on the nature of the activity, distance from the High Tide Line and the level of development of the region.	A similar approach can be adopted in the case of zoning of activities along the river/stream
14	Environment (Protection) Act, 1986	Umbrella legislation enabling the Central Government to develop rules and policies for the protection of environment. The Central Government can impose restrictions of areas in	The Rules on specific aspects are discussed below. The central government has wide

		which any industries/ activities may be carried out. It can also appoint authorities for the appropriate implementation of laws or protection of certain region.	powers to designate an area / stretch for restriction of activities, and an appropriate authority may be appointed for the protection of the region
15	Environment Impact Assessment Notification, 2006	Outlines the process of conducting the environment impact assessment and obtaining environment clearance. Category A projects (with hydro-electric component ≥ 50 MW and or irrigation component ≥10,000 ha) need the clearance of the MoEF&CC (after being appraised and recommended by the Expert Appraisal Authority (EAC) Category B projects (with hydro-electric component < 50 MW and ≥ 25 MW and or irrigation component <10,000 ha) require the clearance of the State Environment Impact Assessment Authority (SEIAA)	The clearance granted usually contains a list of management and mitigation measures. For river valley projects, this could be minimum flows, catchment area treatment and other management and mitigation measures.
16	Municipal Solid Waste (Management and Handling) Rules, 2000	Provides for collection, segregation and disposal of solid waste The State Pollution Control Board is responsible for monitoring the compliance of standards of groundwater, leachate, etc.	The disposal of untreated municipal and industrial waste deteriorates the water quality. This has to be prevented, and compliance with the standards have to be strictly monitored
17	Guidelines on Sustainable Sand-mining, 2015	The guidelines suggest a mandatory cumulative impact of all mining proposals. It also provides for monitoring, *inter alia*, changes in river bed, channel morphology, aquatic and riverine habitat	The components of a river bed, like sand, boulder and gravels in the river bed play a significant role in maintaining the

			ecology of a river system.
18	Guidelines on Felling and Transit Regulations for Tree Species Grown on Non-Forest Private Lands, 2014	States should develop a simple and uniform regulatory procedure of tree felling and transit pass. It also provides for a simple and decentralized methodology for maintenance of records of tree plantation, and the use of information technology to regularly update verification of plantation and felling of trees.	This will be crucial for implementation of Forestry Interventions along the Chenab River and the utilization of forest produce by communities in a sustainable manner.
19	Guidelines for Conservation, Development and Management of Urban Greens, 2013	Integration of green areas in master plans of cities; guidelines for maintaining and enhancing tree cover; felling / removal of trees only after scientific assessment	Relevant for mainstreaming Forestry Interventions for the Ganga in urban areas.

B. Definitions			
S. No.	**Term**	**Definition**	**Implications in Context of River Management**
1	Forest Land	The term 'Forest land' defines; the land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use. (FRA, 2015) The term 'forest' is not be applicable on the plantations raised on private lands (Guidelines for the application of the Forest (Conservation) Act, 1980, 2003).	The definition of what constitutes 'Forest land' is important for the decision-making in relation to felling of trees for use/ diversion of land.
2	River	A river is a hydrological and ecological system, which is a natural, living and organic whole. A river system has to be understood in terms of its sediments and nutrients transported by it, its catchment, the river bed, river bank, floodplain as	The conceptual understanding of a river should include both its components (which includes the river bed and nutrients, biodiversity, sediment besides water), as well as its functions.

		well as the vegetation on the floodplain. (Delhi Declaration at India Rivers Week, 2014) The term 'river basin' encompasses the surface and sub-surface water resources, soil and land resources, wetlands and associated ecosystems, including those coastal and near shore marine systems that are hydrologically or ecologically linked to the river basin (Handbook on Ramsar Convention, 2010).	The close interrelation between land use and river systems should be emphasized.
3	River corridor	Land area adjacent to a river that is required to accommodate the dimensions slope, planform and buffer of the naturally stable channel and that is necessary for the maintenance of natural restoration of a dynamic equilibrium condition and for minimization of fluvial erosion hazards, as delineated by the Agency in accordance with river corridor protection procedures (Rule 29-201, Vermont Flood Hazard Area and River Corridor Rule)	The National Water Policy, 2012 specifically mentions the preservation of river corridors.
4	Environmental flow (E-flow)	Environmental flows, or E-flows, describe the quantity, timing and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems (Brisbane Declaration, 2007).	Hydro-engineering structures lead to large scale impoundment or diversion of water. Maintaining environmental flows is essential for ensuring that rivers are able to continue their ecological functions. A three Member Committee (which includes the MoWR,RD&GR and the MoEF&CC) recommended arriving at an e-flow regime on the basis of temporal

			versions in depth of flow required for the survival of keystone species, longitudinal connectivity in all seasons and lateral connectivity of active flood plain (March, 2015).
5	Biodiversity or Biological diversity	Biological diversity or "Biological diversity" means the variability among living organisms from all sources and the ecological complexes of which they are part, and includes diversity within species or between species and of eco-systems (Section 2(b), Biological Diversity Act, 2002).	River systems support, and provide habitat to a wide range of life forms and habitats. Rivers also provide important connectivity and migration paths.
6	Wildlife	Includes any animal, aquatic or land vegetation which forms part of any habitat (Section 2(37), Wildlife (Protection) Act, 1972.	In addition to the specific species referred to in the Wildlife (Protection) Act, river systems and vegetation along rivers, especially those declared to be 'protected areas' would also constitute wildlife.
7	Wetland	'An area of marsh, fen, peatland or water; natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 m and includes all inland waters such as lakes, reservoir, tanks, backwaters, lagoon, creeks, estuaries and man-made wetland and the zone of direct influence on wetland that is to say that drainage area or catchment region of the wetlands as determined by the authority but, does not include main river channels, paddy fields and coastal wetlands' (Section 2(g), Wetlands (Conservation and Management) Rules, 2010).	Wetlands serve as a link between the land and the water, and provide a range of services that benefit all aspects of river activities. The critical linkage between wetlands, water and river basin management is emphasized in the Ramsar Convention on Wetlands.
8	Cumulative Impact Assessment	Cumulative Impact Assessment effects generally refer to impacts that are additive or interactive	The natural flow of rivers is severely altered through hydro-engineering structures,

		(synergistic) in nature and result from multiple activities over time, including the project being assessed. (NGT, Vimal Bhai*vs*. MoEF&CC& Others, 2011)	as well as associated land use. The cumulative impacts assessment of all existing and proposed activities should be factored into the decision-making of clearance for projects, as well as river basin management.
9	Eco-centrism	(There is a) 'moral imperative to respect intrinsic value, inter dependence and integrity of all forms of life. Eco-centrism supports the protection of all life forms, not just those which are of value to humans or their needs and underlines the fact that humans are just one among the various life forms on earth' (Supreme Court, T.N. Godavarman-Thirumalpad*vs*. UOI, 2005).	Rivers should be viewed as critical ecosystems, rather than merely a 'water resource'. This is fundamental to the premise of river basin management.

S. No.	**C. Relevant Authorities**	
	Authority	**Functions**
1	National Ganga River Basin Authority	Authority constituted under the Environment (Protection) Act. Planning, Financing, Monitoring, and Coordinating bodies of the Centre and States responsible for the conservation and abatement of pollution of the Ganga.
2	Central Empowered Committee	Constituted under the Environmental (Protection) Act pursuant to the Order of the Supreme Court in 2002 for all matters relating to the application of the Forest (Conservation) Act, 1972
3	Expert Appraisal Committee	Constituted under the EIA Notification to appraise and grant clearance for projects.
4	Pollution Control Board	The Central Pollution Control Board is entrusted with promoting the cleanliness of the streams (including rivers and sea). And laying down the standards of quality of water. State Pollution Control Board can establish standards for discharge of effluents. It is also responsible for minimizing water pollution through granting consent

		for the establishment and operation of units.
5	Water Quality Assessment Authority	Constituted under the Environment (Protection) Act to standardize methods for monitoring of water quality and ensuring quality of data generation and utilization. The powers and functions of the authority include preparing schemes for restriction of discharge of treated sewage/ trade effluent on land, rivers and other water bodies with a view to mitigate crisis of water quality. The authority can also review the status of quality of national water resources (both surface and ground water) and identify 'hot spots' for taking necessary actions for improvement in water quality.
6	Central Water Commission	**Central Water Commission (CWC)** is a premier Technical Organization of India in the field of Water Resources, and is presently functioning as an attached office of the Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation, Government of India. The Commission is entrusted with the general responsibilities of initiating, coordinating and furthering in consultation of the State Governments concerned schemes for control, conservation and utilization of water resources throughout the country, for purpose of Flood Control, Irrigation, Navigation, Drinking Water Supply and Water Power Development.
7	National Green Tribunal	The **National Green Tribunal (NGT)** has been established under the National Green Tribunal Act, 2010 for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto. It is a specialized body equipped with the necessary expertise to handle environmental disputes involving multi-disciplinary issues.

D. Conservation and Management Tools		
Sr. No.	**Conservation and Management tools**	**Implications in Context of River Management**
1	Ganga River Basin Environment Management Plan	Acknowledges the importance of the *Aviral Dhara* (continuous flow), *Nirmal Dhara* (unpolluted flow), ecological entity and geological entity of a river. The emphasis on Forestry Interventions also gives legal recognition to the significance of land use in integrated watershed management.
2	Cumulative Impact Assessment; Carrying Capacity Study	The impact assessment of individual project in isolation does not reflect the combined impact of a cascading development of projects in river basins, which may be significantly higher. The carrying capacity of the river basin should be carefully studied and the impact resulting from all past, present and foreseeable developments in the region should be viewed in light of the carrying capacity of the river basin. This is a fundamental tool for sustainable river development planning. An Office Memorandum (OM) of the MoEF&CC, dated 29.5.2013 requires State Governments to conduct Cumulative Impact assessment and Carrying Capacity Study of river basins, As per the OM: 'Cumulative impact study of a basin would reflect the cumulative impact of commissioned/ up-coming HEPs in the basin on environmental flows, biodiversity, muck disposal sites, traffic flow in the region, R&R issues, etc. It should be incumbent on the developer to incorporate all possible and potential impact of other project(s) in the basin to get a Cumulative Impact Assessment done'.

		The carrying capacity study of a river basin is important to plan optimal number of HEPs in a basin. All State Governments will be required to get such studies done for river basins in their State. The carrying capacity study report would be made a prerequisite for considering EF/FC cases of projects of any basin'. In the context of the Ganga River basin, the Supreme Court in Alaknanda Hydropower corporation *vs*. Anuj Joshi &Ors. Has ordered a Cumulative Impact Assessment and Carrying Capacity in the upper reaches of the Ganga River. The MoEFCC has set up an Expert Body in 2015 pursuant to the order of the Supreme Court.
3	Environmental flows	A three number committee set up by the MoWR, RD&GR and comprising of Technical Experts and Senior Officials of the MoWR, RD&GR and MoEFCC has submitted its recommendations on the environmental flows, with special references to sites studied in the upper Ganga River basin. The Report highlights that environmental flows are required to maintain ecosystem functions. The report recommends assessment of e-flows based on minimum depth of flow required for survival and spawning of key species. It also stipulates assessment of water required for longitudinal (upstream - downstream) connectivity and lateral connectivity with floodplains.
4	Development master plans for cities	The NGT has asked the State authorities to demarcate the floodplain for the flood of once in 25 years and to prohibit any kind of development activity in such areas (NGT, Manoj Misra*vs*. Union of India, 2015).

		Guidelines for Conservation, Development and Management of Urban Greens, 2013 provide for integration of existing trees/ green areas within the development master plans of cities.
5	Eco-Sensitive Zone and Zonal Master Plan	The stretch of river from Gurumukhi to Uttarakashi was declared as an Eco-Sensitive Zone under Section 3 of the Environment (Protection) Act, 1986. As per rules, the ESZ will have well defined permitted, prohibited and regulated activities. The State Government has to prepare a Zonal Master Plan, which has to be approved by the MoEF&CC. The Plan should specifically address issues like restoration of denuded areas, conservation of water bodies, management of catchment area, and soil and moisture conservation.
6	'Brief Document' under the Wetlands Rules	The State Government have to identify the 'protected wetlands' in the State and submit the proposal to the Central Wetlands Regulatory Authority. Considering the important function of wetlands in river basins, they should be included in the Brief Document, and adequate measures should be undertaken to improve and conserve these wetlands
7	Memorandum of Understanding between Joint forest Management Committee and the Forest Department of the State	The MoU should contain location-specific work programme for forestry initiatives, and also provide for the consumption and livelihood needs of forest dependent communities.
8	Working Plan of the Forest Department of the State	The Working Plan lays down the manner in which trees within forest areas can be felled. State Governments are responsible for drawing up a working Plan to ensure sustainable forest management and utilization practices. The Working Plan should also enable the

		proper and simultaneous application of different legislations relating to forests, wildlife and biodiversity. The National Working Plan Code, 2014 of the MoEF&CC provides a uniform code for drawing up the Working Plans of each Forest Division by State Government.

(Source: Adopted from FRI, 2016)

4.3.15 Implications and the Way Forward

Water is the most precious natural resource essentially required for continuity of life on earth. Infact, it is a composite resource with different manifestations viz., surface water, ground water, rivers, ponds, rainfall, streams and lakes. Presently, the rivers and other freshwater resources are afflicted with multitude of issues and plethora of problems. The existing instruments of law and legal policies/principles related to the conservation and management of these resources are disharmonious, uncertain and variable. There is evident policy deficit with many gaps and grey areas due to number of socio-political factors. Therefore, a lot of scope exists to revisit, revise and restructure the legal context for ensuring proper maintenance and long term sustainability of these resources. Different aspects related to water viz., precipitation, evapo-transpiration, runoff, rivers, lakes, and ground water are interlinked and river basin constitute the fundamental unit of planning and management of rivers. River conservation programme should be the joint venture of hydrologists, environment activist, geologists, soil scientists, sociologists, agriculturists, industrialists, urban managers, ecologists and government regulators, etc. The policy interventions should look into the river environment holistically and identify the role of forests and different sub-environments in maintaining the perennial flow in the rivers and its tributaries. The provision under prevailing acts, laws and policies pertinent to forests, environment, and bio-diversity conservation can be clubbed together for better management of forests and freshwater resources. The extant legal framework can be utilised as given below.

(a) Declaration of select biodiversity rich river stretches of conservation priority as protected areas under the Wildlife (Protection) Act, 1972.
(b) Declaration of biodiversity rich areas as the biodiversity heritage sites under the Biological Diversity Act, 2002.
(c) Declaration of identified areas as the ecologically sensitive sites under the Environment (Protection) Act, 1986.
(d) Ensuring cumulative EIA as well as comprehensive EIA with respect to any developmental project or biotic interference such as sand and bolder mining.
(e) Facilitating implementation of the Wetland Rules, 2010, particularly in demarcation of the zone of influence as far as wetland areas are adjacent to rivers.

The massive abstraction of river waters for the hydro-power development coupled with increasing pollution load has rendered the aquatic ecosystems unable to provide the basic

ecosystem services. The recently evolved concept of environmental flows is of prime importance for better functioning of the river ecosystems (Maasri, 2013). It is therefore, very important to implement the standards of maintenance of e-flows in the rivers. The decisions making process should be evolved so as to keep the sustainable functioning of human activities through e-flows. There should be adequate provisions for summative assessment of adverse impacts of loss of vegetation cover on the ecological functioning of river ecosystems.

Overall, in a vast country like India the governance of water resources are affected by various policies and provisions at national and state levels. These policies and principles are comprehensive in nature and adequately applied for conservation of aquatic resources with better coordination.

4.4 Institutions and Implementing Agencies – Central and State Governments

It is important to comprehend the various accountable institutions and agencies controlling the land, the protection of forests and wildlife. This helps in engagement of right authorities or agencies in conservation of rivers. A comprehensive detail have been given in the foregoing sections about the different government and non-governmental agencies at the centre and state levels besides diverse stakeholders and the civil society those are involved with the prominent disciplines/ sectors of forest management, wildlife conservation, environmental management, water resource management, river development and restoration of rivers in the country. The Union Ministry of Jal Shakti and the Ministry of Environment, Forest and Climate Change at the centre are the two prominent Ministries those are directly concerned with the Chenab River. The succeeding sections provide details on the MoEF&CC as the Nodal Agency for overseeing and steering the programme implementation; the ICFRE, Dehra Dun and its regional institute i.e., the HFRI, Shimla as the National Partner Organization for capacity development and monitoring; and the pivotal role of the concerned State Forest Department, Municipal corporations, State Agricultural Department etc. as the Implementing Agencies.

4.4.1 The Ministrty of Environment Forest and Climate Change (MoEF&CC)

The MoEF&CC at the centre is the Nodal Ministry responsible for the planning, promotion, coordination and overseeing the implementation of country’s environmental and forestry policies and programmes aiming for sustainable management of wide range of natural ecosystems (i.e., forests, grasslands, wetlands including lakes and rivers, and coastal and marine), associated biodiversity, ensuring the welfare of animals, and the prevention and abatement of pollution. While implementing various policies and programmes related to forests, environment and wildlife, the Ministry is guided by the principle of sustainable development and enhancement of human well-being. The Ministry also serves as the nodal agency in the country for the United Nations Environment Programme (UNEP), South Asia Cooperative Environment Programme (SACEP), International Centre for Integrated Mountain Development (ICIMOD), and for the follow up of the strategies and programmes

of the United Nations Conference on Environment and Development (UNCED). The Ministry is also entrusted with important tasks related to multilateral bodies such as the Commission on Sustainable Development (CSD), Global Environmental Facility (GEF), and of regional bodies like the Economic and Social Council for Asia and Pacific (ESCAP) and the South Asian Association for Regional Cooperation (SAARC) on matters related to the environment. The Ministry is also entrusted to implement programmes related to various international conventions *viz*., the United Nations Convention on Biological Diversity (UNCBD), United Nations Convention to Combat Desertification (UNCCD), United Nations Framework on Climate Change (UNFCC), Ramsar Convention on Wetlands, Convention on Control of International Trade in Endangered Species of Wild Fauna and Flora (CITES), etc. for which the country is signatory and thus, committed. Till recent past the MoEF&CC also dealt with the various programmes and activities related to river Ganga *viz*., the Ganga Action Plan, National Ganga River Basin Authority (NGBRA), and National Mission for Clean Ganga. These subjects and activities were transferred to the Ministry of Water Resources (presently Ministry of Jal Shakti) with its broad mandate. The MoEF&CC is supported in its mandate, functions and responsibilities by wide range of Authorities, Agencies, Organizations/ Institutions and Sub-ordinate offices.

4.4.2 The ICFRE and HFRI

The Indian Council for Forestry Research and Education (ICFRE), an Autonomous Council under the MoEF&CC is supported by 09 regional research institutes and 05 Forest Research centre in performing the wide range of functions across the country those include conduct of forestry research; transfer of innovative technologies in the field of forestry relevant to the different biogeographic regions of the country to the States/ UTs and other agencies; and to impart forestry education. The Himalayan Forest Research Institute (HFRI) at Shimla is one of the regional institutions under the umbrella of ICFRE and mandated to generate, preserve, disseminate and advance knowledge, technologies and solutions for addressing issues arising out of interactions between people and forests and environment on a sustained basis through research, education and outreach and the specific goal of contributing research relevant to the conservation of Western Himalayan forests and forest ecosystems. HFRI has been assigned the jurisdiction of two Union Territories-Jammu and Kashmir and Ladakh, and one State i.e. Himachal Pradesh. As stated earlier in the Chapter 1, the MoEF&CC has entrusted a major task to ICFRE on the preparation of DPRs on Forestry Interventions for rejuvenation of major Indian rivers. Considering the expertise and appropriate location of HFRI in the Himalayan State of Himachal Pradesh, the ICFRE assigned the responsibility of preparing the DPR on the Chenab River along with four other DPRs on major rivers of the Indus River system. The HFRI with its expertise in the field of forestry relevant to the western Himalaya, multi-disciplinary scientific staff including practising professional foresters, well-placed vast campus amidst deodar forests and adequately equipped various laboratories and other physical infrastructure is the most appropriate scientific agency not only for the preparation of present DPR but, for its effective implementation, capacity development and monitoring through the State Forest Department(s).

4.4.3 Institutional Framework of State Forest Departments

As per the Constitution of India, the subjects of Forests, Wildlife and Environment are in the Concurrent List. Accordingly, the MoEF&CC is the Nodal Agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental, forestry and wildlife policies and programmes. However, the State Forest Department (SFD) in each State and UT is the custodian of forests and wildlife of the State/UT, besides being responsible for management, conservation, and protection of the environment (i.e., land, water and air). The State Forest Department is also responsible for the management of forest lands or Recorded Forest Area, irrespective the type of vegetation these lands harbour. The State Governments SFDs are mandated for the enforcement of laws and implementation of various policies and strategies enacted/ formulated by the Central Ministry from time to time.

4.5 Mandate of State Forest Departments

The history of scientific management of forests in India is older more than 154 years as in 1864, the British Regimeestablished the 'Imperial Forest Department'. Dietrich Brandis, a German Forest Officer, was appointed as the Inspector General of Forests. The stated mandate of the Department was scientific management of the forests to exploit it on a sustained basis for primarily timber products. The Indian Forest Act of 1865 extended the British colonialism in India and claimed over forests in India. The 1865 Act was a precursor to the Forest Act of 1878, which truncated the centuries-old traditional use by communities of their forests and secured the colonial government's control over the forestry. The Act of 1865 empowered the British Government to declare any land covered with trees as a government forest and make rules to manage it. The Government of India Act 1935, transferred forestry to the Provisional list. The management of the forests went into the hands of the provincial government in 1935 and even today the Forest Departments in the States/ UTs are managing the forests under the respective State Governments/UT Administration. Since the subject of forestry was shifted to the concurrent list in the year 1977, the Central Government plays an important role, particularly at the policy level in the management of the forests. During 150 years or so, emerging needs has led to paradigm shift in forest management. Thus, the forest management gradually moved from exploitation to conservation, multiple use to multiple benefits, sustainable yield to sustainable management, species to ecosystem management, authoritative (policing) type of management to participatory approaches to management.

In view of the above, the primary mandate of SFDs can be summarized as below:

i) Protection of forests, enforcement of various laws, and management of forests pests
ii) Creation of physical infrastructure (forest roads, patrolling stations, waterholes, barriers, watch towers, etc.) and their management
iii) Implementation of silviculture-based forest management
iv) Afforestation and restoration activities to increase forest cover of the State/ Country

v) Conservation of forests and other natural ecosystems (grasslands, alpine pastures, wetlands including rivers, coastal and marine)
vi) Integrated watershed management through soil and moisture conservation works and afforestation
vii) Wildlife management and conservation of biodiversity including population estimation of prominent wildlife
viii) Eco-development, joint forest management, improvement of livelihoods, management of sustainable livelihoods in forest fringe villages and protected areas
ix) Promotion and management of nature tourism/ eco-tourism in forests/ PAs
x) Mitigation of PA- people and human-wildlife conflict
xi) Nature education, nature interpretation, mass awareness, outreach and advocacy
xii) Research and monitoring activities
xiii) Establishment and maintenance of forestry/wildlife/PA management/ biodiversity conservation related databases
xiv) Capacity development

Thus, from the above long list of activities of the SFDs, it is amply clear that scope of works and mandates have significantly enlarged and diversified in just 150 years or so. Most of the activities, roles, responsibilities, and functions cut across different disciplines viz., silviculture, ecology, hydrology, law, socio-economics, etc. guided by scientific principles and administrative excellence, the newer perspective of natural resource management requires adoption of landscape/riverscape/seascape approach to conservation. In past three decades or so, the SFDs have been successful in providing the desired thrust on the ecosystem management, landscape approach, and participatory approaches so as to contribute to the larger agenda of sustainable development. In the process, the focus of working of SFDs has shifted from small extent of forest stands/ coupes to large landscapes those incorporate protected areas, managed forests and the dominating 'matrix'. The newer approaches seek inter-agency cooperation and sectoral convergence in order to meet diverse goals and multiple objectives of forestry. Hence, in recent decades, SFDs have been working in close cooperation of allied sectors.

4.6 Multi-Sectoral Convergence

The newer requirements of above stated enlarged scope, mandate and adopted holistic approaches to conservation and sustainable management of forests for multiple values, demand that SFDs work in close cooperation with various line agencies, Gram Panchayats and other local self-governance bodies at the grassroots level, NGOs and local communities. The new mandate has made the SFDs a focal point of convergence among various allied departments. Accordingly, in recent decades, increasingly SFDs have worked in partnership with the Department of Agriculture and Horticulture, Department of Animal Husbandry, Public Works Department, Public Health Department, Department of Tribal Development, Panchayati Raj, Revenue Department, Irrigation Department, District Rural Development Agency, Department of Science and Technology, etc. The SFDs have made considerable contribution in various centrally sponsored schemes relying on inter-sectoral convergence. In

past 3-4 decades, the SFDs have implemented several externally funded forestry and conservation projects by various international agencies *viz*., the World Bank, International Development Agency (IDA), Global Environmental Facility (GEF), United Nations Development Programme (UNDP), Food and Agriculture Organization (FAO), United States Agency for International Development (USAID), Japan International Cooperation Agency (JICA), German Developmental Agency (GIZ), etc. and gained considerable experience.

4.7 Decentralised Approach

The National Forest Policy, 1988 and the National Wildlife Action Plan, 1984 envisaged people-centric approach towards management of forest and wildlife resources in the country and laid emphasis on participatory and decentralized approaches involving local communities, both in decision making as well as in programme implementation. In past four decades or so, the SFDs witnessed a paradigmshift from top down approach to bottom up approach. The SFDs adopted the concept and approach of the Joint Forest Management (JFM), promoting the creation of Joint Forest Management Committees (JFMCs) so as to restore degraded forest areas and elicit people's support in forest and wildlife conservation. JFMCs are known by different names in various States, such as *Van Sanrakshan Samiti* (VSS), Village Forest Development Committees (VFDCs), Village Forest Protection Committees (VFPCs) and Village Forest Development Societies (VFDSs). However, their functions were essentially similar to each other. These Community Based Organisations (CBOs) included the local representatives in the executive body and all the adult villagers as member in the general body. The CBOs were either registered as Societies under the Society Registration Act, 1860 or as a constituent of the Division-level Forest Development Agency (FDA) which in turn is registered under the Society Registration Act. The MoEF&CC has issued detailed rules and Operational Guidelines of National Afforestation Project (NAP) including benefit sharing mechanism under JFM. In accordance with these guidelines, the respective State Government has also framed resolutions and rules for implementation. The JFMCs across the country along with SFDs carried out forestry activities related to protection, regeneration, afforestation, utilization and sustainable management of forest areas allotted to them. Certainly, the initiative on the formation of CBOs by the SFDs was a significant move towards the process of decentralization and people's empowerment. Already existing JFMCs and their variants in two States (Himachal Pradesh and Punjab) can be optimally utilized for ensuring public participation and eliciting their support at all the stages *viz*., planning, implementation, monitoring and evaluation of any major project related to management of forests, wildlife or river restoration.

4.8 Projects and Schemes Operated by SFDs

The SFDs have been executing a wide array of projects and schemes in order to accomplish entrusted mandates and fulfil the requirements of various goals and objectives. These projects and schemes can be grouped as: (a) the State Government funded schemes, (b) the Centrally Sponsored Schemes (CSS), and (c) the Externally Aided Projects (EAPs) (**Table 4.7**). The

funding source is amply clear as reflected in the nomenclature of stated categories projects/ schemes. Predominantly, the World Bank was the first International Agency to support EAPs on forestry in select States of the country, in late 1980s. The World Bank supported forestry projects provided a new focus on the incorporation of modern technologies *viz*., Information Technology, Remote Sensing and GIS, people-centric and participatory approaches in the fields of forestry and forest managements. The IDA funded Forestry Research, Education and Extension Project (FREEP) was primarily implemented to enhance the capacity in the field of forestry research, education and extension, and the five year programme supported various activities at forestry institutions under the umbrella of ICFRE and also facilitated comprehensive, multidisciplinary research and monitoring projects in two PA sites in the States of Himachal Pradesh and Tamilnadu. Indeed, it was the pioneer effort in two large PAs (the Great Himalayan National Park Conservation Area and the Kalakad-Mundanthurai Tiger Reserve) of significant biodiversity values wherein concurrent researches on various physical, biological and socio-economic aspects were carried out. The project attempted to demonstrate the eco-development approach in the context of these two priority conservation PA sites. Based on the success of this pilot project on eco-development and various initiatives on capacity building, the World Bank executed the GEF/ IDA supported yet another major EAP on the theme of eco-development in seven prominent PA sites across the country. The project was named as the 'India Eco-development Project'. Subsequent to these pioneer projects, various International Agencies (i.e., UNDP, USAID, JICA, GIZ, etc.) came forward to support several new EAPs on different themes *viz*., wildlife management, biodiversity conservation, sustainable land and ecosystem management, climate change mitigation and adaptation, and sustainable livelihoods in different SFDs. Recently, the World Bank with IDA funding implemented the 'Biodiversity Conservation and Rural Livelihood Improvement Project (BCRLIP)' in two field/ PA sites and facilitated development of three Learning Centres relevant to the demonstration of landscape approach to conservation alongside improvement of rural livelihoods. Further, EAPs focusing on the conservation of coastal and marine ecosystems in select States through the concerned SFDs were also implemented. Hence, over the years, SFDs have gained considerable experience in execution of major projects on wide range of emerging themes involving different stakeholders including local communities. The MoEF&CC, Government of India, has also been formulating and implementing a variety of CSSs in different States/ UTs covering priority themes of afforestation, eco-development, tiger conservation (Project Tiger/ NTCA), elephant conservation (Project Elephant), snow leopard conservation (Project Snow Leopard) wetland conservation, protected area management, management of threatened species and their habitats, Biosphere Reserve Programme, Ganga Action Plan, etc. The SFDs in five States are presently implementing the National Mission for Clean Ganga (NMCG) sponsored five year on Forestry Interventions for rejuvenation of Ganga in five States along the course of Ganga River through concerned SFDs. Fig. 4.1 presents a broad nature and components of schemes implemented by SFDs. Thus, it is amply clear that SFDs have diversified their activities over the past decades so as to implement numerous projects/ schemes sponsored by the State/ Central Government or different international agencies. Hence, the SFDs in concerned state

and union territory along the course of Chenab have adequate experience in implementing the present DPR on proposed Forestry Interventions.

Table: 4.7– Diversity of Projects and Schemes Implemented by SFDs

State Government Schemes	Centrally Sponsored Schemes	Externally Aided Projects
Afforestation/ Reforestation	Afforestation/ Reforestation (National Afforestation Programme - NAP, Green India Mission – GIM, Compensatory Afforestation Fund Management and Planning Authority- CAMPA)	The World Bank supported Forestry Projects
Soil and Water Conservation Structures	Livelihood Improvement (NAP, GIM)	IDA/ GEF supported India Eco-development Project and 'Biodiversity Conservation and Rural Livelihood improvement Project – BCRLIP'
Public Distribution of Plants	Planting and Restocking Bamboo (National Bamboo Mission – NBM)	IDA funded Forestry Research, Education and Extension Project
Cultivation and Plantation of Medicinal Plants	Augmenting Medicinal Plants (National Medicinal Plants Board - NMPB)	UNDP/ GEF supported Projects on 'Sustainable Land and Ecosystem Management (SLEM)' and 'Securing Livelihoods, Conservation, Sustainable Use and Restoration of High Range Himalayan Ecosystems - SECURE Himalaya'
	Watershed Management and Livelihoods (Integrated Watershed Development Programme- IWDP, Integrated Watershed Management Programme – IWMP)	Carbon Sequestration and Climate Change
	Soil and Water Conservation (NAP, GIM, IWMP, CAMPA)	Watershed Management and Integrated Development of Landscapes
	Integrated Development of Wildlife Habitats – IDWH	
	Project Tiger – PT, Project Elephant – PE	

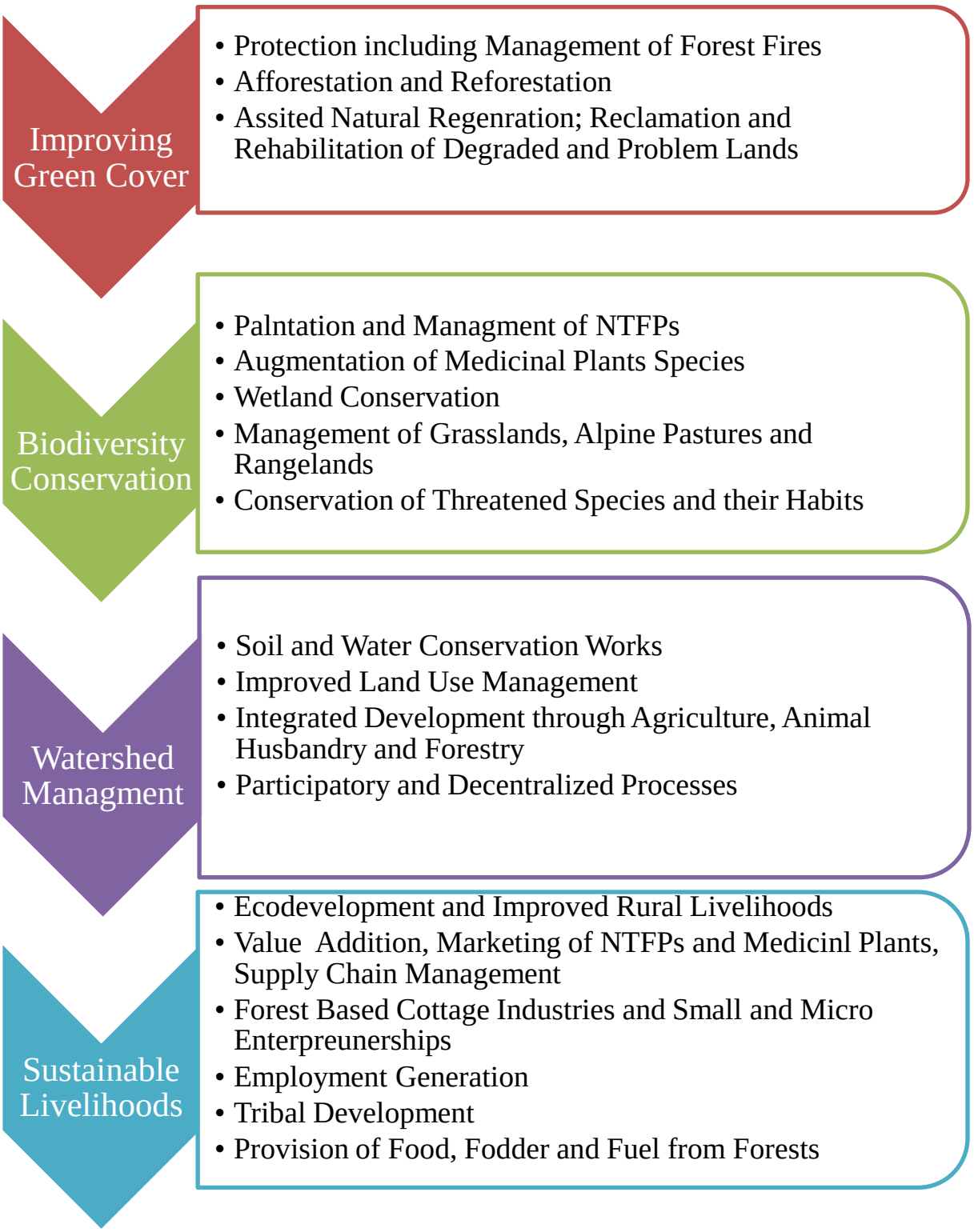


Fig. 4.1- Broad Nature and Components of Schemes Implemented by SFDs

4.10 Expertise and Capacity

The SFDs manned by the Indian Forest Service (IFS) and State Forest Service (SFS) Officers not only have the well-organized hierarchical organizational setup, state-wide infrastructure, and long experience of managing diverse forests alongside other natural ecosystems, but also have much desired capacity, multi-disciplinary expertise and well equipped with modern equipment, tools and technologies. This makes the SFDs more amenable to capacity development at even short notice to adopt newer approaches and improved methods and also to diversify as per the emerging needs in the fields of ecosystem management, climate change mitigation and adaptation, river conservation and sustainable development.

4.11 The Indian Armed Forces and Central Armed Police Forces

The Republic of India has the military force represented by the Indian Armed Forces (IAFs) consisting of three professional uniformed services *viz*., the Indian Army, the Indian Navy, and the Indian Air Force. In addition, the Indian armed forces supported by the Central Armed Police Forces (CAPFs), formerly referred as the Paramilitary Forces. However, the Union Ministry of Home Affairs (MoHA) adopted uniform nomenclature of CAPF in the case of six forces *viz*., CRPF, BSF, ITBP, CISF, SSB, and the NSG. As such, the primary mandates of the IAFs and CAPFs include, protection of the frontiers to safeguard the country's sovereignty, and important and sensitive establishments (i.e., airports, sea ports, industrial units, hydroelectric projects, temples, etc.), but these forces have also been helping in conservation of nature and wildlife resources in difficult terrain and harsh climatic conditions all along the frontiers of the country whether on the land or in coastal and marine water. Further, under the ages of MoEF&CC and Ministry of Defence (MoD), dedicated force such as the Eco Task Force (ETF) was raised as the Territorial Army Unit in conjunction with States to take on challenging assignments in the ecologically fragile and sensitive areas. The ETF battalions have successfully achieved twin objectives of their establishment, (a) eco- regeneration of degraded areas, and (b) rehabilitation of ex-serviceman. Presently, nine infantry battalions (TA), comprising 22 operational companies are carrying out afforestation in difficult and degraded areas in States/ UTs of Uttarakhand, Rajasthan, J&K, Ladakh, Delhi, Himachal Pradesh, Assam and Maharashtra. In addition, a composite ETF (CETF) for National Mission for Clean Ganga has also been raised at Allahabad. One company each at Kanpur, Varanasi and Allahabad have been planned for the said mission. Till date, various ETF battalions across the country have planted nearly 60.8 million saplings and covered an area of 727.4 km^2, with 75-80% of survival rate. The CETF is supposed to patrol the sensitive river areas for the protection of biodiversity and other tasks such as safeguarding the river from pollution and illegal sand mining, etc. The 127 ETF Battalion in Uttarakhand was awarded the Indira Priyadarshini Paryavaran Puruskaar by the MoEF&CC for the commendable work in the field of ecological restoration. In recent past, High Court of Himachal Pradesh had ordered for involving ETFs protecting different rivers of the State from illegal sand mining.

Recognizing the past contributions and experience of ETFs in ecological restoration of degraded land and protecting rivers like Ganga, the potential of ETF battalions can be utilized in Forestry Interventions in difficult areas under Chenab Riverscape e.g., Lahaul, Pangi and Kishtwar, etc. for materialising the endeavours rejuvenation programme of Chenab river on ground.

4.12 Civil Society

The civil society represents the collective group of individuals, non-governmental organizations and institutions in a society that mark interests and will of citizens, and also referred as the 'third sector' of the society, distinct from the government and corporate. The civil society plays a wide variety of roles by way of development of social institutions at various levels for specific purposes *viz*., promotion of cultural and religious values, campaigns against social evils, protection and conservation of nature, and other social welfare measures including relief operations during natural disasters and other stresses and disturbances. Since, the Chenab River and its tributaries flow in major towns and some sub-urban areas throughout their journey from origin to confluence, therefore,the civil society can play vital role in creation of mass awareness, protection of river and river resources, and allied activities. The religious bodies (e.g., *Village Devta*, temples, *Gurdwaras*, *Radha Soami Satsang*, etc.) can also play vital role in efforts towards river restoration. Likewise, numerous organizations and institutions (e.g., *Panchayats*, JFMCs, Eco-development Committees, Biodiversity Management Committees –BMCs, Aanganwari Workers, Nehru Yuva Kendras (NYKs), National Service Scheme – NSS, etc.) can be of utmost importance, and can be involved in awareness campaigns, cleaning drives for river and surrounding lands, protection and monitoring, and also implementation of proposed Forestry Interventions.

4.13 Nehru Yuva Kendras

The Ministry of Youth Affairs and Sports (MoYA&S), Government of India is the Nodal Ministry responsible for the establishment of Nehru Yuva Kendras since 1972 with the objective of providing rural youth avenues to take part in the process of nation building as well as offer opportunities for the development of their personality and skills. In 1987-88, the MoYA&S set up the Nehru Yuva Kendra Sangathan (NYKS), an Autonomous Organization under the Ministry to oversee working of NYKs. The NYKS is the largest grassroots level voluntary organization that channelizes the power of youth in the age group of 13-35 years on the principles of voluntarism, self-help and community participation. The NYKs has a country wide network of village-based Youth Clubs and *Mahila Mandals*. It is network of 28 Zonal offices, 501 District level offices, and more than 1.25 lakh Youth Clubs in nearly half of the villages of the country constitute a large force of voluntary movement under the auspices of the MoYA&S. The vast network of Youth and Mahila Mandals operating at village level could be meaningfully involved in the effective implementation of proposed Forestry Interventions.

4.14 National Service Scheme

Yet another student voluntary group named as the National Service Scheme (NSS), under the MoYA&S exists. The NSS was launched in 1969 during the Mahatma Ghandhi's Birth Centenary Year. Today, NSS has more than 3.2 million student volunteers enrolled in over 298 Universities and +2 Senior Secondary Councils and Directorate of Vocational Education all over the country. The community service rendered by NSS volunteers undertakes varied works related to intensive development in adopted villages, conduct of medico-social surveys, setting up of medical centres, programmes of mass immunization, cleaning, afforestation, etc. Thus, the NSS can be involved in proposed Forestry Interventions for rejuvenation of Chenab River and its tributaries and also in creation of mass awareness campaigns.

4.15 Incorporation of Laws, Policies and Institutions in DPR

Succinctly, the present Chapter attempts to provide a brief overview of the comprehensive legal framework existing in the country for conservation and management of natural resources for sustainable and equitable use by the society. It encapsulates the relevant policies, acts, laws authorities, institutions at federal, state and local levels and relevant to management of forests, environment, wetlands, and rivers, etc. The Chapter also illustrates the larger role, responsibilities and functional aspects of different agencies, departments and organisations viz., State Departments (SFDs), National Service Schemes (NSS), Nehru Yuva Kendras (NYKs), civil society, etc. in the effective implementation of the proposals of DPR for rejuvenation of Chenab River through Forestry Interventions.

Chapter 5

Proposed Forestry Intervention

5.1 The Chenab River Ecosystem – Environmental Trends

The chapter describes the various river characteristics, structures and functioning of riverine ecosystems, interactions, past trends of management, major challenges, constraints, problems, issues and concerns. It not only unfolds the interconnection and interface between the Chenab River and other adjacent natural ecosystems, socio-economics, and developmental activities within the basin/ Chenab riverscape, but, also provides the suitable interpretation of underlying causes, human activities/processes, and stressors accountable for deterioration of the ecological functioning and degradation of the river ecology and environment. It is well established that large scale degradation of the natural landscapes, aquatic ecosystems, and biodiversity loss is caused due to multiple human disturbances (Vitousek *et al.*, 1997). Universally, over exploitation of natural resources and heavy dependence on the ecosystem services have led to the degradation of these vital resources and loss of precious biodiversity (MA, 2005). The increased human intrusions on woody landscapes, destruction of forested corridors for haphazard developmental activities, and massive deterioration of water resources have altered the structure and distorted functioning of these life supporting natural assets to the extent that now they are far from being 'natural' (Hladyz *et al*., 2011; Mulder *et al.*, 2011).

The review of past trends in context with Chenab River ecosystem revealed that anthropogenic activities had impacted the pristine forests, grasslands, lakes, and wetlands along the course of Chenab River and its tributaries. All together, the varied processes at surrounding landscapes have imperiled the network of important life support systems by influencing the domains of essential ecosystem services significantly. Therefore, the factors causing large scale damage and degradation to the natural functioning, ecological integrity, and the river health have been reasonably elucidated. More conspicuously, biodiversity loss, over exploitation of resources, regulation of the natural flows, mismanagement of land resources, pollution, and possible climate change effects on freshwater resources were highlighted. The review of existing information revealed extensive use of the natural resources for development purposes and human benefits not only cause massive environmental degradation but, also the major determinant for a range of problems including erratic weather patterns, food insecurity, poverty, livelihood issues, drought, water crisis, and all sorts of imbalances and adversities affecting the communities at large. In this backdrop, it is imperative to strike a balance between development and environment security. The activities and interventions in the catchment landscapes/riverscapes should be planned and implemented without endangering the invaluable ecosystems which are ceaselessly providing manifold benefits and essential ecosystem services for the survival of mankind and society.

5.2 Key Thrust Areas

Since last few decades, India is not only confronting the problems of environmental degradation and depletion of natural resources but, also a potential partner in the management of global commons and resultant rising global concerns. The proposition of global concerns is wide ranging beyond the regional territories up to the transnational spaces and boundaries. These encompasses concerns such as, biodiversity conservation, climate change international peace and security, degradation of land and water resources, poverty, water crisis, hunger, gender disparity, malnutrition, etc. These specific issues have become focus of much international interest. Due to rapidly emerging issues and concerns of environmental degradation especially deterioration of our rivers, the Government of India (GoI) has undertaken of policies and legislative initiatives as narrated in the preceding Chapter and launched multi-focal area programme so as to address priority concerns about land and ecosystem degradation, erosion of biodiversity, ever increasing pollution and implications of climate change that are closely inter-twined and in most instances share common drivers and stressors. For almost last five decades, India has initiated actions to either halt or reverse the process of environmental degradation by way of numerous country-wide programmes and implementation of global and national level strategies relevant to different sectors *viz*., sustainable land and ecosystem management, conservation of biodiversity, watershed management, urban environment, climate change, rural livelihoods, and sustainable development. India has also joined bandwagon of global conventions and committed to fulfill its global obligations and assurances to address various environmental and social issues. The country has a firm belief in conservation of biodiversity as a national priority and recognizes its crucial linkages with the livelihood and well-being of millions of people, particularly the poor and the vulnerable. India's National Biodiversity Action Plan (NBAP), formulated through a comprehensive inter-ministerial process and approved by the Union Cabinet in 2008, was developed prior to Convention on Biological Diversity of (CBD) strategic plan for biodiversity (2011-2020) and the Aichi Biodiversity Targets (CBD, 2010). India's fifth National Report (NR 5) on the CBD made a special effort to assess the funding support for biodiversity conservation in India and reported that country was spending about Rs. 92,000 million in 2013-2014 on activities that have a direct and indirect bearing on conservation of biodiversity (MoEF&CC, 2014). Likewise, much prior to the signing of the Paris Agreement on Climate Change, the country has formulated the National Action Plan on Climate Change (NAPCC) in 2008 with eight specific missions and adopted the multi-pronged strategy to address issues related to climate change mitigation and adaptation. Considering the significance of rivers, river development and priority to rejuvenate the major rivers of the country, the GoI declared the Ganga River as the India's National River in 2008, constituted the National Ganga River Basin Authority (NGRBA) on 20 February, 2009 and established National Council for Rejuvenation, Protection and Management of River Ganga in 2011, and created the National Mission for Clean Ganga (NMCG) as the implementation wing of the National Ganga Council. Subsequently, the Union Government approved the National Water Mission (NWM) in 2012 and also renamed the Ministry of Water Resources (MoWR) as the Ministry of Water Resources, River Development and Rejuvenation of Ganga (MoWR, RD

&GR) in 2014. The Government of India soon faced the challenge of restoration of Ganga River and recognized the multi-sectoral, multi-dimensional and multi-stakeholder nature of the river ecosystem. In view of this key ministries comprising of MoWR, RD&GR, MoEF&CC, MoS, MoT, MoUD, MoDW&S, and MoRD worked together to arrive at an action plan on Ganga River. The Union Budget 2014-15 announced the setting of an Integrated Ganga Conservation Mission called 'Namami Gange' and since then the Central Government and concerned State Governments are implementing the Namami Gange programme. In May 2019, this Ministry was merged with Ministry of Drinking Water and Sanitation to form the Ministry of Jal Shakti. Thus, it is evident that the subjects of water resources, rivers, and river rejuvenation are not only amongst the highest priority agendas of the government, but also the Government is fully committed to achieve the mission goals in a time bound manner. Further, the present DPR and concurrent preparation of DPRs of other major Indian rivers testify the priority and commitment of the Union Government towards restoration/ rejuvenation of rivers.

5.3 Problems in Achieving Objectives

Management of the Chenab River and its tributaries has many problems and conservation issues which have been summarized based on SWOT analysis. More specific and precise problems in achieving different project objectives are given below.

i) Fragile ecology and environment, difficult and rugged terrain comprising of steep slopes, rocky surfaces and deep gorges and many inaccessible areas particularly in the upper catchments of the Riverscape.

ii) Seismicity prone locations and presence of fault lines in downstream riverscape areas combined with recurrent landslides, soil and riverbank erosion, and increased sedimentation.

iii) Extreme climatic conditions, heavy snowfall and torrential rainfall, retreat of glaciers and increased snow melt and runoff and other vagaries of nature.

iv) Developmental and tourism activities and their adverse pressure and impact on forests/and natural ecosystems.

v) Habitat loss and fragmentation of terrestrial ecosystems including rivers and streams, and their degradation.

vi) Shallow soil depth and low soil fertility.

vii) Alteration in river course by linking river or diversion of water; sequential physical barriers by construction of dams, barrages, and establishments of HEPs.

viii) Traditional resource dependence, biotic activities, and human disturbances on natural ecosystems; limited opportunities for alternate occupation and income generation; unsustainable harvest practices; illiteracy, lack of awareness, and poverty and vulnerable communities.

ix) Widespread and extensive land use changes and faulty land use; expansion and intensification of agriculture and horticulture; and excessive use of fertilizers, pesticides, weedicides, etc.

x) Encroachment of forest lands, PAs, and other natural ecosystems; and all round rapid developmental activities (i.e., expanding highways, widening of road network, mushrooming of cities/ towns, irrigation and HEPs, transmission lines, etc.).

xi) Forest fragmentation, enhanced patchiness, habitat loss and degradation of terrestrial and aquatic ecosystems by proliferation of invasive alien species; and decline in productivity and lack of regeneration of native species.

xii) Erosion of biodiversity values, smaller and isolated populations of threatened species; and reduced distributional range of prominent faunal species.

xiii) Fragmentary approach of environmental impact assessment in case of sequential developmental projects and inadequate efforts for cumulative assessments.

xiv) Multiplicity of policies and laws; isolationist, conflicting or counterproductive strategies/ approaches adopted by different agencies/ sectors; lack of sectoral convergence; and lackadaisical law enforcement and implications of judiciary activism.

xv) Inadequate researches, databases, and baseline information; ineffective monitoring; lack of technological support, and innovations; inadequate capacity

5.4 Strategies

The methodical description given in the above section put forth the common vision of Implementation Plan (IP) of the DPR, along with broad and all-encompassing goals relevant to four distinct thrust areas in connection with conservation and restoration of river ecosystem. These thrust areas are, **(a)** sustainable land and riverscape management through appropriate Forestry Interventions, **(b)** conservation of biodiversity in the terrestrial and aquatic environments of the river, **(c)** enhanced benefits and sustainable livelihoods, and **(d)** project implementation, knowledge management and innovative approaches. The accomplishment of four goals under the project has been envisaged through proposed Forestry Interventions with an array of significant supporting activities including enabling policy level interventions, strategic adaptive research and development, innovative and low cost bio-engineering methods for stream/ riverbank stabilization, participatory monitoring, evaluation, awareness, capacity development, and project management. The Implementation Plan (IP) of present DPR has been projected for the fulfillment of four objectives with five broad outcomes and twelve clear-cut outputs.

The assessment of the riverscape environment and understanding developed thereafter have adequately revealed that the riverscape is a mosaic of varied land uses and it includes, **(a)** natural ecosystems, **(b)** rural system predominated by agro-ecosystems, and **(c)** built-up

urban environment represented by cities and towns. Each of these broad land use category represents significant area of the riverscape with unique conditions and situations, and varied use patterns, ownerships and management needs. Hereafter, three broad land use categories within the riverscape are being referred as the 'natural', 'agriculture', and the 'urban' landscapes. These three landscapes immensely influence the intricate and vibrant nature of Chenab River ecosystem, especially the environmental flow, water quality and aquatic biota besides terrestrial biodiversity in surrounding lands, and the various ecological and fluvial processes of the *lotic* system. Hence, in view of the prominence of three types of landscape elements within the riverscape, a multipronged strategy for the proposed Forestry Interventions addressing specific requirements of each of the land use type/ landscape category has been planned for the execution as a part of the implementation plan during the Phase I, 5-year duration. The Phase I will be followed by Phase II (i.e., Maintenance Phase). As a part of the broader strategy, zoning within the riverscape is visualized keeping in view of three distinct landscape categories and specific targeted Forestry Interventions those are being planned in each of the zone.

5.4.1 Zoning and Lower Order Zone Plans

As elaborated above, three broad and distinct landscape types or 'three zones' have been deciphered within the riverscape for the purpose of proposed Forestry Interventions. The following section presents an elaborate account of specific Forestry Interventions in each of the zone or represents the self-contained 'Lower Order Zone Plan 'for the natural, agriculture and urban landscapes, respectively within the riverscape.

Following three lower order zone/landscape plans in the riverscape are incorporated for the purpose of proposed Forestry Interventions.

(a) Natural Landscape (NL)

The information on the different land use and land cover categories (LULC) and their distribution within the Chenab Riverscape revealed that various categories of LULC within the natural environment represent the extent of the riverscape. Prominent natural LULC categories were: diverse forests, scrubs, and alpine pastures, covering area of the Riverscape was under snow/ glaciers, clouds and cloud shadow was barren. In addition, perennial rivulets, sand areas, wetlands and numerous water bodies represent the significant portion of riverscape area. Thus, the 'natural landscape' constitutes the largest zone within the riverscape. Hence, from the perspective of Forestry Interventions, this zone acquires the greatest significance for river conservation and restoration. Various planned Forestry Interventions, thus, include protection, habitat improvement and management by way of soil and water conservation works, weed control, afforestation/ reforestation, eco-restoration, bio-filters and bioremediation, etc. Keeping in view the diversity of forests and other natural ecosystems, native vegetation, soil conditions, and agro-climatic zones, potential models of various types of forestry intervention, particularly plantations were identified, designed and developed by the HFRI using its multi-disciplinary expert knowledge. For developing treatment models, insight obtained from the consultative process, field acquaintance,

professional judgment, forest working plans, and CAT plans was optimally used. For the natural landscape, suggested models are segregated into two broad groups, **(a)** models for the Himalayan mountainous tract in Himachal Pradesh, and **(b)** models for the mountainous parts of Jammu and Kashmir UT. The primary purpose of various models planned and proposed in the natural landscape is protection, eco-restoration, and conservation. Each recommended treatment model includes background information on site characteristics, recommended plant species for the proposed plantation besides details on spacing, quantity of different activities and man days during the establishment year and in subsequent years of maintenance. Details of potential treatment models were shared with SFDs in concerned States seeking feedback for appropriate finalization. For the state of Himachal Pradesh and Jammu and Kashmir UT, 31 models were selected and incorporated in the present DPR. Altogether, 8 models selected for natural landscapes numbered from CN/HP/NL/01 to CN/HP/NL/08 in the hilly regions of Himachal Pradesh while 13 models for natural landscape in Jammu and Kashmir UT, numbered from CN/JK/NL/01 to CN/JK/NL/13 have been included. Details of these models in natural landscape relevant to hills along with incorporated abbreviations/ code are summarized in (Table 5.1)**.**

In all, 8 models for natural landscapes in the hills of Himachal Pradesh are proposed for treatment and Forestry Interventions. The model CN/HP/NL/03 specific to moist sub-alpine and alpine areas between 3,600 - 4,500 m amsl and is mostly snow bound while one model is specific to sub-alpine area (2,900 - 3,600 m). The model CN/HP/NL/04 deals with enrichment and development of alpine areas. The model CN/HP/NL/08 pertains to the protection model for natural regeneration. Three different models (CN/NL/H/05 to CN/NL/H/07) are proposed for lower, middle and upper temperate forested tracts in the Himalayan Mountains of Himachal Pradesh.

Thirteen different treatment models are proposed and for the vast areas of Jammu and Kashmir UT included in the DPR.

Table: 5.1- Recommended Treatment Models in Different States and Landscapes

S. No.	Model Type	Model Number
I	**Natural Landscape (NL)**	
A.	**Himachal Pradesh**	
1	Cold Desert Greening	CN/HP/NL/01
2	Cold Desert Conservation	CN/HP/NL/02
3	Alpine Conservation	CN/HP/NL/03
4	Sub-Alpine Enrichment	CN/HP/NL/04
5	Temperate Conifer Forest	CN/HP/NL/05
6	Temperate Mixed Forest	CN/HP/NL/06
7	Pasture and Grazing Land Development	CN/HP/NL/07

8	Protection Model for Natural Regeneration	CN/HP/NL/08
B.	**Jammu and Kashmir UT**	
9	Sub-Alpine Conservation	CN/JK/NL/01
10	Sub-Alpine Enrichment	CN/JK/NL/02
11	Dry Temperate Conifer Forest Enrichment	CN/JK/NL/03
12	Temperate Conifer Forest	CN/JK/NL/04
13	Temperate Mixed Forest	CN/JK/NL/05
14	Pasture and Grazing Land Development	CN/JK/NL/06
15	Himalayan Chir Pine Forest	CN/JK/NL/07
16	Himalayan Mixed Forest	CN/JK/NL/08
17	Sub-Tropical Dry Deciduous Forest	CN/JK/NL/09
18	Eradication of Lantana (> 50%)	CN/JK/NL/10
19	Control/ Removal of Invasive Species or <50% Lantana	CN/JK/NL/11
20	Protection Model for Natural Regeneration	CN/JK/NL/12
21	Fire Protection Model	CN/JK/NL/13
II	**Agriculture Landscape (AL)**	
A.	**Himachal Pradesh**	
22	Boundary Plantation Model	CN/HP/AL/01
23	Block Plantation Model	CN/HP/AL/02
B.	**Jammu and Kashmir UT**	
24	Boundary Plantation Model	CN/JK/AL/01
25	Block Plantation Model	CN/JK/AL/02
III	**Urban Landscape (UL)**	
A.	**Himachal Pradesh**	
26	Riverfront Development	CN/HP/UL/01
27	Institution Plantation	CN/HP/UL/02
B.	**Jammu and Kashmir UT**	
28	Bio-remediation and Bio-filtration	CN/JK/UL/01
29	Riverfront Development	CN/JK/UL/02
30	Institution Plantation	CN/JK/UL/03
31	Eco-park Development	CN/JK/UL/04

(b) Agriculture Landscape: The second lower order zone i.e., the agriculture landscape largely in the rural environment constitutes the matrix of Chenab riverscape. The activities in this zone are mainly agriculture and horticulture. Various agriculture and horticulture crops are sown by villagers/farmers on the private land. The purpose of this zone is to promote productivity of agricultural lands by appropriate soil and moisture conservation works and planting of economic and fruit trees so as to enhance the overall conservation values and other expected ecological functions and ecosystem services. Two models for the agriculture landscape in the hill state of Himachal Pradesh are proposed. They are, (a) model CN/HP/AL/01 of Boundary Plantation Model and (b) Model CN/HP/AL/02 of Block Plantation Model. In case of Jammu and Kashmir UT also, two models; (a) CN/JK/AL/01 of Boundary Plantation Model and (b) CN/JK/AL/02 of Block Plantation Model have been proposed.

(c) Urban Landscape: This type of Land Use category refers to the towns, and sub-urban areas distributed along the main course of the river or adjacent to it. Proposed Forestry Interventions in this lower order zone i.e., the urban landscapes include institutional plantations, eco-park development, riverfront development and also to develop a small number of pilot demonstration models of bio-filtrations and bio-remediation. Total six models have been proposed under this category. In Himachal Pradesh, only two models i.e., (i) Model for Riverfront Development (CN/HP/UL/01), and (ii) Model for Institutional plantation (CN/HP/UL/02) have been proposed. Accordingly, altogether four different models focusing on Jammu region Jammu and Kashmir UT are: (i) Bio-filtrations and Bio-remediation (CN/JK/UL/01); (ii) Riverfront development (CN/JK/UL/02), (iii) Institutional plantation (CN/JK/UL/03), and iv) Eco-park development (CN/JK/UL/04) has been proposed.

5.4.2 Model-Wise Treatment Plans under Three Lower Order Zones

The treatment plans for proposed models (Natural-21; Agriculture-04; and Urban-06) meant for above described three lower order zones or landscapes within the riverscape are elaborated below one by one. In case of each model, the treatment plan includes the details on site characteristics, recommended species for plantations, specific activities and cost norms.

In general, following guidelines would be applicable to all proposed Plantation Models meant for three different Land scapes *viz*. Natural, Agriculture and Urban Landscape and Three types of Conservation Interventions viz. Soil & Water Conservation, Riverine and Riparian Management, and Wetland Management within the riverscape:

1. All the Models/ Interventions are prescribed which come under Forestry Interventions in proposed DPR of Rivers.
2. Native species of trees, shrubs, herbs and grasses would be selected for proposed treatment models/ plantations in consultation with stakeholders of the respective States/UT. Traditional and prominent horticultural and ornamental species those under cultivation in the region for quite sometime, are proposed in the Agriculture and Urban Landscapes. Mixed plantations are proposed as far as possible instead of

monoculture for enhancing plant diversity and greater ecosystem services. The species are proposed according to their occurrence in the altitudinal zones however, Implementing Agencies may plant site specific species also.

3. Suitable native species suggested for different plantation models are finalized after due consultation with Forest Department and other stakeholders of concerned States/UTs. Native species proposed for plantation under each treatment models are provided in the following section. In addition, landscape-wise model description has been further supplemented with the species-wise attributes and model-wise listing in (Annexure: 7 - Annexure: 10).
4. The necessary preparations for planting works including digging of pits would be completed two-three months before the onset of monsoon or planting season. However, the period between pit digging and scheduled planting time would not be more than four months so that run-off of soil by wind and water could be minimized.
5. Appropriate quantity of farmyard or organic manure or AM would be applied to boost plant growth in nurseries and plantation sites. Eco-friendly measures (i.e. physical or mechanical methods, use of natural products, etc.) for weed and pest control would be adopted without resorting to the use of synthetic chemicals
6. Plantation sites would be protected against all types of biotic disturbances and abiotic stresses so as to effectively safeguard planted material for three years through fence, watch and ward, as well as local public awareness programmes and their active involvement.
7. The Implementing Agency should either develop modern and centralized nurseries or identify various certified Research Institutes, Universities, NGOs, Institutions and progressive farmers for supply of best quality planting material.
8. The Schedule of Rates (SoR) is adopted from prevailing SoR of respective States/UTs. For Himachal Pradesh, SoR of Shimla Forest Circle for the year 2012-13 @ wage rate of Rs.150/ with increase of 66.66% i.e., Rs. 250/-, for J&K UT SoR of 2017 @ Rs. 225/- has been applied. Also an increase of 7% has been added each year i.e., 2nd year onwards to compensate inflation.
9. The budget will be provided after submission of Annual Plan Operations (APO) for each year. So the prevailing wage rate will be applicable whenever DPR is implemented. Also site can be changed as per the availability at the time of implementation wherever required.
10. In Himachal Pradesh, further 25% hike in wage rates would be applied for Tribal Areas
11. The fencing cost has been calculated on average basis of enclosure of area to the extent of 5 hectare and average carriage lead is taken as 1 km (up & down)
12. The nursery time for plants in multitier model is taken on average basis i.e., 1.5 – 4.5 year so average is 3 years, for calculating the norm. Also the plant cost is taken from the norm prescribed by the Forest Department of respective States.
13. These cost Norms indicate the upper limits. The expenditure will be booked under various items shown in the detailed models as per actual work done in the field as per

Schedule of Labour rates of the respective States/UTs and will not exceed these Departmental Norms.

14. The suggestive cost models are to create multistoried forest cover for improving the bio-diversity of the area which in turn conserves the water and soil in-situ.
15. In *Lantana* eradication models or wherever Lantana removal is involved, the Cut Root Stock (CRS) method should be adopted.
16. The fencing work includes the 4-strands of barbered wire with interlacing of thorny bushes.
17. In Fire Protection Model, as area is virtually targeted, hence Implementing Agency should rotate fire protection operations in areas of the Division so that each selected area takes operations after 3 years.
18. In Agriculture models the guidelines of Sub-Mission on Agroforestry (SMAF) of Central Government should be considered as being adopted in States and UT.
19. Under Urban Landscapse, the Seechewal Model (Punjab) for bio-remediation and bio-filteration may be taken into consideration.
20. Also in Urban Landscape, Eco-Park Development, Institutional Plantation and Riverfront Development models can be converged with Nagar Van Yojna as launched by GoI.
21. In Soil and water conservation models, the watershed approach and techniques should be adopted for desired results. For this intervention the Annual Plan Operation (APO) should be submitted each year with the proposal of micro plan of specific sites with detailed estimates.
22. In Riverine and Riparian Management and Wetland Management models, areas shown in budgetary provisions are virtual and concerned Implementing Agency (IA) should clearly mention the proposed activities in Annual Plan operation (APO) to be taken up in particular area with detailed microplan and estimates.
23. Plantation models are for the general areas as proposed by the Territorial Divisions but for the protected areas, two models under Conservation Intervention *viz*. Riverine and Riparian Management and Wetland Management.

5.4.3 Natural Landscapes

The proposed treatment models in Natural Landscapes are broadly grouped in two categories: (a) in mountainous tract/ hills of Himachal Pradesh; and (b) in mountainous tract/ hills of Jammu and Kashmir UT. The elaborate details on various treatment models included in the present DPR are presented in the following section.

(A) Treatment Models for Natural Landscapes in Himachal Pradesh

Various natural land use and land cover categories together constitute the largest area of the Chenab Riverscape. It is represented by diverse forests, cold desert areas, alpine pastures, scrubs, snow cover/ glaciers, temperate areas, etc. Thus, sufficient numbers of treatment models have been proposed in the mountainous/ hill portion of the Riverscape. Various Forestry Interventions are proposed to be implemented in the entire upper basin of the Chenab River and its tributaries through following models. Primarily, these models would be

applied on forest lands under the control of State Forest Department (SFD). The proposed treatment sites would mainly include areas under open forests, scrubs, grasslands, alpine pastures and cold deserts or along the river and its tributaries. Details of each of the 8 treatment models prescribed for the natural landscapes are presented below one by one.

1) MODEL – CN/HP/NL/01	**Cold Desert Greening**
Zone: Cold Desert Areas	

The Cold Desert area in Chenab River Basin covering the Chandra and Bhaga valleys, is located 3,000-6,500 m amsl approximately. The valleys face extreme climatic conditions. The temperature remains below -20^{0}C during winter months and 35^{0}C during summer season. The growing period is around five to six months *i.e.*, from April to September. Annual precipitation in these areas is below 300 mm and mostly in the form of snow. The main vegetation of the area is shrubs and herbs especially thorny bushes e.g., *Rosa webbiana, Hippophae rhamnoides* ssp. *turkestanica, Caragana brevifolia, Colutea nepalensis, Capparis spinosa, Ribes orientale, R. alpestre, R. himalense, Ephedra gerardiana, Myricaria germanica,* etc. The tree species includes *Picea smithiana, Abies pindrow, Hippophae salicifolia, Pinus wallichiana, Juniperus polycarpos* and *Betula utilis* in some pockets along with *Populus ciliata, P. alba, Salix alba, S. tetrasperma, S. fragilis, S. flagellaris,* and *S. daphnoides* which are planted by the local communities near villages for their requirement of fuel wood, timber and fodder for feeding their livestock, some among them are naturalised along moist streams and rivulets.

In this model, it is proposed to green cold desert areas with the blend of exotic and native species around water channels, *Nallah*, rivers and other water bodies. The major focus will be on conservation of native biodiversity and livelihood generation for local communities. Conservation practices as prescribed in Working Plan of the respective territorial Forest Division and Wildlife Management Plan of protected areas will be applicable. Collection of medicinal and aromatic plants would be regulated as per the State's policy on medicinal and aromatic plants and accordingly benefit will be shared with local communities.

In this model, trees@800plants/ha at 3m x3m spacing and shrubs @ 400/ ha at 2 x2m spacing will be planted. Dry habitat loving shrubs will be planted towards hill side and moisture loving shrubs near *nallah*. The cold desert medicinal plants require 3 years nursery period and planting will be done in the 4th year. For producing quality nursery stock of desired species, native zone soil will be used for cold desert species and VAM (Vesicular Arbuscular Mycorrhiza) will be added in nursery to boost growth either species specific or as consortium. The plants will be maintained in the field during 5th, 6th and 7th years (Table. 5.2; Fig. 5.1)

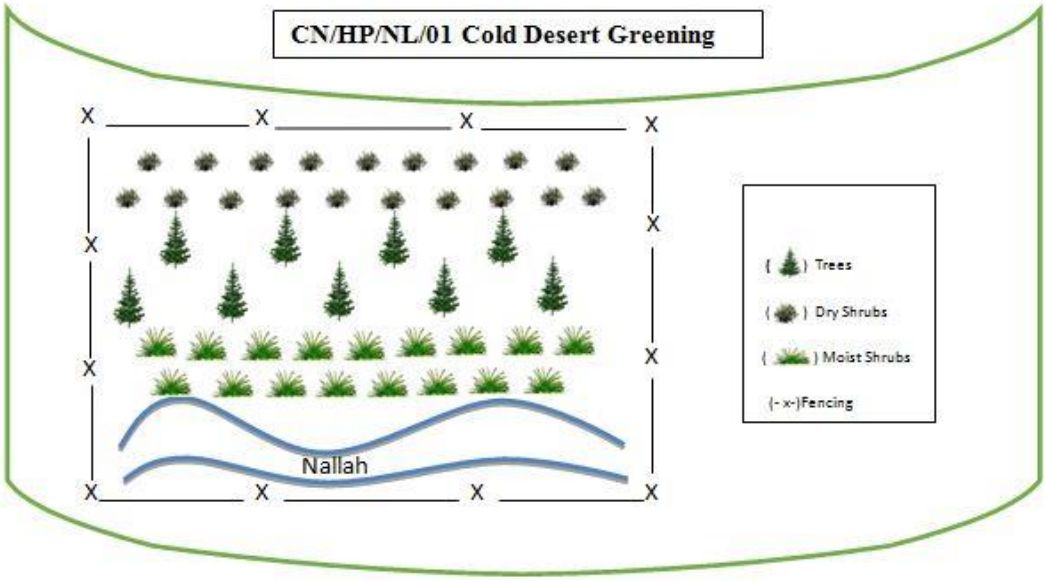
List of Species for plantation

Trees: *Juniperus polycarpos, Betula utilis, Hippophae salicifolia, Abies pindrow, Pinus wallichiana, Salix alba, S. tetrasperma, S. fragilis, S. flagellaris, S. daphnoides, Populus ciliata, P. alba,* etc.

Shrubs (Near water bodies**):** *Hippophae rhamnoides* ssp. *turkestanica, H. salicifolia, Myricaria germanica, M. elegans, Lonicera hypoleuca,* etc.

Shrubs (Dry Areas**):** *Ephedra gerardiana, Capparis spinosa, Rosa webbiana, Colutea nepalensis, Caragana brevifolia, C. versicolor, Ribes orientale, R. alpestre, R. himalense,* etc.

Fig. 5.1 Plantation Design/ Cost norms CN/HP/NL/01 Cold Desert Greening



Trees: 800 No., Spacing (m)-3x3, Pit size (cm) – 30x30x30
Shrubs: 400 No., Spacing (m) -2x2, Pit size (cm) – 30x30x30, Pit = 400 no.
Fencing: Cement pole/ local material wood/ Branches

Table: 5. 2– Cost Norms for Model CN/HP/NL/01

Plantation Cost- Model CN/HP/NL/01 Cold Desert Greening (in Tribal area)				
Year	**Item**	**Details of works**	**Amount**	**Man days**
Number of Plants (No.)		Plants- 800, Shrubs –400		
1st Year	Advance Work Labour Cost (Rs.)	Establishment of Nursery	1,400	4
2nd year	Advance Work Labour Cost (Rs.)	Establishment of Ist year and maintenance of plants	13,351	41

3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery of herbs+ 1st and 2nd year maintenance of plant nursery.	17,968	50
4th year	Advance Work Labour Cost (Rs.)	Nursery 1st year of herbs+ 1st, 2nd and 3rd years Maintenance of trees nursery.	47,665	124
4th year	Advance Work Material (Rs.)	Cost of Seeds, Farm Yard Manure (FYM), Barbed wire and Reinforced Cement Concrete (RCC) poles	52,000	0
4th year	Advance Work Labour Cost (Rs.)	Site preparation- Site preparation i/c survey & demarcation, Bush Cutting in strips, collection of debris, burning of debris, Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and fixing of poles, Stretching & fixing of Barbed wire	75,775	198
5th year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery for creation and maintenance works 1st and 2nd years	29,248	71
5th year	Creation (Rs.)	Carriage of plants, Layout of pits and patches, Pitting & planting of plants, Patches & planting of herbs, Preparation of strips including (i/c) sowing in strips, Weeding and mulching	70,055	171
	Total Establishment Cost (Rs.)		**3,07,462**	**659**
MAINTENANCE				
6th year	Maintenance Cost - I Year i/c Material (Rs.)	Nursery maintenance, material cost, planting cost & other maintenance works	36,950	82
7th year	Maintenance Cost - II Year (Rs.)	Nursery maintenance, material cost, planting cost & other maintenance works	26,546	55
8th year	Maintenance Cost - III Year (Rs.)	Nursery maintenance, material cost, planting cost & other maintenance works	15,820	30
	Total Maintenance Cost (Rs.)		**79,316**	**167**
		Total cost of plantation	**3,86,978**	**826**

2) MODEL – CN/HP/NL/02	**Cold Desert Conservation**
Zone:Cold Desert Areas	

The Cold Desert area is located between 3,000 – 4,500m amsl, and faces severe climatic conditions. The main vegetation of the area is shrubs and herbs. The notable shrubs are *Rosa webbiana*, *Hippophae rhamnoides* ssp. *turkestanica*, *Caragana brevifolia*, *Colutea nepalensis*, *Capparis spinosa*, *Ribes orientale*, *R. alpestre*, *R. himalense*, *Ephedra*

gerardiana, Myricaria germanica, etc. The tree species includes *Juniperus polycarpos*, and *Betula utilis* in small pockets along with *Populus ciliata, P. alba, Salix. tetrasperma, S. fragilis, S. flagellaris, and S. daphnoides* which are planted by the local communities near villages for their requirement of fuel wood, timber, and fodder for feeding their livestock. In general, the cold desert region is quite barren and very scattered few green pockets are present. The vegetation is sparsely distributed.

The model, has proposed to plant shrubs and herbaceous species of cold desert areas for soil conservation purpose near water channels and water bodies. As these areas are prone to air sheet erosion due to high wind velocity, hence, these cold desert species are quite useful for controlling soil erosion. The high valued medicinal plants found in these hills will be beneficial for the tribal communities. The major focus under this model will be on conservation and enrichment of native biodiversity and additional livelihood generation for local communities. Conservation practices as prescribed in Working Plan of the respective Territorial Forest Division and Wildlife Management Plan of protected areas will be applicable. Collection of medicinal and aromatic plants would be regulated as per the State's policy on medicinal plants and accordingly benefit will be shared with tribal communities.

In this model, shrubs @800plants/ha at 2 x 4m spacing and herbs @ 600 patches/ha at 2 x 8m spacing along with grasses @ 600 patches/ha at 2 x 8m spacing will be planted. Dry shrubs habitat loving will be planted towards hill side and moisture loving shrubs near *nallah* and river banks. The cold desert medicinal plant requires 3 years nursery period and planting will be done in the 4^{th} year. For producing quality nursery stock of desired species, native zone soil will be used for cold desert species and VAM will be added in nursery to boost growth either species specific or as consortium. The plants will be maintained in the field during 5^{th}, 6^{th} and 7^{th} years (Table 5.3; Fig. 5.2).

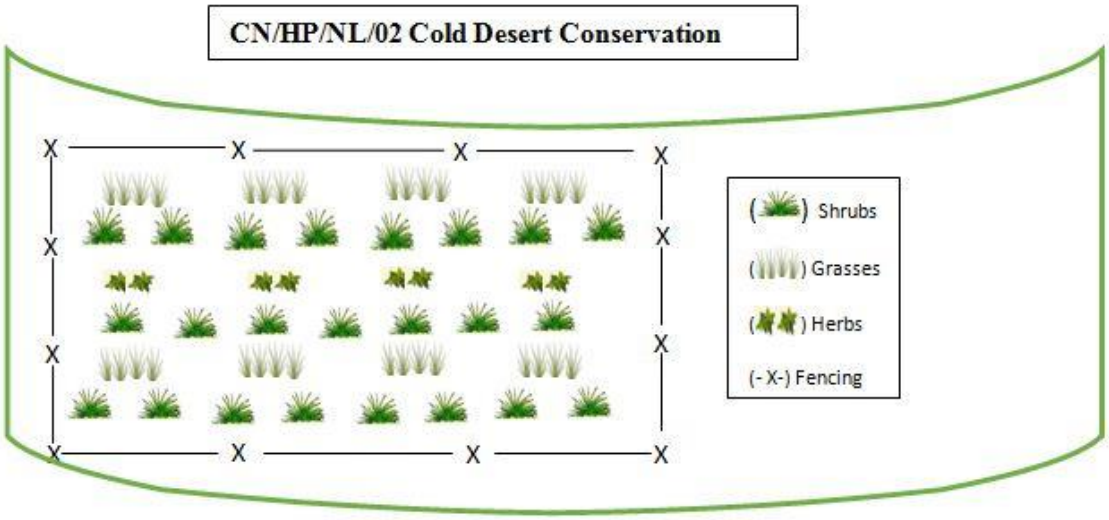
List of Species for Plantation

Shrubs: *Ephedra gerardiana, Capparis spinosa, Hippophae rhamnoides* ssp. *turkestanica, Salix denticulata, Rosa webbiana, Colutea nepalensis, Caragana brevifolia, Ribes orientale, R. alpestre, R. himalense,* etc.

Herbs: *Dactyloriza hatagirea, Aconitum heterophyllum, Picrorhiza kurroa, Eremurus himalaicus, Arnebia euchroma, Achillea millfolium, Artemisia maritima, Heracleum candicans, Rheum australe, R. webbianum, Inula racemosa, Hyssopus officinalis, Hyoscyamus niger, Allium carolinianum*, etc.

Grasses/Forbs: *Danthonia cachemyriana, Cicer songaricum, Festuca pratensis, Trifolium pratense, Poa pratensis, P. annua, Dactylis glomerata, Eragrostis* spp., *Melilotus* spp., *Koeleria* spp., etc.

Fig. 5.2- Plantation Design CN/HP/NL/02 Cold Desert Conservation



Shrubs: Plants: 800 no., Spacing (m) -2x4, Pit size (cm) – 30x30x30.

Herbs: Plants: 2400, Patch no. - 600, Patch size (cm) – 30x30x5. Spacing (m) – 2x8, plant/patch- 4, Spacing (cm) – 20x20

Grasses: Patch no- 600, Patch size (cm) – 100x30x5. Spacing (m) – 2x8, Seed/ patch (gm) – 6gm, Spacing (cm) – 10x10

Fencing: Cement pole/ local material wood/ Branches

Table: 5. 3– Cost Norms for Model CN/HP/NL/02

Plantation Cost- Model CN/HP/NL//02 Cold Desert Conservation				
Year	**Item**	**Details of work**	**Amount (Rs)/ ha**	**Man days**
Number of Plants (No.)		Shrubs- 800, 2400 herbs and 600 patch of Grasses		
1st Year	Advance Work Labour Cost	Establishment of Nursery	16,916	54
2nd year	Advance Work Labour Cost	Maintenance of Nursery+ Establishment of I st year maintenance	49,492	148
2nd year	Advance Work Material	Cost of Seeds, Farm Yard Manure (FYM), Barbed wire and Reinforced Cement Concrete (RCC) poles	58,000	0

2nd year	Advance Work Labour Cost	Site preparation - Site preparation i/c survey & demarcation , Bush cutting in strips, Collection of debris, Burning of debris, Preparation of inspection path, Carriage of RCC poles, Digging of holes and Fixing for poles, Stretching & fixing of Barbed wire	66,185	198
3rd year	Advance Work Labour Cost	Maintenance of Nursery for creation and maintenance work in 1st and 2nd year	38,623	108
3rd year	Creation	Carriage of plants, Layout of pits and patches, Pitting & planting of plants, Patches & planting of herbs, Preparation of strips including (i/c) sowing in strips, Weeding and mulching, etc.	66,765	187
	Total Establishment Cost		**2,95,981**	**695**
MAINTENANCE				
4th year	Maintenance Cost - I Year i/c Material	Nursery maintenance, cost of material, planting & other maintenance works	50,566	126
5th year	Maintenance Cost - II Year	Nursery maintenance, cost of material, planting & other maintenance works	38,328	89
6th year	Maintenance Cost - III Year	Nursery maintenance, cost of material, planting & other maintenance works	25,792	56
7th year	Maintenance Cost - IV Year	Maintenance cost of fencing	728	2
	Total Maintenance Cost		**1,15,414**	**273**
		Total cost of plantation	**4,11,394**	**968**

3) Model - CN/HP/NL/03	**Alpine Conservation**
Zone: Sub Alpine and Alpine Areas	

The sub-alpine and moist alpine zones are located between 3,600 – 5,000 m amsl, and are mostly snow-bound. The temperature remains below -20 °C or below 5 °C for 6 months in a year. The active plant growth season is from mid-May to September. This region is above the tree line with varied rock formations. Vegetation is dominated by the scattered shrubs grasses and herbs. A low deciduous scrub formation usually about 1 m high forms a dense cover in some patches along the moist, *nallah* and river bank habitats.

Under this model, it is proposed to conserve and augment vegetation of the alpine meadows. The major focus will be on conservation of native species and livelihood generation for local

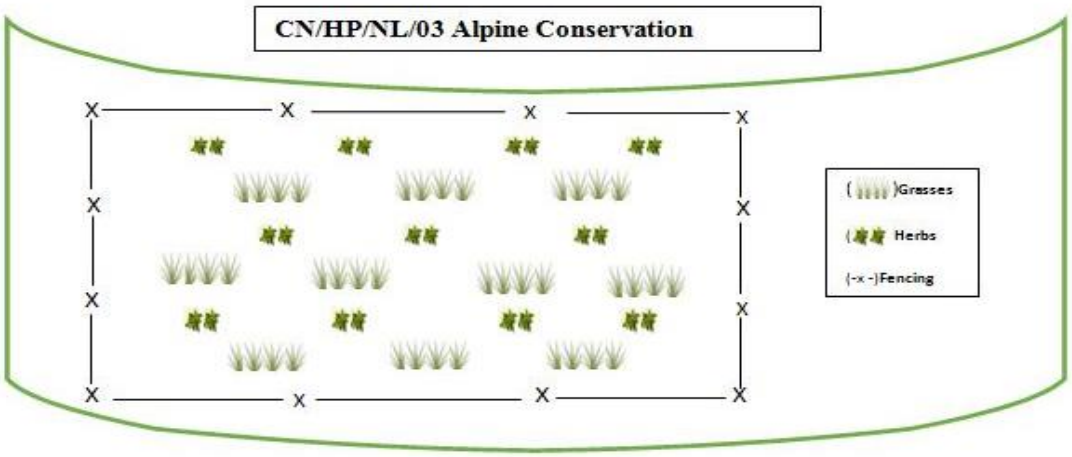
communities. The conservation practices as prescribed in the Working Plan of respective Territorial Forest Division and Wildlife Management Plan of protected areas will be applicable. The collection of Medicinal and Aromatic Plants(MAPs) would be regulated as per the State and UT policy on the MAPs and accordingly the benefit will be shared with local communities. Under this model, MAPs species will be planted at the rate of 2,400 plants/ha in the blank areas in 600/ha patches. Root slips/ seeds of native grasses will be put in continuous contour strips immediately after melting of snow in 600/ha patches. The high altitude medicinal plants require two years nursery period and third year planting in the field along with grasses. For producing quality nursery stock of desired species, native zone soil will be used and VAM will be added in nursery to boost growth either species specific or as consortium. It will be followed by two years Maintenance. Harvesting can be started after 5th year onwards in a sustainable manner (Table 5.4; Fig. 5.3).

List of Species for Plantation

Herbs/Medicinal Plants: *Aconitum heterophyllum, Achillea millefolium, Ainsliaea aptera, Arnebia benthamii, Dactylorhiza hatagirea, Heracleum candicans, Angelica glauca, Polygonatum verticillatum, P. cirrhifolium, Selinum tenuifolium, Allium humile, Geranium wallichianum, Rheum australe, R. moorcroftianum, Sinoodophyllum hexandrum, Saussurea costus, Inula racemosa*, etc.

Grasses and Forbs: *Festuca pratensis, F. valesiaca, Trifolium pratense, Poa pratensis, P. annua, Dactylis glomerata, Erianthus rufipilus, Agrostis gigantea, A. pilosula, A. munroana, Agropyron* spp.,*Danthonia cachemyriana, Calamagrostismontana, Koeleria* spp., *Brachypodium sylvaticum, Bromus himalaicus, B. ramosus, Danthonia cumminsii, Stipa roylei*, etc.

Fig. 5.3 - Plantation Design- Model CN/HP/NL/03 Alpine Conservation



Herbs: Patch number - 600, Patch size (cm) - 30 x 30 x 5. Spacing (m) - 2 x 8, Plant/ patch - 4, Spacing (cm) – 20 x 20

Grasses: Patch number - 600, Patch size (cm) – 100 x 30 x 5. Spacing (m) – 2 x 8, Seed/ patch (gm) – 6gm, Spacing (cm) – 10 x 10

Fencing: Cement pole/ Local material - wood/ Branches

Table: 5. 4 – Cost Norms for Model CN/HP/NL/03

Plantation Cost- Model CN/HP/NL/03 Alpine Conservation				
Year	**Item**	**Details of work**	**Amount (Rs)/ ha**	**Man days**
Number of Plants (No.)		2400 herbs + 600 patch of Grasses		
1st Year	Advance Work Labour Cost	Establishment of Nursery	15,000	48
2nd year	Advance Work Labour Cost	Maintenance of Nursery+ Establishment of 1st year maintenance.	12,000	36
2nd year	Advance Work Material	Cost of Seeds, Farm Yard Manure (FYM), Barbed wire and Reinforced Cement Concrete (RCC) poles	55,600	0
2nd year	Advance Work Labour Cost	Site preparation i/c survey & demarcation, Bush Cutting in strips, Collection of debris, Burning of debris, Preparation of inspection path, Carriage of RCC poles, Digging of holes and fixing for poles, Stretching & fixing of barbed wire	66,185	198
3rd year	Advance Work Labour Cost	Maintenance of Nursery for creation and maintenance work 1st and 2nd year	10,200	29
3rd year	Creation	Carriage of plants, Layout of pits and patches, Pitting & planting of plants, Patches & planting of herbs, Preparation of strips including (i/c) sowing in strips, Weeding and mulching, etc.	23,686	66
	Total Establishment Cost		**1,82,671**	**377**
MAINTENANCE				
4th year	Maintenance Cost - I Year i/c Material	Nursery maintenance, cost of material, planting & other maintenance works.	24,132	58
5th year	Maintenance Cost - II Year	Nursery maintenance, cost of material, planting & other maintenance works.	18,906	43
6th year	Maintenance Cost - III Year	Nursery maintenance, cost of material, planting & other maintenance works.	14,337	30

7th year	Maintenance Cost - IV Year	Maintenance cost of fencing.	728	2
	Total Maintenance Cost		**58,103**	**133**
		Total cost of plantation	**2,40,775**	**510**

4) Model No – CN/HP/NL/04	**Sub-Alpine Enrichment**
Zone: Sub-alpine Zone	

The Sub-alpine zone occurs between 2,800-3,600 m amsl in the Chenab Riverscape, and is covered with snow for 4-5 months. The temperature remains below 5-20 °C for around 4 months in a year. Vegetation in sub-alpine zone is dominated by trees, shrubs, herbs, and grasses. The area is sloppy and generally soil depth is very low. Among the trees, *Betula utilis, Juniperus polycarpos, Pinus wallichiana, Abies pindrow, Picea smithiana, Salix daphnoides* and *Hippophae salicifolia* and among shrubs, *Rosa, Rhododendron, Lonicera, Salix, Myricaria, Ribes, Contoneaster, Hippophae, Ephedra*, etc. are very popular.

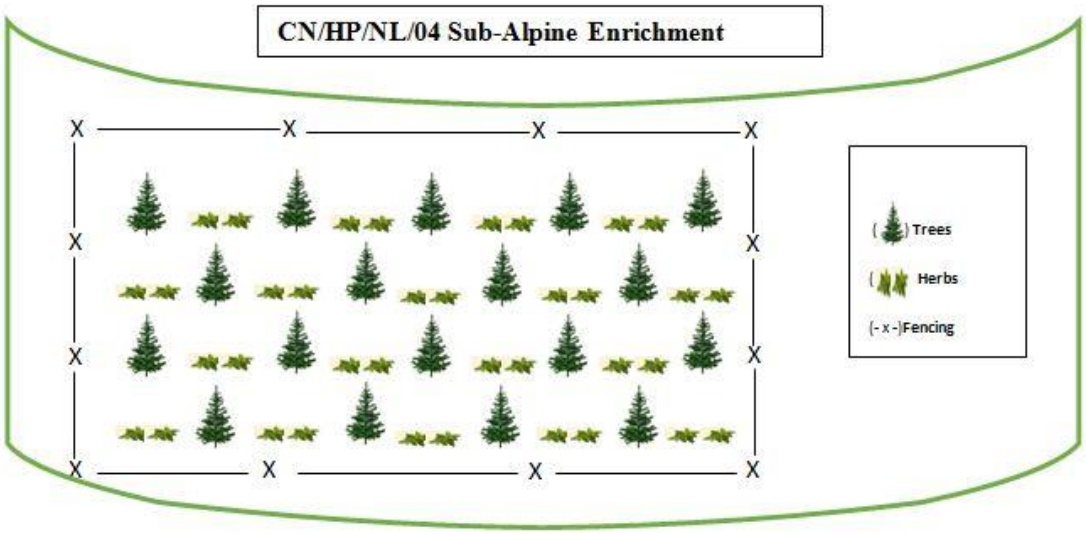
Under this model, it is proposed to conserve and augment vegetation in sub-alpine zone by adopting specific interventions to enrich such areas. The major focus will be on conservation and enrichment of native species besides generation of sustainable livelihoods for local communities. Conservation and enrichment practices as prescribed in the Working Plan of respective Territorial Forest Division and Wildlife Management Plan of a protected area will be applicable. The collection of Medicinal and Aromatic Plants would be regulated as per the State's policy on medicinal plants and accordingly the accrued benefit will be shared with local communities. In this model, native trees @ 200 plants/ha at 6 x 8 m spacing and medicinal plant species @ 800 plants/ha at 6 x 8 m spacing in 200/ha patches will be planted in barren areas. The high altitude tree species require around 3 years nursery period and planting will be done in the 4th year. For producing quality nursery stock of desired species, native zone soil will be used in conifer species and VAM will be added in other forestry species either species specific or as consortium. To synchronize planting of trees and medicinal plants in the 4th year, nursery of high altitude medicinal plants will be raised 2nd year onwards. The plants will be maintained in the field during 5th, 6th and 7th years of project implementation (Table 5.5; Fig. 5.4).

List of Species for Plantation

Trees: *Betula utilis, Pinus wallichiana, Picea smithiana, Abies pindrow, Juniperus polycarpos, Salix daphnoides, Hippophae salicifolia, Prunus cornuta,* etc.

Herbs/Medicinal Plants: *Aconitum heterophyllum, Arnebia benthamii, Dactylorhiza hatagirea, Heracleum candicans, Polygonatum verticillatum, P. cirrhifolium, Selinum tenuifolium, Allium humile, Geranium wallichianum, Bergenia stracheyi, Angelica glauca, Picrorhiza kurroa, Eremurus himalaicus, Artemisia maritima*, etc.

Fig. 5.4- Plantation Design: CN/HP/NL/04 Sub-Alpine Enrichment



Tree: Plants: 200 no/ha., Spacing (m) - 6 x 8, Pit size (cm) – 30 x 30 x 30

Herbs: Plants: 800/ha, Patch no – 200/ha, Patch size (cm) - 30 x 30 x 5. Spacing (m) - 6 x 8 plant/ patch - 4, Spacing– 20 x 20 (cm)

Fencing: Cement pole/ local material Wood/ Branches

Table: 5. 5 – Cost Norms for Model CN/HP/NL/04

Plantation Cost – Model CN/HP/NL/04 Sub-Alpine Enrichment				
Year	**Item**	**Details of works**	**Amount Rs**	**Man days**
Number of Plants (No.)		Shrubs: 200, herbs 800		
1st Year	Advance Work Labour Cost (Rs.)	Establishment of Nursery	500	2

2nd year	Advance Work Labour Cost (Rs.)	Establishment of Ist year maintenance of plant	4,682	14
3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery of herbs+ 1st and 2nd year maintenance of plant nursery	13,312	37
4th year	Advance Work Labour Cost (Rs.)	Nursery 1st of herbs+ 1st, 2nd and 3rd years maintenance of trees nursery	22,234	12
4th year	Advance Work Material (Rs.)	Cost of Seeds, Farm yard Manure (FYM), Barbed wire and Reinforced Cement Concrete (RCC) poles	51,400	0
4th year	Advance Work Labour Cost (Rs.)	Site preparation - Site preparation i/c survey & demarcation, Bush Cutting in strips, Collection of debris, Burning of debris, Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and fixing for poles, Stretching & fixing of Barbed wire	75,775	198
5th year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery for creation and maintenance. works 1st and 2nd year	16,006	39
5th year	Creation (Rs.)	Carriage of plants, Layout of pits and patches, Pitting & planting of plants, Patches & planting of herbs, Preparation of strips including (i/c) sowing in strips, weeding and mulching	7,252	18
	Total Establishment Cost (Rs.)		**1,91,161**	**320**
MAINTENANCE				
6th year	Maintenance Cost - I Year i/c Material (Rs.)	Nursery maintenance, cost of material, Planting & other maintenance works	14,798	32
7th year	Maintenance Cost - II Year (Rs.)	Nursery maintenance, cost of material, Planting & other maintenance works	9,659	19
8th year	Maintenance Cost - III Year (Rs.)	Nursery maintenance, cost of material, Planting & other maintenance works	2,917	5
	Total Maintenance Cost (Rs.)		**27,374**	**56**
		Total cost of plantation	**2,18,535**	**376**

5) Model No – CN/HP/NL/05	**Temperate Conifer Forest**
Zone: Moist Temperate Area	

The moist temperate area lies between 1,800 - 3,500 m asml. This zone is characterized by dense forests, mainly of conifer species. However, barren areas and degraded land also at several places which will be taken up for proposed treatment. In some areas, especially in found deodar, kail, fir and spruce forests, soil is covered with a thick layer of humus as the

decomposition rate is very slow in these areas. The reforce Temperate Conifer Forest Model is suggested for the treatment of these areas.

Planting of 300/ha plants of various tree species and 300/ha shrub species will be carried out per ha. In addition, 300/ha patches of medicinal plants with 1200 plants/ha will also be planted in the treatment site. In small streams or *nallah* facing side of the treatment area plantation with two rows of hill bamboo at 2 x 2 m spacing with 200/ha plants will be planted. The major focus will be on the conservation and development of native species and livelihood generation for local communities. The collection of Medicinal and Aromatic plants in protected areas would be regulated as per the State's policy on medicinal plants and in accordance with the rights of local communities. Most of the conifer plants require around 3 years of nursery period and planting will be done in the 4th year. For producing quality nursery stock of desired species, native zone soil will be used in conifer species and VAM will be added in shrubs and herbs either species specific or as consortium. To synchronize planting of trees, medicinal herbs and shrubs in 4th year, the nursery for selected herbs and shrubs will be raised 2nd year onwards. The plants will be maintained in the field during 5th, 6th and 7th years of the project implementation (Table.5.6 ; Fig.5.5).

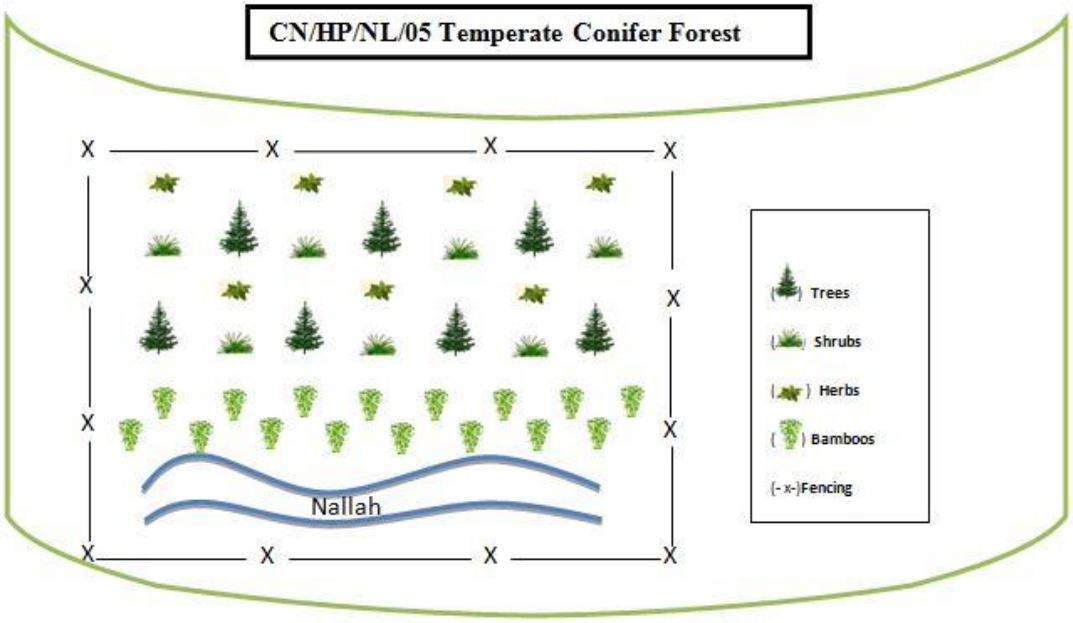
List of Species for Plantation

Trees:*Cedrus deodara, Pinus wallichiana, Picea smithiana, Taxus wallichiana, Abies pindrow, Fraxinus xanthoxyloides, Crataegus* spp., *Populus ciliata, Corylus jacquemontii, Juglans regia,* etc.

Shrubs: *Drepanostachyum falcatum, Daphne papyracea, Prinsepia utilis, Rosa sericea, R. macrophylla, Cotoneaster bacillaris, C. acuminatus, Viburnum grandiflorum, Thamnocalamus spathiflorus, Inula cuspidata, Skimmia laureola, Salix denticulata, Hippophae rhamnoides ssp.turkestanica, Lonicera quinquelocularis, Berberis pseudumbellata, Berberis jaeschkeana, Syringa emodi, Indigofera heterantha, Desmodium elegans, Hypericum oblongifolium,* etc.

Herbs:*Aconitum heterophyllum, Picrorhiza kurroa, Heracleum candicans, Angelica glauca, Geranium wallichianum, Sinopodophyllum hexandrum, Polygonatum verticillatum, P. cirrhifolium, Bergenia stracheyi, Bergenia ciliata, Viola biflora, Trillium govanianum, Phytolacca acinosa, Valeriana jatamansi,* etc.

Fig. 5.5- Plantation Design: CN/HP/NL/05 – Temperate Conifer Forest



Trees:300/ha, Spacing (m) – 5 x 5, Pit size (cm) – 45 x 45 x 45

Bamboo (hill): 200/ha, Spacing (m)-5 x 5, Pit size (cm) – 45 x 45 x 45 (along Nallah)

Shrubs: Plants: 300/ha., No. of Pit - 300, Spacing (m) - 5 x 5, Pit size (cm) – 30 x 30 x 30

Herbs: Plants: 1200/ha, Patch no – 300/ha, Patch size (cm) - 30 x 30 x 5. Spacing (m) – 5 x 5, Plant/patch - 4, Spacing (cm) – 20 x 20

Fencing: Cement pole/ local material wood/ Branches

Table: 5. 6 – Cost Norms for Model CN/HP/NL/05

CN/HP/NL/05 Temperate Conifer Forest				
Year	**Item**	**Details of work**	**Amount Rs/ha**	**Man days**
Number of Plants (No.)		Plants- 300 No., Bamboos-200no., Shrubs-300 no., Herbs- 1200 no. (300 no. patches)		
1st Year	Advance Work Labour Cost (Rs.)	Establishment of Nursery	10,000	40
2nd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery+ Establishment of 1styear maintenance	38,879	145

2nd year	Advance Work Material (Rs.)	Cost of Seeds, Farm Yard Manure (FYM), Barbed wire and Reinforced Cement Concrete (RCC) poles	52,000	0
2nd year	Advance Work Labour Cost (Rs.)	Site preparation - Site preparation i/c survey & demarcation, Bush Cutting in strips, Collection of debris, Burning of debris, Preparation of inspection path, Carriage of RCC poles, Digging of holes and fixing for poles, Stretching & fixing of Barbed wire in 4 strands	54,910	205
3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery for creation and Maintenance works 1st and 2nd year	28,603	100
3rd year	Creation (Rs.)	Carriage of plants, Layout of pits and patches, Pitting & planting of plants, Patches & planting of herbs, Preparation of strips including (i/c) sowing in strips, Weeding and mulching	45,157	158
	Total Establishment Cost (Rs.)		**2,29,549**	**648**
MAINTENANCE				
4th year	Maintenance Cost - I Year i/c Material (Rs.)	Nursery maintenance, Cost of material cost, Planting & other maintenance works	37,034	118
5th year	Maintenance Cost - II Year (Rs.)	Nursery maintenance, Cost of material cost, Planting & other maintenance works	20,711	61
6th year	Maintenance Cost - III Year (Rs.)	Nursery maintenance, Cost of material cost, Planting & other maintenance works	16,107	44
7th year	Maintenance Cost - IV Year (Rs.)	Maintenance cost of fencing	582	2
	Total Maintenance Cost (Rs.)		**74,434**	**225**
		Total cost of plantation	**3,03,985**	**873**

6) Model No – CN/HP/NL/06	**Temperate Mixed Forest**
Zone: Moist Temperate Area	

The moist temperate forest area occurs at 1,800 to 3,300 m amsl. Dominant species of the area are *Betula utilis, B. alnoides, Aesculus indica, Juglans regia, Alnus nitida, Acer acuminatum, Pinus gerardiana, Corylus jacquemontii, Ulmus wallichiana, Pinus wallichiana, Cedrus deodara, Picea smithiana,* and *Abies pindrow.,* Sometime, one species may occur in form of pure stands. This zone is often characterized by degraded stretches along the river banks running close to the area of dense temperate forests, mainly of conifers.

This zone experiences snowfall and rainfall several times during winter months and enjoys a cool climate with comparatively less monsoon rains.

Annual precipitation in this zone is around 800 mm. In some areas, snow lasts till spring season. The soil on slopes is shallow, exposed and prone to erosion, and in forest, it is deep this zone is heavily grazed by domestic animals and cause huge loss of vegetation. Besides this, road construction and other developmental activities such as hydro-electric projects also cause severe soil erosion, resulting in loss of vegetation. There is heavy dependence of local communities on Oak fodder within Chenab Riverscape in Jammu region of Jammu and Kashmir UT. Further, owing to several famous tourist spots *viz*., Trilokinath Keylong, Udaipur, Pangi, Killar, etc. and the enhanced tourism activities in such zones within the riverscape cause damage to vegetation and disturbance to wild fauna.

Temperate mixed forest treatment model has been proposed specifically for the barren and degraded patches within the temperate zone. Planting of trees @300/ha belonging to conifers and broadleaved species will be carried out in the barren and degraded patches. In this model, preferably broad leaved plants will be planted in general and conifer plants can be planted on the ridges and shallow soil depth area. The native shrubs @300 plants/ha will be planted in between the tree plantations. The medicinal plants will also be planted in patches @ 4 plants/ patch and that means planting of total of 1,200 medicinal plants/ ha will be planted. The small streams or nallah facing side of the treatment site will be planted with two rows of hill bamboo @ 200/ha at 2 x 2 m spacing. The major focus of the proposed treatment model will be on the conservation and propagation of native species alongside improved livelihoods for local communities. Most of conifer plants require around 3 years of nursery period and planting will be done in the 4^{th} year. For producing quality nursery stock of desired species, native zone soil will be used in conifer and broad leaved species. The VAM will be added in shrubs and herbs either species specific or as consortium. To synchronize planting of trees, medicinal herbs and shrubs in 4^{th} year, the nursery for selected herbs and shrubs will be raised 2^{nd} years onwards. The plants will be maintained in the field during 5^{th}, 6^{th} and 7^{th} year of the project implementation (Table 5.7; Fig. 5.6). The collection of Medicinal and Aromatic Plants in protected areas would be regulated as per the State and UT policy on medicinal plants and in accordance with the rights of local communities.

List of Species for Plantation

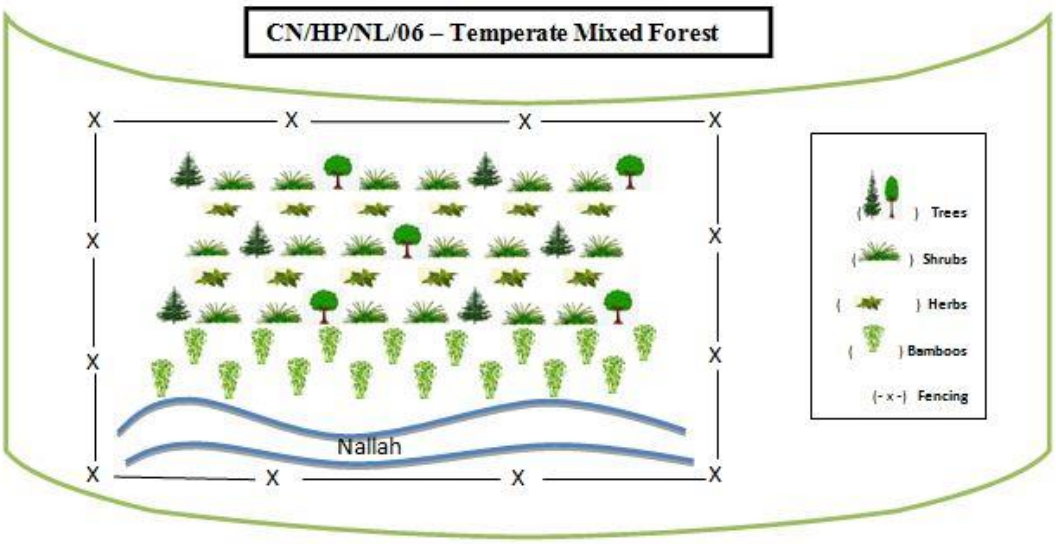
Trees: *Cedrus deodara, Pinus wallichiana, Picea smithiana, Taxus wallichiana, Aesculus indica, Prunus cornuta, P. cerasoides, Acer acuminatum, Corylus jacquemontii, Cornus macrophylla, Neolitsea pallens, Alnus nitida, A. nepalensis, Ulmus wallichiana, Quercus* spp., *Olea ferruginea,* etc.

Shrubs: *Daphne papyracea, Prinsepia utilis, Rosa macrophylla, R. sericea, Debregeasia hypoleuca, D. longilfolia, Cotoneaster bacillaris, C.acuminatus Viburnum grandiflorum, Elaeagnus conferta, Hypericum oblongifolium, Rubus biflorus, R. niveus, R. foliosus, Inula cuspidata, Lonicera quinquelocularis, Drepanostachyum falcatum,* etc.

Herbs:*Trillium govanianum, Heracleum candicans, Angelica glauca, Polygonatum*

verticillatum, P. cirrhifolium, Sinopodophyllum hexandrum, Bergenia ciliata, Viola canescens, Valeriana jatamansii, and *Hedychium spicatum, etc.*

Fig. 5.6- Plantation Design/ Cost Norms: CN/HP/NL/06 – Temperate Mixed Forest



Trees: 300/ha, Spacing (m) - 5 x 5, Pit size (cm) – 45 x 45 x 45 (50;50 of B/L & Conifer)

Bamboo (Hill): 200/ha, Spacing (m) -5 x 5, Pit size (cm) – 45 x 45 x 45 (along Nallah river banks)

Shrubs: 300 /ha, No. of Pit - 300, Spacing (m) - 2 x 5, Pit size (cm) – 30 x 30 x 30

Herbs: 1200/ha, Patch no – 300, Patch size (cm) - 30 x 30 x 5. Spacing (m) - 3 x 5, plant /patch - 4, Spacing (cm) - 20 x 20

Fencing: Cement pole/ local material wood/ Branches

Table: 5. 7 – Cost Norms for Model CN/HP/NL/06

Plantation Cost – Model CN/HP/NL/06Temperate Mixed Forest				
Year	**Item**	**Details of works**	**Amount Rs/ ha**	**Man days**
Number of Plants (No.)		Plants- 300 No., Bamboos-200, Shrubs-300 No., Herbs- 1200 No. (300 no. patches)		
1st Year	Advance Work Labour Cost (Rs.)	Establishment of Nursery	14,491	58
2nd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery+ Establishment of 1styear maintenance	33,045	124
2nd year	Advance Work Material (Rs.)	Cost of Seeds, Farm Yard Manure (FYM), Barbed wire and Reinforced Cement Concrete (RCC) poles	52,000	0
2nd year	Advance Work Labour Cost (Rs.)	Site preparation - Site preparation i/c survey & demarcation, Bush cutting in strips, Collection of debris, Burning of debris, Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and fixing for poles, Stretching & fixing of Barbed wire	54,910	205
3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery for creation and Maintenance. works 1st and 2nd year	28,925	101
3rd year	Creation (Rs.)	Carriage of plants, Layout of pits and patches, Pitting & planting of plants, Patches & planting of herbs, Preparation of strips including (i/c) sowing in strips, Weeding and mulching	45,157	158
	Total Establishment Cost (Rs.)		**2,28,528**	**646**
MAINTENANCE				
4th year	Maintenance Cost - I Year i/c Material (Rs.)	Nursery Maintenance, Cost of material, Planting & other maintenance works	38,815	117
5th year	Maintenance Cost - II Year (Rs.)	Nursery maintenance, Cost of material, Planting & other maintenance works	20,711	61
6th year	Maintenance Cost - III Year (Rs.)	Nursery maintenance, Cost of material, Planting & other maintenance works	16,107	44
7th year	Maintenance Cost - IV Year (Rs.)	Maintenance cost of fencing	582	2
	Total Maintenance Cost (Rs.)		**76,215**	**224**
		Total cost of plantation	**3,02,743**	**870**

7) Model No – CN/HP/NL/07	Pasture and Grazing Land Development
Zone: Temperate to Alpine Areas	

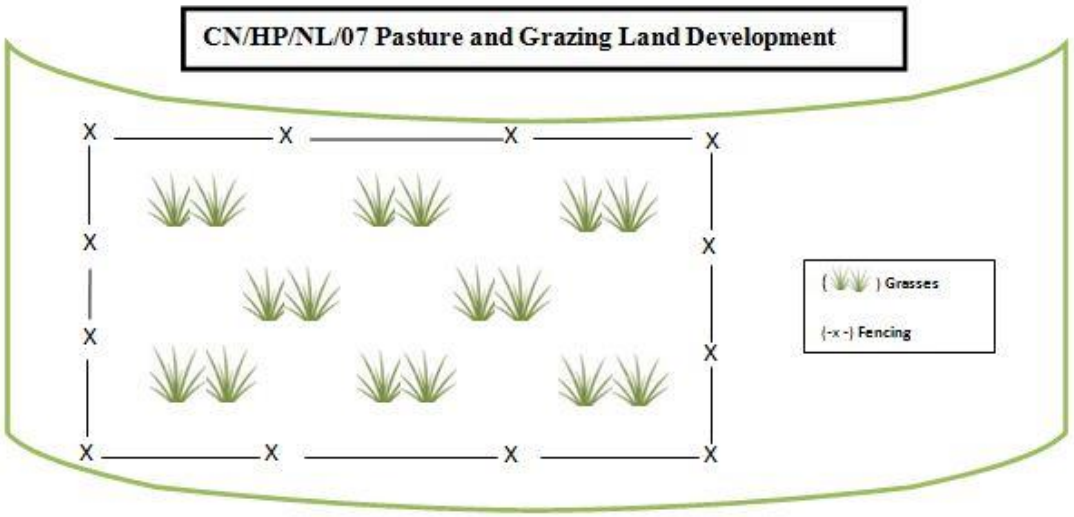
The moist temperate areas located between 1,800 to 4,500 m asml, particularly on southern slope and around habitations are characterized by pasture and grazing lands. This zone experiences snowfall and rainfall several times during winter months and enjoys a moderate climate with plenty of monsoon rains. Annual precipitation is around 800 mm. In some areas, snow lasts till spring season. The soil is shallow, exposed and prone to erosion, particularly in moderate to steep slopes. This zone is heavily grazed by livestock and cause huge damage to the vegetation and results into heavy soil erosion. Besides disturbance by livestock, road construction and other developmental activities also cause significant soil degradation and damage to native flora by proliferation of invasive alien species. The local communities are heavily dependent on these grasslands in the Chenab Riverscape. This zone also severely affected on account of enhanced tourism activities in several popular tourist destinations *viz*., Trilokinath, Keylong, Tandi, Gondla, Udaipur, Pangi, Killar, etc. causing damage to flora and disturbance to fauna.

Under this model, pasture and grazing land development are proposed by protection, development and enrichment of areas within this zone. Suitable grass species will be planted/ sowing of seeds after carrying out necessary land development works like trenching/ terracing/ moisture conservation measures, etc. besides removal of weeds and unpalatable grasses. The proposed treatment model mainly includes plantation of native and nutritionally important grass species. In this model, grass sowing in furrows/ strips of 100 x 30 x 5 cm along contours at an interval of 2 m apart is proposed. Selected species will be raised / Maintained in the nursery during 1st year and planting will be done in the second year. The grasses will be replenished in the field during 3rd and 4th year (Table 5.8; Fig. 5.7)

List of Species for Plantation

Grasses and Forbs: *Festuca pratensis, Trifolium pratense, T. repens, Poa pratensis, P. annua, Dactylis glomerata, Erianthus rufipilus, Agrostis munroana, Danthonia cachemyriana, Calamagrostis* spp., *Koeleria* spp., *Saccharum spontaneum, Chrysopogon gryllus, Arundinella nepalensis, A. pumila, Cymbopogon distans, Setaria glauca, Alopecurus aequalis, A. nepalensis, Bothriochloa pertusa, B. parviflora,* etc.

Fig. 5.7- Plantation Design/ Cost Norms: CN/HP/NL/07 - Pasture and Grazing Land Development



Grasses: Patch no -2000, Patch size (cm) – 100 x 30 x 5. Spacing (m) – 2 x 2, Seeds per patch (gm) - 6, seed, Spacing (cm) – 10 x 10, Type - Staggered

Fencing: Cement pole/ local material wood/ Branches/ Brushwood fencing

Table: 5. 8 – Cost Norms for Model CN/HP/NL/07

Plantation Cost – Model CN/HP/NL/07Pasture and Grazing Land Development				
Year	**Item**	**Details of works**	**Amount Rs/ha**	**Man days**
Number of Plants (No.)		Grasses-2000 no. patches		
1st Year	Advance Work Material (Rs.)	Cost of Seeds, Farm Yard Manure (FYM), Barbed wire and Reinforced Cement Concrete (RCC) poles	66,400	0
1st Year	Advance Work Labour Cost (Rs.)	Site preparation - Site preparation i/c survey & demarcation , Bush cutting in strips, Collection of debris, Burning of debris, Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and fixing for poles, Stretching & fixing of Barbed wire	54,910	205

2nd year	Creation (Rs.)	Carriage of plants, Layout of pits and patches, Pitting & planting of plants, Patches & planting of herbs, Preparation of strips including (i/c) sowing in strips, Weeding and mulching	40,850	143
	Total Establishment Cost (Rs.)		**1,62,160**	**348**
MAINTENANCE				
3rd year	Maintenance Cost - I Year i/c Material (Rs.)	Material cost, Planting cost & other maintenance work	27,994	67
4th year	Maintenance Cost - II Year (Rs.)	Material cost, Planting cost & other maintenance works	20,711	61
5th year	Maintenance Cost - III Year (Rs.)	Material cost, Planting cost & other maintenance works	16,107	44
6th year	Maintenance Cost - IV Year (Rs.)	Maintenance cost of fencing	582	2
	Total Maintenance Cost (Rs.)		**76,215**	**224**
		Total cost of plantation	**238375**	**572**

8) Model No – CN/HP/NL/08	**Protection Model for Natural Regeneration**
Zone: All Hill Areas	

All the hill areas between 1,300 - 4,500 m amsl is characterized by dense forests, mainly conifers and broadleaved forests, Sub-Alpine vegetation i.e. herbs, grasses, shrubs and scattered small trees and Alpine pastures. However, barren/ degraded areas also occur at several locations that can be taken up for the proposed treatment. In selected areas, especially in Deodar, Blue pine, Fir, Spruce, Oaks forests and even the Sub-Alpine and Alpine areas, adequate regeneration can be observed under favorable conditions. Owing to varied disturbances by human and livestock in these areas, establishment of natural regeneration is generally poor and need immediate attention. Often, a thick layer of humus is typically present and the soil is generally moist and conducive for natural regeneration.

Under this treatment model, it is proposed to protect and conserve vegetation so as to promote ample establishment and recruitment of natural regeneration. The major focus will be on protection of special areas like patches of good natural regeneration of various conifers, broadleaved species, shrubs, etc. and thereby conserving native plant species, particularly

herbs. In natural regeneration areas, cleaning operation twice a year in the month of September and March will be carried out *viz.*, climber cutting, eradication of obnoxious weeds, unwanted species, pruning of plants, and removing dead and dying trees. The broadcasting of selected seeds will be done in the closed area to supplement the natural regeneration (Table 5.9).

List of Species for Plantation:

Trees: No plantation proposed.

Shrubs: No plantation proposed.

Herbs: No plantation proposed.

Cleaning Operations: Cleaning and un-saleable thinning (non-commercial) in regeneration areas, Climber cutting in the forests/ plantation areas, Debris collection and burning

Seeds Broadcasting: Seed (2 kg for conifer and 15 kg for Broad leaved forest per hectare)

Fencing: Cement pole/ local material wood/ Branches

Table: 5. 9 – Cost Norms for Model CN/HP/NL/08

Plantation Cost – Model CN/HP/NL/08 Protection Model for Natural Regeneration				
Year	**Item**	**Detail of works**	**Amount/ ha (Rs)**	**Man days**
Number of Plants (No.)		Seeds Broadcasting - (2 kg for conifer and 15 kg for Broad leave)		
1st Year	Advance Work Material (Rs.)	Cost of Seeds, Farm Yard Manure (FYM), Barbed wire and Reinforced Cement Concrete (RCC) poles	50,400	0
1st Year	Advance Work Labour Cost (Rs.)	Site Preparation- site preparation i/c survey & demarcation, Debris collection and burning, Preparation of inspection path, Carriage of RCC poles, Digging of holes and fIxing of poles, Stretching & fixing of Barbed wire	55,207	221
2nd year	Creation (Rs.)	Cleaning and un-saleable thinning (non-commercial) in regeneration areas, Climber cutting in the forests/ plantation areas, Broadcasting sowing in Plantation/ Regeneration areas, Preparation of fire lines 2.5 m wide, Pruning of established saplings in Plantation/regeneration 1/3 portion, Burning/Maintenance of lines 2.5 m around	22,694	85

		the fencing		
	Total Establishment Cost (Rs.)		**1,28,301**	**306**
MAINTENANCE				
3rd year	Maintenance Cost - I Year i/c Material (Rs.)	Cleaning and un-saleable thinning (non-commercial) in regeneration areas, Climber cutting in the forests/ plantation areas (50%), Broadcasting sowing in Plantation/Regeneration areas (50%), Pruning of established saplings in Plantation/ regeneration 1/12 portion, Burning/ Maintenance of lines 2.5 m around the fencing (2 times)	15,389	50
4th year	Maintenance Cost - II Year (Rs.)	Cleaning and un-saleable thinning (non-commercial) in regeneration areas, Climber cutting in the forests/ plantation areas (30%), Broadcasting sowing in Plantation/Regeneration areas (30%), Pruning of established saplings in Plantation/ regeneration 1/15 portion, Burning/Maintenance of lines 2.5 m around the fencing (2 times)	14,216	44
5th year	Maintenance Cost - III Year (Rs.)	Cleaning and un-saleable thinning (non-commercial) in regeneration areas, Climber cutting in the forests/ plantation areas (20%), Broadcasting sowing in Plantation/Regeneration areas (20%), Pruning of established saplings in Plantation/ regeneration 1/18 portion, Burning/Maintenance of lines 2.5 m around the fencing (2 times)	13,174	39
6th year	Maintenance Cost - IV Year (Rs.)	Cleaning and un-saleable thinning (non-commercial) in regeneration areas, Climber cutting in the forests/ plantation areas (15%), Broadcasting sowing in Plantation/Regeneration areas (15%), Burning/Maintenance of lines 2.5 m around the fencing (2 times)	8,146	23
	Total Maintenance Cost (Rs.)		**50,925**	**156**
		Total Cost of plantation	**1,79,226**	**462**

(B) Treatment Models for Natural Landscape in Jammu Region (Jammu and Kashmir UT)

As already stated, various natural land use and land cover categories together constitute the largest area of the Chenab Riverscape. It is represented by diverse forests, alpine pastures, scrubs, snow cover/ glaciers, rivers, wetlands, etc. Thus, the maximum number of treatment models has been proposed in the mountainous/ hill portion of the riverscape in Jammu region of Jammu and Kashmir UT. Interventions are proposed to be implemented in the entire upper basin of the Chenab River and its tributaries. Primarily, these models would be applied on forest lands under the control of SFD (J&K UT). The proposed treatment sites would mainly include areas under open forests, scrubs, grasslands, and alpine pastures or along the river and its tributaries. Details of each of the 13 treatment models prescribed in the natural landscape are presented below.

9) Model - CN/JK/NL/01	**Sub-Alpine Conservation**
Zone: Sub-Alpine and Moist Alpine Areas	

The sub-alpine and moist alpine zones are between 3,600-4,200 m amsl, and are mostly snow-bound. The temperature remains below 5 °C for 6 months in a year. The active plant growth season is of almost 4-6 months. This region is above the tree line with varied rock formations. Vegetation is dominated by grasses, herbs and scattered shrubs. A low deciduous scrub formation usually about 1 m high forms a dense cover in some patches.

Under this model, it is proposed to conserve and augment vegetation of the alpine meadows. The major focus will be on conservation of native species and livelihood generation for local communities. The conservation practices as prescribed in the Working Plan of respective Territorial Forest Division and Wildlife Management plan of protected areas will be applicable. The collection of medicinal and aromatic plants would be regulated as per the State and UT policy on the medicinal plants and accordingly the benefit will be shared with local communities. Under this model, medicinal plant will be planted at the rate of 2,400 plants/ha in the barren areas in 600/ha patches. Root slips/ seeds of native grasses will be put in continuous contour strips immediately after melting of snow in 600/ha patches. The high altitude medicinal plants require two years nursery period and third year planting in the field along with grasses. For producing quality nursery stock of desired species, native zone soil will be used and VAM will be added in nursery to boost growth either species specific or as consortium. It will be followed by two years maintenance. Harvesting can be started after 5th year onwards in a sustainable manner (Table 5.10; Fig. 5.8).

List of illustrative species for plantation

Herbs/Medicinal Plants: *Aconitum heterophyllum, A. violaceum, Eremurus himalaicus, Ainsliaea aptera, Arnebia benthamii, Dactylorhiza hatagirea, Heracleum candicans,*

Herbs: Patch number - 600, Patch size (cm) - 30 x 30 x 5. Spacing (m) - 2 x 8, Plant per patch - 4, Spacing (cm) – 20 x 20 **Grasses:** Patch number - 600, Patch size (cm) – 100 x 30 x 5. Spacing (m) – 2 x 8, Seeds per patch (gm) – 6gm, Spacing (cm) – 10 x 10 **Fencing:** Cement pole/ Local material - wood/ Branches

Polygonatum verticillatum, P. multiflorum, Fritillaria roylei, Picrorhiza kurroa, Selinum tenuifolium, Allium humile, Geranium wallichianum, Rheum australe, R. moorcroftianum, Sinopodophyllum hexandrum, Saussurea costus, etc.

Grasses and Forbs: *Festuca pratensis, F. valesiaca, Trifolium pratense, T. repens, Poa pratensis, Poa annua, Dactylis glomerata, Erianthus rufipilus, Agrostis gigantea, A. pilosula, A. munroana, Agropyron* spp., *Calamagrostismontana, Brachypodium sylvaticum, Bromus himalaicus, B. ramosus, Danthonia cumminsii, D. cachemyriana, Stipa roylei,* etc.

Fig. 5.8- Plantion Design:CN/JK/NL/01 Sub-Alpine Conservation

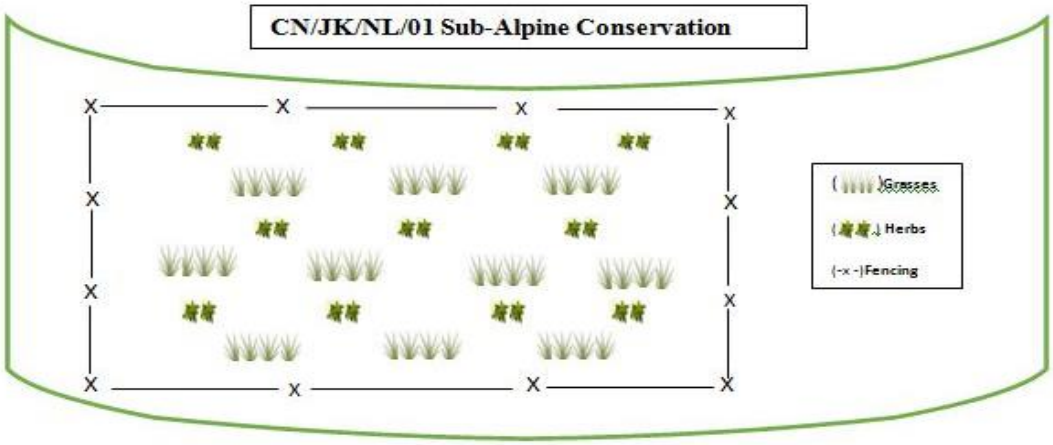


Table: 5. 10 – Cost Norms for Model CN/JK/NL/01

Plantation Cost Model- CN/JK/NL/01 Sub-Alpine Conservation				
Year	**Item**	**Details of work**	**Amount (Rs)**	**Man days**
No. of Plants (No.)		600 herbs and 1200 Grass Patches		
1st Year	Advance Work Labour Cost	Raising of Nursery including maintenance in Ist year	12,000	53
2nd year	Advance Work Labour Cost	Maintenance of Nursery including maintenance of Ist year plants and raising of plants for Ist year maintenance (30%)	8,089	34

2nd year	Advance Work Labour Cost	Site preparation - Site preparation i/c survey & demarcation, Cutting grubbing and removal of bushes, Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and fixing of poles, Stretching & fixing of Barbed wire at spacing 20cm and 4 strands Barbed wire and Reinforced Cement Concreate (RCC) poles	124589	518
3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery including maintenance of Ist year plants, Plants for Ist year maintenance (30%) and raising of plants for 2nd year maintenance (25%)	11,403	44
3rd year	Creation	Carriage of plants, Layout of patches, Patches & planting of herbs, Preparation of strips including (i/c) sowing of grasses in strips	9,617	37
	Creation	Carriage of plants, Layout pits, Planting of plants and shrubs	0	0
	Total Establishment Cost (Rs.)		**1,65,698**	**686**
Maintenance				
4th year	Maintenance Cost - I Year	Maintenance of Nursery including maintenance of plants for Ist year maintenance (30%), 2nd year maintenance (25%) and raising of plants for 3rd year maintenance (15%), Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	9,261	34
5th year	Maintenance Cost - II Year (Rs.)	Maintenance of Nursery including 2nd year maintenance (25%) and 3rd year maintenance (15%) Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	5,741	19
6th year	Maintenance Cost - III Year (Rs.)	Maintenance of Nursery including maintenance of 3rd year maintenance, Carriage of plants, Pitting & planting of plants & planting of herbs, Watch and ward i/c repair of fencing, Weeding and mulching	2,777	9
7th year	Maintenance Cost - IV Year (Rs.)	Watch and ward i/c repair of fencing	12,156	36

	Total Maintenance Cost (Rs.)		**29,936**	**98**
		Grand Total	**1,95,634**	**784**

10) Model No – CN/JK/NL/02	**Sub-Alpine Enrichment**
Zone: Sub-Alpine Zone	

The sub-alpine zone occurs between 2,800 - 3,600 m amsl in the Chenab Riverscape of Jammu region (J&K UT) and is covered with snow for 4-5 months. The temperature remains below 5°C for around 4 months in a year. Vegetation in sub-alpine zone is dominated by *Betula utilis, Abies pindrow, Pinus wallichiana, Acer* spp., *Quercus* spp., herbs, grasses, and shrubs. Area is sloppy and generally soil depth is very low.

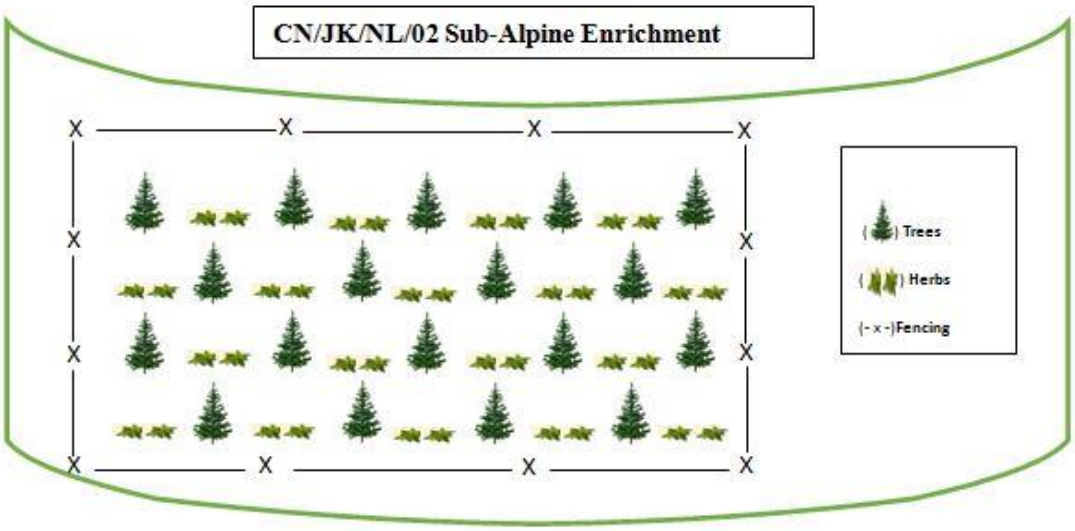
Under this model, it is proposed to conserve and augment vegetation in sub-alpine zone by adopting specific interventions to enrich such areas. The major focus will be on conservation and enrichment of native species besides generation of sustainable livelihoods for local communities. Conservation and enrichment practices as prescribed in the Working Plan of respective Territorial Forest Division/Wildlife Management Plan of a protected area will be applicable. The collection of medicinal and aromatic plants would be regulated as per the State's policy on medicinal plants and accordingly the accrued benefit will be shared with local communities. In this model, native trees @ 200 plants/ha at 6 x 8 m spacing and medicinal plant species @ 800 plants/ha at 6 x 8 m spacing in 200/ha patches will be planted in barren areas. The high altitude trees require around 3 years nursery period and planting will be done in the 4^{th} year. For producing quality nursery stock of desired species, native zone soil will be used in conifer species and VAM will be added in other forestry species either species specific or as consortium. To synchronize planting of trees and medicinal plants in the 4^{th} year, nursery of high altitude medicinal plants will be raised 2^{nd} year onwards. The plants will be maintained in the field during 5^{th}, 6^{th} and 7^{th} years of project implementation (Table 5.11; Fig. 5.9).

List of Species for Plantation

Trees: *Betula utilis, Pinus wallichiana, Acer caesium, A. acuminatum, A. pictum, Corylus jacquemontii, Prunus cornuta, Quercus semecarpifolia, Abies pindrow*,etc.

Herbs/Medicinal Plants: *Eremurus himalaicus, Aconitum heterophyllum, Arnebia benthamii, Dactylorhiza hatagirea, Heracleum candicans, Polygonatum verticillatum, P. cirrhifolium, P. multiflorum, Selinum tenuifolium, Allium humile, Geranium wallichianum, Bergenia stracheyi, Phytolacca acinosa, Hyoscyamus niger, Angelica glauca, Picrorhiza kurroa, Fritillaria roylei, Sinopodophyllum hexandrum, Trillium govanianum,* etc.

Fig. 5.9- Plantation Design: CN/JK/NL/02 Sub-Alpine Enrichment



Trees: Plants: 200 no/ha, Spacing (m) - 6 x 8, Pit size (cm) – 30 x 30 x 30
Herbs: Plants: 800/ha, Patch no – 200/ha, Patch size (cm) - 30 x 30 x 5. Spacing (m) - 6 x 8, plant per patch - 4, Spacing (cm) – 20 x 20
Fencing: Cement pole/ local material Wood/ Branches

Table: 5. 11 – Cost Norms for Model CN/JK/NL/02

Plantation Cost Model-CN/JK/NL/02 Sub-Alpine Enrichment				
Year	**Item**	**Details of work**	**Amount (Rs)**	**Man days**
No. of Plants (No.)		200 Plants, 800 herbs and 200 Grass Patches		
1st year	Advance Work Labour Cost	Raising of Nursery including Maintenance in Ist year	6,400	28
2nd year	Advance Work Labour Cost	Maintenance of Nursery including maintenance of Ist year plants and raising of plants for Ist year maintenance (30%)	4,920	20
2nd year	Advance Work Labour Cost	Site preparation - Site preparation i/c survey & demarcation, Cutting grubbing and removal of bushes, Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and fixing of poles, Stretching & fixing of Barbed wire at spacing 20cm and 4 strands Barbed wire and Reinforced Cement Concreate (RCC) poles	124589	554

3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery including maintenance of I st year plants, plants for I st year maintenance (30%) and raising of plants for 2nd year maintenance (25%)	5,610	22
3rd year	Creation	Carriage of plants, Layout of patches, Patches & planting of herbs, Preparation of strips including (i/c) sowing of grasses in strips	1,603	6
	Creation	Carriage of plants, Layout of pit, digging & refilling of pit, Planting of plants and shrubs in pits	6,718	26
	Total Establishment Cost (Rs.)		**1,49,840**	**656**
Maintenance				
4th year	Maintenance Cost - I Year	Maintenance of Nursery including maintenance of plants for Ist year maintenance (30%), 2nd year maintenance (25%) and raising of plants for 3rd year maintenance (15%), Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	15,571	56
5th year	Maintenance Cost - II Year (Rs.)	Maintenance of Nursery including 2nd year maintenance, (25%) and 3rd year maintenance, (15%) Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	14,375	49
6th year	Maintenance Cost - III Year (Rs.)	Maintenance of Nursery including maintenance of 3rd year maintenance, Carriage of plants, Pitting & planting of plants & planting of herbs, Watch and ward i/c repair of fencing, Weeding and mulching	13,395	42
7th year	Maintenance Cost - IV Year (Rs.)	Watch and ward i/c repair of fencing	12155.9158	36
	Total Maintenance Cost (Rs.)		**55,497**	**184**
		Grand Total	**2,05,337**	**840**

This model is recommended for the altitudinal zone between 1,700 – 3,250 m asml. This conifer forests type consists of open pure *Pinus gerardiana*, Blue pine, Deodar and Spruce forests. This zone is characterized by steep slopes, exposed sites and loose strata. The soil depth is very low. The rainfall rarely exceeds 1000 mm. This type mainly occurred in Gulabgarh area of Kishatwar district in Chenab River catchment.

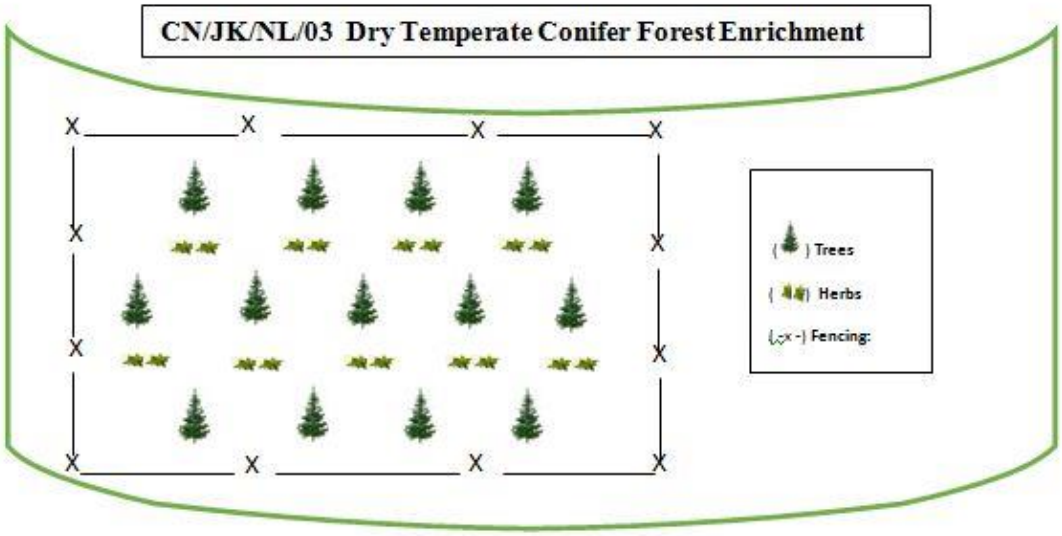
The suggested plantation model for this site is Dry Temperate Conifer Forest Enrichment model. Planting of 400 plants/ha of native conifer species and 400 patches of medicinal herbs will be done. The trees will be planted at a spacing of 5 x 5 m in the blank patches. *Pinus gerardiana* is specially recommended for planting in Kishtwar district to provide ultimate benefits to local communities. Between two rows of trees of the treatment site, medicinal plants will be planted in patches (30 x 30 cm). The collection of medicinal and aromatic plants in protected areas would be regulated as per the State's policy on medicinal plants and in accordance with the rights of local communities for ultimately generating additional income for the native communities. Most of conifer plants require about 3 years of nursery period and planting will be done in the 4^{th} year. For producing quality nursery stock of desired species, native zone soil will be used in conifer species and VAM will be added in trees, shrubs and herbs either species specific or as consortium. To synchronize planting of trees and medicinal herbs in 4^{th} year, the nursery for selected herbs will be raised 2^{nd} year onwards. The plants will be maintained in the field during 5^{th}, 6^{th} and 7^{th} years of the project implementation (Table 5.12; Fig. 5.10).

Trees: *Pinus gerardiana, Pinus wallichiana, Cedrus deodara, Fraxinus xanthoxyloides, Alnus nitida, Celtis australis, Olea ferruginea, Quercus baloot, Picea integerrima, Picea smithiana, Abies pindrow,*etc.

Herbs:*Aconitum heterophyllum, Picrorhiza kurroa, Heracleum candicans, Angelica glauca, Geranium wallichianum, Viola canescens, Valeriana jatamansi, Heracleum candicans, Sinopodophyllum hexandrum, Polygonatum verticillatum, Allium stracheyi, Trillium govanianum, Selinum tenuifolium, Selinum vaginatum,* etc.

11) Model No – CN/JK/NL/03	**Dry Temperate Conifer Forest Enrichment**
Zone: Dry Temperate Area	

Fig. 5.10 - Plantation Design/ Cost norms: CN/JK/NL/03 Dry Temperate Conifer Forest Enrichment



Trees:400, Spacing (m)-5x5, Pit size (cm) – 45x45x45

Herbs: Plants: 1600 Patch no- 400, Patch size (cm) - 30x30x5. Spacing (m)-5x5, plant per patch- 4, Spacing (cm)- 20x20

Fencing: (- x – x-) Cement pole/ local material wood/ Branches

Table: 5. 12 – Cost Norms for Model CN/JK/NL/03

Plantation Cost Model-CN/JK/NL/03 Dry Temperate Conifer Forest Enrichment				
Year	**Item**	**Details of work**	**Amount (Rs)**	**Man days**
No. of Plants (No.)		400 Plants, 1600 herbs and 400 Grass Patches		
1st Year	Advance Work Labour Cost	Raising of Nursery including Maintenance in Ist year	12,800	57
2nd year	Advance Work Labour Cost	Maintenance of Nursery including maintenance of Ist year plants and raising of plants for Ist year maintenance (30%)	9,840	40

2nd year	Advance Work Labour Cost	Site preparation - Site preparation i/c survey & demarcation, Cutting grubbing and removal of bushes, Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and Fixing of poles, Stretching & fixing of Barbed wire at spacing 20cm and 4 strands Barbed wire and Reinforced Cement Concreate (RCC) poles	124589	554
3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery including maintenance of I st year plants, plants for I st year maintenance (30%) and raising of plants for 2nd year maintenance (25%)	11,220	44
3rd year	Creation	Carriage of plants, Layout of patches, Patches & planting of herbs, and Preparation of strips including (i/c) sowing of grasses in strips	3,206	12
	Creation	Carriage of plants, Layout of pit, digging & refilling of pit, Planting of plants and shrubs in pits	13,437	52
	Total Establishment Cost (Rs.)		**1,75,091**	**760**
Maintenance				
4thyear	Maintenance Cost - I Year	Maintenance of Nursery including maintenance of plants for I st year maintenance (30%), 2nd year maintenance. (25%) and raising of plants for 3rd year Maintenance. (15%), Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	21,219	77
5th year	Maintenance Cost - II Year (Rs.)	Maintenance of Nursery including 2nd year maintenance (25%) and 3rd year maintenance (15%), Carriage of plants, Pitting & planting of plants & Planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	18,134	61

6th year	Maintenance Cost - III Year (Rs.)	Maintenance of Nursery including maintenance of 3rd year maintenance, Carriage of plants, Pitting & planting of plants & planting of herbs, Watch and ward i/c repair of fencing, Weeding and mulching	15,429	49
7th year	Maintenance Cost - IV Year (Rs.)	Watch and ward i/c repair of fencing	12155.9158	36
	Total Maintenance Cost (Rs.)		**66,937**	**223**
		Grand Total	**2,42,028**	**983**

12) Model No – CN/JK/NL/04	**Temperate Conifer Forest**
Zone: Moist Temperate Area	

The moist temperate area lies between 1,800-3,500 m asml. This zone is characterized by dense forests, mainly dominated by conifer species. However, barren and degraded lands also too occur at several places which will be taken up for proposed treatment. In some areas, especially in fir and spruce forests, soil is covered with a thick layer of humus as the decomposition rate is very slow in these areas. The suggested treatment model for these areas is being referred as the Temperate Conifer Forest Model.

Planting of 400/ha plants of various tree species and 400/ha shrub species will be carried out per ha. In addition, 400/ha patches of medicinal plants with 1600 plants/ha will also be planted in the treatment site. The major focus will be on the conservation and development of native species and livelihood generation for local communities. The collection of medicinal and aromatic plants in protected areas would be regulated as per the State and UT policy on medicinal plants and in accordance with the rights of local communities. Most of conifer plants require around 3 years of nursery period and planting will be done in the 4th year. For producing quality nursery stock of desired species, native zone soil will be used in conifer species and VAM will be added in shrubs and herbs either species specific or as consortium. To synchronize planting of trees, medicinal herbs and shrubs in 4th year, the nursery for selected herbs and shrubs will be raised 2nd year onwards. The plants will be maintained and monitored in the field during 5th, 6th and 7th year of the project implementation (Table 5.13; Fig. 5.11)

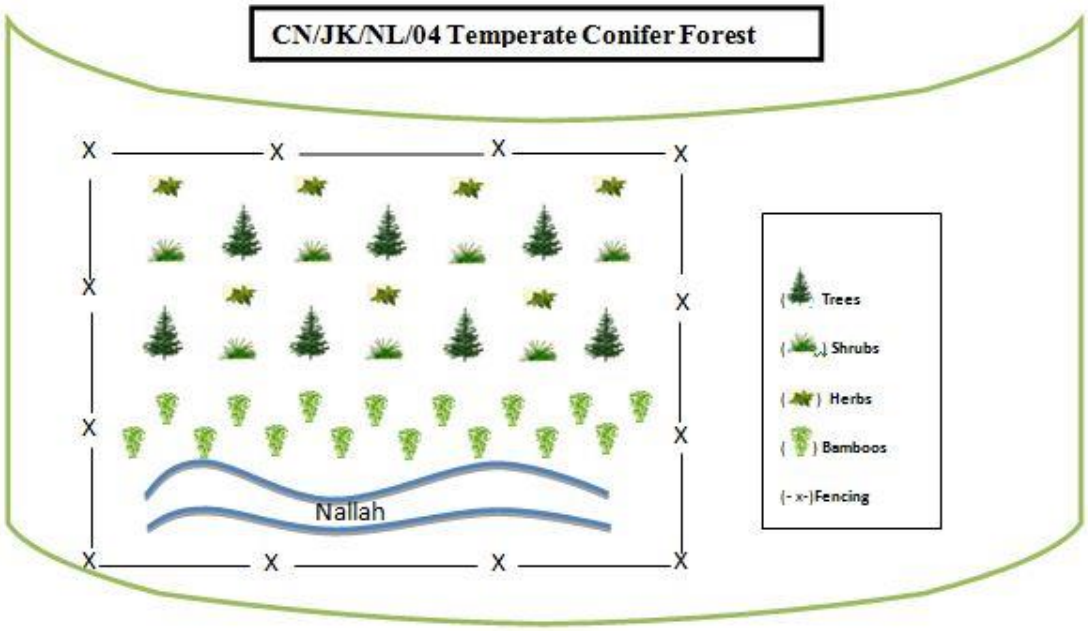
List of Species for Plantation

Trees:*Cedrus deodara, Pinus wallichiana, Picea smithiana, Taxus wallichiana, Cupressus torulosa,* etc.

Shrubs: *Daphne papyracea, Prinsepia utilis, Rosa macrophylla, R. sericea, Debregeasia longifolia, Cotoneaster bacillaris, Viburnum cotinifolium, Cornus oblonga, Syringa emodi, Indigofera heterantha, Desmodium elegans, Hypericum oblongifolium, Inula cuspidata, etc.*

Herbs:*Aconitum heterophyllum, Picrorhiza kurroa, Heracleum candicans, Angelica glauca, Geranium wallichianum, Polygonatum verticillatum, Bergenia ciliata, Viola canescens, Trillium govanianum, Phytolacca acinosa, Valeriana jatamansi, Hedychium spicatum, etc.*

Fig. 5.11- Plantation Design: CN/JK/NL/04– Temperate Conifer Forest



Trees: 400 No/ha, Spacing (m) – 5 x 5, Pit size (cm) – 45 x 45 x 45
Shrubs: Plants: 400/ha., No. of Pit - 400, Spacing (m) - 5 x 5, Pit size (cm) – 30 x 30 x 30 (gap filling)
Herbs: Plants: 1600/ha, Patch no – 400/ha, Patch size (cm) - 30 x 30 x 5. Spacing (m) – 5 x 5, plant per patch - 4, Spacing (cm) – 20 x 20
Fencing: Cement pole/ local material wood/ Branches

Table: 5. 13 – Cost Norms for Model CN/JK/NL/04

Plantation Cost Model-CN/JK/NL/04 – Temperate Conifer Forest				
Year	**Item**	**Details of work**	**Amount (Rs.)**	**Man days**
No. of Plants (No.)		900 Plants, 1600 herbs and 400 Grass Patches		
1st Year	Advance Work Labour Cost	Raising of Nursery including maintenance in Ist year	18,800	84
2nd year	Advance Work Labour Cost	Maintenance of Nursery including maintenance of Ist year plants and raising of plants for Ist year maintenance (30%)	14,060	58
2nd year	Advance Work Labour Cost	Site preparation - Site preparation i/c survey & demarcation , Cutting grubbing and removal of bushes, Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and Fixing of poles, Stretching & fixing of Barbed wire at spacing 20cm and 4 strands Barbed wire and Reinforced Cement Concreate (RCC) poles	124589	518
3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery including maintenance of Ist year plants, plants for Ist year maintenance (30%) and raising of plants for 2nd year maintenance (25%)	15,742	61
3rd year	Creation	Carriage of plants, Layout of patches, Patches & planting of herbs, Preparation of strips including (i/c) sowing of grasses in strips	3,206	12
	Creation	Carriage of plants, Layout of pit, Digging & refilling of pit, Planting of plants and shrubs in pits	30,232	117
	Total Establishment Cost (Rs.)		**2,06,629**	**850**
Maintenance				

4th year	Maintenance Cost - I Year	Maintenance of Nursery including maintenance of plants for I st year maintenance (30%), 2nd year maintenance (25%) and raising of plants for 3rd year maintenance (15%), Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	28,907	105
5th year	Maintenance Cost - II Year (Rs.)	Maintenance of Nursery including 2nd year maintenance (25%) and 3rd year maintenance (15%), Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	23,891	81
6th year	Maintenance Cost - III Year (Rs.)	Maintenance of Nursery including maintenance of 3rd year maintenance, Carriage of plants, Pitting & planting of plants & planting of herbs, Watch and ward i/c repair of fencing, Weeding and mulching	18,936	60
7th year	Maintenance Cost - IV Year (Rs.)	Watch and ward i/c repair of fencing	12156	36
	Total Maintenance Cost (Rs.)		**83,890**	**282**
		Grand Total	**2,90,519**	**1,132**

13) Model No – CN/JK/NL/05	**Temperate Mixed Forest**
Zone: Moist Temperate Area	

The moist temperate forest area occurs between 1,800 - 3,500 m asml. Dominant species of the area are: *Betula alnoides, Aesculus indica, Quercus leucotricophora, Q. floribunda, Q. semecarpifolia, Alnus nitida, Acer caesium, A. pictum, A. cappadocicum, A. acuminatum, Ulmus wallichiana, Pinus wallichiana, Cedrus deodara, Picea smithiana, Abies pindrow, A. spectabilis* and *Prunus cornuta*. Most of these species form a pure stand. This zone is often characterized by degraded stretches along the river banks running close to the area of dense

temperate forests, mainly of conifers. It experiences snowfall and rainfall several times during winter months and enjoys a cool climate with plenty of monsoon rains.

The annual precipitation in this zone is between 1,000 - 1,200 mm. In some areas, snow lasts till March. The soil in many places is shallow, exposed and prone to erosion. This zone is heavily grazed by domestic animals and cause huge damage to the vegetation. Besides this, road construction and other developmental activities also cause severe soil erosion, resulting loss of biodiversity. There is heavy dependence of local communities on the forest of Chenab Riverscape of various purposes. Further, owing to several famous tourist spots *viz*., Bhadarwah, Doda, Patni Top, etc. and the enhanced tourism activities in such fragile zone within the Riverscape cause damage to vegetation and disturbance to wild fauna.

The temperate mixed forest treatment model has been proposed specifically for the forest gap barren and degraded patches within the temperate zone. Planting of trees @400/ha belonging to conifers and broadleaved species will be carried out in the forest gaps of barren and degraded patches. In this model preferably broadleaved plants will be planted in general and conifer plants can be planted on the ridges and shallow soil depth area. The native shrubs @400 plants/ha will be planted between the tree plantation. The medicinal plants will also be planted in patches @ 4 plants/ patch and that means planting of total of 1,600 medicinal plants/ ha will be planted. The major focus of proposed treatment model will be on the conservation and propagation of native species alongside improved livelihoods for local communities. Most of conifer plants require about 3 years of nursery period and planting will be done in the 4^{th} year. For producing quality nursery stock of desired species, native zone soil will be used in conifer and broad leaved species and VAM will be added in shrubs and herbs either species specific or as consortium. To synchronize planting of trees, medicinal herbs and shrubs in 4^{th} year, the nursery for selected herbs and shrubs will be raised 2^{nd} year onwards. The plants will be maintained in the field during 5^{th}, 6^{th} and 7^{th} years of the project implementation. The collection of medicinal and aromatic plant species in protected areas would be regulated as per the State and UT policy on medicinal plants and in accordance with the rights of local communities (Table 5.14; Fig. 5.12)

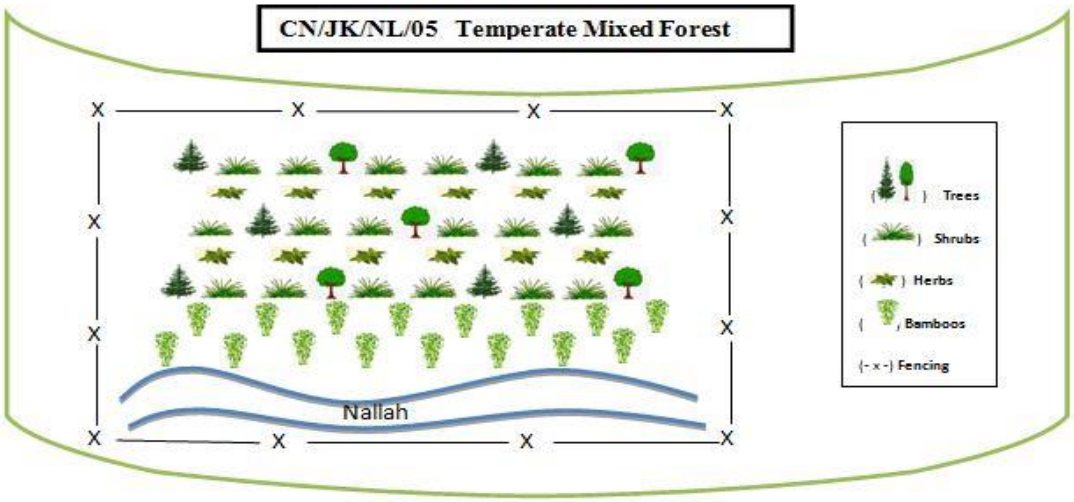
List of Species for Plantation

Trees: *Cedrus deodara, Pinus wallichiana, Picea smithiana, Taxus wallichiana, Aesculus indica, Prunus cerasoides, Juglans regia, Fraxinus micrantha, Acer* spp., *Betula alnoides, Myrica esculenta, Cornus macrophylla, Alnus nitida, Ulmus wallichiana, Quercus oblongata, Q. floribunda, Q. semecarpifolia, Olea ferruginea, Neolitsea pallens, Lyonia ovalifolia,* etc.

Shrubs: *Daphne papyracea, Prinsepia utilis, Rosa macrophylla, R. sericea, Parrotiopsis jacquemontiana, Viburnum nervosum, Debregeasia longifolia, Cotoneaster bacillaris, C. acuminatus, Plectranthus rugosus, Dodoniea viscosa, Hypericum oblongifolium, Rubus foliolosus, R. niveus, Zanthoxylum armatum, Deutzia staminea, Spiraea canescens, Berberis* spp., etc.

Herbs: *Aconitum heterophyllum, Eremurus himalaicus, Heracleum candicans, Angelica glauca, Geranium wallichianum, Polygonatum verticillatum, P. cirrhifolium, Sinopodophyllum hexandrum, Bergenia ciliata, Viola canescens, Valeriana jatamansii, Hedychium spicatum, Trillium govanianum, Ajuga bracteosa,* etc.

Fig. 5.12- Plantation Design/ Cost Norms: CN/JK/NL/05 Temperate Mixed Forest



Trees: 400, Spacing (m) - 5 x 5, Pit size (cm) – 45 x 45 x 45 (50;50 of B/L & Conifer)

Shrubs: Plants: 400, No. of Pit - 400, Spacing (m) - 2 x 5, Pit size (cm) – 30 x 30 x 30

Herbs: Plants: 1600, Patch no – 400, Patch size (cm) - 30 x 30 x 5. Spacing (m) - 3 x 5, plant per patch - 4, Spacing (cm) - 20 x 20

Fencing: Cement pole/ local material wood/ Branches

Table: 5. 14 – Cost Norms for Model CN/JK/NL/05

Plantation Cost Model- CN/JK/NL/05 – Temperate Mixed Forest				
Year	**Item**	**Details of work**	**Amount (Rs.)**	**Man days**
No. of Plants (No.)		900 Plants, 1600 herbs and 400 Grass Patches		
1st Year	Advance Work Labour Cost	Raising of Nursery including Maintenance in Ist year	21,500	96
2nd year	Advance Work Labour Cost	Maintenance of Nursery including maintenance of Ist year plants and raising of plants for Ist year maintenance (30%)	15,890	66

2nd year	Advance Work Labour Cost	Site preparation - Site preparation i/c survey & demarcation, Cutting grubbing and removal of bushes, and weeds Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and Fixing of poles, Stretching & fixing of Barbed wire at spacing 20cm and 4 strands, Barbed wire and Reinforced Cement Concreate (RCC) poles	124589	518
3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery including maintenance of I st year plants, Plants for I st year maintenance (30%) and raising of plants for 2nd year maintenance (25%)	16,824	65
3rd year	Creation	Carriage of plants, Layout of patches, Patches & planting of herbs, Preparation of strips including (i/c) sowing of grasses in strips	3,206	12
	Creation	Carriage of plants, Layout of pits, Digging & refilling of pit, and Planting of plants and shrubs in pits	30,232	117
	Total Establishment Cost (Rs.)		**214,641**	**874**
Maintenance				
4th year	Maintenance Cost - I Year	Maintenance of Nursery including maintenance of plants for I st year maintenance (30%), 2nd year maintenance. (25%) and rising of plants for 3rd year maintenance. (15%), Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	29,679	108
5th year	Maintenance Cost - II Year (Rs.)	Maintenance of Nursery including 2nd year maintenance (25%) and 3rd year maintenance, (15%) Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	24,068	82

6th year	Maintenance Cost - III Year (Rs.)	Maintenance of Nursery including maintenance of 3rd year maintenance, Carriage of plants, Pitting & planting of plants & planting of herbs, Watch and ward i/c repair of fencing, Weeding and mulching	18,936	60
7th year	Maintenance Cost - IV Year (Rs.)	Watch and ward i/c repair of fencing	12156	36
	Total Maintenance Cost (Rs.)		**84,839**	**285**
		Grand Total	**2,99,479**	**1,159**

14) Model No – CN/JK/NL/06	**Pasture and Grazing Land Development**
Zone: Sub-Tropical to Temperate Areas	

These areas located between 600-2,800 m, particularly on southern slope and around habitations are characterized by pasture and grazing lands. This zone very rarely experiences snowfall and rainfall several times during winter months and enjoys a moderate climate with plenty of monsoon rains. Annual precipitation is about 1,000-1,200 mm. In some areas, snow lasts till spring season. The soil is shallow, exposed and prone to erosion, particularly in moderate to steep slopes. This zone is located near habilitations and heavily grazed by livestock and cause huge damage to the vegetation and results into heavy soil erosion. Besides disturbance by livestock, road construction and other developmental activities also cause significant soil degradation and damage to native flora by proliferation of invasive alien species. The local communities are largely dependent on these grasslands in the Chenab Riverscape. This zone also severely suffers on account of enhanced tourism activities in several popular tourist destinations *viz*., Kishtawar, Bhadarwah, Doda, Patni Top etc. causing damage to flora and disturbance to fauna.

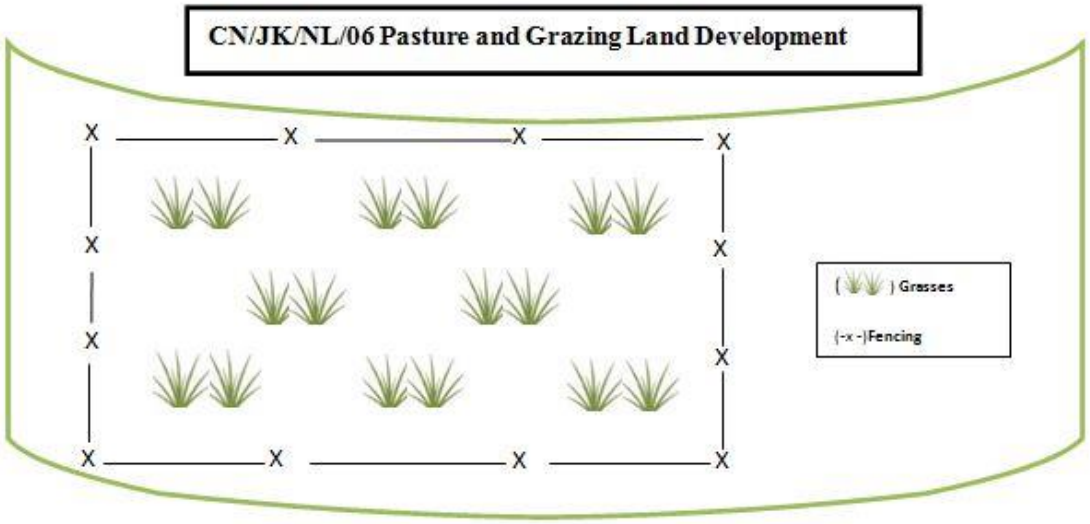
Under this model, pasture and grazing land development are proposed by protection, development and enrichment of areas within this zone. Suitable grass species will be planted/ sowing of seeds after carrying out necessary land development works like trenching/ terracing/ moisture conservation measures, etc. besides removal of weeds and unpalatable grasses. The proposed treatment model mainly includes plantation of native and nutritionally important grass species. In this model, grass sowing in furrows/ strips of 100 x 30 x 5 cm along contours at interval of 2 m apart is proposed. Selected species will be raised / maintained in the nursery during 1st year and planting will be done in the second year. The grasses will be replenished in the field during 3rd and 4th years (Table 5.15; 5.13).

List of Species for Plantation

Grasses and Forbs: *Festuca pratensis, Trifolium pratense, T. repens, Poa pratensis, P. annua, Dactylis glomerata, Erianthus rufipilus, Agrostis* spp., *Agropyron* spp., *Calamagrostis* spp., *Koeleria* spp., *Saccharum spontaneum, Chrysopogon gryllus, Arundinella nepalensis, A. pumila, Themeda anathera, Cymbopogon distans, Setaria glauca, Alopecurus aequalis, A. nepalensis, Bothriochloa pertusa, B. intermedia,* etc.

Shrubs: *Drepanostachyum falcatum*

Fig. 5.13- Plantation Design/ Cost Norms: CN/JK/NL/06 - Pasture and Grazing Land Development



Grasses: Patch no -2000, Patch size (cm) – 100 x 30 x 5. Spacing (m) – 2 x 2, Seeds per patch (gm) - 6, seed, Spacing (cm) – 10 x 10, Type - Staggered

Fencing: Cement pole/ local material wood/ Branches/ Brushwood fencing

Table: 5. 15 – Cost Norms for Model CN/JK/NL/06

Plantation Cost Model- CN/JK/NL/06 - Pasture and Grazing Land Development				
Year	**Item**	**Details of work**	**Amount (Rs)**	**Man days**
No. of Plants (No.)		2000 Grass Patches		
1st Year	Advance Work Labour Cost	Raising of Nursery including Maintenance in Ist year	0	0

2nd year	Advance Work Labour Cost	Maintenance of Nursery including maintenance of Ist year plants and raising of plants for Ist year maintenance (30%)	0	
2nd year	Advance Work Labour Cost	Site preparation - Site preparation i/c survey & demarcation, Cutting grubbing and removal of bushes, Preparation of inspection path, Carriage of fence post (RCC poles), Digging of holes and Fixing of poles, Stretching & fixing of Barbed wire at spacing 20cm and 4 strands, Barbed wire and Reinforced Cement Concreate (RCC) poles	124589	554
3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery including maintenance of Ist year plants, plants for Ist year maintenance (30%) and raising of plants for 2nd year maintenance (25%)	0	0
3rd year	Creation	Carriage of plants, Layout patches, Patches & planting of herbs, Preparation of strips including (i/c) sowing of grasses in strips	16,029	62
	Creation	Carriage of plants, Layout of pits, Digging & refilling of pit, Planting of grasses in pits	0	0
	Total Establishment Cost (Rs.)		**1,40,617**	**616**
Maintenance				
4th year	Maintenance Cost - I Year	Maintenance of Nursery including maintenance of plants for Ist year maintenance (30%), 2nd year maintenance (25%) and raising of plants for 3rd year maintenance (15%), Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	15,068	55
5th year	Maintenance Cost - II Year (Rs.)	Maintenance of Nursery including 2nd year maintenance (25%) and 3rd year maintenance, (15%) Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	15,205	52

6th year	Maintenance Cost - III Year (Rs.)	Maintenance of Nursery including maintenance of 3rd year maintenance, Carriage of plants, Pitting & planting of plants & planting of herbs, Watch and ward i/c repair of fencing, Weeding and mulching	14,306	45
7th year	Maintenance Cost - IV Year (Rs.)	Watch and ward i/c repair of fencing	12,156	36
	Total Maintenance Cost (Rs.)		**56,735**	**188**
		Grand Total	**1,97,353**	**804**

15) Model No – CN/JK/NL/07	**Himalayan Chir Pine Forest**
Zone: Sub-Tropical to Lower Temperate Area	

In this zone of Jammu region (J&K UT) particularly on southern aspect Chir pine is the dominant species. The altitude ranges is between 800 - 1,800 m asml and annual rainfall varies from 900 - 1,200 mm. In these areas, high temperature and humidity conditions prevail during summer. Ground is densely covered with pine needles during winter to summer season and such areas are prone to forest fires. Grasses flush during summer and monsoon season. The heavy rains in monsoon lead into severe soil erosion in this zone, ultimately results into high rate of sedimentation in Chenab River and its tributaries. This is one of the major causes of siltation of dams and floods in Jammu plains. Open and degraded forests on southern aspect with sparse vegetation coupled with agriculture on steep slopes, construction and developmental activities are prominent reasons behind large scale soil erosion in this zone. These areas experience heavy rainfall during monsoon season and modest rainfall during the winter season. Snowfall occurs in cooler aspects of higher reaches, but the snow stays for a few days only. Most of the rainwater flows down the streams washing away top soil especially on sloppy sites. The soil is acidic in nature and shallow on steep slopes while valleys have deep soil. The biotic pressure in terms of livestock grazing, and fuel wood and tree fodder collection is conspicuous. Suitable Forestry Interventions in this zone can immensely help in improvement of pastures and grazing lands besides checking soil erosion and siltation into Chenab River and its tributaries.

For such areas in this zone, the Himalayan Chir Pine Forest Model is proposed. Grass species such as *Heteropogon contortus*, *Arundinella pumila*, *Themeta anathera*, *Chrysopogon serrulatus*, etc. are proposed to be sown in the treatment site, particularly towards the river or nallah side. The area will be planted with *Pinus roxburghii* mainly in drier sites with shallow soil depth whereas broadleaved species like *Quercus oblongata*, *Lyonia ovalifolia*, Bamboo spp., etc. on moist sites are proposed to be planted at 5 x 5 m spacing. A total of 300 plants of

tree/ha, 100 bamboo species /ha along with 300 plants of shrubs/ha and 800 patches of grasses will be planted 2m apart in staggered fashion. Chir pine and associated broadleaved species require around 2 years nursery period and planting will be done in the 3rd year. For producing quality nursery stock of desired species, native zone soil will be used in conifer species and VAM will be added in shrubs and herbs either species specific or as consortium. The plants will be maintained in the field during 4th, 5th and 6th years. The fire line of width 5m both side along the fencing of the plantation area will be maintained twice a year (Table 5.16; Fig. 5.14).

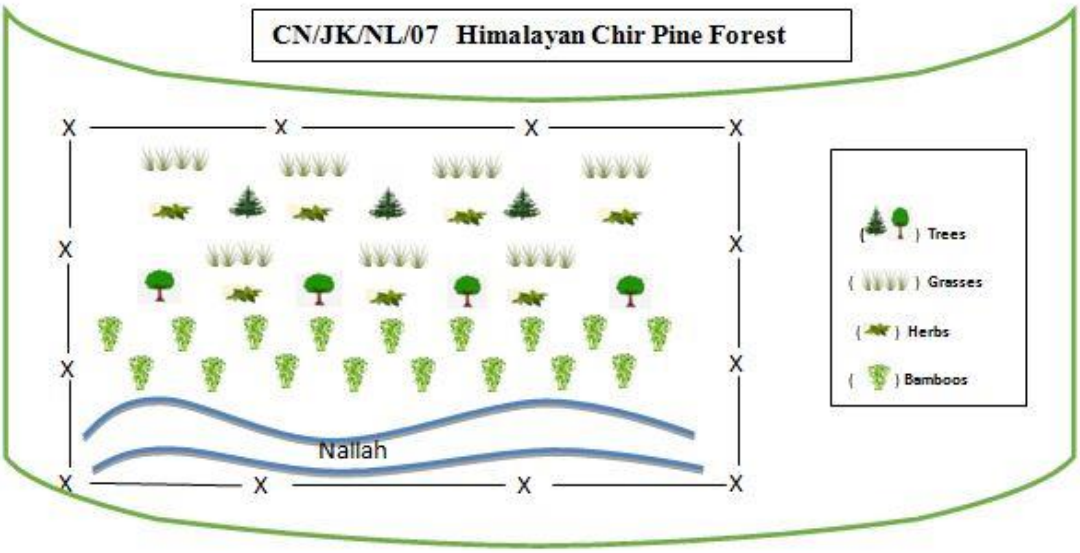
List of Species for Plantation

Trees: *Pinus roxburghii, Quercus oblongata, Lyonia ovalifolia, Dendrocalamus strictus, Dendrocalamus hamiltonii, Bambusa* spp., *Holoptelea integrifolia, Ficus benghalensis, F. racemosa, F. rumphii, Albizia* spp., *Alstonia scholaris, Phyllanthus emblica, Diospyros montana, Bauhinia variegata, Olea ferruginea, Grewia optiva, Pyrus pashia, Azadirachta indica, Cinnamomum tamala, Mallotus philippensis, Aegle marmelos, Ulmus wallichiana, Punica granatum,* etc.

Shrubs: *Justicia adhatoda, Myrsine africana, Murraya koenigii, M. paniculata, Ricinus communis, Tinospora cordifolia, Woodfordia fruticosa, Maesa indica, Nyctanthes arbor-tristris, Vitex negundo, Carissa opaca, Berberis lycium, B. aristata, Ziziphus jujuba, Desmodium elegans, Tephrosia hamiltonii,* etc.

Grasses and Forbs: *Heteropogon contortus, Chrysopogon serrulatus, Boerhavia diffusa,Festuca pratensis,Festuca arundinacea***,** *Poa pratensis, Erianthus filifolius, E. rufipilus, Agrostis gigantea, Setaria glauca, Dichanthium annulatum, Digitaria cruciata, Phleum pratense***,** *Themeda anathera, Arundo donax, Cymbopogon martini, Phragmites karka, Bothriochloa pertusa, B. intermedia, Eulaliopsis binata, Calamagrostis emodensis, Thysanolaena maxima,* etc.

Fig. 5.14- Plantation Design: CN/JK/NL/07 Himalayan Chir Pine Forest



Trees: 300 No, Spacing (m) - 5 x 5, Pit size (cm) – 45 x 45 x 45

Bamboo: 100, Spacing (m) - 5 x 5, Pit size (cm) – 45 x 45 x 45 along Nallah (if available)

Shrubs: Plants: 300 no., No. of Pit - 300, Spacing (m) - 5 x 5, Pit size (cm) – 30 x 30 x 30

Grasses: Patch no - 800, Patch size (cm) – 100 x 30 x 5. Spacing (m) – 2 x 5, Seeds per patch (gm) - 6, seeds, Spacing (cm) - 10 x 10, Type – Staggered

Fencing: Cement pole/ local material wood/ Branches /Brushwood fencing

Table: 5. 16 – Cost Norms for Model CN/JK/NL/07

Plantation Cost Model-CN/JK/NL/07 Himalayan Chir Pine Forest				
Year	**Item**	**Details of work**	**Amount (RS)**	**Man days**
No. of Plants (No.)		800 Plants and 200 Grass Patches		
1st Year	Advance Work Labour Cost	Raising of Nursery including maintenance in Ist year	12,000	53
2nd year	Advance Work Labour Cost	Maintenance of Nursery including maintenance of Ist year plants and raising of plants for Ist year maintenance (30%)	6,800	

2nd year	Advance Work Labour Cost	Site preparation - Site preparation i/c survey & demarcation, Cutting grubbing and removal of *Lantana* or other weeds and bushes, Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and Fixing of poles, Stretching & fixing of Barbed wire at spacing 20cm and 4 strands, Barbed wire and Reinforced Cement Concreate (RCC) poles	1,24,589	554
3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery including maintenance of Ist year plants, plants for Ist year maintenance (30%) and raising of plants for 2nd year maintenance (25%)	8,197	32
3rd year	Creation	Carriage of plants, Layout patches, Patches & planting of herbs, Preparation of strips including (i/c) sowing of grasses in strips	6,411	25
	Creation	Carriage of plants, Layout of pits, Digging & refilling of pit, Planting of plants and shrubs in pits	26,873	104
	Total Establishment Cost (Rs.)		**1,84,871**	**768**
Maintenance				
4th year	Maintenance Cost - I Year	Maintenance of Nursery including maintenance of plants for Ist year maintenance (30%), 2nd year maintenance (25%) and raising of plants for 3rd year maintenance (15%), Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses , Watch and ward i/c repair of fencing, Weeding and mulching	24,968	91
5th year	Maintenance Cost - II Year (Rs.)	Maintenance of Nursery including 2nd year maintenance (25%) and 3rd year maintenance, (15%) Carriage of Plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	21,822	74

6th year	Maintenance Cost - III Year (Rs.)	Maintenance of Nursery including maintenance of 3rd year maintenance, Carriage of plants, Pitting & planting of plants & planting of herbs, Watch and ward i/c repair of fencing, Weeding and mulching	18,150	58
7th year	Maintenance Cost - IV Year (Rs.)	Watch and ward i/c repair of fencing	12156	36
	Total Maintenance Cost (Rs.)		**77,097**	**258**
		Grand Total	**2,61,967**	**1,026**

16) Model No – CN/JK/NL/08	**Himalayan Mixed Forest**
Zone: Sub-Tropical to Lower Temperate Area	

This zone occurs in mid hill region on the northern aspect and is dominated by broadleaved species with some Chir pine in exposed areas. The altitudinal variation in this zone is between 800-1,800 m asml and the zone receives annual rainfall ranging from 1,000-1,200 mm. The zone experiences high temperature and humidity during the summer season. In areas wherein Chir pine species is about 50%, the ground is mostly covered with pine needles and area is prone to forest fires. Grasses in slopes flush during the mid summer rainy season. Heavy rains in the rainy season cause severe soil erosion and sedimentation in Chenab River or its tributaries. Moderately dense to open forests on the northern aspect coupled with agriculture on terraces along moderately steep slopes, and construction and development activities are primary reasons for large scale soil erosion in this zone. These areas experience heavy rainfall during the rainy season and modest rainfall during the winter season. Snowfall occurs on cooler aspects of higher reaches but, the snow stays for a short duration of few days. Most of the rainwater flows down the streams washing away top soil especially on sloppy sites. The soil is neutral to acidic in nature and shallow on slopes while valleys have deep soils. The biotic pressure (i.e., livestock grazing, and collection of fuel wood and tree fodder) is severe. Appropriate Forestry Interventions in this zone can immensely help in improvement of the zone and also river flow.

The Himalayan Mixed Forest Model is recommended for this zone. Grass species such as *Heteropogon contortus, Chrysopogon serrulatus,* etc. will be sown or planted in the part of treatment site, particularly on the ridges. The treatment area will be planted with broadleaved species like *Quercus oblongata, Lyonia ovalifolia, Toona ciliata, T. sinensis,Syzygium cumini, Grewia optiva, Pyrus pashia,Albizia spp., Phyllanthus emblica, Holoptelea integrifolia, Ficus* spp., *Punica granatum, Bauhinia variegata, B. retusa,*etc. Plants will be planted at 5 x 5 m spacing. A total of 300 plants of trees /ha., 300 plants of shrubs/ha and 200

patches of 2x2 m apart grasses on the ridges/degraded sites will be planted. Broadleaved species of this zone require about one and half year to two years of nursery period and planting will be done in the 3rd year. For producing quality nursery stock of desired species VAM will be added either species specific or as consortium. The plants will be maintained in the 4th - 6th year. The fire line of width 5m both side along the fencing of plantation area be will be maintained twice a year (Table 5.17; Fig. 5.15).

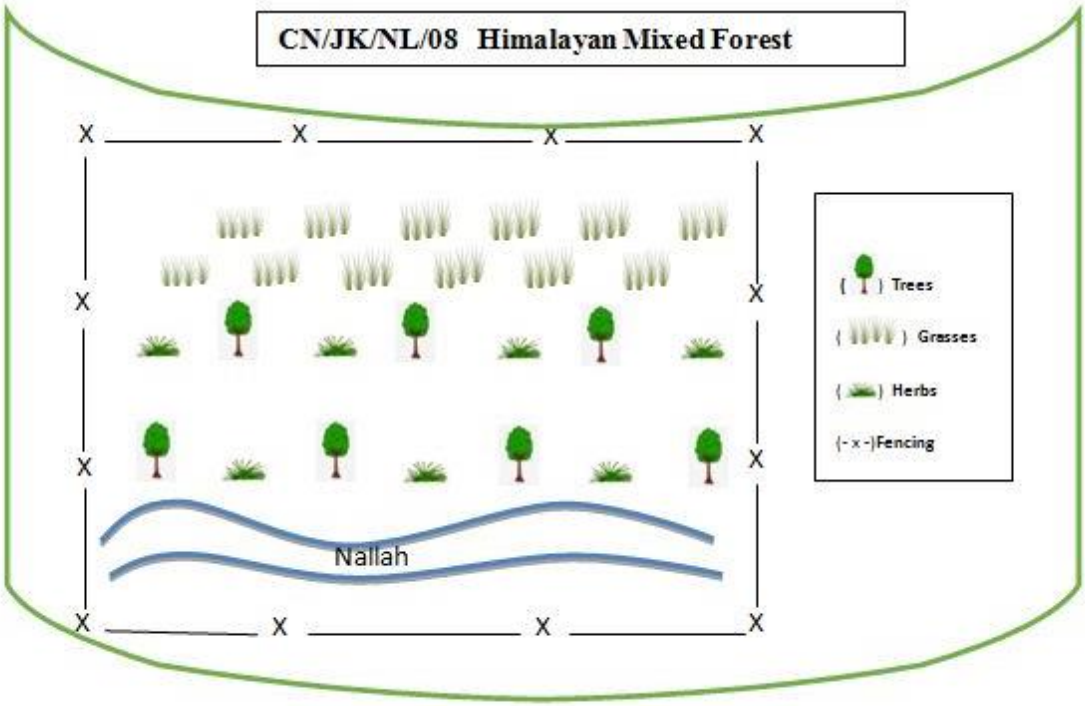
List of Species for Plantation

Trees: *Quercus oblongata, Lyonia ovalifolia, Holoptelea integrifolia, Ficus benghalensis, Ficus racemosa, Ficus rumphii, Albizia lebbek, Alstonia scholaris, Phyllanthus emblica, Bauhinia variegata, B. retusa, Grewia optiva, Olea ferruginea, Pyrus pashia, Toona ciliata, T. sinensis, Terminalia chebula,Syzygium cumini, Punica granatum, Pistacia integerrima, Terminalia bellirica, Cinnamomum tamala*, etc.

Shrubs:*Rosa moschata, Debregeasia hypoleuca, Elaeagnus conferta, Zanthoxylum armatum, Deutzia staminea, D. corymbosa, Berberis aristata, B. lycium, Ziziphus* spp., *Carissa opaca, Murraya koenigii, Desmodium gangeticum, D. elegans, Indigofera heterantha, Tephrosia hamiltonii, Justicia adhatoda, Ricinus communis, Withania somnifera, Tinospora cordifolia, Woodfordia fruticosa, Maesa indica, Nyctanthes arbor-tristris, Vitex negundo* etc.

Grasses and Forbs: *Heteropogon contortus, Chrysopogon fulvus, C. serrulatus, Boerhavia diffusa,Festuca pratensis,Festuca arundinacea***,** *Poa pratensis, Erianthus filifolius,Erianthus rufipilus, Agrostis gigantea, Agropyron* spp., *Phleum pratense***,** *Themeda anathera,Arundo donax, Cymbopogon martini, C. jwarancusa, Phragmites karka, Bothriochloa pertusa, B. intermedia, Eulaliopsis binata, Calamagrostis* spp., *Setaria glauca, Neyraudia arundinacea, Thysanolaena maxima,* etc.

Fig. 5.15 - Plantation Design: CN/JK/NL/08 Lower Himalayan Mixed Forest



Trees: 300 No, Spacing (m) – 5 x 5, Pit size (cm) – 45 x 45 x 45

Shrubs: 300 no., spacing (m) – 5 x 5, Pit size (cm) – 30 x 30 x 5,.

Grasses: Patch number – 200, Patch size (cm) – 100 x 30 x 5. Spacing (m) – 2 x 2, Seed per patch (gm) – 6gm, Spacing (cm) – 10 x 10, Type –Staggered,

Fencing: Cement pole/ local material wood/ Branches /Brushwood fencing

Table: 5. 17 – Cost Norms for Model CN/JK/NL/08

Plantation Cost Model-CN/JK/NL/08 Himalayan Mixed Forest				
Year	**Item**	**Details of work**	**Amount (Rs.)**	**Man days**
No. of Plants (No.)		800 Plants and 200 Grass Patches		
1st Year	Advance Work Labour Cost	Raising of Nursery including maintenance in 1st year	12,000	53
2nd year	Advance Work Labour Cost	Maintenance of Nursery including maintenance of I st year plants and raising of plants for I st year maintenance (30%)	6,800	

2nd year	Advance Work Labour Cost	Site preparation - Site preparation i/c survey & demarcation, Cutting grubbing and removal of *Lantana* or other bushes, Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and fixing of poles, Stretching & fixing of Barbed wire at spacing 20cm and 4 strands, Barbed wire and Reinforced Cement Concreate (RCC) poles	1,24,589	554
3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery including maintenance of I st year plants, plants for I st year maintenance (30%) and raising of plants for 2nd year maintenance (25%)	8,197	32
3rd year	Creation	Carriage of plants, Layout of patches, patches & planting of herbs, Preparation of strips including (i/c) sowing of grasses in strips	1,603	6
	Creation	Carriage of plants, Layout of pit, Digging & refilling of pit, Planting of plants and shrubs in pits	26,873	104
	Total Establishment Cost (Rs.)		**1,80,062**	**749**
Maintenance				
4th year	Maintenance Cost - I Year	Maintenance of Nursery including maintenance of plants for I st year maintenance (30%), 2nd year maintenance (25%) and raising of plants for 3rd year maintenance (15%), Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses , Watch and ward i/c repair of fencing, Weeding and mulching	23,425	85
5th year	Maintenance Cost - II Year (Rs.)	Maintenance of Nursery including 2nd year maintenance (25%) and 3rd year maintenance, (15%) Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching	20,446	69

6th year	Maintenance Cost - III Year (Rs.)	Maintenance of Nursery including Maintenance of 3rd year, Carriage of plants, Pitting & planting of plants & planting of herbs, Watch and ward i/c repair of fencing, Weeding and mulching	17,267	55
7th year	Maintenance Cost - IV Year (Rs.)	Watch and ward i/c repair of fencing	12,156	36
	Total Maintenance Cost (Rs.)		**73,293**	**245**
		Grand Total	**2,53,355**	**994**

17) Model No – CN/JK/NL/09	**Sub-Tropical Dry Deciduous Forest**
Zone: Sub-Tropical Area	

This zone occurs in foot hills of Jammu region (J&K UT) and dominated by broadleaved deciduous species. The altitudinal range in this zone is between 300 - 900 m. It experiences annual rainfall around 1,000 mm. Several broadleaved species grow in this zone which shed their leaves during summer months. The zone is represented by deep soil and moderate slope and experiences heavy rainfall during the rainy season and modest rainfall during the winter season. Heavy rains during the rainy season transport silt from these areas through number of seasonal water channels, *nallah*, rivulets, etc. to the Chenab River causing siltation and floods in downstream areas. Besides this, agriculture on slopes and construction and developmental activities are the main reasons for soil erosion from these areas. A large part of rainwater flows down the streams within a few hours of rainfall as surface run off. The soil is shallow on slopes while valleys have deep soil depth. The biotic pressure (i.e., livestock grazing, fuel wood and tree fodder collection, etc.) is significant in this zone. Appropriate Forestry Interventions in this zone would not only check soil erosion and improve vegetation but, would also help in improvement of the e-flow of the Chenab River and its tributaries.

The Sub-Tropical Dry Deciduous Forest Model is recommended for this zone. Under this model, it is proposed to plant 300 trees of broadleaved species or bamboos. 300 shrubs at 5 x 5 m will be planted in between the tree rows. Strong soil binding grasses like *Arundinella nepalensis*, *Apluda mutica*, and *Chyrsopogon fulvus*, and sedges like *Carex cruciata* will be planted on the river or *nallah* facing side of the treatment site. In case of trees, a mixture of timber species like *Dalbergia sissoo*, *Acacia catechu*, *Haldina cordifolia*, *Lannea coromandelica*, *Alstonia scholaris*, *Mallotus philippensis*, *Trema politoria*, *Tamarindus*

indica, etc. along with medicinal trees like *Terminalia* spp., *Phyllanthus emblica, Oroxylum indicum, Sapindus mukrossi, Agele marmelos, Azadirachta indica, Terminalia arjuna*, etc. will be planted at 5 x 5 m spacing. Management practices and conservation measures as prescribed in the Working Plan of the respective Territorial Forest Division or the Wildlife Management Plan of the protected area will be applicable. Collection of medicinal plants and other NTFPs along with sharing of accrued benefits to local communities would be regulated as per the State and UT policy on medicinal plants. Nursery of selected trees, shrubs, etc. will be established during 1st year and 2nd years and planting will be done in 3rd year. For producing quality nursery stock of desired species, VAM will be added either species specific or as consortium. Subsequently, the plantation will be managed during next three years. The fire line of width 5m both side along the fencing of the plantation area will be maintained twice a year (Table 5.18; Fig.5.16).

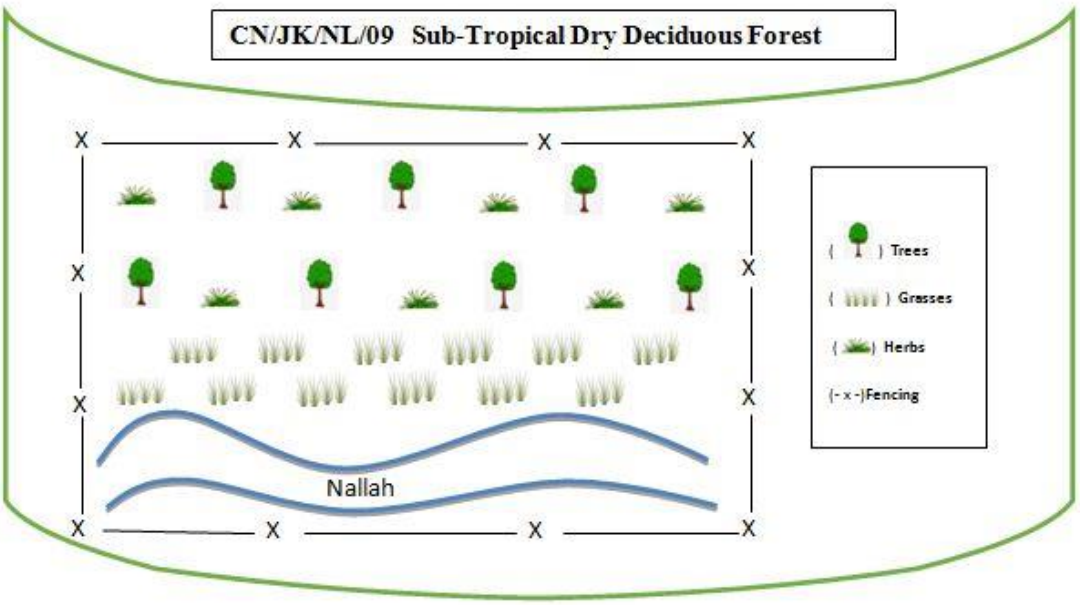
List of Species for Plantation

Trees:*Dalbergia sissoo, Acacia catechu, Haldina cordifolia, Aegle marmelos, Terminaliabellirica, T. chebula, T. arjuna, Mallotus philippensis, Syzygium cumini, Oroxylum indicum, Sapindus mukorossi, Dendrocalamus strictus, D. hamiltonii, Bambusa arundinacea, Holoptelea integrifolia, Ficus benghalensis, F. racemosa, F. rumphii, Albizia lebbek, A. procera, Celtis australis, Boehmeria rugulosa, Lanea coromandelica, Cinnamomum tamala, Pyrus pashia, Alstonia scholaris, Phyllanthus emblica, Diospyros montana, Bauhinia variegata, Hymenodictyon suaveolens, Grewia optiva, Azadirachta indica, Morus alba*, etc.

Shrubs: *Rosa moschata, Debregeasia hypoleuca, Zanthoxylum armatum, Berberis lycium, Ziziphus mauritiana, Z. jujuba, Carissa opaca, Desmodium gangeticum, Tephrosia hamiltonii, Justicia adhatoda, Murraya koenigii, M. paniculata, Ricinus communis, Tinospora cordifolia, Woodfordia fruticosa, Maesa indica, Nyctanthes arbor-tristris, Vitex negundo*, etc.

Grasses/Forbs:*Heteropogon contortus, Chrysopogon fulvus, C. serrulatus, Boerhavia diffusa,Festuca pratensis,F. arundinacea***,** *Poa pratensis, Erianthus filifolius,E. rufipilus, Agrostis gigantea, Saccharum munja, Neyraudia arundinacea, Phleum pratense***,** *Themeda anathera,Arundo donax, Cymbopogon martini, Phragmites karka, Bothriochloa pertusa, B. intermedia, Eulaliopsis binata, Calamograstis* spp., *Thysanolaena maxima*, etc.

Fig. 5.16- Plantation Design: CN/JK/NL/09 Sub-Tropical Dry Deciduous Forest



Trees: 300 No, Spacing (m) - 5 x 5, Pit size (cm) – 45 x 45 x 45

Shrubs: 300 no., spacing (m) - 5 x 5, Pit size (cm) – 30 x 30 x 30

Grasses: Patch no - 200, Patch size (cm) - 100 x 30 x 5. Spacing (m) - 2 x 2, Seed per patch (gm) - 6, seed, Spacing (cm) - 10 x 10, Type –Staggered, along *Nallah*/depressions(if available)

Fencing: Cement pole/ local material wood/ Branches/Brushwood fencing

Table: 5. 18 – Cost Norms for Model CN/JK/NL/09

Plantation Cost Model-CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest				
Year	**Item**	**Details of work**	**Amount (Rs.)**	**Man days**
No. of Plants (No.)		800 Plants and 200 Grass Patches		
1st Year	Advance Work Labour Cost	Raising of Nursery including maintenance in Ist year	12,000	53
2nd year	Advance Work Labour Cost	Maintenance of Nursery including maintenance of Ist year plants and raising of plants for Ist year maintenance (30%)	6,800	

2nd year	Advance Work Labour Cost	Site preparation - Site preparation i/c survey & demarcation, Cutting grubbing and removal of *Lantana* or other weeds and bushes, Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and fixing of poles, Stretching & fixing of Barbed wire at spacing 20cm and 4 strands, Barbed wire and Reinforced Cement Concreate (RCC) poles	1,24,589	518
3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery including maintenance of Ist year plants, plants for Ist year maintenance (30%) and raising of plants for 2nd year maintenance (25%)	8,197	32
3rd year	Creation	Carriage of plants, Layout patches, Patches & planting of herbs, Preparation of strips including (i/c) sowing of grasses in strips	1,603	6
	Creation	Carriage of plants, Layout of pit, Digging & refilling of pits, Planting of plants and shrubs in pits.	26,873	104
	Total Establishment Cost (Rs.)		**1,80,062**	**713**
Maintenance				
4th year	Maintenance Cost - I Year	Maintenance of Nursery including maintenance of plants for Ist year maintenance (30%), 2nd year maintenance (25%) and raising of plants for 3rd year maintenance (15%), Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses , Watch and ward i/c repair of fencing, Weeding and mulching	23,425	85
5th year	Maintenance Cost - II Year (Rs.)	Maintenance of Nursery including 2nd year maintenance (25%) and 3rd year maintenance, (15%) Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and	20,446	69

		mulching		
6th year	Maintenance Cost - III Year (Rs.)	Maintenance of Nursery including maintenance of 3rd year maintenance, Carriage of plants, Pitting & planting of plants & planting of herbs, Watch and ward i/c repair of fencing, Weeding and mulching	17,267	55
7th year	Maintenance Cost - IV Year (Rs.)	Watch and ward i/c repair of fencing	12,156	36
	Total Maintenance Cost (Rs.)		**73,293**	**245**
		Grand Total	**2,53,355**	**958**

18) Model No – CN/JK/NL/10	**Eradication of *Lantana* (> 50%)**
Zone: Lower Temperate to Sub-Tropical Areas	

Invasive alien species are plants which hamper natural regeneration and growth of native species, thereby replacement of native plant species coupled with loss of biodiversity, forage, habitat, aesthetics and productivity of native species in lower temperate and sub-tropical areas. Owing to considerable area of this zone under the influence of *Lantana camara*, tangible and intangible benefits from lower temperate to sub- tropical forests within the Chenab Riverscape have been adversely affected.

The area for the proposed model referred as 'Eradication of *Lantana* (>50%)' covers forest sites between 300-1,200 m wherein the topography is with gentle slopes. Such areas have sub-tropical to lower-temperate climate with around 1,000-1,200 mm annual rainfall. Soils are generally fertile and moderately deep. The proposed treatment area for this model usually has open or moderately dense forest or scrub vegetation. Luxuriant growth of *Lantana camara* forms dense undergrowth in the forest suppressing the native vegetation of that area.

It is proposed to cut and manually uproot above stated invasive species in treatment sites as per the prescription of CRS (Cut Root Stock) method for complete eradication of this obnoxious weed. These areas after Lantana eradication will be planted in the third year of project implementation. Local grass species will be grown in the treatment site. The treatment area will be planted with broadleaved species like *Toona ciliata, Syzygium cumini, Grewia optiva, Pyrus pashia, Albizia spp., Phyllanthus emblica, Holoptelea integrifolia,*

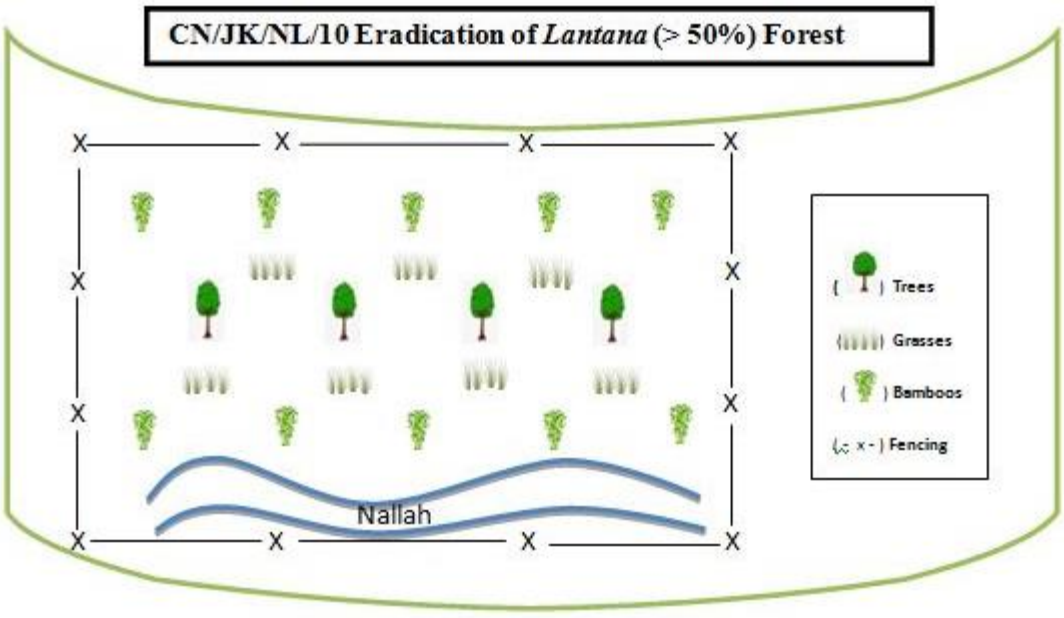
Ficus spp., *Punica granatum, Bauhinia variegata, Dendrocalamus* spp., *Bambusa* spp. etc. Species will be planted at 4 x 4 m spacing. A total of 600 plants of trees and bamboos /ha along with 600 patches of 4x4 m apart grasses on sites will be planted. Alternate rows of bamboo and broadleaved species will be planted throughout the treatment area. Broadleaved species of this zone require around two and half years of nursery period to produce sturdy plants and planting will be done in the 3rd year. For producing quality nursery stock of desired species, VAM will be added either species specific or as consortium. The plants will be maintained in the 4th to 6th years (Table 5.19; Fig. 5.17).

List of Species for Plantation

Trees:*Dalbergia sissoo, Acacia catechu, Toona ciliata, Haldina cordifolia, Aegle marmelos, Terminaliabellirica, T. chebula, T. arjuna, Mallotus philippensis, Syzygium cumini, Oroxylum indicum, Sapindus mukorossi, Dendrocalamus strictus, D. hamiltonii, Bambusa arundinacea, Holoptelea integrifolia, Ficus benghalensis, F. racemosa, F. rumphii, Albizia* spp., *Celtis australis, Litsea chinensis, Myrica esculenta, Pyrus pashia, Alstonia scholaris, Phyllanthus emblica, Diospyros montana, Bauhinia variegata, Grewia optiva,* etc.

Grasses/Forbs:*Arundinella nepalensis, Apluda mutica, Chyrsopogon serrulatus, Boerhavia diffusa, Heteropogon contortus, Trifolium repens, Eragrostis nigra, Deschamsia* spp., *Panicum maximum, Phleum pratense, Cymbopogon citratus, Arundo donax, Phragmites karka, Themeda arundinacea, Eulaliopsis binata, Dichanthium annulatum, Sporobolus diander, Thysanolaena maxima, Hierochloe laxa,* etc.

Fig. 5.17 - Plantation Design: CN/JK/NL/10 – Eradication of *Lantana* (> 50%)



Trees/Bamboo: 600 No, Spacing (m) - 4 x 4, Pit size (cm) – 45 x 45 x 45

Grasses: Patch no - 600, Patch size (cm) - 100 x 30 x 5. Spacing (m) - 4 x 4, Seed per patch (gm) – 6gm, Spacing (cm) - 10 x 10, Type –Staggered

Fencing: Cement pole/ local material wood/ Branches /Brushwood fencing

Table: 5. 19 – Cost Norms for Model CN/JK/NL/10

Plantation Cost Model-CN/JK/NL/10 – Eradication of *Lantana* (> 50%)				
Year	**Item**	**Details of work**	**Amount (Rs)**	**Man days**
No. of Plants (No.)		600 Plants and 600 Grass Patches		
1st Year	Advance Work Labour Cost	Raising of Nursery including Maintenance in Ist year	9,000	40
1st Year	Advance work	Site Preparation includes *Lantana* by Cut Root Stock method and Cleaning of *Lantana* (sprouts) and seedlings, one times in Ist year	26,340	109
2nd year	Advance Work Labour Cost	Maintenance of Nursery including maintenance of Ist year plants and raising of plants for Ist year maintenance (30%)	5,457	23
2nd year	Advance Work Labour Cost	Cleaning of *Lantana* (sprouts) and seedlings, 3 times a year @ 15% of unit cost (Estd), Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and fixing of poles, Stretching & fixing of Barbed wire at spacing 20cm and 4 strands, Barbed wire and Reinforced Cement Concreate (RCC) poles	1,11,110	462
3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery including maintenance of Ist year plants, plants for Ist year maintenance (30%) and raising of plants for 2nd year maintenance (25%)	6,148	24
3rd year	*Lantana* Cutting	Cleaning of *Lantana* (sprouts) and seedlings,3 times a year @ 15% of unit cost (establishment)	11,800	46
3rd year	Creation	Carriage of plants, Layout of patches, Patches & planting of herbs, Preparation	4,809	19

		of strips including (i/c) sowing of grasses in strip		
	Creation	Carriage of plants, Layout of pits, Digging & refilling of pits, Planting of plants and shrubs in pits	17,604	78
	Total Establishment Cost (Rs.)		**1,95,867**	**800**
Maintenance				
4th year	Maintenance Cost - I Year	Maintenance of Nursery including maintenance of plants for Ist year maintenance (30%), 2nd year maintenance (25%) and raising of plants for 3rd year maintenance (15%), Carriage of plants, Pitting & planting of plants & herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching, Cleaning of *Lantana* (sprouts) and seedlings, 3 times a year	21,207	77
5th year	Maintenance Cost - II Year (Rs.)	Maintenance of Nursery including 2nd year maintenance (25%) and 3rd year maintenance, (15%) Carriage of plants, Pitting & planting of plants & herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching, Cleaning of *Lantana* (sprouts) and seedlings, 2 times a year	19,021	64
6th year	Maintenance Cost - III Year (Rs.)	Maintenance of Nursery including maintenance of 3rd year maintenance, Carriage of plants, Pitting & plants & planting of herbs, Watch and ward i/c repair of fencing, Weeding and mulching	16,453	52
7th year	Maintenance Cost - IV Year (Rs.)	Watch and ward i/c repair of fencing, Cleaning of *Lantana* (sprouts) and seedlings, 2 times a year	12,156	36
	Total Maintenance Cost (Rs.)		**68,837**	**230**
		Grand Total	**2,64,704**	**1,030**

19) Model No – CN/JK/NL/11	Control/ Removal of Invasive Species or <50% *Lantana*
Zone - Lower Temperate to Sub-Tropical Areas	

Invasive alien species are plants those hamper regeneration and growth of native species, thereby replacement of native plant species coupled with loss of biodiversity, forage, habitat, aesthetics and productivity of native species. Owing to considerable area of this zone under the influence of invasive alien or weed species, tangible and intangible benefits from lower temperate to sub- tropical forests within the Chenab Riverscape have been adversely affected.

The area for the proposed model referred as 'Control/ Removal of Invasive Species' covers forest sites between 300 - 1,200 m asml wherein the areas are is with gentle slopes. Such areas have sub-tropical to lower-temperate climate with 1,000 - 1,200 mm annual rainfall. Soils are generally fertile and moderately deep. The proposed treatment area usually has open or moderately dense forests or scrubs vegetation. Luxuriant growth of weed species including *Lantana camara* (<50%) forms considerably dense undergrowth in the forest suppressing the native vegetation. *Ageratum conyzoides, Ageratina adenophora*and *Parthenium hysterophorus* also cause considerable hazard especially near agriculture fields and settlements.

It is proposed to cut and manually uproot above stated invasive species in treatment sites prior to their flowering, and immediately to be followed by planting of native plant species. In case of *Lantana* infested areas, CRS (Cut Root Stock) method will be used for complete eradication/ control of this obnoxious weed. In case of other weeds, cuttings and removal of infested plants will be done at such a time and such a way as to cause least disturbance to soil and provide opportunity to the nearby economically important plants to occupy the space vacated by weeds. These areas will be intensively managed after plantation subsequently for two years to minimize the chances of their re-growth. For controlling herbaceous weeds like *Ageratum conyzoides, Ageratina adenophora,* and *Parthenium hysterophorus*, eco-friendly measures (e.g., physical or mechanical methods, use of natural products, etc.) will be adopted without resorting to the use of synthetic chemicals. These areas after *Lantana* eradication will be planted in the third year of project implementation. Grass species such as *Heteropogon contortus, Chrysopogon serrulatus*, etc. will be sown in the part of treatment site. The treatment area will be planted with broadleaved species like *Toona ciliata, Syzygium cumini, Grewia optiva, Pyrus pashia, Albizia spp., Phyllanthus emblica, Holoptelea integrifolia, Ficus* spp., *Punica granatum, Bauhinia variegata*, *Dendrocalamus* spp. and *Bambusa* spp. etc. Species will be planted at 5 m x 5 m spacing. A total of 400 plants of trees and bamboos/ha. A mixture of broad leaved species and bamboos will be planted. In additions, 400 patches of grasses, 5x5 m apart will be planted. The rows of trees and grasses will be planted alternatively. Broadleaved species of this zone require about two and half years of nursery period to produce sturdy plants and planting will be done in the 3rd year. For

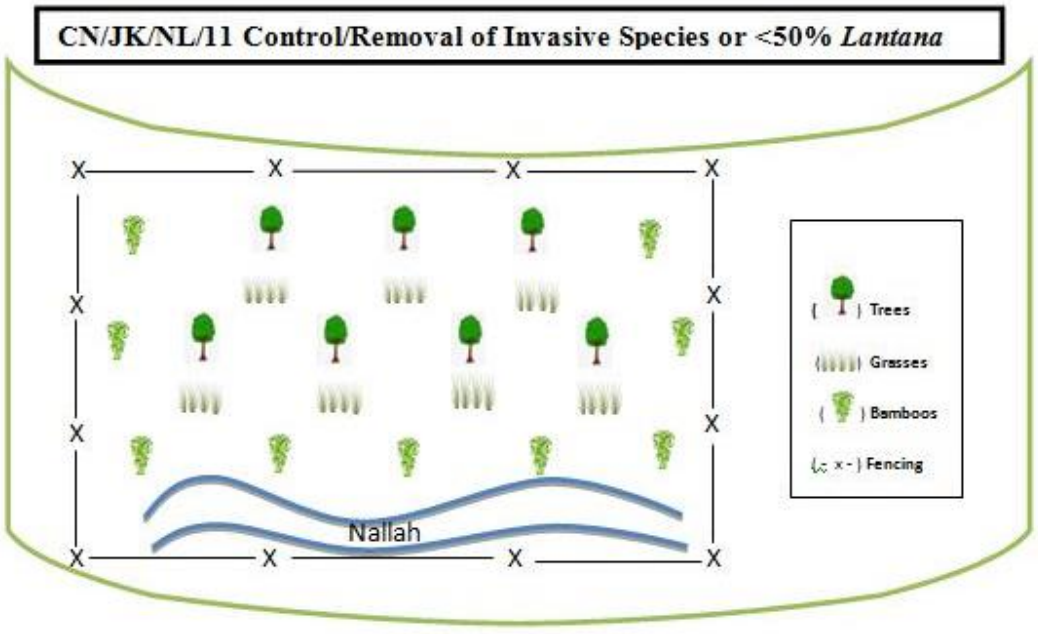
producing quality nursery stock of desired species, the VAM will be added either species specific or as consortium in the potting media. The plants will be maintained in the 4th to 6th years (Table 5.20 ; Fig. 5.18)

List of Species for Plantation

Trees:*Toona ciliata, Dalbergia sissoo, Acacia catechu, Haldinia cordifolia, Cassia fistula, Aegle marmelos, Terminaliabellirica, T. chebula, T. arjuna, Mallotus philippensis, Syzygium cumini, Sapindus mukorossi, Dendrocalamus* spp., *Bambusa* sp., *Holoptelea integrifolia, Albizia* spp., *Celtis australis, Pyrus pashia, Alstonia scholaris, Phyllanthus emblica, Diospyros montana, Bauhinia variegata, Morus alba, Grewia optiva,* etc.

Grasses/Forbs:*Arundinella nepalensis, Apluda mutica, Chyrsopogon serrulatus, Boerhaavia diffusa, Heteropogon contortus, Trifolium repens, Eragrostis nigra, Deschamsia* spp., *Panicum maximum, Phleum pratense, Cymbopogon citratus, Arundo donax, Phragmites karka, Themeda arundinacea, Eulaliopsis binata, Dichanthium annulatum, Sporobolus diander, Thysanolaena maxima, Hierochloe laxa,* etc.

Fig. 5.18 - Plantation Design CN/JK/NL/11 – Control/ Removal of Invasive Species or <50% *Lantana*



Trees/Bamboo: 400 No, Spacing (m) - 5 x 5, Pit size (cm) – 45 x 45 x 45

Grasses: Patch No - 400, Patch size (cm) - 100 x 30 x 5. Spacing (m) - 5 x 5, Seed per patch (gm) - 6, seed, Spacing (cm) - 10 x 10, Type –Staggered

Fencing: Cement pole/ local material wood/ Branches /Brushwood fencing

Table: 5. 20 – Cost Norms for Model CN/JK/NL/11

Plantation Cost Model- CN/JK/NL/11 – Control/ Removal of Invasive Species or <50% *Lantana*				
Year	**Item**	**Details of work**	**Amount (Rs)**	**Man days**
No. of Plants (No.)		400 Plants and 400 Grass Patches		
1st Year	Advance Work Labour Cost	Raising of Nursery including Maintenance in Ist year	6,000	27
1st Year	Advance work	Site Preparation includes *Lantana* by Cut Root Stock method and Cleaning of *Lantana* (sprouts) and seedlings, one times in Ist year	26,340	109
2nd year	Advance Work Labour Cost	Maintenance of Nursery including maintenance of Ist year plants and raising of plants for Ist year maintenance (30%)	3,638	15
2nd year	Advance Work Labour Cost	Cleaning of *Lantana* (sprouts) and seedlings, 3 times a year @ 15% of unit cost (establishment), Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and fixing of poles, Stretching & fixing of Barbed wire at spacing 20cm and 4 strands Barbed wire and Reinforced Cement Concrete (RCC) poles	1,11,110	462
3rd year	Advance Work Labour Cost (Rs.)	Maintenance of Nursery including Maintenance of Ist year plants, Plants for Ist year Maintenance (30%) and raising of plants for 2nd year Maintenance (25%)	4,099	16
3rd year	*Lantana*Cutting	Cleaning of *Lantana* (sprouts) and seedlings, 3 times a year @ 15% of unit cost (establishment)	11,800	46
3rd year	Creation	Carriage of plants, Layout patches, Patches & planting of herbs, Preparation of strips including (i/c) sowing of grasses in strips	3,206	12
	Creation	Carriage of plants, Layout of pit, Digging & refilling of pits, Planting of plants and shrubs in pits	13,437	52

	Total Establishment Cost (Rs.)		**1,82,029**	**739**
Maintenance				
4th year	Maintenance Cost - I Year	Maintenance of Nursery including maintenance of plants for I st year maintenance (30%), 2nd year maintenance (25%) and raising of plants for 3rd year maintenance (15%), Carriage of plants, Pitting & planting of plants & planting of herbs, Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching, Cleaning of *Lantana* (sprouts) and seedlings, 3 times a year	17,446	63
5th year	Maintenance Cost - II Year (Rs.)	Maintenance of Nursery including 2nd year maintenance (25%) and 3rd year maintenance, (15%) Carriage of plants, Pitting & planting of plants & herbs, sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching, Cleaning of lantana(sprouts) and seedlings, 2 times a year	16,220	55
6th year	Maintenance Cost - III Year (Rs.)	Maintenance of Nursery including maintenance of 3rd year maintenance, Carriage of plants, Pitting & planting of plants & planting of herbs, Watch and ward i/c repair of fencing, Weeding and mulching	14,755	47
7th year	Maintenance Cost - IV Year (Rs.)	Watch and ward i/c repair of fencing, Cleaning of *Lantana* (sprouts) and seedlings, 2 times a year	12,156	36
	Total Maintenance Cost (Rs.)		**60,577**	**201**
		Grand Total	**2,42,605**	**940**

20) Model No – CN/JK/NL/12	Protection Model for Natural Regeneration
Zone: All Hill Areas	

The hill areas between 800 - 4,100 m amsl are characterized by dense forests, mainly conifers and Oak forests, Sub-Alpine vegetation dominated by coniferous and broadleaved species and Alpine pastures i.e., herbs, grasses, and shrubs. However, forest gap also occur at several locations that can be taken up for the proposed treatment. In selected areas, especially in Deodar, Blue pine, Fir, Spruce, and Oak forests and even the Sub-Alpine and Alpine areas, adequate regeneration can be observed under favorable conditions. Owing to varied disturbances by human and livestock in these areas, establishment of natural regeneration is generally poor and need immediate attention. Often, a thick layer of humus is typically present and the soil is generally moist and conducive for natural regeneration.

Under this treatment model, it is proposed to protect and conserve vegetation so as to promote ample establishment and recruitment of natural regeneration of trees, shrubs and herbs. The major focus will be on protection of special areas like patches of good natural regeneration of various conifers, broadleaved species shrubs, and herbs etc. and thereby conserving native plant species. In Natural regeneration areas, cleaning operation twice a year in the month of September and March will be carried out *viz.*,climber cutting, obnoxious weeds, unwanted species, pruning of plants, removing dead and dying trees. The broadcasting of desired seeds is to be done in the closed area to supplement the natural regeneration (Table 5.21).

List of Species for Plantation

Trees: No plantation proposed.

Shrubs: No plantation proposed.

Herbs: No plantation proposed.

Trees/Bamboo: 400 No, Spacing (m) - 5 x 5, Pit size (cm) – 45 x 45 x 45

Grasses: Patch No - 400, Patch size (cm) - 100 x 30 x 5. Spacing (m) - 5 x 5, Seed per patch (gm) - 6, seed, Spacing (cm) - 10 x 10, Type –Staggered

Fencing: Cement pole/ local material wood/ Branches /Brushwood fencing

Table: 5. 21 – Cost Norms for Model CN/JK/NL/12

Plantation Cost Model- CN/JK/NL/12 Protection Model for Natural Regeneration				
Year	**Item**	**Details of work**	**Amount (Rs.)**	**Man days**
No. of Plants (No.)		400 Grass Patches		
1st Year	Advance Work Labour Cost	Pruning and training of existing root stocks (tending operations), Cleaning and un-saleable thinning (non-commercial) in regeneration areas, Climber cutting in the forests/ plantation area, Debris collection and burning	1,905	8
2nd year	Advance Work Labour Cost	Pruning and training of existing root stocks (tending operations) 300 no., Preparation of inspection path, Carriage of fence post and RCC poles, Digging of holes and fixing of poles, Stretching & fixing of Barbed wire at spacing 20cm and 4 strands, Barbed wire and Reinforced Cement Concreate (RCC) poles	1,02,120	424
3rd year	*Lantana* Cutting	Pruning and training of existing root stocks (tending operations) (150 plants), Cleaning and un-saleable thinning (non-commercial) in regeneration areas, Climber cutting in the forests/ plantation area, Debris collection and burning (15% area)	1,091	4
3rd year	Creation	Carriage of plants, Layout of patches, Patches & planting of herbs, Preparation of strips including (i/c) sowing of grasses in strips	3,206	12
	Total Establishment Cost (Rs.)		**1,10,721**	**449**
Maintenance				
4th year	Maintenance Cost - I Year	Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching, Cleaning of climbers, 3 times a year	10,952	40

5th year	Maintenance Cost - II Year (Rs.)	Sowing of grasses, Watch and ward i/c repair of fencing, Weeding and mulching, Pruning and training of existing root stocks (tending operations), 2 times a year	11,535	39
6th year	Maintenance Cost - III Year (Rs.)	Watch and ward i/c repair of fencing, Weeding and mulching	11,950	38
7th year	Maintenance Cost - IV Year (Rs.)	Watch and ward i/c repair of fencing, Pruning and training of existing root stocks (tending operations)	12,156	36
		Total	**46,593**	**153**
		Grand Total	**1,57,314**	**602**

21) Model No – CN/JK/NL/13	**Fire Protection Model**
Zone: Sub-Tropical Area to Lower Temperate Area	

This zone occurs in sub-tropical i.e., from foot hills to mid hills of Jammu region (J&K UT). It is dominated by Chir pine in southern aspects and mixed vegetation in other aspects. The altitude is 800 - 1800 m amsl and annual rainfall is 1000 - 1200 mm, and mostly during rainy season and some portion in summer and winter months. This zone experiences 7-8 dry months every year making these forests highly vulnerable to fires. Even a small negligence during dry months in Chir pine dominated areas carries the high risk of igniting forest fires that spread very fast riding on the wind. Damage caused by the forest fire in Jammu region is immense with loss to regeneration, pole crop, productivity, Ecosystem services, Wildlife, etc. Heavy monsoon rains in the burnt out areas transport huge qualities of silt to Chenab River causing siltation of dams, canal, etc. and floods in lower Jammu region. Effective fire control measures can help significantly in reducing the silt load in Chenab River and its tributaries.

For these fire prone forest areas, 'Fire Protection Model' is recommended. In this model, existing fire lines are cleared of vegetation and Maintained all around the forest in such a way that a compact block or area is separated from adjoining areas. These fire lines are usually cleared before the start of fire seasons in order to avoid the spread of fires from one forest to another. Engagement of fire watchers in fire sensitive beats, procurement of fire fighting equipments and use of elide fire extinguishing balls. Construction of water harvesting and storage structure with locally available materials in the middle of fire sensitive zones e.g., Ponds, Khals, etc. Besides these, awareness campaigns among rural masses particularly about overall damage by forest fires to nature flora and fauna, soil and other ecosystem services of the forests such as hydrological functions, moderation of local climate, etc. influencing horticulture/ agriculture productivity of farmlands. Role of local communities in bringing down the forest fire incidences in Chir-pine zone is very important and need to be highlighted at various levels (Table 5.22).

Cleaning of Fire lines

Control burning

Engagement of fire watchers

Procurement of fire fighting equipments/ Elide fire extinguishing balls

Constructions of Ponds/ water harvesting structures

Awareness campaign, Community awareness.

Table: 5. 22 – Cost Norms for Model CN/JK/NL/13

Plantation Cost Model- CN/JK/NL/13 Fire Protection Model									
S. No.	Particular of work to be done.	Unit	Total Quantity	Unit Cost (Rs.)	1st year Amount (Rs.)	2nd year Maintenance	3rd year Maintenance	4th year Maintenance	5th year Maintenance
	Year-I								
1	Cleaning of Fire lines (10 mt width) including the burning of slash debris, dry leafs, fallen branches and other inflammable material and labour charges	km	0.2	1,4625	2,925	2,925	2,925	2,925	2,925
3	Engagement of fire watchers per 1000 ha (3 months)	ha	1	25	25	25	25	25	25
4	Constructions of Ponds/ water harvesting structures and Maintenance	ha	1	10,000	10,000	1,000	1,000	1,000	1,000
6	Procurement of fire fighting equipment's/ Elide fire extinguishing	ha	1	10,000	10,000	4,000	3,000	2,000	1,000

	balls and Maintenance								
7	Awareness campaign, Community awareness	ha	1	1,500	1,500	1,500	1,500	1,500	1,500
					24,450	9,450	8,450	7,450	6,450
					24,450	10,112	9,674	9,127	8,455
					109	42	38	33	29

5.4.4 Treatment Models for Agriculture Landscape

The tree cover outside forest area, particularly on farm lands is of vital importance for the ecological functions of agro-ecosystems (e.g., pollinators, soil and moisture conservation regime, carbon sequestration (CS), environmental amelioration, etc.). As per the strategies given in the foregoing description, 'Agriculture Landscapes' have been recognized as one of the zones within the Chenab River/ Chenab riverscape. Comprehensive afforestation/ plantations on private farm lands in agriculture landscape have been proposed in the DPR. The Forest Survey of India (FSI) in the biennial 'India State of Forest Report (ISFR)' also includes information on forest cover outside green wash area, tree cover and 'Trees Outside Forests (TOFs)' for the entire country/ state-wise to distinguish it from actual pure forest cover of the country as digitalized information on public and private lands is lacking in most of the states. The proportion of TOFs and tree cover is on increase in several states as per past two ISFRs. According to the IFSR, 2019 report, the agricultural landscape which accounts for forest cover outside green wash area and tree cover accounts for 12.19% and 5.40% of the total geographical area in Himachal Pradesh and Jammu and Kashmir UT, respectively. The growing stock in TOF which is 25.19 m cum in case of Himachal Pradesh and 125.14 m cum in case of Jammu and Kashmir UT which accounts for 1.53 % and 7.62 % respectively contribution to the country (**Table.5.23**).

Table: 5. 23 - Forest Cover, Tree Cover and TOF Growing Stock in Himachal Pradesh and Jammu and Kashmir UT including Ladakh UT

S. No.	Forest Cover, Tree Cover and TOF Growing Stock	Himachal Pradesh	Jammu and Kashmir UT including Ladakh UT
1	Forest Cover Outside Green Wash Area (in Sq Km)		
	VDF	342	1,617

	MDF	2,178	3,566
	OF	2,276	6,207
	TOTAL	**4,796**	**11,390**
2	Tree Cover Area (in Sq Km)	829	7,944
	Total of Forest Cover and Tree Cover Area (in Sq Km)	**5625**	**19,334**
3	Growing Stock in TOF	25.19 m cum	125.14m cum

Thus, it is evident that farmers/ villagers do recognize significance of trees on farm/private lands and they come forward for availing saplings of economic and fruit trees for plantations not only to augment their income but, they also do recognize ecological merits of such plantations. The current DPR, therefore, also proposes plantation activities in agriculture landscapes by adopting four models (CN/HP/AL/01, CN /HP/AL/02, CN /JK/AL/01 and CN /JK/AL/02).

NYKS, Mahila Mandals, Clubs and other NGOs/CBOs which may play an important role in awareness campaigns about Forestry Interventions, have also been included in the DPR. It is widely assumed and accepted that farmers usually do not indulge in cutting of such economic and fruits trees except those are solely planted as agro-forestry plantations of fast growing species as they do recognize multiple values obtained from such tree plantations on farmlands. Moreover, incentives in the form of Maintenance cost to be provided to the farmers at the rate of Rs. 70/-, 35/-, 35/- and 35/- per plant for first, second, third and fourth year, respectively, will motivate them to protect and retain these planted tree species on their private lands. The monetary aid proposed for the plantation will ensure sustainability of proposed plantations (maximum 150 trees/ ha) in agriculture landscapes and thus adding ecological benefits. Further, though the ownership of the plantation raised under the agriculture landscapes is vested with farmers but, the felling, removal, and transportation of such plantation material are regulated under the framework of various acts and procedures, e.g. State Felling and Transit Regulations, Land Preservation Act, etc., and other relevant regulations enforced from time to time by the concerned states.

The proposed agricultural models will be implemented in private farmlands and community/ Panchayat lands in rural areas. Availability of land will be ascertained by local officials of State Forest Department based upon proposals from local farmers and communities. Plants will be supplied to farmers and local communities who will carry out planting. Maintenance cost will be given to the land owners based upon plant survival at the end of first, second, third and fourth years. Nehru Yuvak Kendra may play a pivotal role in facilitating coordination between State Forest Department and farmers/communities.

(A) Treatment Models for Agriculture Landscape in Himachal Pradesh

22) Model No – CN /HP/AL/01	Boundary Plantation Model
Zone: Agriculture/Horticulture lands in Himachal Pradesh	

This model will be implemented in agricultural land in temperate to cold desert zones in Himachal Pradesh. The area is mostly hilly for most of this zone with steep slopes. The sites proposed for this model are agricultural or horticultural lands where off season vegetables and fruit crops are grown; hence these sites possess better soil fertility and managerial care with occasional subsistence irrigation mostly available water judiciously divided among local communities collectively by them.

The zone experiences scanty rainfall during rainy season and moderate to heavy snowfall during winter seasons. Monsoon or winter rains transport silt from these areas through numbers of seasonal water channels, Nallas, rivulets, etc. to Chenab River causing siltation and floods down streams. Besides this, agriculture, construction and developmental activities are the main reasons behind soil erosion. A large part of precipitation flows down the streams within a few hours of rainfall as surface run-off causing lot of soil erosion. The pressure for grazing, fuel wood and tree fodder collection is considerable. Effective Forestry Interventions in agricultural/ horticultural/ grassland areas can help significantly in improvement of the flow of Chenab River and its tributaries.

The methodology for deciding physical targets have been finalized after consultation with stakeholders. A simple methodology has been adopted based on number of farmers and their landholdings. For boundary plantation model, out of total farmers of the various forest divisions in the Chenab riverscape, 10% farmers have been included under this treatment model irrespective of their landholdings. Distribution of 150 plants per farmer would be taken as virtual one hectare area for budgetary provisions.

Choice of species

Tree: *Prunus* spp., *Diospyros* spp., *Malus pumilus, Hippophae salicifolia, Juglans regia, Corylus jacquemontii, Populus* spp., *Salix* spp., etc.

Shrubs: *Hippophaerhamnoides* ssp. *turkestanica, Berberis* jaeschkeana, *Rosa macrophylla, Rosa webbiana, Rosa sericea,* etc.

Cost Sharing: The Govt. will share cost Material i.e., plant cost Rs. @ 70/- , 35/-, 35/-, 35/- for Ist to IVth year and maximum of 150 trees per ha.

Table:5. 24 –Norms and Pattern of Assistance for Peripheral and Boundary Plantations (PBPs)

S. No	Type of Interventions	Indicative Unit cost per plant (Rs.)
1	Pre-Plant activities/ Land clearing/ Maintenance, etc.	20
2	Digging /Planting, etc.	12
3	Single unit Planting material, etc.	30
4	Transportation charges	3
5	Critical inputs *viz.*, FYM, Fertilizer., seed treatment, Vesicular Arbuscular Mycorrhizae (VAM), etc.	20
6	Planting cost	5
7	Fencing	20
	Maintenance (weeding+ watering, etc.)	40
	Total	**150**
Note: (i) The activity wise cost indicated above are tentative and State and UT have the flexibility to formulate their own estimate based on local requirements subject to a maximum of Rs. 150/- per plant (ii) The assistance will be given in the year wise proportion of 40:20:20:20		

Table: 5. 25 –Model – CN/HP/AL/01 Boundary Plantation Model

Year	Amount (Rs)/ha	Man days
Ist year Estabishment	9,000	36
Maintenance Ist Year	4,815	18
Maintenance IInd Year	5,152	18
Maintenance IIrd Year	5,513	18
TOTAL	**24480**	**90**

23) Model No – CN /HP/AL/02	Block Plantation Model
Zone: Agriculture/Horticulture lands in Himachal Pradesh	

This model will be implemented in Agricultural/ Horticultural landscapes in temperate to cold desert zones in Himachal Pradesh. The area is hilly and the slope is moderate to steep. The sites proposed for this model are agricultural/ horticultural/ grasslands where grains, off season vegetables, stone fruit crops, grasses, etc. are grown, hence these sites possess better soil fertility and managerial care with occasional subsistence irrigation mostly available water judiciously divided among local communities collectively by them.

The zone experiences scanty rainfall during rainy season and moderate to heavy snowfall during winter months. Monsoon or winter rains transport silt from these areas through number of seasonal water channels, *nallah*, rivulets, etc. to Chenab River causing siltation and floods down streams. Besides this, agriculture, construction and developmental activities are the main reasons behind soil erosion from these areas. A large part of precipitation flows down the streams within a few hours of rainfall as surface run-off causing lot of soil erosion. The pressure for grazing, fuel wood, tree fodder collection, etc. is considerable. Effective Forestry Interventions in agricultural/ horticultural/ grassland areas can help significantly in improvement of the flow of Chenab River and its tributaries.

For this zone, planting of economic trees is recommended. The farmer/ orchardist will decide the species and numbers of plants of per unit area of economically important tree species i.e., *Prunus* spp. ,*Diospyros* spp., *Juglans regia, Malus pumilus, Corylus jacquemontii*, *Populus* spp., *Salix* spp., etc. Block plantation in vacant and fallow lands can be taken up by the farmers to increase their income and utilising the fallow and other grass lands also.

Similarly, as in model CN/HP/AL/01, for deciding Physical Targets, listing of number of farmers (District/ Division wise) whose land holdings comes under small farmers and above is to be done (as described category) by Agriculture Department of the respective states are to be considered under the proposed model. About 5% of total such farmers enlisted in the Chenab Riverscape would be included division wise in the proposed treatment model. Block plantation per farmer would be taken as virtual one hectare area for budgetary provisions and number of plants/ha can vary from 500 to > 1500 as per the requirements of species specific high density plantations.

Choice of species:

Tree: *Prunus* spp., *Diospyros* spp., *Juglans regia, Malus pumilus, Corylus jacquemontii, Populus* spp., *Salix* spp., etc.

Table: 5. 26 – Cost Norms and Pattern of Assistance for High Density Block Plantation (HDBP)

S. No.	Magnitude of block Plantations (No. of plants/block of 1 ha)	Total cost (Rs) for the block			
		1st Year	2nd year	3rd Year	4th Year
1.	500 to 1000 (Spacing 3.5 x 3.5m)	28,000	14,000	14,000	14,000
2.	>1000 to 1200 (Spacing 3 x 3m)	33,600	16,800	16,800	16,800
3.	>1200 to 1500 (Spacing 2.5 x 2.5m)	48,000	24,000	24,000	24,000
4.	>1500(Spacing less than 2.5 x 2.5 m)	52,000	26,000	26,000	26,000

S. No.	Magnitude of block Plantations (No. of plants/block of 1 ha)	Total cost (Max.) (Rs) for the block (or in proportion to planting intensity)				Total
		1st Year	2nd year	3rd Year	4th Year	
1.	1200	48,000	25,680	27,478	29,401	1,30,559
	Man days	192	96	96	96	480

(B) Treatment Models for Agriculture Landscape in Jammu Region (J&K UT)

24) Model No – CN /JK/AL/01	Boundary Plantation Model
Zone: Agricultural /Horticultural lands in Jammu Region (J&K UT)	

The model will be applied in agriculture fields in Jammu region (J&K UT). These fields are cultivated with traditional crops as well as some commercial production and open to soil erosion especially during flood irrigation and heavy rainfall.

Moderate to heavy monsoon rains in this zone transport huge quantities of silt to Chenab River causing siltation and flood like situation in lower Jammu region. Cultivation in this zone makes these areas vulnerable to soil erosion. Effective Forestry Interventions in these sites can help significantly in improvement of the flow of Chenab River and its tributaries.

The sites proposed for this model are agriculture lands where selected clones of Poplar, Salix, Walnut, *Acacia catechu, Dalbergia sissoo,* etc., will be planted at 4 x 4m spacing. Pit size of 60 x 60 x 60cm will be used for plantation. Selected plants will be distributed to farmers for planting on their agricultural land. Planting will be done by the farmers. The farmers will place requirement for plants to local forest officials who will supply the plants at the start of planting season.

The methodology for deciding physical targets has been finalized after consultation with stakeholders. A simple methodology has been adopted based on number of farmers and their landholdings. For boundary plantation model, out of total farmers of the various forest divisions in the Chenab riverscape, 10% farmers will be included under this treatment model irrespective of their landholdings. Distribution of 150 plants per farmer would be taken as virtual one hectare area for budgetary provisions.

Choice of species

Trees/Bamboo: *Populus* spp., *Salix* spp., *Melia azedarach, Phyllanthus emblica, Aegle marmelos, Albizia spp., Juglans regia, Terminalia* spp., *Quercus* spp., *Morus* spp., *Pistacia integerrima, Grewia optiva, Bauhinia variegata*, *Dendrocalamus* spp., *Bambusa* spp., *Acacia catechu, Dalbergia sissoo,* etc.

Cost Sharing: The Govt. will share cost Material i.e., plant cost Rs.@ 70/- , 35/-, 35/-, 35/- for Ist to IVth year and maximum of 150 trees per ha.

Table: 5. 27 – Cost Norms and Pattern of Assistance for Peripheral and Boundary Plantations (PBPs)

S.No	Type of Interventions	Indicative Unit cost per plant (Rs.)
1.	Pre-Plant activities/Land clearing/Maintenance, etc.	20
2.	Digging /Planting, etc.	12
3.	Single unit Planting material, etc.	30
4.	Transportation charges	3
5.	Critical inputs viz., FYM, Fertilizer, seed treatment, Vesicular Arbuscular Mycorrhizae (VAM), etc.	20
6.	Planting cost	5
7.	Fencing	20
8.	Maintenance (weeding+ watering, etc.)	40
	Total	**150**
Note: (i) The activity wise costs are tentative and states have the flexibility to formulate their own estimate based on local requirements subject to a maximum of Rs. 150/- per plant. (ii) The assistance will be given in the year wise proportion of 40:20:20:20.		

For Jammu region of Jammu and Kashmir UT

Table: 5. 28 – Model – CN/JK/AL/01 Boundary Plantation Model

Year	Amount (Rs)/ha	Man days
Ist year Establishment	9,000	40
Maintenance Ist Year	4,815	20
Maintenance IInd Year	5,513	20
Maintenance IIrd Year	5,899	20
TOTAL	**25,226**	**100**

25) Model No – CN /JK/AL/02	**Block Plantation Model**
Zone: Agricultural /Horticultural lands in Jammu Region (J&K UT)	

The model will be applied in agriculture fields in Jammu region (J&K UT). These fields are cultivated with traditional crops as well as some commercial production and open to soil erosion especially during flood irrigation.

Moderate to heavy monsoon rains in this zone transport huge quantities of silt to Chenab River causing siltation and flood like situation in lower Jammu region. Cultivation in this zone makes these areas vulnerable to soil erosion. Effective Forestry Interventions in these sites can help significantly in improvement of the flow of Chenab River and its tributaries.

The sites proposed are agricultural lands where selected clones of Poplar, Salix Walnut, *Acacia catechu, Dalbergia sissoo,* etc. will be planted at 4 x 4 m spacing. Pit size of 60 x 60 x 60cm will be used for plantation. Selected plants will be distributed to farmers for planting on their agricultural lands. Planting will be done by the farmers. The farmers will place requirements for plants to local forest officials at the start of the planting season.

Similarly, as in model CN/JK/AL/01, for deciding Physical Targets, listing of the number of farmers District/ Division wise whose land holdings comes under small farmers and above (as described category) by Agriculture Department of the respective states will be done and considered under the proposed model. About 5% of total such farmers enlisted in the Chenab Riverscape would be included division wise in the proposed treatment model. Block plantation per farmer would be taken as virtual one hectare area for budgetary provisions and number of plants/ha can vary from 500 to > 1500 as per the requirements of species specific high density plantations.

Choice of species

Trees/Bamboo: *Populus* spp., *Salix* spp., *Melia azedarachta, Phyllanthus emblica, Aegle marmelos, Cassia fistula, Albizia spp., Juglans regia, Terminalia* spp., *Quercus* spp., *Morus* spp., *Pistacia integerrima, Grewia optiva, Bauhinia* spp., *Dendrocalamus* spp., *Bambusa* spp., *Acacia catechu, Lannea coromandelica, Mallotus pdilippensis, Dalbergia sissoo,* etc.

Table: 5. 29– Cost Norms and Pattern of Assistance for High Density Block Plantations (HDBPs)

S.No.	Magnitude of Block Plantations (No. of plants/block of 1 ha)	Total cost (Rs) for the Block			
		1st Year	2nd year	3rd Year	4th Year
1.	500 to 1000 (spacing 3.5 x 3.5m)	28,000	14,000	14,000	14,000
2.	>1000 to 1200 (spacing 3 x 3m)	33,600	16,800	16,800	16,800
3.	>1200 to 1500(spacing 2.5 x 2.5m)	48,000	24,000	24,000	24,000
4.	>1500(spacing less than 2.5 x 2.5m))	52,000	26,000	26,000	26,000

S. No.	Magnitude of Block Plantations (No. of plants/block of 1 ha)	Total cost (Max.) (Rs) for the Block (or in proportion to planting intensity)				Total
		1st Year	2nd year	3rd Year	4th Year	
1.	1200	48,000	25,680	27,478	29,401	1,30,559
	Mandays	213	107	107	107	533

5.4.5 Urban Landscapes

(A) Treatment Models for Urban Landscape in Himachal Pradesh

River Front Development

Many cities, towns and semi-urban areas are located along the Chenab River and its tributaries. Urban and peri-urban areas along the river may be developed to attract residents and visitors and provide them a grand sight of the river along with fresh air, mental peace, solace and spiritual fulfilment that would connect them with the river.

River front development envisages riverbank plantations to stabilize it by protecting it from soil erosion. This involves covering the entire ground by intercepting the sunlight at various heights of canopy through multiple layers of vegetation. At the ground surface, the grasses or

surface growers are allowed to cover and bind the surface soil, control the surface soil erosion like sheet erosion, splash erosion and rill erosion. It also promotes the rain water percolation and minimizes the surface runoff. At the second layer of vegetation, small to medium sized herbs and shrubs are accommodated to intercept some amount of sunlight and slow down the speed and reduce the erosive force of rain drops falling directly from sky and/or upper layers of canopy thereby reducing soil erosion (splash erosion). At the third layer of canopy above the ground surface, small to medium sized trees or larger shrubs are accommodated to provide a dense crown cover. This comprises light loving plants having good timber value and multipurpose benefits like fodder, fuel etc. Scattered taller strong light demander trees may make one or two higher layers of canopy. Strong root binders are promoted on this type of site. Multi-tier planting methods are preferred. A basic support system may also be developed for the convenience of visitors.

The riverfronts of Chenab and tributaries have different owners i.e., farmers, Municipal Corporations, Panchayat, Irrigation Department, Institutions, Forests Department, etc. and substantial portions are under private ownership. Suitable steps will be taken to ensure smooth coordination of the activities among different agencies.

In this model the river HFRI team has identified the major areas around district Headquarters or any other prominent places of religious importance in consultation with various stakeholders and area be decided as per availability at those places.

One model for riverfront development has been proposed. Site-specific activities will be carried out at different places commensurate with the local site conditions available for riverfront development. Description of the model is given below.

26) MODEL – CN/HP/ UL/01	**Riverfront Development**

The proposed model of riverfront development would involve plantation of avenue shrubs and trees along the riverbank to stabilize the soil and protect the bank from erosion. It would also have beds of annual flowering plants and patches of grasses. The developed area would provide a pleasing and relaxing environment to the visitors. It would be a typical landscaping area comprised of vegetation and non-vegetation components.

According to requirements, following components need to be created for Riverfront development:

1. **Vegetation Part:** Grove consisting of shade trees, ornamental trees & bamboos, small herbal garden, climbers, hedges, grasses for lawns, etc.
2. **Non-vegetation part:** Stairs, pathways, walking trails, stone pitching, benches, rain shelters, e-public utilities, parking area, information centre, refreshment area, etc. as per the site specific requirements.

The vegetation and non-vegetation components will be arranged in such a way to enhance the aesthetic beauty of Riverfront. Ornamental species will be planted according to their recommended spacing and site specific suitability.

For using the available space economically and efficiently, multi-tier planting methods will be used. Soil binding and water loving ornamental trees and shrubs are ideal choice for riverbank planting. To bind the surface soil, grasses and surface growers will be allowed, to cover the surface and protect soil from erosion especially during rainy season or river flooding. It will minimise soil loss through sheet, splash and rill erosions. It will also improve rain water per collation or absorption. Besides this, small to medium sized herbs and shrubs will be accommodated at the second layer of vegetation to intercept some amount of sunlight and stop the fast/ forceful falling of rain drops directly from sky in turn which stop soil erosion (splash erosion). Small to medium sized ornamental trees or larger shrubs i.e., mainly light demanding plants will be accommodated at the third layer of canopy to cover the crown area. This layer will provide small timber, fuel, fodder and intangible benefits. The top canopy will be occupied by the strong light demanding species which are ultimately the dominant species on riversides.

In this model, the HFRI river team has identified the major areas around district Headquarters or any other prominent places of religions important with consultation of various stakeholders and area will be decided as availability at those places

Choice of Species

Tree*:* *Cedrus deodara, Ligustrum nepalense, Cinnamonum tamala, Mangifera indica, Michelia champaca, Taxus wallichiana, Bauhinia variegata, Juniperus polycarpos*, *Salix* spp., *Populus* spp., *Platanus* spp.,*Corylusjacquemontii,Magnolia grandiflora,,Alnus* spp., *Pinus wallichiana, Prunus* spp., *Ulmus* spp., etc.

Shrubs: *Rosa* spp., *Spiraea canescens, Murraya paniculata, Indogofera* spp., *Berberis* spp., *Hippophae* spp., *Lonicera* spp., *Cycas* spp., and *Palms* spp., etc.

Institutional Plantations

Number of Educational Institutes, Hospitals, Government and Private Sector Offices, religious places, historical places, hotels, Guest houses, etc. are located in the whole stretch on the bank of Chenab River and its tributaries. Many of such institutions and industries may have possibility to accommodate number of trees of different sizes for beautifying the overall landscape. Tree/shrub/climber plantations will be encouraged on such lands within the project area. This would improve aesthetics, provide shade, produce non-wood and wood produce, reduce air, noise and dust pollution, harbour birds, reduce erosion, and create awareness about the importance of trees. Some of the trees may serve religious purpose too and could be developed as small sacred grooves with the approval of management of such Institutions.

The HFRI river team has consulted the secondary data of District wise/ Block wise in riverscape regarding Schools, Universities, Colleges, Corporates/ Hotels, Corporations, NGOs, and others. Total number will be worked out and 20% of those can be taken in this component and individual Institution would be take one hectare (virtual) for calculating

budgetary provision. The Forest Department and Deputy Commissioner of the district can be taken on board for providing land to the Institutions for establishing plantations under this model. The budgetary provision for those Institutions can be distributed in three years in equal proportion or in the ratio of 30:30:40 in each year.

One model has been proposed for Institutional and Industrial Estate Plantation. Site-specific activities will be carried out according to the site conditions. The detailed description of the model is given below.

27) MODEL – CN/HP/ UL/02	**Institution Plantation**

Under this model, mainly ornamental, shade and fruit plants will be encouraged for planting. Evergreen plants especially *Juniper* (*Juniper polycarpos*) in higher elevations and *Biota orientalis* in lower elevation will be preferred so that the leaves do not shed during winter months. Plantation of forest species including *Pinus gerardiana* will be raised near the vicinity of various Institutions and Industries at 3m x 3m. Pit size of 45 x 45 x 45 cm will be used for plantation. After land development, pit digging, etc., plants mainly of broadleaved species, *Salix* spp., *Cedrus deodara, Corylus jacquemontii, Populus* spp., *Juniperus* spp., etc. will be planted. The initiative will beautify the area, create awareness among people associated with Institution and Industries, and promote environmental services, besides providing economic returns from under-utilized land.

Species Preference

Trees*:* *Cedrus deodara, Juniperus polycarpos, Salix* spp., *Populus* spp., *Platanus orientalis, Magnolia grandiflora, Juglans regia, Corylus jacquemontii, Alnus* spp., *Pinus wallichiana, Pinus grardiana, Prunus* spp., *Ulmus wallichiana, U. villosa,*etc.

Table: 5. 30 – Treatment Models for Urban Landscapes in Himachal Pradesh

S. No	Model No.	Amount Rs/Ha	Man days	Amount Rs/Ha	Man days	Amount Rs/Ha	Man days	Amount Rs/Ha	Man days
		Estt.		1st year Maintenance		2nd year Maintenance		3rd year Maintenance.	
1.	CN/HP/UL/01 Riverfront Development	2,50,00,000	30000	75,00,000	9000	50,00,000	6000	37,50,000	4500
2.	CN/HP/UL/02 Institution Plantation	2,60,000	312	78,000	94	52,000	62	39,000	47

(B) Treatment Models for Urban Landscapes in Jammu region (J&K UT)

Bio-remediation and Bio-filteration

Under the Urban Landscape models, Bio-remediation and bio-filteration are one of the important forestry intervention activities proposed for rejuvenation of rivers/tributaries.

Varied anthropogenic activities and ever burgeoning population have resulted in deterioration of river ecosystems making them unfit for survival of indigenous biological forms. Rampant industrialization, improper agricultural methods, unchecked discharge of pollutants both organic and inorganic into water bodies, drains, nallahs, hillsides, rivulets and streams ultimately leads to the contamination of the river systems. Heavy metal effluents from the processing units of industrial agglomerations situated in the towns are refused in the river systems which degrade the quality of water, and rendering of little or no use in the downstream.

Water bodies including rivers, lakes and streams have been heavily impacted due to the indiscriminate human activities and sometimes natural calamities. There is a great loss to the biodiversity or utility.

In this dismal scenario, cleaning of water bodies and removal of toxic pollutants from the river ecosystems to rejuvenate fresh water bodies by making them free of contaminants is urgently required.

In comparison to the conventional methods like physical, chemical and thermal processes, bio-remediation techniques involving biological systems such as microorganisms or their products and plants are sustainable and cost effective options for abatement of pollution of the water bodies. In bio-remediation, biological systems are applied for reclamation of the contaminated water by transformation of toxic pollutants into less hazardous or completely non-hazardous forms. The bio-remediation technology includes use of microorganisms or their enzymatic machineries, phyto-remediation (plants) and rhizo-remediation (plant and microbe interactions) techniques. Thus, Bio-remediation is an effective and eco-friendly technique for removing toxic pollutants from aquatic environment.

Water pollution from untreated urban and peri-urban waste water is an enormous problem in urban agglomerations. Low-cost, decentralized, and wetland-based bio-filters have strong potential to dramatically improve the water quality. Well-designed bio-treatment systems with inclusion of appropriate native species are ideal for removing pollutants from municipal wastewater. They can be applied extensively in rural areas, small towns, peri-urban areas or institutional campuses. The bio-filters are simple to construct, easy to operate, and cost effective. Major advantage of this method is that the pollutant is converted into bio-degradable waste which can decompose within a moderate time frame, thus producing no secondary pollutants.

Broadly, in this technique, plants and microbes associated with plant root systems are used to remove the pollutants in the form of inorganic and organic wastes. Selection criteria of plants for achieving high efficiency are always important. For example plants such as *Tecoma*

stans, *Scirpus grossus*, *Eichhornia crassipes* (water hyacinth), *Spirodela polyrrhiza* (aquatic plant), *Azolla* sp., etc. have been found good for dye degradation.

Organic and inorganic substances released from various sources into the existing natural water bodies cause their contamination. Among various water pollutants, nitrogen compounds form a significant role in waste water contamination due to increase in anthropogenic sources like agriculture. Release of nitrate into fresh water poses severe problems including eutrophication. Biological denitrification is one of the more versatile and promising methods for the treatment of nitrate contaminated waters.

It is very well recognized fact that the plants in bio-filters play a great role in removing phosphates, nitrates, nitrites and ammonia. Many substances harmful to people and animals are conducive to plant growth. Plants require ammonia, phosphates and nitrates, and most synthetic fertilizers. Duckweed, nut grass water lilies and other aquatic plants are known to absorb these substances.

The pollution control board already released the list of Urban/ Semi Urban areas which are polluting the Rivers or their tributaries, so the areas are identified in the riverscape accordingly and one site can be termed as 1 hectare (virtually) and where possible Seechewal model of Punjab or its modification can also be adopted.

28) MODEL – CN/JK/UL/01	**Bio-remediation and Bio-filtration**

The Pollution Control Board has already released the list of Urban/ Semi Urban areas which are polluting the Rivers or their tributaries, so the areas are identified in the riverscape accordingly and one site can be termed as 1 hectare (virtually) and where possible Seechewal model of Punjab or its modification can also be adopted

The State Forest Department, Municipal or Panchayat bodies have to adopt the suitable approach for bio-filter suiting to the specific requirements and site characteristics. The model will include the following activities.

1. Waste water treatment through mechanical measures as per the site requirement.
2. Drainage line treatment by planting grasses, herbaceous vegetation and shrubs.
3. Bio-filters: Bio-filters may be of different types: Free floating macrophyte bio-filters, emergent macrophyte bio-filters, sub-merged macrophyte bio-filters, and multispecies algal bio-filter.

Choice of Species:

Tecoma stans, *Cyperus rotundus*, *Potamogeton* spp., *Nymphaea* spp., *Nelumbo* spp., *Typha angustata*, *Scirpus grossus*, *Eichhornia crassipes* (water hyacinth), *Spirodela polyrrhiza* etc.

29) MODEL – CN/ JK /UL/02	Riverfront Development

The proposed model of riverfront development would involve plantation of avenue shrubs and trees along the riverbank to stabilize the soil and protect the bank from erosion and floods. It would also have beds of annual flowering plants and patches of grasses. The area will be designed and in such a way that would attract the visitor and provide them pleasing and relaxing environment. It would be a typical landscaping area comprised of vegetation and non-vegetation components.

According to requirements, following components need to be created for Riverfront development:

1. **Vegetation Part**: Grove consisting of shade trees, ornamental trees and bamboos, small herbal garden, climbers, hedges, grasses for lawn, etc.
2. **Non-vegetation part**: Stairs, pathways, walking trails, stone pitching, benches, rain shelters, e-public utilities, parking area, information centre, refreshment area, etc. as per the site specific requirements.

The vegetation and non-vegetation components will be arranged in such a way to enhance the aesthetic beauty of Riverfront. Ornamental species will be planted according to their recommended spacing and site specific suitability.

For using the available space economically and efficiently, multi-tier planting methods will be used. Soil binding and water loving ornamental tree and shrub species are ideal choice for riverbank planting. To bind the surface soil, grasses and surface growers will be allowed to cover the surface and protect soil from erosion especially during rainy season or river flooding. It will minimise soil loss through sheet, splash and rill erosions. It will also improve rain water per collation or absorption. Besides this, small to medium sized herbs and shrubs will be accommodated at the second layer of vegetation to intercept some amount of sunlight and stop the fast/ forceful falling of rain drops directly from sky in turn which stop soil erosion (splash erosion). Small to medium sized ornamental trees or larger shrubs i.e., mainly light demanding plants will be accommodated at the third layer of canopy to cover the crown area. This layer will provide small timber, fuel, fodder and intangible benefits. The top canopy will be occupied by the strong light demanding species which are ultimately the dominant species on riversides.

Choice of Species

Trees*:* *Jacaranda mimosifolia, Cassia fistula, Magnolia grandiflora, Michelia champaca, Ginkgo biloba, Alstonia scholaris, Syzygium venosum, Grevillea robusta, Pongamia pinnata, Albizia orientalis,, Butea monosperma, Kigelia pinnata, Dalbergia sissoo, Delonix regia, Salix* spp., *Sesbania sesban, Thuja orientalis, Saraca asoca, Polyalthia longifolia, Callistemon citrinus,* Palms andBamboo species, etc.

Shrubs: *Bougainvillea* spp., *Rosa* spp., *Murraya paniculata, Bignonia* spp., *Euphorbia pulcherrima, Cycas* spp., *Nerium indicum, Nyctanthes arbor-tristis, Spiraea* spp., etc.

30) MODEL – CN/ JK /UL/03	Institution Plantation

Under this model, mainly ornamental, shade and fruit plants will be encouraged for planting. Evergreen plants especially, *Magnolia grandiflora,Michelia champaca, Sesbania sesban, Callistemon citrinus, Cinnamomum zeylanicum, Polyalthia* spp., etc. will be preferred so that the leaves do not shed during winter months when air pollution is usually high in plains. Plantation of forest species will be raised near the vicinity of various Institutions and Industries at 3 x 3 m. Pit size of 60 x 60x 60 cm will be used for plantation. After land development, pit digging, etc., plants mainly of broadleaved species such as *Syzygium venosum, Ficus rumphii, F. benghalensis, Anthocephalus kadamba, Dalbergia sissoo, Melia indica, Pongamia pinnata, Holoptelea integrifolia, Juniperus* spp., *Salix* spp., etc. will be planted. The initiative will help in beautifying the area, create awareness among people associated with Institutions and Industries and promote environmental services, besides providing economic returns from under-utilized land.

The HFRI Chenab River Team has consulted the secondary data of District wise and Block wise in Riverscape regarding Schools, Universities, Colleges, Factories, Hotels, Corporations, other NGOs, the Railways, etc. Total numbers will be worked out 20% of these Institutions and one hectare area can be taken in this component. The Forest Department and District Commissioner can be taken on board for providing the land to Institutions for plantations. The 20% of total numbers can be distributed in these years in equal proportion or in the ratio of 30:30:40 in each year.

Choice of Species

Trees:*Syzygium venosum, Anthocephalus kadamba, Cassia fistula, Alstonia scholaris, Melia indica, Pongamia pinnata, Thuja*sp., *Ficus benghalensis, Sesbania sesban,Cryptomeria japonica, Araucaria araucana, Jacaranda mimosifolia, , Albizia* spp., *Delonix regia, Salix* spp., *Saraca asoca, Polyalthia longifolia, Callistemon citrinus, Kigelia pinnata, Platanus orientalis, Ginkgo biloba,* etc.

Eco-park Development

Development of some sites of the Urban Landscapes, into Eco-park is an important activity keeping in view the growing population and settlements in urban areas. Actually, landscaping and beautification are proposed for Urban and Peri-urban Landscapes of frequent public visitation to bring forth aesthetics and entertainment coupled with natural awareness. The natural layout of the land will be maneuvered in such a way that the aesthetic beauty will be enhanced without much investment by greening the blank areas. Landscaped area will be designed to afford good soil, moisture and biodiversity conservation, in addition to improvement in aesthetic values.

The HFRI River Team has consulted various stakeholders having land for developing Eco-park which can be near any Urban and Semi- urban areas. The availability of land should be taken after consultation with respective stakeholders that can be between 0.5-2 ha.

One model has been proposed for Eco-park development. Site-specific activities will be carried out at different places in harmony with the selected site conditions. Description of the model is given below:

31) MODEL – CN/ JK /UL/04	**Eco-park Development**

An eco-park will be better equipped than riverfront development to facilitate visitors. An eco-park will have both vegetation and non-vegetation components. Even in the Eco-parks the proportion of ornamental plants will be relatively more than in the riverfront development model.

According to requirement, list of components to be created under this model;

1. **Vegetation part**: Miscellaneous ornamental plant species e.g., trees, shrubs, herbs, creepers, hanging plants etc.
2. **Non-vegetation part**: Fencing, stairs, pathways, walking trails, stone pitching, rain shelter, e-public utilities, benches, parking area, information centre, children playing area, pond beautification, landscaping, etc. as per site-specific requirements.

The HFRI River team has consulted various stakeholders having land for developing Eco-park which can be near any urban/ semi urban area. The availability of land should be taken after consultation with respective stakeholders that can be anything from 0.5-2 hact.

Choice of Species

Trees:*Jacaranda mimosifolia, Magnolia grandiflora, Thujaorientalis, Mechelia champaca, Alestonia scholaris, Sesbania sesban, Cryptomeria japonica, Araucaria araucana, Albizia spp., Delonix regia, Butea monosperma, Kigelia pinnata, Dalbergia sissoo, Pongamia pinnata, Salix* spp*., Saraca asoca, Polyalthia longifolia, Callistemon citrinus,* etc.

Shrubs: *Bougainvillea* spp., *Rosa* spp., *Nerium indicum, Nyctanthes arbor-tristis, Spiraea* spp., *Euonymus sp., Bignonia sp., Palms,* etc.

Table: 5. 31 – Treatment Models for Urban Landscape in Jammu region of Jammu and Kashmir UT

S. No	Model No.	Amount Rs/Ha	Man days	Amount Rs/Ha	Man days	Amount Rs/Ha	Man days	Amount Rs/Ha	Man days
		Estt.		1st year Maintenance		2nd year Maintenance		3rd year Maintenance.	
1.	CN/JK/UL/01 Bioremediation and Bio filtration	15,00,000	2000	4,50,000	561	3,00,000	349	2,25,000	245
2.	CN/ JK/UL/02 Riverfront Developme	2,50,00,000	33333	75,00,000	9346	50,00,000	5823	37,50,000	4081

	nt								
3.	CN/ JK/UL/03 Institution Plantation	2,60,000	347	78,000	97	52,000	61	39,000	42
4.	CN/JK/UL /04 Eco-Park Developme nt	1,50,00,000	20000	45,00,000	5607	30,00,000	3494	22,50,000	2449

5.4.6 Projected Targets – Model-wise Extent and Costs

The foregoing description has provided details on the potential treatment models under different landscapes within the Chenab riverscape. It is evident that the model-wise cost ranged from Rs. 0.15 to 56.93 Crore. The proposed extent under different models during five year implementation plan period would range from 1.50 to 3620 ha. The projected targets of proposed Forestry Interventions under two types of landscapes are summarized in **Table 5.32**

Table: 5.32 – Projected Physical Targets of Proposed Plantations in Natural and Agricultural Landscapes within the Chenab Riverscape

Sr.No.	Landscape	State/ UT		Total Number of Plants to be Planted
		Himachal Pradesh	Jammu and Kashmir UT	
1.	Natural	436	3,245	28,89,200
2.	Agriculture	74	558	2,20,800
Total		**510**	**3,803**	**31,10,000**

5.4.7 Theme Plans

Conservation interventions and supporting activities which common to two or lower order sub-zones or three type of landscapes described above, referred as theme plans are also proposed. Details of proposed conservation interventions and supporting activities are provided below.

5.4.8 Conservation Interventions

Three types of conservation interventions *viz.*, **(a)** soil and water conservation, **(b)** riverine and riparian management, and **(c)** wetland management are proposed for implementation by the Implementing Agencies (IAs) of Himachal Pradesh and Jammu and Kashmir UT. Details of three types of conservation interventions proposed are presented below:

Conservation Interventions

a) Soil and Water Conservation

b) Riverine and Riparian Management

c) Wetland Management

a) Soil and Water Conservation Measures

The description on physical sub-environment provided earlier in the context of Chenab Riverscape has highlighted that the catchment of Chenab river, particularly in the mountainous tract of Himachal Pradesh is suffering on account of landslides, bank erosion, habitat loss, due to construction and other unsustainable human activities resulting into severe problem of soil erosion and sedimentation. Conservation interventions by way of appropriate soil and water conservation measures are of paramount importance in order to ensure *Aviral Dhara*, *Nirmal Dhara* and ecological integrity of the river.

The soil and water conservation works are required in all landscapes *viz.*, Natural Landscapes, Urban Landscapes and Agricultural Landscapes. These soil and water conservation works are extremely important for protecting fertile soils of all the landscapes, regulating stream flows and reducing silt load of Chenab River and its tributaries. The following Models have been finalized for treatment of sites as soil and water conservation interventions in HP and Jammu and Kashmir UT.

Himachal Pradesh

1. CN/HP/CI/01 - Brushwood Interventions
2. CN/HP/CI/02 - Dry Stone Interventions & Activities
3. CN/HP/CI/03 - Crate Wire Interventions & Activities
4. CN/HP/CI/04 - Water Ponds
5. CN/HP/CI/05 - Silt Detention Dams

Jammu region (J&K UT)

1. CN/JK/CI/01 - Brushwood Interventions
2. CN/JK/CI/02 - Dry Stone Interventions & Activities
3. CN/JK/CI/03 - Crate Wire Interventions & Activities
4. CN/JK/CI/04 - Water Ponds
5. CN/JK/CI/05 - Silt Detention Dams

The details of cost of these models in Himachal Pradesh and Union Territory of Jammu and Kashmir are given below.

Table: 5. 33 – Cost Norms of Treatment Models for Soil and Water Conservation Interventions in Himachal Pradesh

S. No.	Model No.	Amount Rs./Cumt	Man days
1.	CN/HP/CI/01 Brushwood Interventions	300	2
2.	CN/HP /CI /02 Dry Stone Activities	1800	8
3.	CN/HP /CI /03 Crate Wire Activities	4500	15
4.	CN/HP/CI/04 Water Ponds	65,000	288
5.	CN/HP/CI/05 Silt Detention Dam Type Activities	80,000	248

Table: 5. 34 – Cost Norms of Treatment Models for Soil and Water Conservation Interventions in Jammu region (J&K UT)

S.No.	Model No.	Amount Rs./Cumt	Man days
1.	CN/JK/CI/01 Brushwood Interventions	300	1
2.	CN/ JK /CI /02 Dry Stone Activities	1,800	8
3.	CN/ JK /CI /03 Crate Wire Activities	4,500	20
4.	CN/JK /CI/04 Water Ponds	65,000	289
5.	CN/JK /CI /05 Silt Detention Dam Type Activities	80,000	356

The meticulous descriptions of Potential bio-engineering and mechanical measures applicable extensively for soil and moisture conservation interventions are illustrated below:

Bio-Engineering Measures - A Homeopathy of Environmental Restoration

Bio-engineering is the designed use of grasses, shrubs and trees to improve and protect the land. The hydrological and mechanical effects of the plant community are used to fulfill an engineering function. Vegetation can be used alone or in conjunction with engineering structures in which case it can be termed as bio-technical engineering. Bio-engineering techniques have emerged as an effective method to prevent soil erosion and to assist re-vegetation of disturbed sites such as hill slopes and stream banks. The plant species will be used to construct live structures along the low cost engineering structures so that not only stabilization of hill slope takes place but, also stimulate growth as well as provide a permanent solution to unstable hill slopes. The vegetative conservation technology covers the set of biological measures often planned and designed in conjunction with

engineering/mechanical measures to conserve soil and water resources for sustainable biomass production.

(i) Special Characteristics of Conservation Flora

The plant species providing dense ground cover during rainy season like *Bhabbar* grass (*Eulaliopsis binata*) and other tussocky forming grasses are considered as erosion resistant crop. There are some plant species which are preferred because of their special characteristics as summarized below:

The selected plant species should be generally evergreen.

i) The species should be adapted to local climate, soil and site conditions.

ii) They must have a dense, fibrous and strong root system for soil binding.

iii) They should have a genetic ability to thrive on poor/impoverished/marginal lands.

iv) They must be fast growing and of primary colonizing nature.

v) They should not be attacked by termites/insects/pests and damaged by frost.

vi) They species should multiply very fast by profuse tillering or through suckers.

vii) They should have social and some economic value to local population.

viii) They should profusely grow during monsoon when soil erosion is highest.

ix) Their architecture should be such that plants bend with currents of water and erect again when flow stops.

(ii) Vegetative Measures for Soil and Water Conservation

The vegetative measures are cost effective and play important role in conserving soil and water, and are included in any watershed management plan. These bio-engineering measures are different for arable and non-arable lands and generally divided into five categories *viz*., **(a)** land slope management, **(b)** drainage line treatment, **(c)** stream bank protection, **(d)** landslide stabilization, and **(e)** land-fill, mine spoiled and other problem areas.

(iii) Bio-engineering measures for land slope management

a) Barriers of suitable and compatible grasses, shrubs and trees are established against over land slope on contour to intercept soil and water.

b) The species vary according to agro-climatic conditions.

c) There is considerable variation in soil working, planting techniques and planting material.

d) In general, the soil excavated from contour trenches/ V-ditches/ contour furrows is deposited on the down-slope side leaving a 15 cm berm to form a parallel contour bund along the contour trench having breaks at regular interval.

e) Rooted slips of grasses are planted at a spacing of 10-15 cm on bunds and fodder trees are planted in/ along the trenches.

f) On the lower side of the bunds, a row of grasses are raised to form complete barrier.

g) The vertical interval between the rows varies usually with slope and tree rows spacing which may vary from 3-6 m

h) The contour trenches get partly filled with eroded soil and store rainwater which in turn provide sufficient moisture to the vegetative strips.

i) Once established, the closely growing hedges along with dense roots reduce soil erosion by breaking the slope length, reduce velocity of water and increase infiltration to the soil, induce deposition of the eroded soil and help in establishing trees raised on trenches by improving moisture regime.

The grass barriers are established during rainy season and when planted during drizzling establish very quickly. *Vetiveria zizanioides* grass performs well only on wet/moist areas in non-arable lands, but suffers high mortality and then termite attack on drier slopes. Bhabar grass (*Eulaliopsis binata*) performs well when planted properly during light showers and particularly in association with local trees having light/ thin canopy like Khair (*Acacia catechu*) and Napier grass (*Pennisetum purpureum*) are most liked by the farmers and provide forage for livestock. These species take 2-3 years to establish and over a period of time eroded soil accumulate above the hedges. This would tend to form terraces by breaking the slope into series of terraces.

(iv) Bio-engineering Measures for Drainage Line Treatment

A wide range of measures are available for the drainage line treatment. These are described below one by one:

a) **Live Check Dams:** Live check dams are the barriers created by planting available tussock forming grasses and shrubs across the first order gullies to check soil erosion, and retain fine soil and moisture. These are also raised to check extension of gully heads to upper slopes. To prolong the life of water storage structures, live check dams in drainage lines above the water storage structures and in between the silt detention dams assumes significance.

b) **Construction:** Live check dams are constructed using locally available plant species such as *Vitex negundo, Arundo donax, Ipomoea carnea,* and *Agave sislana*. Two rows of grasses like *Vetiveria zizanioides, Panicum maximum,Napier (Pennisetum purpureum),*other tussock forming, etc. are planted at 10cm interval from plant to plant and 20 cm row to row spacing. On the down side of grass row, two rows of shrubs like *Vitex negundo, Arundo donax, Murraya paniculata, Euomymus* spp.,and *Ipomoea* spp. are planted at close spacing of 30cm from plant to plant and 50cm from row to row across the nalla bed. In case, sand/debris load is large then series of live check dams are constructed above and below the crate/dry stone check dams.

c) **Brush Wood Check Dams:** Brush wood check dams are constructed using locally available brush wood material and wooden poles from the forest. They are feasible where such material is available. They are constructed in small gullies not deeper than

one meter depth. They are of two types *viz*., **(a)** single row post brush wood dams, and **(b)** double row post brush wood dams.

d) **Single Row Post Brush Wood Dams**: These are made of wooden stakes to which long branches of trees and shrubs are tied in a zigzag manner across the small gully. The site is first eased to slope of 1:1 and bottom of the gully excavated by about 25cm. Then, the wooden stakes of about 10 cm in diameter are driven about 0.75-0.90 m deep and 0.60-0.90m apart along the dam axis. Their tops are kept in such a way that a depression is formed in the centre for disposal of excess water. In order to control termite attack, the wooden stakes are treated with coal tar. The height may vary from 30 - 60 cm. On the lower side, the brush wood is laid in such a way that cut end side half is placed inside the structure and remaining half extended downward as a mat to act as apron which may protect the base against erosion.

e) **Double Row Post Brush Wood Dam:** When the size of gully increases from 1-2.5m depth and 5-6 m wide, then double row post brush wood dams are more appropriate. The construction is same as that of single row dam except that the brush wood is laid across the gully in between of two rows of poles spaced about 0.9m apart. At the base, some branches are laid along the slope of gully with cut ends laid upside and branches extending to lower side to form an apron of branches. A row of live hedge is planted both on the upstream and downstream side of brush wood check dam which may become functional when brush wood decay after some time (**Fig. 5.1**).

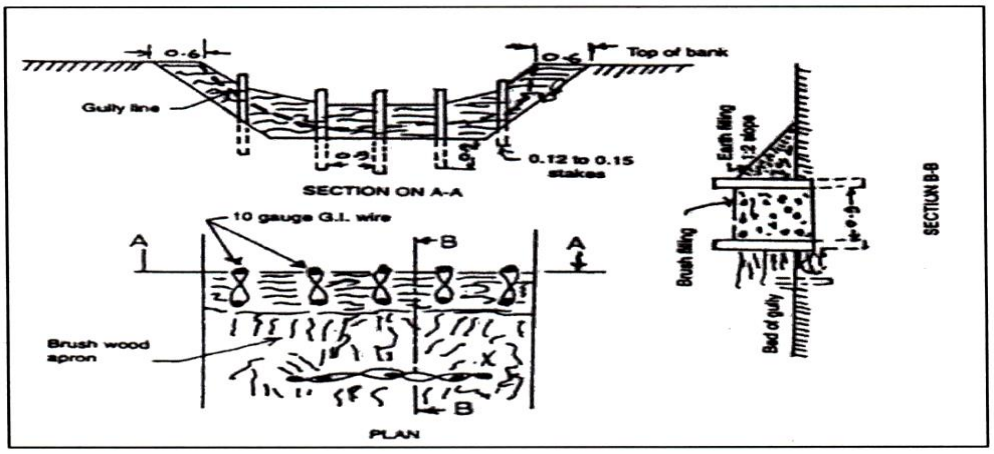
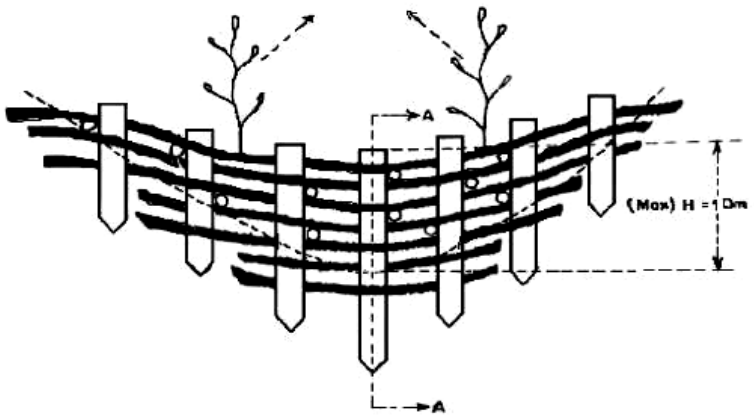


Fig.5. 19- Design of Double Row Post Brush Wood Dam

Another method is to lay branches of trees horizontally between the wooden poles and tie those with wire to wooden poles and fill the central portion with some brush wood at the base and place heavy stones to press the brush wood. Because of serious termite problem, brushwood is decomposed very quickly and hence live hedge are preferred **Fig 5.2.**



Front view

A - Seedlings

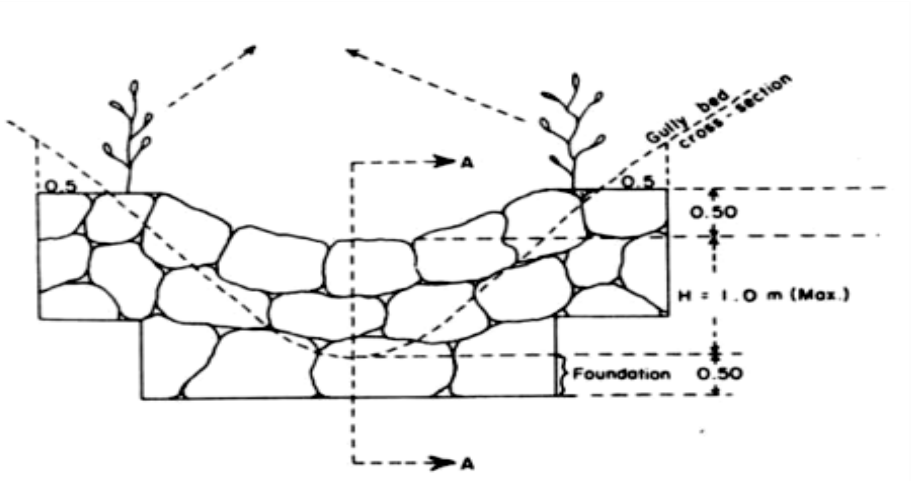


Fig.5. 20- Alternative Construction Design of Double Row Post Brush Wood Dam

Contour Wattling: Contour wattling is a method of breaking the length of slope into shorter portions by providing contour wattles at 3 – 5m interval. It is normally used on portions of the side which is easily accessible. The advantage is that it holds the downward movement of earth and reduces the raindrop impact. Wattles are laid out at a vertical interval of 3m up to 66% slope and 5 – 7m up to 33% slope. Trenches of 0.3m wide and 0.3-0.5m deep are dug up on contour and filled with brush wood bundles of 5-6 cm diameter branches laid horizontally. The poles of 8 – 12cm diameter and around 1.5m length of plant species which sprout on planting are embedded about half the length at about one meter interval on the lower side of the trenches. Some self sprouting species are;*Ficus infectoria, Lannea coromandelica, Erythrina suberosa, Vitex negundo, Salix tetrasperma* (willow), *Hamiltonia suaveolens, Euomymus sp.*,etc. The inter-space between the wattles is protected by mulching with a thick layer of locally available grasses and tied with a thin wire or rope to avoid its displacement by water or wind. The inter-space area should be planted by soil binding grasses/shrubs. The wattling should be preferred on fragile slopes where soil working is difficult and mulching

material should be locally available. The live contour wattles obstruct the movement of debris and allow the run off to pass through.

Contour Live Hedges: Contour live hedges serve the purpose of vegetative barriers and created by planting suitable erosion resistant grass/herb species on lower side of contour trenches which form a dense hedge to intercept soil and water (Fig. 5.3).

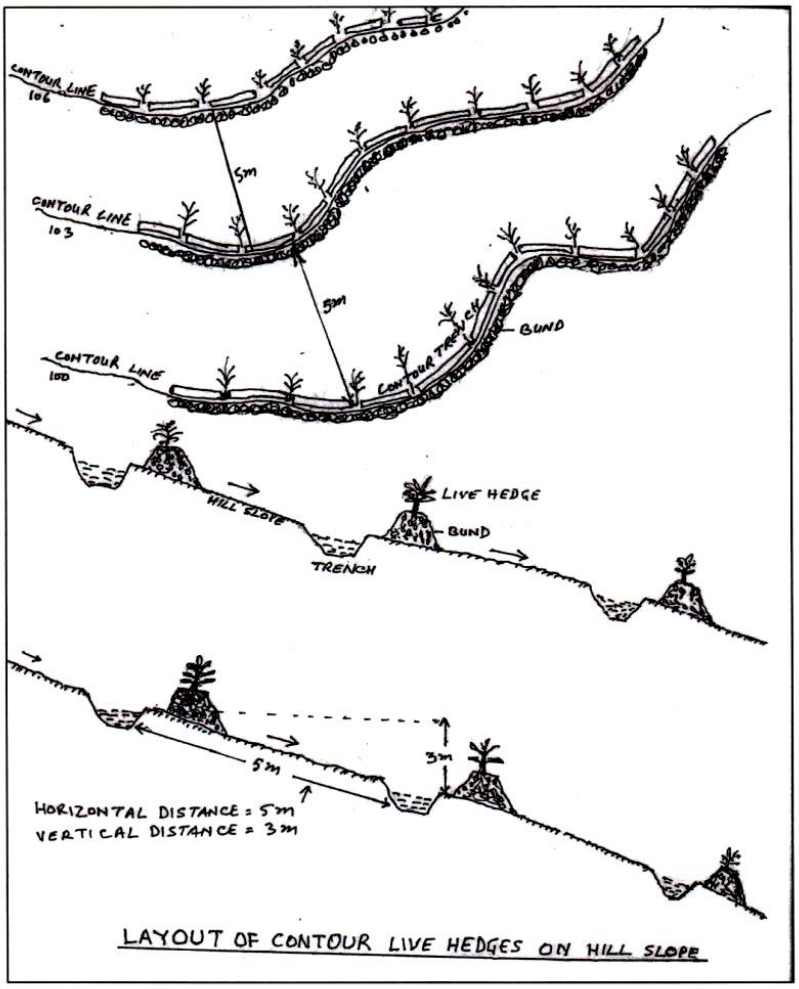


Fig.5. 21- Design of Contour Live Hedge

(v) Bio-engineering Vegetative Measures For Stream Bank Protection

When drainage lines meander like a snake on relatively steep slopes, the problem of stream bank erosion becomes quite serious. Generally, the *khad* cut the bank on the outer side on a curve because of higher velocity and deposit the eroded debris on the inner side of the curve. The protection of the banks is necessary particularly when infrastructure and costly farm lands are at risk of bank cutting. With the retards and revetments, vegetative reinforcement is always considered essential. When flow discharges are low, the *khad* do not meander much, the vegetation alone can serve the purpose of bank protection.

Two lines of *Ipomoea carnea*, *Arundo donax* or other similar plant species are planted along the eroded bank at one meter apart. Along with this, on cutting side, repelling type spurs are raised in double rows at 15-20 m apart and extending only up to $1/4^{th}$ length of active flow. In between the spurs, seedings of fast growing plant species are carried out. In these vegetative spurs, mixing of *Ipomoea carnea* and *Arundo donax* provides better results. If possible, brush wood of Ber *(Ziziphus mauritiana),* Karonda *(Carissa opaca),* or any thorny shrub may be imbedded which not only protect the vegetation from under cutting by reducing the velocity of water but, also induce sediment deposition. In the subsequent year, bamboo may be planted on sand deposited moist bank sides to provide the additional strength to the spurs.

Such live hedges are used extensively for stream bank protection both alone and in conjunction with mechanical spurs and retaining walls. It is recommended that suitable shrub species like *Ipomoea carnea* should be planted in between the spurs along the gully banks and also along the spurs and particularly at its nose. These hedges break the velocity of water and induce deposition along the banks and near the structures. Once the land reclamation process starts, a row of bamboo is planted along the gully banks behind the live hedges. Bamboo as such is the most suitable plant for stream bank protection. On the reclaimed beds of the gullies, tree species like Khair *(Acacia catechu),*Shisham(*Dalbergia sissoo*) *Cassia fistula, Albizia spp.,* etc are planted during second and third rainy season.

Where live spurs and hedge rows of *Ipomoea carnea* were planted for stream bank protection, the silt deposition along the bank takes place. In case, *Arundo donax*, *Phragmites karka,* and *Ipomoea carnea* are mixed together, the stability is further enhanced. The best time for planting these vegetative structures is mid June to mid August when there is sufficient moisture in the soil. Most plants are vegetatively propagated.

vi) Bio-engineering Measures for Landslide Control

The Himalayan Mountains are vulnerable to landslides where debris flow and other forms of mass wasting are common. The problem is pronounced in the Himalaya with high energy environment due to active tectonics, rugged topography with very high relief and highly concentrated monsoon precipitation. Moreover, high densities of both human and livestock populations and consequent changes in land use and land cover have caused further intensification of the processes of landslide and debris flow. The loss of life and properties from landslides, debris flow and flood has been increasing and the livelihood options of mountain people have been threatening. There are many factors responsible for enhanced landslides in the mountainous regions of Himachal Pradesh and Jammu and Kashmir UT.

Measures for Control of Landslides: As stated above, the cause for landslide could be multiple. Depending upon the reason for landslide, different treatments would be applicable. These are described below one by one.

Landslides Caused by Excessive Wetness/Over Saturation of Slip Zone: In order to treat landslides caused by excessive wetness/ over saturation of slip zone, the proposed mitigation measure involves the following five steps:

Step 1: The foremost requirement is to locate the source of water entering from upper areas. In case water is entering from some leaking irrigation channel, the control of such a leak by

suitable technique would be necessary. The channel may have to be lined or water is allowed to pass through a pipeline in that particular stretch. In case of runoff water, the construction of a diversion channel would be necessary to divert the runoff and dispose it off at non-erosive velocity to a side drainage way. The diversion channel on gentle gradient may be protected by stone laid bed and sides supported by vegetation.

Step 2: As a second step, drainage of excess water in the soil mass would require cross drainage works which may be carried out by installing perforated pipes, filter drains of stones/rubble (wire bolsters) and /or simple open drains converging to main pipe drain as shown in the **Fig. 5.4**

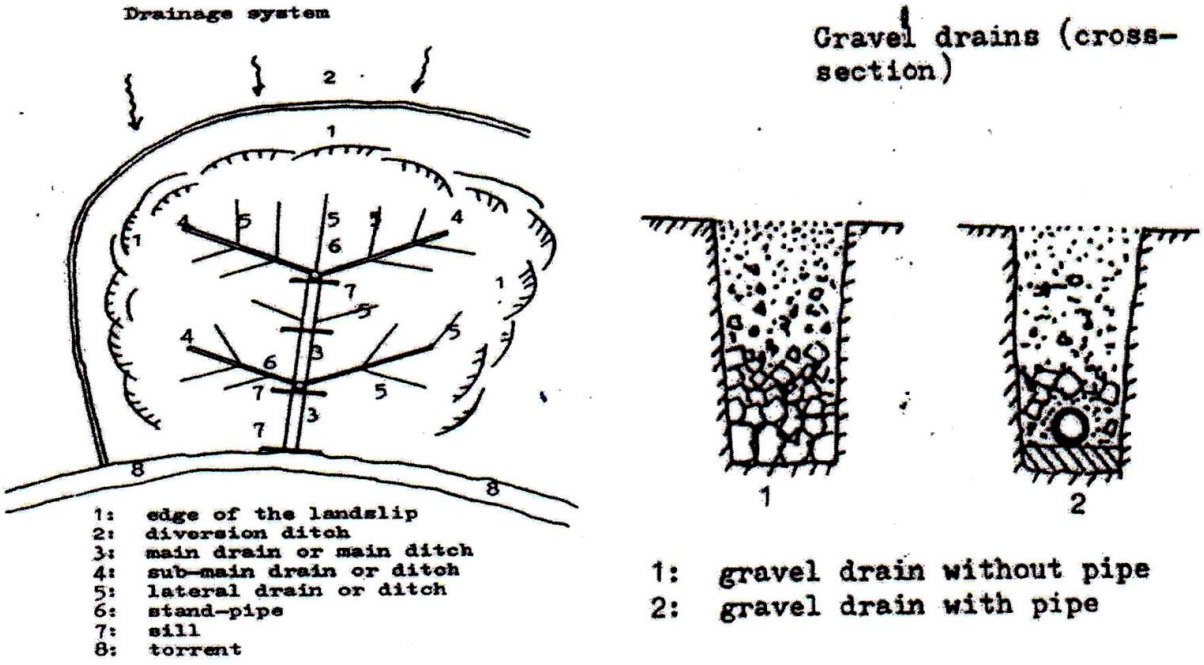


Fig. 5.22 - Drainage System of a Typical Landslip Site

Note: In Fig - 5.4 various legends indicate: (1) The landslide area is shown by outer hachuring; (2) A diversion ditch is provided to carry away the water from top for safe disposal; (3) A main drain of perforated pipes or gravel filter is provided in the centre along the slope; (4) Four sub-drains are provided as laterals to carry seepage/ surface water to the main drain; (5) In each sub- drain, few lateral drains are provided to drain water from the wet/ moist land; (6) At each junction, vertical stand pipes are provided in which sub-pipes discharge water; (7) The main pipe at the end is placed over a wall of check dam or retaining wall for support and water fall over this wall/structure without causing scouring at the base; and (8) All the drained water is ultimately drained into the main torrent or drainage system.

Step 3: The most important part is the construction of gabion/ masonry/ dry stone retaining walls. One major retaining wall at the base of the landslide/slip zone to hold back the entire soil mass is necessary. The site should be selected carefully where maximum load can be retained with minimum length. The height of the retaining wall may vary from 1.5-4 m

depending upon the height of the soil mass at site. The base width of 2 m and top width of 1 m is often suggested. The retaining wall is constructed either straight with steps or slanting at an angle of 75°-80° from the base. Weep holes of 7.5cm must be made at regular interval and one hole for every 6 m^2 area. Back of the wall is filled with boulders for ensuring quick drainage. A toe drain in the foot of wall may be required to carry the overflow to nearby *khad*.

Step 4: Construction of series of staggered retaining walls are suggested on the slope. In addition to the main retaining wall at the base, series of staggered dry stone retaining walls are often required over the slipped land mass to retain the debris *in situ*. The local slate type stones are preferred for better stability. The number should not be too large as it would increase the weight of soil mass. More reliance has to be placed on vegetative measures.

Step 5: The final step relates to the live hedges as part of bio-engineering measures**.** The live hedges of selected tree and shrub species are planted almost on contour and soil binding grasses are planted between the rows of hedges. Close growing plant types forming mat and showing spreading and creeping habit hold promise. Hardy and xerophytic plants are ideal for dry areas. *Woodfordia fruticosa, Coriaria neplanensis, Murraya paniculata, M. koenigii,* etc. shrubs have great potential because of deep root system and *Mimosa himalayana* a shrub is also a good colonizer. *Alnus nepalensis* (tree), *Debregeasia logifolia*, *Populus ciliata, Albizia* spp., etc., are considered as potential soil conserving tree species. *Berberis lycium, Pyracantha crenulata, Myrsine africana, Rosa moschata,* etc.Shrubsand *Penisetum clandestinum, Chrysopogon gryllus, C. serrulatus, Cymbopogon* spp., etc. grass species on forest slopes damaged by landslides are also recommended.

The tree species suitable for bio-engineering application are given in Table.5.35

Table: 5. 35 – Plant Species Recommended for Bio-engineering Works

Category	**Area**	**Plant Species**
Woody Perennials (Trees)	Dry Open Areas	*Boehmeria rugulosa, Debregeasia salicifolia, Ficus semicordata, Ficus palmata, Wendlandia exserta, Toona sinensis, Alnus nitida, Populus ciliata, Salix tetrasperma*, and *Hymenodictyon suaveolens.*
Woody Perennials (Shrubs)	Moist Areas	*Boerhavia platyphylla, Berberis* spp., *Justicia adhatoda, Zanthoxylum armatum, Asparagus racemosus, Indigofera heterantha, Colebrookea oppositifolia, Agave* spp., *Woodfordia fruticosa, Jasminum humile, Murraya koenigii, Cotinus coggygria, Spiraea canescens, Rosa moschata, Tinospora cordifolia, Drepanostachyum falcatum, Salix elegans, Murraya paniculata, Rubus ellipticus,* and *Flemingia macrophylla.*
Perennial Grasses, Creeping, stout root	Dry Open Areas	*Arundo donax* (Nal), *Thysanolaena maxima* (Broom grass), *Saccharum munja* (Munj), *Saccharum*

Category	Area	Plant Species
stock		*spontaneum* (Kana), *Eulaliopsis binata* (Bhabar), *Cynodon dactylon* (Dub), *Chrysopogon serrulatus*, *Vetiveria zizanoides* (Khas), *Cymbopogon citratus* (lemon grass), *C. distans, C. jwarancusa, Arundinella nepalensis, A. pumila,* and *Chrysopogon gryllus.*
Live Hedges Woody perennials, Fast growing extensive root system, Thorny Non palatable, Bush forming, and Local natives of local use.	Temperate and Sub-tropical	*Berberis spp., Justicia spp., Vitex spp., Zanthoxylum, Indigofera* spp., *Desmodium* spp., *Euonymus* spp., *Murraya* spp.and plant at close spacing – 0.50m apart. 2 rows.

Plant Species Recommended for Bio- engineering in landslide and soil erosion areas of Chenab River Basin (Himachal Pradesh and Jammu and Kashmir UT)

Species for the bio-engineering in landslide and soil erosion areas have been recommended according to their occurrence along the altitudinal gradients. Three tiers plantations of the species i.e., (i) herbs, grasses, and sedges; (ii) shrubs and (iii) treess have been suggested as happens in natural succession. Altitudinal zone wise recommended species as given in (Table 5.36)

Table: 5. 36 – Plant Species Recommended for Bio- engineering in landslide and soil erosion areas of Chenab River Basin (Himachal Pradesh and Jammu and KashmirUT)

S.No	Suitable Bio-engineering species for Himachal Pradesh and Jammu Region (J &K UT)
A.	**Himachal Pradesh**
(i)	**Altitudinal Zone (2001- 3000 m amsl)**
	Trees:*Cedrus deodara, Pinus wallichiana, Picea smithiana, Taxus wallichiana, Abies pindrow, Fraxinus xanthoxyloides, Crataegus songarica, Populus ciliata, Corylus jacquemontii, Juglans regia, Aesculus indica, Prunus cornuta, P. cerasoides, Acer acuminatum, Cornus macrophylla, Neolitsea pallens, Alnus nitida, Ulmus wallichiana, Salix babylonica, S. tetrasperma*, etc.
	Shrubs: *Drepanostachyum falcatum, Daphne papyracea, Prinsepia utilis, Deutizia staminea, D. corymbosa, Rosa sericea, R. macrophylla, Cotoneaster bacillaris, C. acuminatus, Viburnum grandiflorum, Thamnocalamus spathiflorus,*

	Inula cuspidata, Skimmia laureola, Salix denticulata, Hippophae rhamnoides ssp.*turkestanica, Lonicera quinquelocularis, Berberis pseudumbellata, Berberis jaeschkeana, Syringa emodi, Indigofera heterantha, Desmodium elegans, Hypericum oblongifolium, Elaeagnus conferta, Rubus biflorus, R. niveus, R. foliosus, Rosa* spp.*, Spirarea* spp.*, Inula cuspidata, Lonicera quinquelocularis*, etc.
	Grassess and Forbs: *Chrysopogon gryllus*, *Arundinella nepalensis*, *A. pumila*, *Apluda mutica*, *Carex* spp., *Cyperus* spp., *Goldfussia dalhousiana*, *Strobilanthus atropurpureus*, *Polygonatum* spp., *Heracleuam candicans, Dactylis glomerata*, *Mondo intermedius*, etc.
(ii)	**Altitudinal Zone (> 3000 m)**
	Trees: *Juniperus polycarpos, Hippophae salicifolia, Salix alba, S. tetrasperma, Populus ciliata, P. alba, Betula utilis, Pinus wallichiana, Picea smithiana, Abies pindrow, Salix daphnoides, Prunus cornuta*, etc.
	Shrubs : *Hippophae rhamnoides* ssp. *turkestanica, Juniperus indica, J. communis, Myricaria germanica, M. elegans, Lonicera* spp., *Ephedra gerardiana, Capparis spinosa, Rosa webbiana, Colutea nepalensis, Caragana versicolor, Ribes* spp., *Salix* spp., etc.
	Grasses and Forbs: *Festuca pratensis, F. valesiaca, Trifolium pratense, Poa pratensis, P. alpina, Dactylis glomerata, Agrostis gigantea, A. pilosula, A. munroana, Danthonia cachemyriana, Calamagrostis montana, Koeleria* spp., *Brachypodioum sylvaticum, Bromus himalaicus, B. ramosus, Stipa roylei, Artemisia* spp., *Potentilla* spp., *Carex* spp., *Cyperus* spp., *Selinum* spp., *Rumex* spp., *Bistorta* spp., *Heracleum* spp., etc.
B.	**Jammu and Kashmir UT**
(i)	**Altitudinal Zone (<1000)**
	Trees :-*Albizia spp., Terminalia* spp. *, Cassia fistula, Acacia catechu, Syzyium fromosum, Lannea coromandelica***,** *Ficus rumphii, F. semicordata, Grewia optiva, Broussonetia papyrifera, Butea monosperma, Lannea coromandelica, Toona ciliata, Dalbergia sissoo, Acacia catechu, Adina cordifolia, Cassia fistula, Terminalia bellirica, T. chebula, Mallotus philippensis, Sapindus mukorossi, Holoptelea integrifolia, Celtis australis, Pyrus pashia, Phyllanthus emblica, Diospyros montana, Bauhinia variegata, Morus alba, Azadirachta indica, Dalbergia sissoo, Boehmeria rugulosa,Dendrocalamus strictus, D. hamiltonii, Bambusa arundinacea.*

	Shrubs:- *Woodfordia fruticosa, Carissa opaca, Trema orientalis, Ziziphus* spp., *Vitex negundo, Boehmeria platyphylla, Maesa indica, Tinospora cordifolia, Justicia adhatoda, Clerodendrum* spp., *Pogostemon* spp.**,** *Murraya paniculata, M. koenigii, Nyctanthes arbor-tristis, Jasminum* spp., *Colebrookea oppositifolia, Rhamanus* spp., *Phragmitis* spp., *Heteropogon contortus, Chrysopogon serrulatus, Cymbopogon martini, Arundo donax*, etc.
	Grasses and *Forbs:* *Arundinella nepalensis, Saccharum munja, Apluda mutica, Chrysopogon serrulatus, Boerhavia diffusa, Heteropogon contortus, Trifolium repens, Cymbopogon jwarancusa, Deschamsia* spp., *Panicum maximum, Phleum pratense, Cymbopogon citratus, Arundo donax, Phragmites karka, Themeda arundinacea, Eulaliopsis binata, Dichanthium annulatum, Sporobolus diander, Setaria* spp., *Fimbristylis* spp., *Thysanolaena maxima, Neyraudia arundinacea, Hierochloe laxa, Polygonum* spp., *Cyperus* spp.,*Carex* spp., etc.
(ii)	**Altitudinal Zone (1001- 2000 m)**
	Trees: *Quercus oblongata, Lyonia ovalifolia, Ficus semicordata, F. rumphii, Albizia chinensis, A. julibrissin, Phyllanthus emblica, Bauhinia variegata, B. retusa, Grewia optiva, Olea ferruginea, Pyrus pashia, Toona ciliata, T. sinensis, Terminalia chebula,Syzygium cumini, Punica granatum, Pistacia integerrima, Cinnamomum tamala, Pinus roxburghii, Salix babylonica, S. tetrasperma, Neolitsea pallens, Cornus macrophylla, C. capitata, Alnus nitida, Celtis australis, Cedrus deodara, Ficus nemoralis, Melia azedarach, Mallotus philippensis, Ulmus wallichiana, Punica granatum, Debregeasia hypoleuca, Hymenodictyon excelsum*, etc.
	Shrubs: *Rosa moschata, Debregeasia hypoleuca, Elaeagnus conferta, Zanthoxylum armatum, Deutzia staminea, D. corymbosa, Berberis aristata, B. lycium, B. chitria, Hypericum oblongifolium, Desmodium gangeticum, D. elegans, Indigofera heterantha, Tephrosia hamiltonii, Justicia adhatoda, Ricinus communis, Woodfordia fruticosa, Maesa indica, Vitex negundo, Rubus* spp., *Colebrookia oppositifolia, Randia tetrasperma, Myrsine africana,Carissa opaca, Ziziphus jujuba, Desmodium elegans*, etc.
	Grasses and Forbs: *Heteropogon contortus, Chrysopogon fulvus, C. serrulatus, C. gryllus, Festuca pratensis,F. arundinacea**,** Erianthus filifolius,E. rufipilus, Agrostis gigantea, Agropyron* spp., *Phleum pratense**,** Themeda anathera,Arundo donax, Cymbopogon martini, C. jwarancusa, C. distans, Phragmites karka, Bothriochloa pertusa, B. intermedia, Eulaliopsis binata, Apluda mutica, Arundinellia nepalensis, A. pumila, Fimbristylis* spp., *Calamagrostis* spp., *Setaria glauca, Carex* spp., *Thysanolaena maxima*, etc.

(iii)	**Altitudinal Zone (2000-3000 m amsl)**
	Trees: *Pinus gerardiana, Pinus wallichiana, Salix babylonica, S. tetrasperma, Cedrus deodara, Fraxinus xanthoxyloides, Corylus jacquemontii, Alnus nitida, Celtis australis, Quercus baloot, Picea smithiana, Abies pindrow,Taxus wallichiana, Cupressus torulosa,* etc.
	Shrubs: *Daphne papyracea, Prinsepia utilis, Rosa macrophylla, R. sericea, Cotoneaster bacillaris, Viburnum cotinifolium, Deutzia staminea, D. corymbosa, Rubus* spp., *Lonicera* spp., *Cornus oblonga, Syringa emodi, Indigofera heterantha, Desmodium elegans, Hypericum oblongifolium, Inula cuspidata, Salix denticulata,* etc.
(iv)	**Altitudinal Zone (3000-3500 m)**
	Trees: *Betula utilis, Pinus wallichiana, Acer acuminatum, Corylus jacquemontii, Prunus cornuta, Quercus semecarpifolia, Abies pindrow*, etc.

A landslide generated a huge mass of debris on the river bank. Need treatment including retaining walls at the base and planting of hedge plants across the slope. The retaining wall is constructed at the base of the landslide to protect the road. The bio-engineering measures are needed to stop the downward movement of the debris.

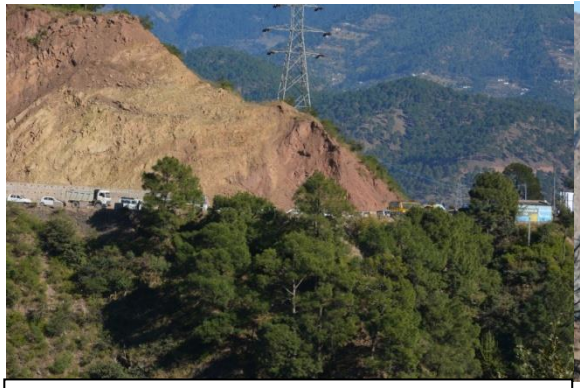


Landslide Generated Mass of Debris on the River Bank



Retaining Wall at the Base of the Landslide to Protect the Road

The Jammu (Udhampur) landslide is famous and frequently blocks traffic to Jammu due to debris deposition on the road. The debris further slides up to the bank of Chenab River. The complete treatment of upper area including diversion of flow, proper drainage and live hedges in series are required. The main cause is the fragile geology, over saturation of slope and almost vertical cutting of the base along the road. The construction of new roads and widening of existing roads disregarding the rules and regulations on hill road construction is creating havoc with the ecology of sensitive hill slopes. Under cutting of hill slopes causes landslides which generate transportable loose mass and carried with rain to silt the reservoirs.



Jammu Landslide Blocking the Road



Sliding of Debris upto the River Bank

(vii) Protection of Landslide Areas Triggered by Faulty Road Construction

The road construction is important for the economic development of hitherto inaccessible remote areas. It is also important for defense point of view. The HEP also need wider roads to take heavy machinery. But, ecological considerations are equally important. The road construction and Maintenance practices should be such that minimum disturbance is caused to the ecology of the fragile mountain ecosystem.



Faulty Rock Cutting for Road Construction



Faulty Rock Cutting Resulting into Collapse of Slope



Use of Geo-Jute Mats as Bio-engineering Measure

The following steps are necessary for eco-friendly road construction.

i) The cutting of rocks should not be vertical but, slanting at an angle of 60° so that slope does not collapse.

ii) All the debris generated should not be pushed along the slopes but, properly dumped at pre-decided dump sites.

iii) The dumping sites should have proper retaining walls to check the debris from falling into *nallah*.

iv) The dumping sites should be planted by suitable tree, shrub and grasses species.

v) The seepage and runoff water should be carried by guide channels and disposed off safely by making culverts and cross drainage works. Vegetation should be established on the slip sites.

vi) The steep slopes can be vegetated by using geo-jute mats.

Geo Jute: Geo-textile is a knitted structure made up of natural material or synthetic polymers. Use of natural geo-textiles (geo-jute) is preferred as they are less expensive, available from local resources, and are environmental friendly due to their biodegradability. Geo-textile has been used in bank protection, establishment of steep hill slope, checking run-off, etc. Geo-jute was used for erosion control in mine spoil on different slopes, ranging from 30°-70°. The geo-jute should be of the grade 500 g/ m^2 with strand thickness - 5 mm and open area 65 %. In recent times, natural geo-textile product called geo-jute have entered the market and becoming popular for eco-restoration of disturbed sites. This is basically a mat made of jute with mesh size of 2-5 mm having aperture of 10 mm. This bio-degradable material was found highly effective when used to stabilize mine-spoiled sites, landslide/slip areas and specific slopes stabilizing of which is essential to Maintenanceain road/ railway network. The area to be treated is carefully measured and the length and width of sheet required is calculated. The surface to be covered is smoothened. The mat sheet is spread over the area, and is secured by driving wooden stakes to a reasonable depth of 50-100cm. The sides of strips can be buried in a 30 cm deep trench. The sheets are overlapped with the adjoining sheet. The seeds/rooted slips/ cuttings of the selected plants are planted during rainy season through the openings at quite close spacing to have good cover in a short time. The jute mat does not allow the movement of eroded mass and allow undisturbed germination and establishment of plants. Geo-jute was found successful for initial establishment of vegetation on degraded slopes up to 60°-70°. The total estimated cost of jute and planting is around Rs.25/-per m^2.



Use of Geo-Jute on Steep Degraded Slopes

Log Crib Structures: The log wood structures are generally constructed where stone check dams are not feasible because of steep slope. The log check dams are constructed as steps by nailing each of the horizontal cross poles of long lasting wood with 3-4 longitudinal poles. These poles are of 3-4 m length and 8-12 cm diameter. These are driven to a depth of 50-60 cm depth and erected in two parallel lines about a meter apart from pole to pole and one meter from line to line. The height may be kept about 1.5 m above the ground. The log wood crib structures are filled with stone/brush wood which can be used to stabilize slopes above 40°. The inter-space between paired lines is vegetated with suitable fast growing plant species. These are stable because horizontal poles can withstand the load of the earth above it and consequently hold the soil more effectively and provide the vegetation an opportunity to establish.

Gunny Bag Structures: The practice of using cement gunny bags for temporary protection is quite common by the PWD Department as they have plenty of bags available. These bags are filled with inert material like sand and gravel (not soil as it hastens decomposition of gunny bag), and used for bank protection, slope stabilization and temporary diversions. For more stability and durability, the cement and sand mixed in the ratio of 1:20 may be used. The filled gunny bags are laid in row over one another to gain the desired height. The back side is filled with earth and compacted.

(viii) Landslides Triggered by Snowmelt

The snow covered upper areas experience very severe landslides when snowmelt. The over saturated soil mass shaken by even slight seismic activity slips down and takes away even full grown trees.



Landslides Triggered by Snowmelt Carrying Away Full Grown Trees

(ix) Bio-engineering Measures for Mine Spoiled and Other Problem Areas

Broadly, there are two methods for rehabilitating mined areas, **(a)** engineering measures, and **(b)** biological measures. While rehabilitating an area where slope is steep, and engineering measures should always preceded biological measure. This is due to the fact that, in initial stages, biological measures are not able to give protection to the area due to their smaller size and tender nature. But, it should be borne in mind that, with the passage of time, the biological measures prove to be more fruitful than engineering measures because engineering measures gets filled up with silt, etc., but, the soil protection capacity of plants increases with the passage of time. Some of the engineering and biological measures applied in mined areas are discussed below:

(A) Mechanical Measures for Soil and Water Conservation

Various mechanical measures are used for soil and water conservation. These include various engineering techniques and structures aim at the following objectives:

i) To divide a long slope of land into a serious of shorter ones in order to reduce the velocity of runoff water.

ii) To retain the water in the land for long period so as to allow maximum water to be absorbed and held in the soil and less water flows down the slope of the land at non-erosive velocity.

iii) To protect the soil against erosion by water.

The important mechanical soil conservation measures are described below one by one.

(i) Engineering Measures for Landslide Control

In case of landslides when the overburden is pushed down slope, and is compacted, it may cause a problem of mass movement of the overburden. In such cases, engineering measures like constructing a toe wall of stone at a bottom of the overburden checks sliding of the overburden. To avoid erosion and land slide through over flowing water from uphill side, a

diversion channel of 0.5 x 0.5 m is constructed. This not only avoids erosion but, also prevents accumulation of water at the active mined site below it. Some have used gabion structure as mechanical measures in mined area to check soil erosion. They were of the view that concrete and brick masonry fails easily in areas which settle down. However, in such areas, gabion structures, owing to their inherent flexibility, ability to bend without breaking, permeability to water but not to soil and their reusable nature prove their success. For the construction of gabion, 12 gauge galvanized iron (G.I.) wires are used while 14 gauge G.I wire is used for binding purpose. Gabion structure is a box type structure which is as follows:

For construction of gabion 2x1x1 dimensions, 4 meshes of 2 x 1m size and 2 meshes of 1 x 1m are constructed. They are then joined together and folded. The gabion structure is placed in the nallah/channel, where *nallah* is narrow and fairly level, with sufficient place in upstream, an apron is constructed to avoid under scoring of the gabion. To avoid the displacement of gabion, its foundation is dug to a depth of at least 0.3m and should be anchored through its sides to the backs of *nallah*. In this structure, boulders/ rocks of large size are kept layer by layer with bigger size rock at the bottom and smaller on upper layer. After filling, the box is closed tightly. For effective control over soil erosion, gabion structure should be constructed at a horizontal interval of 10-20 m in 50°-60° slope, 20-30 m in 20°-30° slope and 30 - 50 m in foot hills. Other soil and water conservation measures for erosion control are described below.

Dry Stone Check Dams - Dry stone check dams are porous checks constructed across the *nallah* using loose boulders to check water velocity and arrest silt (**Fig. 5.5**). This is usable in all areas irrespective of soil and rainfall. They are effective for reducing run-off velocity in upper parts of the drainage lines having steep slopes. These are planned in shallow/first order gullies having stones of suitable quality and required quantity locally available in and around the drainage ways. When properly constructed by the trained masons and suitable sites are selected, such structures help in stabilizing bed gradient and establishment of vegetation in the silted up portions of the gullies. This is a semi-permanent mechanical measure. Slab type dressed stones are arranged with proper spillway in the center. At least half a meter anchorage to sides and half meter foundations are enough for a one meter high structure. The normal design specifications are given in **Table 5.37.**

Table: 5. 37 – Design Specifications of Dry Stone Check Dams

Top width	0.5-1 m
Base width	1 - 2 m
Height above ground level	0.6-1.2 m
Depth of foundation	0.3-0.6 m
Side slopes	0.5 : 1.0
Anchorage to banks	0.45-0.75m

Spillway section	Length should be as per discharge or roughly 1/3 of *nallah* width and bed over crest may be as per discharge or 0.3-0.5 m.
Apron	Width 1 to 1.5 x fall
Length	Entire section below spillway and side walls
Depth	Minimum 0.3m and should be below immediate ground level.

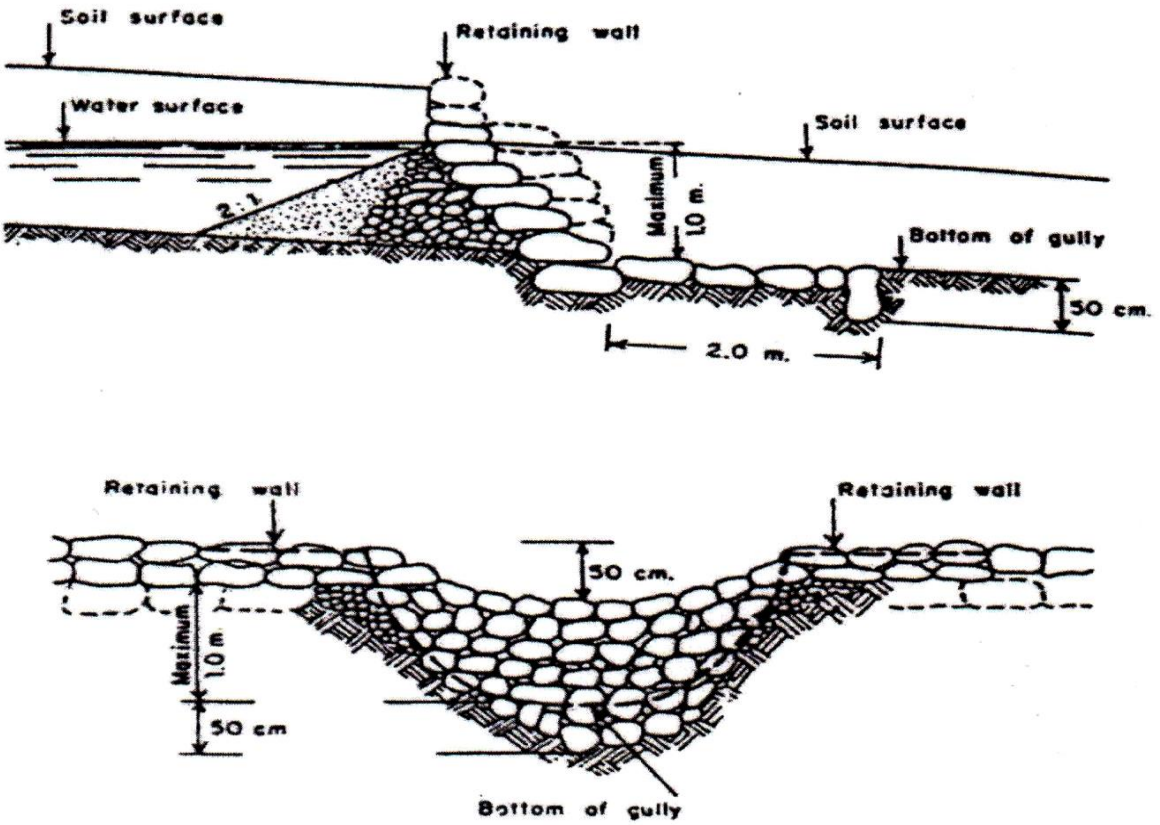


Fig. 5.23 - Design of Dry Stone Check Dams

Proper site selection is very important for all types of erosion control structures. These structures are constructed in series one after the other usually keeping head and toe relationship minus the permissible stable bed gradient. The following points may be considered in site selection:

i) The gully should have narrower section at the dam axis.

ii) It should have bowl type wider section above the site for storage of water and silt.

iii) Preferably, the bed gradient in *nallah* should be as low as possible above the site. This would ensure more storage of water/debris.

iv) Slab type/ flat stones should be available near the sites. No stones should be excavated from the actual *nallah* bed.

v) Construction with stones transported from longer distances is avoided in view of high cost involved.

vi) In case *nallah* bed is well covered with vegetation and no scouring is visible, then dry stone check dams may not be required.

Construction

i) A copy of the approved plans and estimates should be obtained by the field staff executing the work.

ii) First of all, the proposed site should be on the ground.

iii) The slab type stones are collected at site in advance.

iv) The site is cleared of all vegetation including uprooting of trees, bushes, grasses and removal of all organic matter.

v) The foundations are excavated to a uniform depth and dimensions as provided in the plans.

vi) Stones are laid properly by breaking the joints. Anchorage to sides is ensured.

vii) The stones of larger size are used in the central part of spillway portion because of more pressure of water.

viii) The slab type stones in each layer are made stable by inserting smaller broken stone pieces.

ix) The corners of stones are slightly dressed to maintenance in uniformity in size.

x) The gaps are filled with smaller stones or broken pieces such that the holes between the stones are reduced to the minimum size.

xi) Slight curvature is given like half-moon to the main wall on the downstream side so as to provide the strength of an arc to the dam body.

xii) Each layer of stones is receded by about 5cm (slightly more from centre and less from sides) so that a cascading effect is generated when water falls from the spillway section over the apron.

xiii) Round stones are avoided as they do not remain stable in constructed dams without mortar.

xiv) Slabs of soft sandstone are not recommended because of their low structural strength.

xv) The apron should be lowered and embedded in the ground and its top should be 20-30 cm below the immediate ground level.

xvi) Top level of wing walls/head wall extensions should be at the same level.

xvii) Vegetative reinforcement above and below the structure is important for its functional success.

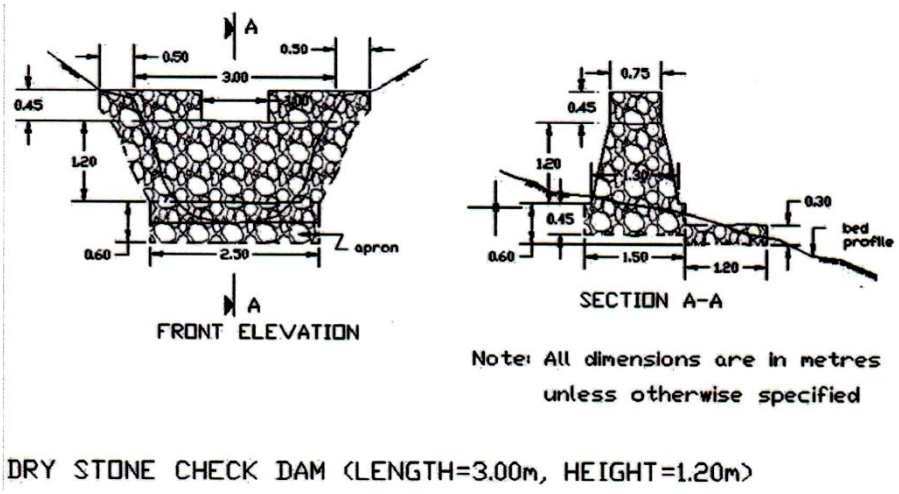


Fig. 5.24 - Design of Dry Stone Check Dam



Typical Dry Stone Structure Made of Slate Type Stones are More Stable

The dry stone structures may fail when:

i) Wing walls/extensions are not anchored sufficiently to the sides or into the banks.

ii) Less anchorage to the sides at the base results in leakage from the sides.

iii) Toe of the structure erodes if no head-toe relationship is maintained.

iv) Structure may tilt, sag or breach, if sufficient foundations are not provided.

v) Structure constructed at a bend or curve in *nallah* is more liable to fail.

Gabion Check Dams: Gabion structures are made with stones/boulders packed closely in wire mesh cages made with G.I. wire of 10 gauge thickness. Gabion structures are preferred in soil conservation works as they are, **(a)** flexible (bend without breaking), **(b)** porous (water can seep through them), **(c)** stable, and **(d)** economical as compared to cement concrete structures.

G.I. wire of 8-10 gauge thickness is used in the fabrication of wire nets and the mesh is generally kept 10-15 cm. Gabion structures have a long life (20-25 years) almost similar to cement masonry permanent structures (**Fig. 5.6**).

Suitability

The gabion check dams may be constructed in main gullies/channels for retention of debris and soil accumulation without pond age. The debris carrying capacity within the inter-structure reach reduces due to reduction in channel gradient. The check dams encourage good plant cover not only along the bank but also in the bed of the stream due to increased moisture regime. Cross barriers are suitable in the head water reaches in higher order streams/main drainage channels receiving relatively large quantities of runoff and debris flow.

Specifications

Top width	1m
Depth of foundation	0.3-0.5m
Height above Ground Level	1-3m
Keying into banks	0.3 - 0.6m into stable portion
Galvanized iron wire	10 gauge (3.14 mm dia)
Mesh size	15 x 15cm - 20 x 20cm

Construction

i) The wire mesh is fabricated and boxes are made with a dimension of 2 x 1 x 1m or any other desired dimensions with a mesh opening size of 10-20 cm depending on the stone size.

ii) Clear the site.

iii) Excavate the foundation trench of required width and upto desired depth (normally a foundation depth of 0.3-0.5m is sufficient). The trench is smoothened and compacted. The sides of gully are also excavated to about 0.3-0.6m for keying of the structure to prevent undercutting.

iv) Place the G.I. wire mesh in the trench and start hand packing of stones. Larger size stones (more than 20cm size) are used at the bottom portion and along the sides. The void space between the stones is filled with small size stones. The construction is carried till the desired height is obtained.

v) The sides of the wire mesh are tied together with the protruding wires. If required next wires mesh cage is laid over/along it and the same procedure is repeated. The adjoining cages are again tied together with the wires.

vi) Provide the desired wire opening to the structure for safe disposal of peak runoff.

vii) On downstream side, provide 2-2.5m wide gabion/rubble soiling along the full length of the structure. This helps to prevent erosion of the downstream side of the structure.

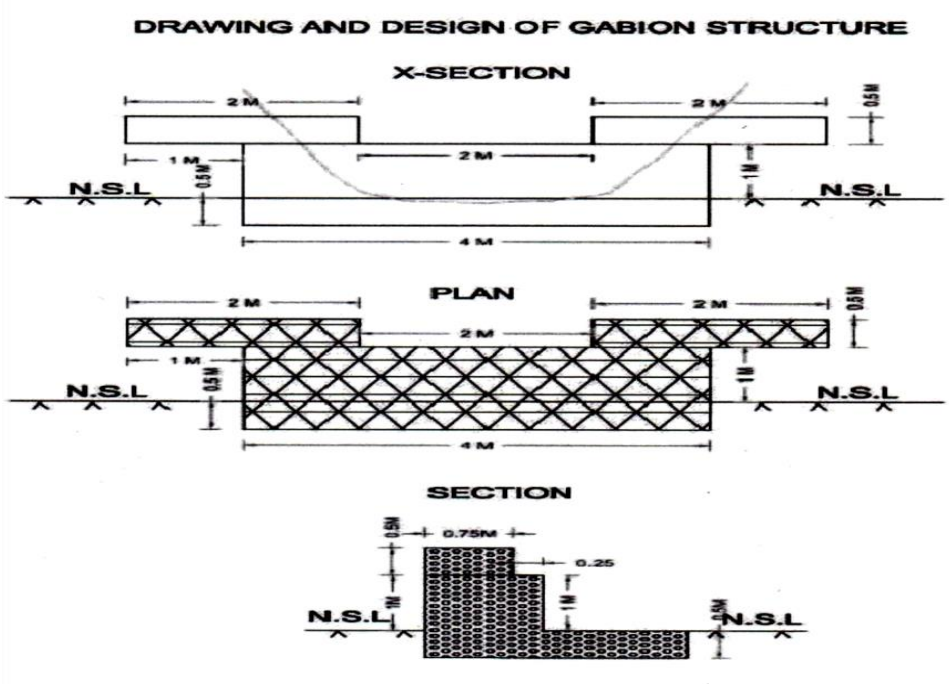


Fig. 5.25 - Drawing and Design of Gabion Structure

Gabion Structure with Ferro-Cement Impervious Barrier - A ferro-cement gabion has 2.5cm thick impervious wall of ferro-cement at the centre of the structure which goes below the ground level up to the hard strata. This ferro-cement partition supported by gabion is able to retain the water as well as withstands the force of runoff water. Use of G.I. wire of good quality for wire mesh fabrication is recommended to ensure durability and strength to the structure.

Construction of Ferro-Cement Impervious Barrier

i) Clean the site first.

ii) Excavate the foundation trench up to the hard strata.

iii) Lay down the concrete in the proportion 1:3:6 and thickness of 15cm for the foundation of Ferro-cement wall.

iv) Construct the ferro-cement wall at the Centre of the foundation trench upto 7.5cm below G.I. Fill up the upstream and downstream sides of the ferro-cement wall with sand (about 15cm thick) and the remaining trench with available soil. The sand layers protect the ferro-cement from swelling action of the surrounding soil and also allows the water which is sprinkled on top for curing to go down to the bottom.

v) Next, provide a 7.5cm thick concrete bed of 1:2:4 proportion on the Ferro-cement wall. Place on it, the G.I. wire mesh of size 15 x 15cm of 10 gauge thickness. Lay the remaining 7.5cm thick concrete above the earlier layer so that the chain link gets fully embedded in the concrete. A ferro-cement wall upto the full supply level of the structure should then be built above the concrete.

vi) Construct a stone bund keeping the ferro-cement wall at the centre.

vii) The whole structure including ferro-cement core wall should go upto 0.3-0.6m into the stable portion of the gully side to prevent end-cuttings.

viii) Raise the end portion of the structure to the level equal to the flood depth. Aim is to prevent scouring of the *nallah* banks.

ix) On the downstream side, provide 2-2.5m wide gabion/rubble soling along the full length of the structure. This helps to prevent erosion of the downstream side of the structure.

Permanent Structures for Gully Stabilization: Permanent soil conservation structures are often used for runoff and sediment control as well as storage of water for irrigation in arable and non-arable lands. These can be constructed of cement masonry or gabion. Their use becomes necessary when the runoff from the catchments is too large to be handled with vegetative measures/temporary structures or where high degree of safety is warranted against the loss of life and property. However, it should be ensured that the benefits from such structures are justifiable against the cost.

Design Criteria

Permanent structures in soil conservation are normally designed for a recurrence interval (RI) or frequency of 10-50 years which means that they are supposed to discharge the maximum discharge during the designed period. The structure should be strong enough to withstand the forces exerted by water/earth. A structure should, therefore, be designed with the following considerations:

Hydrologic design: It involves computation of the peak discharge at the point of the watershed where the structure is to be constructed. Generally, rational method is employed for the purpose.

Hydraulic design: It involves calculation of the dimensions of the spillway which is able to carry the above peak discharge.

Structural design: It involves calculation of the dimensions of each component of the structure which ensures its safety against water/earth forces, the structure is to withstand.

Drop spillways - Drop spillway is a weir structure. Flow passes through the weir opening, drops to an approximately level apron or stilling basin and then passes into the downstream channel. The different components of the drip spillway are; **(a)** head wall and head wall extension, **(b)** side walls, **(c)** wing walls, **(d)** apron, and **(e)** longitudinal sills. These are used for gully stabilization or sometimes as water storage structures where the drop is low. Drop inlet structures are used at appropriate locations in the gully for storage of water/sediment.

Chute spillways are used at gully heads to convey the water safety to the gully bed. The drop spillway is an efficient structure for controlling low heads, normally up to 3 m.

Functional Uses

a) Gully and raving stabilization.

b) Erosion control structures for stabilization of landslides and mined areas.

c) Protection of fields, roads and hutments, etc. from gullies.

d) Grade control for stabilizing channels and waterways.

e) Reservoir spillway where the total drop is relatively low.

f) Control of irrigation water.

g) Adaptability.

h) The drop spillway is an efficient structure for controlling low heads.

Site selection

The site should be selected so that the spillway can be located on a reasonably straight section of the channel, with no upstream or downstream curves within at least 30 m of the structure. Poor alignment may result in reduction of the storage capacity and excessive scour of the embankment and channel banks.

The site should provide an adequate foundation for the spillway. The foundation material must have the required supporting strength, resistance to sliding and piping and be reasonably homogenous so as to prevent unequal settlement of the structure.

Masonry Walls with Apron - In some of the forest areas, suitable stones are not available in the drainage lines and hence crate wire check dams cannot be constructed. In case, large size stones are transported from outside, this turns out to be quite expensive. As a substitute to crate wire structures, masonry drop structures constructed with locally available small sized stones and *bajri* turns out to be cheaper and hence constructed in series in the drainage lines of such areas. When constructed in series, head-toe relationship is maintained. The scouring of toe wall remains a problem when this relationship is not maintained (**Fig. 5.7**).

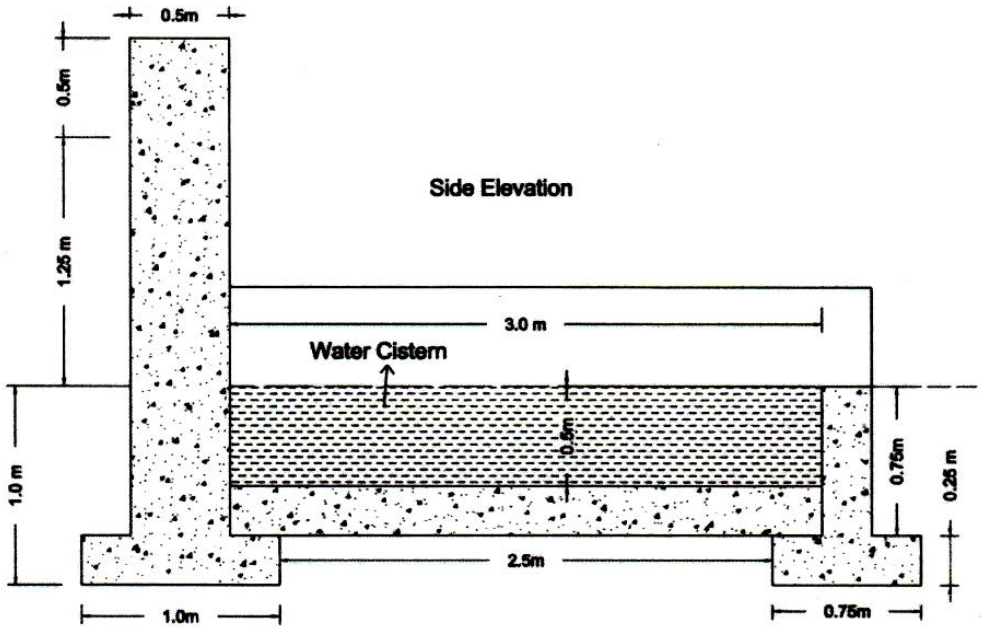


Fig. 5.26 - Masonry Drop Structures (1-1.5 m Height for Silt Control)

Silt Detention Structure: These check dams are constructed in *khads* to check the flow of silt. A cement concrete wall is constructed across the flow of water. On the downstream side the buttresses can be constructed, if the length of the check dam is more than 3.0 m. Such types of check dams need proper foundation, as well as sufficient embedment in the sides. A spillway is constructed on the top of the check dam. A cistern is constructed on the downstream side of the check dam. Apron of the proper length is constructed depending on site conditions and drop (**Fig. 5.9**).

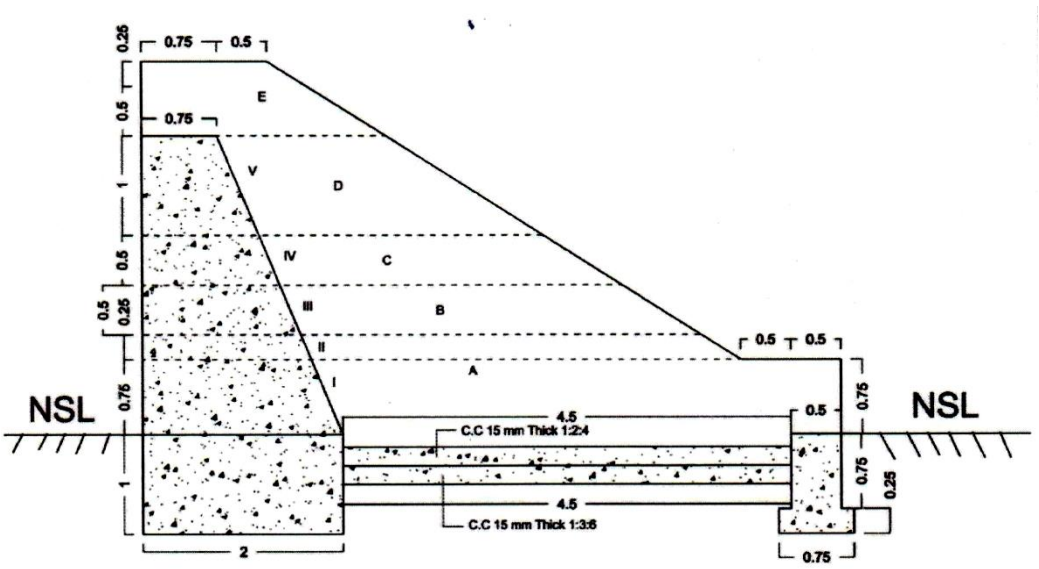


Fig. 5.27 - Silt Detention Structure

Stream Bank Erosion Control – Several mechanical measures can be used for the control of soil bank erosion. These are described below:

(a) Mechanical Spurs for Torrent Control

Torrents are causing vast area submergence and damage to life, property and infrastructure almost every year. This is the most common problem in foothills of Shivaliks, spread over the northern States of India. Study by (Tiwari *et al.,* 2006) based on remote sensing reported that about 1,500 km^2 area and the area affected can be up to 7,500 km^2 in the Shivaliks. This demands economically viable and appropriate measures to combat the menace of torrent in the region. Hill torrents (locally knows as 'Rao' or 'Cho') cause extensive damage to life and property as a result of the frequent changes in their course and associated flash flows with heavy debris loads. However, when the streams reach the relatively flat valley, their debris carrying capacity diminishes due to drastic reduction in flow velocities and the debris gets deposited in the water courses in the form of gravel bars and islands. As a result, the flow tends to braid and migrate laterally overtopping and undermining the low erodible banks and affecting the adjoining forest/agriculture lands and utility services such as roads and bridges, etc. Spurs, retards and retaining walls are used at such downstream reaches for training the torrent flow along desired courses and prevent damage to natural resources, life and property.

Spurs are structures constructed transverse to river flow extending from one of the banks at an angle to the flow. These structures are known by different names, such as spur-dikes, groynes, transverse dikes, jetties, etc. Their main functions are to serve as a protection to the stream bank from erosion and to train the main stream along a desired alignment. A well designed series of spurs built along an eroding bank will, firstly, check the erosion, and secondly induce siltation in the quite water between the spurs. As the silt beds so formed rise above normal low water level, vegetation may be planted on them to bind the silt and to catch more.

Function of Spurs

a) The functions of a spur system may be one or a combination.

b) Protection of river banks including land, road, building, bridge abutments and other structures along them.

c) Reclamation of land along torrent beds, in excess of that required for the flow discharge.

d) Narrowing of floodway to induce scouring along defined lines to create a narrow, deep, straightened channel instead of one which is more wide, shallow and wandering.

e) Diversion of current in a desired direction.

Types of Spurs

The spurs may be classified according to; **(a)** method and material of construction- permeable and solid/impermeable type, **(b)** function served-attracting, deflecting and repelling type, **(c)** height of spur with respect to high water-submerged or un-submerged type, and **(d)** special type-T headed, hockey type, etc. Depending on the purpose, spurs can be used singly or in series. River conditions affecting the choice of type and design of spurs may be:

i) Grade and velocity of river

ii) Character of bed and material carried – shingle, sand mud, etc.

iii) Width of waterways and area of flood way.

iv) Depth of waterway, and height of flood rise.

v) Availability of material and financial resources.

Spur Types According to Material of Construction: Wire created (gabion) and vegetative spurs are the commonly used permeable spurs in torrent control works. They have a dampening action on the velocity of approaching flow. Gabion spurs are ideally suited as they are flexible, porous, stable and economical. They are fabricated using 8-10 gauge G.I wire. Spurs constructed with vegetative materials (i.e., trees, brushwood, etc.) are also in vogue since olden times. Cement masonry or concrete structures come under the impermeable types.

Spur Types According to Function Served: According to the function served, spurs may be of the following types:

(a) Repelling type: The repelling type of spur projects towards upstream direction of the flow current. The spur angle is recommended to be 95^0 to 110^0 from the downstream (i.e., 5^0 to 20^0 with normal to flow towards upstream). It has the property of repelling flow away from it.

(b) Attracting type: Attracting type of spur projects towards the downstream of flow direction, normally an angle of 30^0 to 60^0 from downstream. It attracts the river flow towards it, hence named so.

(c) Deflecting type: Deflecting type of spur is made projecting at right angle with the bank. It is usually of short length and gives local protection.

Design Specification of Spurs: Construction of spurs for river training is quite expensive. Hence, they are to be judiciously planned and executed optimally at the most crucial reaches along a river course. Some of the important factors that determine the use and design parameters of spurs are:

Nature and Extent of the Problem: The use of spurs and other engineering structures is justifiable where the river damage is severe and poses a threat to the life and adjoining property.

River Characteristics: Factor like river geometry (i.e., width, flow depth, bank height), flow velocity, flow pattern, bed slope, sediment – debris-boulder movement, river meandering and curvature, etc. are important parameters that may determine the design specifications of structures.

Super Geometry: The length of spur, its alignment to flow, shape and permeability are important design considerations.

Super Length: Construction of a spur causes constriction of river flow which should be limited so as not to affect the river regime adversely. This is represented by a 'blockage ratio'

b/B, where b is projected length of spur and B is the river width. The blockage ratio should not exceed 0.3 i.e., the projected length of the spur should not exceed 1/3rd of the width of river.

Alignment of Spur: The spur alignment is defined by the angle of the spur made. Attracting (downstream pointing) spurs are normally used for flow diversion whereas short and closely spaced right angled deflecting spurs are recommended for quick sedimentation along banks.

Shape of Spur: Stream lined shapes create fewer disturbances and hence produce less scour than blunt shapes. In oblique faced spurs, such as with trapezoidal cross section, the scour depth is lesser because some of the energy of the downward flow component of the principle vortex, which would otherwise erode the sediment bed, is dissipated on the sloping wall. Simple rounding of corners and edges of spurs reduce the scour considerably. The upstream nose of the spur plays an important part in the phenomenon of scour and the rear of the spur has got no effect.

Permeability of Spur: Permeable spurs are mostly used in torrent training works, yet very little information is available on them. Permeable spurs are less expensive and can be made by locally available material. Their stability is better than the solid ones due to lesser scour around them.

Spacing of Spur: Obviously a spur will protect only a certain length of the bank. It is usual, therefore, to use spurs in series, spaced so as to give a continuous effect. A single spur can protect bank length between 3 to 5 times of the spur length. The recommended optimum spacing of spurs is 3 to 4 times the projected spur length. A larger spacing can be adopted for convex bank and a smaller one for concave bank i.e., 2 to 2.5 times the length of spur. The method to locate the spurs is shown in figure given below.

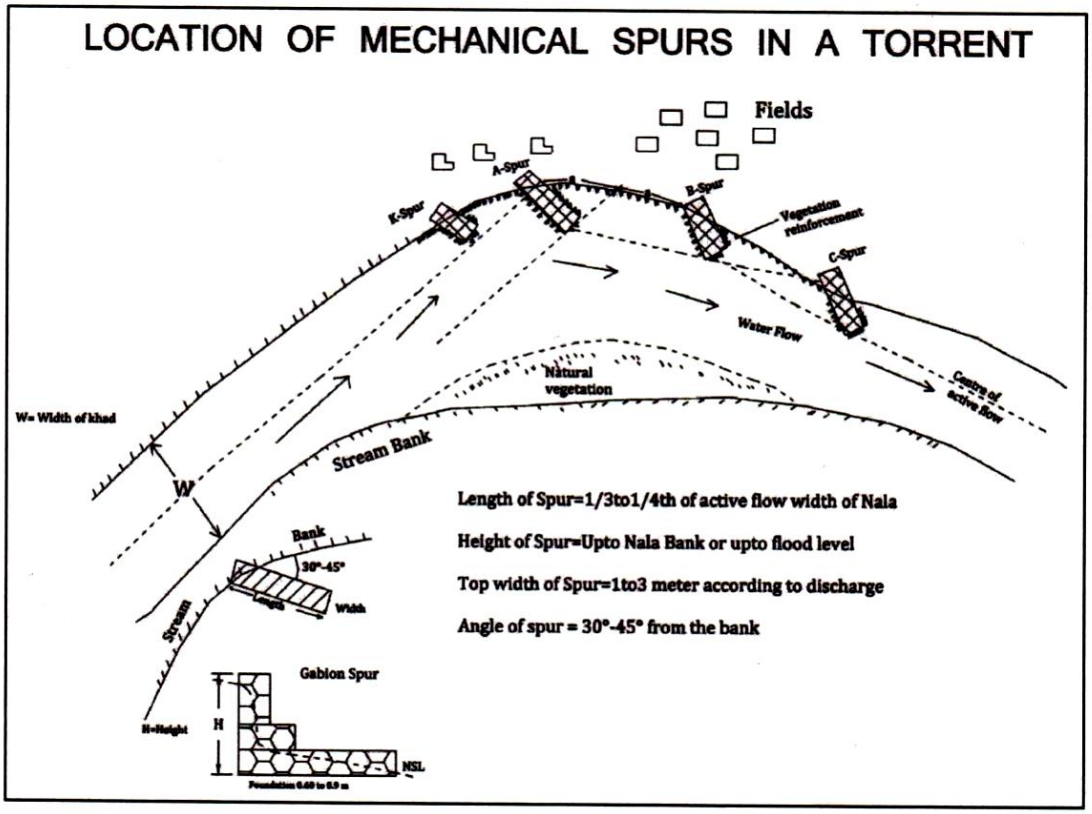


Fig. 5.28 Location of Mechanical Spurs in a Torrent

Crate Wire Spurs - Cement masonry structures are called impermeable but, they are not generally used in soil conservation works. Semi-permeable gabion structures are being used extensively for stream bank protection because they are flexible and economical. Gabion spurs are made of boulders packed closely in wire crates made of 10 gauge G.I. wires.

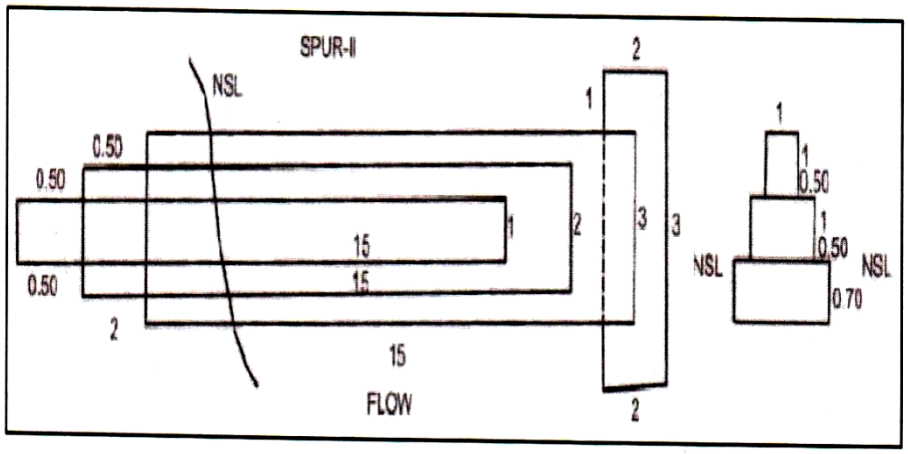


Fig. 5.29 - Crate Wire Spur

Masonry Retaining Walls - The retaining walls are constructed to stabilize steep hill slopes and provide stability to stream banks. In the hill roads, masonry or gabion retaining walls are constructed to retain the sliding debris from the hill sides. The retaining walls are also constructed to provide support to buildings made on steep but unstable slopes. In case *nallah*/gullies are cutting the banks and there is costly land, buildings or road near the top of the banks, then retaining walls are constructed to provide stability to the banks. In case slope length is small, then only one retaining wall may be sufficient. But if slope length is more than series of retaining walls one over the other are made to provide necessary protection. Generally, the bottom width of the retaining wall is kept as two-third of the height. The base width is reduced in steps to 1 m at the top if there is no surcharge in case of gabion structures. In case there is surcharge, 2m top width may be adopted for gabion and one meter for masonry walls. The retaining walls are broadly classified as structures subjected to water pressure (dams and weirs) and earth pressure. In the later case, angle of repose of soil is considered in design and its value depends upon nature of earth and its wetness. The stability of gravity retaining walls is due to the self-weight of the wall which should be more than the pressure generated by the water or the earth mass.

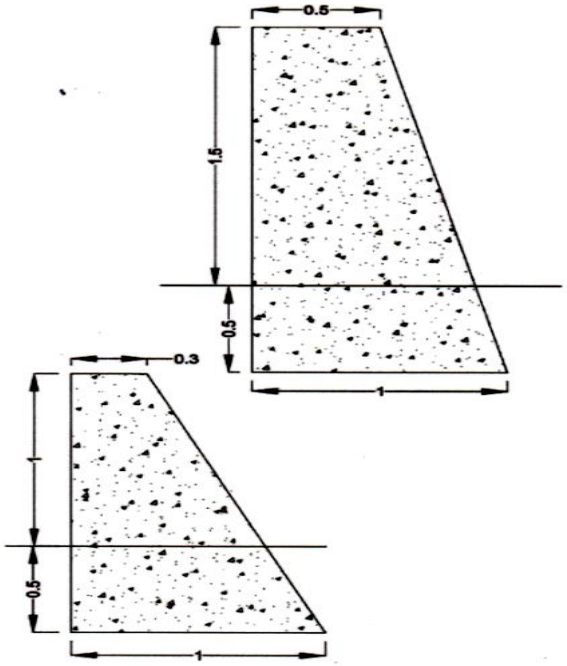


Fig. 5.30 Masonry Retaining Walls

Crate Wall Structures – Often, river banks require retaining wall to protect them from soil erosion and also for the protection of adjacent vegetation. Retaining walls are essential around the muck sites to prevent erosion. In many of the khads suitable size of stones are available and used for the construction of gabion retaining walls (Plate 5.13). The height is decided by the level of flood flow. The size is determined by the size of the khad and flood discharge. One meter foundation is provided.



Need of Retaining Wall Construction to Protect the River Bank from Soil Erosion



Muck Disposal Sites along the Banks of the Bhaga River

Cost Estimates of Soil Conservation Structures: At the prevalent schedule of rates, the cost estimates of some of the civil structures were worked out. Accordingly, the average cost of dry stone check dam was estimated to Rs.1,068/-m^3. The costs of gabion check dam, retaining walls and spurs varied from Rs.1,195/-m^3 to 1,368/-m^3. The cost of cement concrete protection wall comes to Rs.1,950/-m^3 and the cost of silt detention structures of cement concrete comes to Rs.3,031/-m^3.

Source: The report has drawn material from Draft Project Report of Chenab Catchment prepared by NERIL (Naik Environment Research Institute Ltd.). Since NERIL has been paid for the DPR, now it is the property of Himachal Pradesh Forest Department. HFRI has taken the permission from the Himachal Pradesh Forest Department for sharing the information in the DPR.

b) Riparian and Riverine Management

The term 'riparian' and 'riverine' are closely linked to each other. The former represent the biotic communities which exist adjacent to freshwater ecosystems *viz*., rivers, ponds, streams, lakes, reservoirs, and other inland aquatic systems along their shores or banks. While the latter refers to all biota existing in river or other aquatic resources in the form of fishes, amphibians, reptiles, aquatic birds, mammals and benthic phyto-planton, etc. Riparian zones are transitional interface areas between inland aquatic ecosystems and highland terrestrial habitats (Fischer *et al*. 2000). Riparian zones support a large number of wildlife species besides performing many vital ecological functions as well. These areas are unique and dynamic ecosystems and now considered more crucial for restoration (Knopf *et al.,* 1988, Naiman, *et al*., 1993). The 'River Continuum Concept' elaborately explains the diversity and density of important wildlife and plant species within riparian ecosystems (Vannote *et al*., 1980). The RCC establishes interrelatedness and interdependency of riparian and riverine ecosystems. Ecologically, riparian areas integrate the concepts from geomorphology, terrestrial plant succession, and aquatic ecology together. The riverine wetlands are an important component of a river system and they play a critical role in improving flood protection, recharging ground water and increasing the biodiversity, thus providing several ecological services.

The Project aims a holistic riverine landscape (riverscape) approach for sustainable management of Chenab River, its banks, or its riparian areas. Riparian buffer zones are exceptionally rich in biodiversity and they perform a wide range of functions along with economic and social values to people. These functions include; **(a)** trapping/ removing sediment from runoff, **(b)** stabilizing stream banks and reducing channel erosion, **(c)** trapping/ removing phosphorus, nitrogen and other nutrients that can lead to eutrophication of aquatic ecosystems, **(d)** trapping/ removing other contaminants, such as pesticides, **(e)** storing flood waters, thereby decreasing damage to property, **(f)**Maintaining habitat for fish and other aquatic organisms by moderating water temperatures and providing woody debris , **(g)** providing habitat for terrestrial organism, **(h)** improving the aesthetics of stream corridors, and **(i)** offering recreational and educational opportunities.

The principal objective of a riparian buffer may appear simple enough so as to protect the aquatic zone from disturbance by forest operations or any other land use on the adjacent land, it is important to understand the deeper logic and science behind the planning for such vegetation cover and plantations. In several instances, developing a riparian corridor may actually not be a natural aspect of the ecological system at all, and it must be clearly seen as a management initiative which is planned for the protection and restoration of river water flow and quality.

Restoration and Conservation of Aquatic and Riparian Wildlife

In the context of Chenab Riverscape, the riparian forests and riverine ecosystem have been severely imperiled in the mountainous tract of Himachal Pradesh and Jammu and Kashmir UT including the alluvial plains of Jammu due to enhanced human activities. As indicated earlier in the Chapter on riverscape and its environment, wild flora and fauna in the riparian zone as well as the aquatic environment have been adversely impacted due to various anthropogenic pressures. A wide range of species dependent on the riparian zone as well as the *lotic* system have also been impacted. Therefore, the various floral and faunal species in the riverine wetlands need comprehensive long term planning for their conservation and support at all levels so as to ensure the ecological integrity of the wetlands and sustainable management of various Rare, Endemic and threatened (RET) species. There is an urgency to protect, conserve, and rehabilitate species of concern. Several protected areas (i.e., Chander Tal, Saichu Tuan *Nallah*, Nandini Wild life Sanctuary, Surinsar Mansar Wild life Sanctuary, Ramnagar Wild life Sanctuary, Kishtwar High Altitude National Park, Trikuta Wild life Sanctuary) are some of the prominent PAs along the main channel of Chenab River and its tributaries and these PAs are repository of representative biodiversity of North-Western Himalaya and Western Himalaya biotic provinces and harbour several RET species. As there is noticeable emptiness of much desired scientific insight on most of the RET species with respect to their distribution and status, population dynamics, ecology, habitat preference, reproductive behavior, and their likely response to climate change. The Wildlife Wing, State Forest Department of Himachal Pradesh and Jammu and Kashmir UT need support for various activities so as to ensure effective protection and management of wetlands protected areas and conservation of threatened floral and faunal species. Much of the ongoing activities within various wetlands/ protected areas along the river channel and its tributaries need augmentation and strengthening. The community led participatory approaches are thus, visualized so as to augment and strengthen populations of RET species.

In view of the above enormous significance of riparian zones and riverine ecosystem, protected areas, and associated threatened biodiversity, it is vital to have appropriate conservation interventions to protect the wildlife habitat and associated wildlife. The following Forestry Interventions are proposed in the present DPR:

i) Collection of baseline information – distribution, status, and population dynamics
ii) Ecological research on select threatened taxa
iii) Protection and improved management of protected areas
iv) Protection and conservation measures for riparian and riverine wildlife
v) Habitat improvement including control of invasive and alien species in the terrestrial and aquatic environment.
vi) Conservation breeding and reintroduction of gharial, turtle, otter, etc.
vii) Awareness creation
viii) Capacity development

ix) Long term ecological monitoring

The HFRI Chenab River team has consulted the list of riverine/riparian and wildlife areas and made list of prominent or high prioritized areas in consultation with stakeholders which can be taken under this component. The area taken for management can be taken up with the concerned stakeholder (Departments as well as NGOs or any other secondary sources).

The activities included in the proposed Models along with Nomenclature for Himachal Pradesh and Jammu region (J&K UT) are as follows:

Himachal Pradesh
CN/HP/CI /06
Jammu region (J&K UT)
CN/JK/CI /06

Table: 5. 38 - Component-wise details of activities under Riverine and Riparian Management

S.No.	Components	Activities	Year				
			1	2	3	4	5
1	Protection	General Protection from illicit felling, illegal grazing, mining, poaching, etc.	√	√	√	√	√
		Survey and demarcation of boundaries and establishment and Maintenance of permanent boundaries	√		√		√
		Physical Infrastructure (Watch Tower, Patrolling Path); Electric Vehicle;	√	√	√		
		Field Equipment - Tranquillization Gun, Night Vision with Binoculars, GPS, Surveillance equipment, Camera trap etc.	√	√	√		
		Communications equipment including laptops, wifi system, etc.	√	√	√		
2	Habitat Management	Water ponds in every 2x2 km grid	√	√	√	√	
		Habitat enrichment plantations 1. Sloppy area, 2. Riverine area (receded area broadcasting of lintels in strips 3. Riparian area and 4. Grass land development	√	√	√	√	√
		Soil and Water Conservations Measures	√	√	√	√	√
		Control of Invasive and Alien Species	√	√	√	√	√
3	Wild Faunal Species Management	Conservative Breeding; Re-introduction of Species, etc.	√	√	√	√	√
4	Research and Development	Short Term Projects up to 1 year; Long Term Projects (5-Year)	√	√	√	√	√
		Essential Equipment and Field Infrastructure for facilitation of Research and Development and Monitoring					
5	Eco-development	Basic Infrastructure; Training to Tourist Guides of Peripheral Villages; Interpretation Centre for	√	√	√	√	

		Nature Education					
6	Community Awareness and Participation	Creation of Self-help Groups (SHG), Provision of Revolving Fund for SHG; Alternate Income Generation Activities; Federation for Developing Entrepreneurship, Supply Management, etc.	√	√	√	√	√
7	Ecotourism	Provision of Essential Facilities; Regulation of Tourism Activities, with respect to carrying capacity of the area, etc.	√	√	√	√	

d) **Wetland Management**

The introductory Chapter has narrated the importance of freshwater resources, particularly wetlands from the perspective of human well-being and sustainable development. Wetlands provide water for human consumption and agriculture and numerous benefits for people, wildlife and aquatic species. Important functions of wetlands include protecting and improving water quality, providing fish and wildlife habitats, storing flood water, Maintaining surface water flow, and protect shores. Wetlands are ecologically sensitive and adaptive systems. As per the Ramsar Convention, wetlands are areas of land or water, whether natural, permanent or temporary, with water that is static or flowing, fresh, and brackish, including areas of marine water (Ramsar Convention, 1971). Wetlands include lakes, estuaries, deltas, bogs, streams, ponds, reservoirs, etc. The Chapter on the Chenab Riverscape and its Environment has elaborated on the importance of diverse wetlands within the riverscape, multiple functions performed by them; especially their roles in Maintenance of river ecosystems besides the wide range of challenges and threats faced by various wetlands those are located along the main river channel and its tributaries. Natural and manmade wetlands those occur in the concerned State andUT help in Maintaining the ecological balance, serving the various needs of the society by recycling nutrients, purifying water, attenuating floods, Maintaining stream flow, recharging groundwater, etc. Wetlands are not only one of the most productive ecosystems but are also repository of rich and unique biodiversity. In addition, majority of wetlands in Himachal Pradesh and Jammu and Kashmir UT offer enormous opportunity of livelihood for local communities and are major attraction centers for recreation and tourism activities. In the context of Chenab riverscape, Chander Tal is in Himachal Pradesh and Surinsar-Mansar, Ghar-ana, Pargwal wetlands are in Jammu and Kashmir UT, which are some of the prominent wetlands of greater ecological, cultural and recreational importance. Like most wetlands in India and elsewhere, wetlands within the Chenab Riverscape are facing enormous human pressure in the state of Himachal Pradesh and Jammu and Kashmir UT because some of them are surrounded by densely populated townships or other urban areas including villages and some are famous tourist places. Most high altitude wetlands in Himachal Pradesh are fragile and threatened by geological processes, climate change and ever increasing tourism pressure. The wetlands on the account of small size, large interface with urban/ rural environments, traditional resource dependence, and enhanced biotic activities are either deteriorated or in the process of degradation.

In view of this, one of the strategies on conservation interventions, as a part of the proposed Forestry Interventions in Himachal Pradesh and Jammu and Kashmir UT, the present DPR focuses on wetland conservation and restoration efforts. The proposed strategy for conservation and restoration of wetlands is broadly two pronged. Firstly, the proposed strategy aims to protect, manage and restore priority wetlands within the Chenab Riverscape. Secondly, the strategy also focuses on restoration and conservation of featured species and species of concern those are relevant to various wetlands. Only more degraded or prominent wetlands should have been taken up with the consultation of stakeholders (Departments/ NGOs/ secondary sources). The following section provides the details of proposed strategy towards wetland conservation and restoration:

Protection, Management and Restoration of Wetlands along the Chenab River

In majority cases, the foremost requirement is to ensure protection of various wetlands and to facilitate their scientific management. Being complex, fragile and dynamic ecosystems, majority wetlands require much desired protection and scientific management. This urgently calls for the preparation of comprehensive management plans adopting the landscape approach incorporating insights from research and monitoring activities. Majority wetland sites require creation of awareness, reduction in biotic pressure, and eliciting people support for conservation of wetlands through the execution of appropriate, site specific strategies on the eco development. The conservation of wetlands and restoration of degraded wetlands require multidisciplinary insight and appropriate approaches. The officials and frontline staff involved in the protection and management of various wetlands require opportunities for capacity development and support of modern technologies and tools so as to implement prominent activities related to protection, habitat improvement, species management, control of invasive and alien species, eco development, tourism and visitor management, nature interpretation, and monitoring.

The activities included in the proposed Model along with nomenclature for the Himachal Pradesh and Jammu region (J&K UT) are as follows:

Himachal Pradesh

CN/HP/CI /07

Jammu region (J&K UT)

CN/JK/CI /07

Table: 5.39 – Component-wise details of activities under Wetland Management (Natural and Artificial)

S.No.	Components	Activities	Year				
			1	2	3	4	5
1	Protection	General Protection from illicit felling, illegal grazing, mining, poaching, etc.	√	√	√	√	√
		Survey and demarcation of boundaries and	√		√		√

		establishment and Maintenance of permanent boundaries					
		Physical Infrastructure (Watch Tower, Patrolling Path); Electric Vehicle; Field Equipment - Tranquillization Gun, Night Vision with Binoculars, GPS, etc.	√	√	√		
		Communications	√	√	√		
2	Habitat Management	Habitat enrichment plantations 1. Sloppy area, 2. Riverine area (receded area broadcasting of lintels in strips 3. Riparian area and 4. Grass land development	√	√	√	√	√
		Soil and Water Conservations Measures	√	√	√	√	√
		Control of Invasive and Alien Species	√	√	√	√	√
		Creations of Mounds/ Highlands	√	√	√	√	√
3	Wild Faunal Species Management	Conservative Breeding; Re-introduction of Species, etc.	√	√	√	√	√
4	Research and Development	Short Term Projects up to 1 year; and Long Term Projects (5-Year)	√	√	√	√	√
		Essential Equipment and Field Infrastructure for facilitation of Research and Development and Monitoring					
5	Eco-development	Basic Infrastructure; Training to Tourist Guides of Peripheral Villages; and Interpretation Centre for Nature Education	√	√	√	√	
6	Community Awareness and Participation	Creation of Self Help Groups (SHG), Provision of Revolving Fund for SHG; Alternate Income Generation Activities; Federation for Developing Entrepreneurship; Supply Management, etc.	√	√	√	√	√
7	Ecotourism	Provision of Essential Facilities; Regulation of Tourism Activities, etc.	√	√	√	√	

Table: 5. 40 – Cost Norms for other Conservation Interventions in Himachal Pradesh

S. No	Year	CN/HP/CI/06 Riverine and Riparian Management		CN/HP/CI/07 Wetland Management	
		Amount Rs/ha	Man days	Amount Rs/ha	Man days
1.	1st year	3,20,000	512	2,80,000	448
2.	2nd year	2,80,000	448	2,50,000	400
3.	3rd year	1,90,000	304	1,60,000	256
4.	4th year	1,20,000	192	1,20,000	192
5.	5th year	90,000	144	90,000	144

Table: 5. 41 – Cost Norms for other Conservation Interventions in Jammu region (J&K UT)

S.No	Year	CN/JK/CI /06 Riverine and Riparian Management		CN/JK/CI /07 Wetland Management	
		Amount Rs/ha	Mandays	Amount Rs/ha	Mandays
1.	1st year	3,20,000	569	2,80,000	498
2.	2nd year	2,80,000	465	2,50,000	415
3.	3rd year	1,90,000	295	1,60,000	248
4.	4th year	1,20,000	174	1,20,000	174
5.	5th year	90,000	122	90,000	122

5.4.9 Supporting Activities

In addition to the above stated proposed Forestry Interventions in three types of landscapes (i.e., natural, agriculture, and urban) and three types of conservation interventions, execution of priority supporting activities is considered vital for the successful implementation of the present DPR, and envisaged wide range of specific activities in the priority sites identified within the riverscape on the basis of geospatial analysis and inputs from the field.

(A) Policy Level Interventions

The earlier Chapter on Legislative, Policy and Institutional Context has provided an updated insight on the existing legislative acts and policies at the national and state level relevant to forests, wildlife, biodiversity, environment, water and river besides the institutional context. It was evident from the review that the complex and emerging subject of river conservation and restoration in country like India has back up of numerous acts and policies. There is a growing concern about the plight of rivers in India at all levels. However, at the same time, there have been several governmental and non-governmental initiatives towards river conservation including a large number of judgments and specific directives by the various Hon'ble Courts including National Green Tribunal (NGT) so as to safeguard the interests of river ecosystem, surrounding lands, dependent communities, and various user agencies. However, despite considerable progress in recent decades, there are gaps and several issues which continue to affect the river and associated biodiversity, production sectors, and even the human communities all along the main river channel and its tributaries. Undoubtedly, a wide range of stakeholders including numerous government agencies are involved in efforts towards river conservation and there are competing demands and conflicts. By and large, isolationist approaches are still being applied. In the absence of single agency overseen river conservation, there are serious issues of coordination and monitoring. In absence of appropriate alternatives, most concerned government agencies find difficult to effectively implement/ enforce various legislative acts and even the directives of the Hon'ble Courts. In general, the desired institutional framework and infrastructure is inadequate to tackle the complex nature of river ecosystem spread over large extent. Hence, augmentation and strengthening of existing policy and legal frameworks are desirable and much needs to be done so as to recover the past glory of the Chenab River and its tributaries. In view of this, appropriate interventions related to improvement in the policy, law and institutional context are proposed as a part of the present DPR and to be implemented in the plan period. Necessary budget provision for envisaged policy level interventions by way of reviews, seminars, workshops, visits, field level assessments and monitoring has been made. An amount of Rs. 118 lakhs has been provisioned for this purpose for the National Lvel Partner Organization while provisions of Rs.5.73 lakhs and 11.30 lakhs are proposed to Himachal Pradesh and J&K UT, respectively.

(B) Strategic Adaptive Research and Development

The discipline of river ecology, management, restoration and conservation is relatively newer in the country and not much work has been done. Moreover, the approach has been largely piecemeal, fragmentary, and isolated in nature. Much of the information on various aspects of rivers come from different government agencies those are responsible for cryosphere, surface water, groundwater, pollution control, irrigation, hydropower, etc. Most of the researches by various, Scientific Organizations, Universities, Govt. Department and others, and individual efforts have focused so far on inventory of glaciers and wetlands, glacier retreat/ snowmelt, surface water, groundwater recharge and development, water quality and impact of various developmental and biotic activities. Often, such initiatives are just one time efforts or in project mode. In several instances, information is obsolete or specific to a particular tributary

or stretch of a larger river. Only recently, first time effort has been made to carry out comprehensive study on cumulative impact of hydropower projects and carrying capacity. Ecological insight on threatened taxa in the riparian and riverine environments is generally poor. There have been hardly studies on the various aspects of socio-economics and human impacts on the river ecosystem. The subject of restoration of rivers in India is almost new. Hence, neither desired knowledge nor essentially required tools and techniques are available which can be deployed in the socio-economic milieu of the country. In view of this, priority action research is proposed during the plan period by concerned agencies and expert organizations. The experience towards proposed holistic Forestry Interventions for restoration of a major Himalayan river like Chenab River is relatively new, except little experience gained by the country in programme implementation in the context of rejuvenation of Ganga River. Thus, the present DPR seeks adoption of a holistic, integrated, multidisciplinary and multi-scale approach to Forestry Interventions by executing plantation activities, soil and water conservation measures, riparian and riverine wildlife management, and wetland management. As a part of the supporting activities, priority research as the concurrent activity is proposed by the national partner organization, SFDs and other concerned agencies. Research findings would immensely help the agencies in effective implementation of the present DPR and in similar efforts on other rivers. Concurrent research is proposed to be taken up on the following priority thrust areas:

(C) Forest Hydrology Studies:

The introductory Chapter has addressed the intricate relationship between forests and water and highlighted that forests not only influence the hydrological cycle but they also have a profound effect on water resources both quantitatively and qualitatively. The study of water in forests is termed *forest hydrology* and it includes the distribution, storage, movement, and quality of water; hydrological processes within forested areas; and the delivery of water from forested areas (NRC, 2008). Forest hydrological science is regarded as the foundation of modern integrated watershed management. Hence, the subject of forest hydrology has been of great interest for long to natural resource professionals and policy makers. As such, forest hydrology is an interdisciplinary science that evolved from the specialization of traditional hydrological science and forest ecosystem science during the past century and enormous literature exists on the subject, primarily from the western world. However, in spite of nearly 125 year old elaborate country-wide infrastructure exists on forestry research in India, the discipline of forest hydrology has been grossly overlooked. The comprehensive review on the subject in Part 1 of the present DPR amply revealed this situation. All major rivers in the country and other freshwater resources are on decline. There is growing concern about the poor state of rivers and other freshwater resources. Hence, there is an urgency to initiate priority research in the field of forest hydrology in diverse forests of the country so as to understand how different forests are helping in distribution, storage, movement, supply and quality of water. Likewise, to answer the pertinent question that how Forestry Interventions, particularly plantations in different bio-geographic/ agro-climatic zones.

(D) Screening of Suitable Species and Pilot Trials on Bio-remediation and Bio-filtration

Most rivers in the country suffer on the account of multitude of pollutants, waste and sewage originating from agricultural lands, industries and the urban environment. Both organic and inorganic contaminants find their way into rivers and other freshwater resources. Heavy metals are likely to be more in both municipal waste waters and industrial effluents. Approaches like Phyto-remediation, Bi-remediation, and Bio-filters have been developed to treat pollutants in such waters. Removal of metals through phyto-remediation techniques and the subsequent recovery of the metals or their safe disposal are attracting research and commercial interests. Bio-remediation is being used as a method to treat waste water wherein biological organisms are used to convert the hazardous waste into non-toxic or less toxic substances. Usually, microorganisms are being used for bio-remediation of sewage. Much work has been done in these emerging technologies, mainly in developed nations. However, in India these technologies are relatively newer and infancy. Only handful sporadic efforts have been made so far in this direction and the success stories have been inadequately documented and disseminated. Nevertheless, these technologies have enormous potential to treat contaminated water prior to their release in the river or other wetlands. There is an urgent need to initiate and support pilot trials in these priority fields in collaboration with potential scientific institutions and also to undertake researches on screening of suitable species for such purposes. The results obtained can be applied not only to Chenab River but, also on its tributaries, other major river systems and water bodies of the country.

(i) Evaluation of Ecosystem Services Especially in Provisioning of Water Supplies

The concept of ecosystem services has become part of any approach towards conservation of biodiversity, water, primary industries, human settlements, regional planning and climate change. There has been a growing public interest in the role and value of natural ecosystem and how they contribute to quality of human life and to human well-being. Ecosystem services and their continued provision underpin human existence, health and prosperity. Diverse natural ecosystems provide ecosystem services within four categories *viz*., provisioning, regulating, supporting and cultural. Different forest ecosystems and forestry plantations provide a wide range of goods and services, both tangible and intangible in nature. Tangible benefits like timber, non-timber forest products (NTFPs) including medicinal plants, fuel wood, and fodder have been adequately quantified arising from various provisioning services. However, water supply under provisioning services, soil conservation under supporting services, and environmental amelioration under regulatory services are yet to be quantified. Likewise, river ecosystems also provide a wide array of ecosystem services. In general, researches in the context of services provided by forests as well as river ecosystems in the country are wanting. Hence, it is proposed to promote researches and priority in this field.

(E) Bio-engineering Methods for Soil Conservation and Stream/ River Bank Stabilization

The review on the riverscape and its environment highlighted that the Himalayan River like Chenab and its tributaries are severely impacted by soil erosion and eroding stream/ river banks owing to landslides, steep slopes, higher rates of runoff, and enhanced developmental/ biotic activities. Thus, soil and moisture conservation, and stabilization of stream/ river banks

are amongst the priority activities towards river restoration. The use of biological and engineering measures in combination or biological interventions alone to control soil erosion and improve moisture conservation is referred as bio-engineering measures. Appropriate bio-engineering measures involving suitable cultural practices and plant species in addition to engineering structures have proven to be the cost effective methods to check soil erosion and efficient soil moisture conservation strategy. Newer eco-friendly materials (e.g., geo-jute) are being extensively used in stabilizing steep slopes and checking soil erosion. However, researches in this emerging field need augmentation and strengthening, particularly in identification of newer eco-friendly materials, appropriate use of solid waste, screening of suitable plant species, and designing new bioengineering models. Hence, proposed research activities in this emerging field with a focus on innovative and low cost bio-engineering methods for riverbank stabilization and soil and moisture conservation are envisaged by the national level partner organization in collaboration with SFDs and the Indian Institute of Soil and Water Conservation, Dehradun and its regional centers.

(F) Biodiversity, Forestry and Livelihoods

The world over, humanity is strongly intertwined with forests as they offer wide range of ecosystem services. Forests also provide habitat for wildlife and are repository of biodiversity. Forests play a vital role in the rural economy. In India, it has been observed wherever there is a large concentration of forest, there is also high concentration of tribal people in particular and of the rural population in general. Rural people are dependent on forest resources for their livelihood. Forests not only provide resources for economic subsistence, but, the forests are also a way of life socially and culturally. Sustainable livelihood is increasingly linked to the Maintenance of 'natural capital' and environmental conservation at large. The Sustainable Forest Management (SFM) has been recognized as the pillar of biodiversity conservation and ensuring livelihood security of the local people. The United Nations adopted the Agenda 2030 with its core element, the 17 Sustainable Development Goals (SDGs) in September, 2015. Further, it has been realized that forests not only have a special role to just contribute to the Goal 15 (Life on Land), but forests have greater role to play in achieving several interconnected SDGs. Like most other natural ecosystems, the world over forests has also suffered due to enhanced human activities and face enormous challenges. In past five decades or so, country has made concerted efforts to protect and conserve diverse forests in different State and UT through appropriate innovations, policy and legal interventions, setting aside significant proportion of forest lands as protected areas, wildlife management and conservation of biodiversity, wetland management, integrated watershed management, adoption of participatory community led approaches, implementation of afforestation programmes, actions for recovery and conservation of RET floral and faunal species, research and monitoring, capacity development, etc. However, much needs to be done. A comprehensive research agenda on priority themes relevant to SFM, biodiversity conservation, management of Non Timber Forest Products (NTFPs), fire management, eco-development and sustainable livelihoods needs to be planned and implemented. It is proposed that the national level partner organization made responsible under this DPR for research, monitoring and capacity

development will carry out researches on the above stated thrust areas in collaboration with SFDs and other national/ state level scientific organization.

(G) Climate Change Mitigation and Adaptation

The Chenab River originates from the Greater Himalaya in the Lahaul and Spiti district of Himachal Pradesh, India, and flows through the Jammu region of Jammu and Kashmir UT. The fragile mountain environment of the riverscape in Himachal Pradesh is extremely sensitive to the changes in the global climate system, with widespread glacial retreat being one of the major signals of warming temperatures over the past century. The glacial retreat coupled with enhanced human activities by way of expansion of agriculture, infrastructural development, urban growth, and other environmental pressures are considered as significant climate related threats to the river ecosystem, snow cover and high altitude wetlands, forests and biodiversity including aquatic biota, human lives, and livelihoods. The review on the riverscape and its environment has highlighted that one of the prominent/ larger glaciers (Bara Shigari Glacier) within the Chenab riverscape has shown signs of rapid retreat in the past two decades or so. Likely implications of climate change are expected to alter the structure and composition of forests and the distributional range of some of the featured floral and faunal species. Uncertain climatic events (i.e., avalanche, cloud burst, floods, droughts, etc.) are expected to impact the river, surrounding lands, and environmental flows besides local communities and their livelihoods. The slightest changes in the climate patterns can have large implications on the Chenab River and its tributaries, not only for their own ecological values but, also for larger humanity in Himachal Pradesh and Jammu and Kashmir UT. As of now, there is poor insight on the nature of impending impacts and the ways and means to adapt and mitigate. Hence, it is proposed that the national level partner organization undertakes the priority researches relevant to this important theme involving other state/ national level scientific organizations.

(H) Support of Modern Technology in NRM

Degradation of natural resources is a growing concern that threatens the livelihoods of millions of people. Innovations by research and development organizations and local communities themselves have produced several promising technologies and practices for making natural resource management more productive and sustainable. The advent of modern technologies in the fields *viz*., Remote Sensing and Geographic Information Syatem (RS &) GIS, Information technology (IT), biotechnology and genetics, waste management, forestry and agricultural operations, wildlife conservation, nanotechnology, water use and efficiency, etc. have opened several avenues for effective planning and managing of vital natural and manmade resources including cryosphere, forests, wetlands, wildlife, agriculture. However, the potential of advanced technological interventions in Natural Resource Management (NRM) is yet to be fully explored. Hence, collaborative researches with the aim to augment and strengthen advanced technological support in NRM are envisaged and proposed as part of the present DPR. The national level partner organization is expected to play a lead role in this endeavor so as to encourage active involvement and partnership of related organizations. In addition to national level endeavors, the site specific researches in the aforementioned technology fields are proposed to be encouraged, supported, and facilitated by the state level

organizations. As the subject of river conservation and restoration is relatively new for the country and very little experience exists at this juncture, it is proposed that the national level partner organization would organize a research Need Analysis Workshop involving all the probable research organization so as to plan the research agenda for this priority field and to facilitate the cooperative research.

(I) Participatory Monitoring

The dynamic interaction between river and surrounding landscape is known as river morphology (Galay, 2010). The excessive development, deforestation, and industrialization taking place around the river channel contribute too many changes in the river morphology with the passage time (G. Kondolf and Hungry Water, 1997.) Recently, the process based river restoration has gained significance, to improve river processes and morphology (Kondolf, 1998; McDonald *et al.*, 2004; Bernhardt and Palmer, 2007, 2011). Off late, the Government of India has also decided to restore major rivers of the country and new initiatives have been launched. Assessing the outcome of river restoration projects is vital for adaptive management, evaluating project efficiency, optimizing future programmes and gaining public acceptance. In general, monitoring is the tool to assess the effectiveness of any project as per the fixed objectives (Rutherfurd *et al*., 2000). Participation of the various stakeholders and the public in river restoration is increasingly prompted because it is expected to improve resource management and enable participants to engage freely and equally in management. The present DPR has earlier provided an overview on the diverse stakeholders associated with the river, its use, management, restoration, and those are impacted by the river. As a part of the preparation of this DPR, one of the key components was on the involvement of various stakeholders and following the process of extensive consultation at all levels. Concurrent, participatory, results based monitoring is envisaged while implementing the present DPR on Forestry Interventions.

(a) Monitoring:

In case of river restoration projects, monitoring and evaluation are two important activities as these two components help to comprehend that how far the project has been successful to attain the objectives. It involves observing or measuring change. For example, a community measuring the growth and survival parameters of plantation on yearly basis. Monitoring, evaluation and adaptive management play vital roles in supporting effective river restoration. Monitoring against defined and measurable objectives is critical for assessing the effectiveness of river restoration measures and for guiding adaptive management. Monitoring describes the process of gathering qualitative or quantitative data at periodic intervals, using pre-determined indicators of progress towards project or programme objectives. The following regions dictate that the process of monitoring is made an integral part of the programme implementation on proposed Forestry Interventions in the Chenab River:

- **Seasonal Activities and Timely Implementation:** Most proposed Forestry Interventions (i.e., soil and moisture conservation, planting and allied activities) are seasonal in nature. Moreover, the Himalayan mountainous tract in the upper part of the riverscape allows

limited time for field activities owing to harsh climatic conditions and the larger extent of the riverscape is inaccessible during winter when areas are covered by snow. Timely implementation of proposed seasonal activities is vital for the success of the programme. Thus, regular monitoring of progress is essential so as to minimize any risk of failure.

- **Involvement of Multiple Agencies and Stakeholders:** Proposed Forestry Interventions to rejuvenate the Chenab River would be spread across Himachal Pradesh and Jammu region of Jammu and Kashmir UT. It would involve multiple agencies and stakeholders in its implementation. Forestry Interventions have been planned in natural, agriculture and urban landscapes. Obviously, it would include a wide range of stakeholders and implementing partners. Hence, periodic monitoring of the progress of various works through appropriate mechanisms is considered utmost important.
- **Adaptive Management:** River conservation and restoration is a complex activity and is prone to several uncertainties. Moreover, river restoration programmes such as Forestry Interventions in the context of a river are relatively new and very little experience exists within the country. Thus, the adaptive management as an inbuilt programme is vital. Adaptive management is often used in generic sense to reflect the need for flexibility in project and programme management in the light of evidence gathered through monitoring and evaluation programmes. Adaptive management is a tool that can be used not only to change a system but also to learn about the system. Since adaptive management is based on practice and learning through monitoring, therefore, it improves long run management outcomes and builds adaptive capacity (Speed *et al*., 2016).
- **Transparency and Accountability:** Increasingly, there is greater emphasis on transparency and accountability in the prevailing system of governance, particularly when the tax payer's money is involved. Regular and periodical monitoring ensures much desired transparency and accountability in the programme implementation at various levels.

Monitoring Needs: Thorough review on the existing situation of the river and its environment in Part 1 of the present DPR has provided much desired insight about the varied monitoring activities (e.g., glaciers and snow cover; climate – rainfall, snowfall, temperature, wind, etc.; surface water and runoff; groundwater and aquifers; sedimentation; forest cover, growing stock, carbon sequestration and fire incidences; e-flow and water quality; wetlands and water birds; fish production; population monitoring of RET floral and faunal species; visitors to tourism sites; and demography), undertaken by different Central/ State Departments and Agencies. Some of these monitoring activities are well designed, planned, executed and supported by appropriate institutional mechanisms and carried out either on regular basis or for longer stretches. Definitely, to a great extent, baseline information for several important themes, components and variables is available. Nevertheless, there is ample scope to strengthen and augment the current monitoring activities. The logical framework analysis provides a broad based insight on verifiable indicators. However, it is proposed to firm up the verifiable indicators, methods and periodicity besides monitoring sites, etc. so as to ensure a meaningful and diagnostic monitoring on regular basis for vital aspects of the river ecosystem. It is also proposed to plan for collection of baseline data wherever required

during the first year itself. This can be facilitated by the national partner organization responsible for research, monitoring and capacity development.

(b) Concurrent Monitoring Mechanisms for Proposed Forestry Interventions: Considering the complex and dynamic nature of river ecosystem, and the fact that the vast area is covered within the riverscape and much of the area is in difficult terrain and inaccessible, it is essential to adopt various concurrent monitoring mechanisms and relevant tools for carrying out envisaged monitoring activities. Thus, concurrent monitoring mechanisms include; **(a)** IT enabled monitoring, **(b)** RS and GIS based monitoring, **(c)** Online monitoring through web portal, **(d)** on ground monitoring, and **(e)** participatory monitoring. In recent times, increasingly mobile app based monitoring on real time basis in a much more transparent manner is possible. Thus, it is proposed to incorporate IT/ mobile app based monitoring. Since, large, difficult and inaccessible areas form the major part of the river basin/ riverscape, optimal use of RS and GIS technologies, particularly for monitoring glaciers; sedimentation in reservoirs; and changes in channel morphology, land use and land cover, snow cover, forest cover, wetlands, cropping pattern, etc. will be done The SFDs and other governmental agencies have established their own State-of-the-Art RS and GIS facilities which can be used effectively for the monitoring purpose. However, single time financial assistance to the tune of Rs. 3.71 and 7.31 lakhs per State/UT is proposed to SFDs in Himachal Pradesh and Jammu and Kashmir UT respectively, for up gradation of existing GIS facilities, procurement of desired hardware and software, and high resolution satellite data. The Forest Survey of India, Dehradun or its regional centers would play an important role in carrying out RS based monitoring of forest cover. Online monitoring of the proposed interventions is being planned through web portal developed by the HFRI, Shimla during the process of preparation of DPR. The portal would be able to incorporate and process all vital information like area and extent, geo-references and locations of each of the activity, financial expenditure, plantation survival status, Maintenance works, and actual pictures of field sites at various stages of programme implementation and progress. This online web based monitoring shall not only facilitate the compilation of desired information for each of the type of landscape/ forest division/ state and even the entire riverscape on yearly basis but, would also facilitate instant query and report generation. In addition, on-ground monitoring by way of participatory monitoring at division level and third party monitoring are envisaged. The proposed monitoring would include physical as well as financial progress aspects at the local level, and shall be monitored jointly by the field level staff of Forest Department and select community based organizations. The monitoring reports shall be submitted by the Divisional Forest Officers to the Principal Chief Conservator of Forests. The scope of monitoring would include the extent treated, expenditure details, survival of plantations, performance of other activities, flow of tangible benefits to the community and adherence to time schedules. The SFDs may design Performa for participatory monitoring based on local needs. Local level monitoring is proposed to be carried out annually while incorporating vital physical parameters such as e-flow/ discharge rate of streams and silt load at randomly selected field sites in each of the forest divisions. In addition, it is proposed to select at least ten points each on different streams/ tributaries contributing to the main channel, and shall be randomly selected in different micro-watershed areas in each division. Monitoring of e-flow

and siltation shall be carried out seasonally. Further, the DFOs will submit a quarterly progress report of physical and financial achievements. The quarterly reports so obtained from the divisions/ FDAs shall be compiled for analysis by the Project monitoring Unit (PMU) under SFDA at the State level and submitted further to the PMU of the Central Nodal Ministry and the national partner organizations for consolidated monitoring purpose. The proposed multi-tiered monitoring mechanism for proposed Forestry Interventions in Chenab Riverscape is depicted in Fig. 5.12.

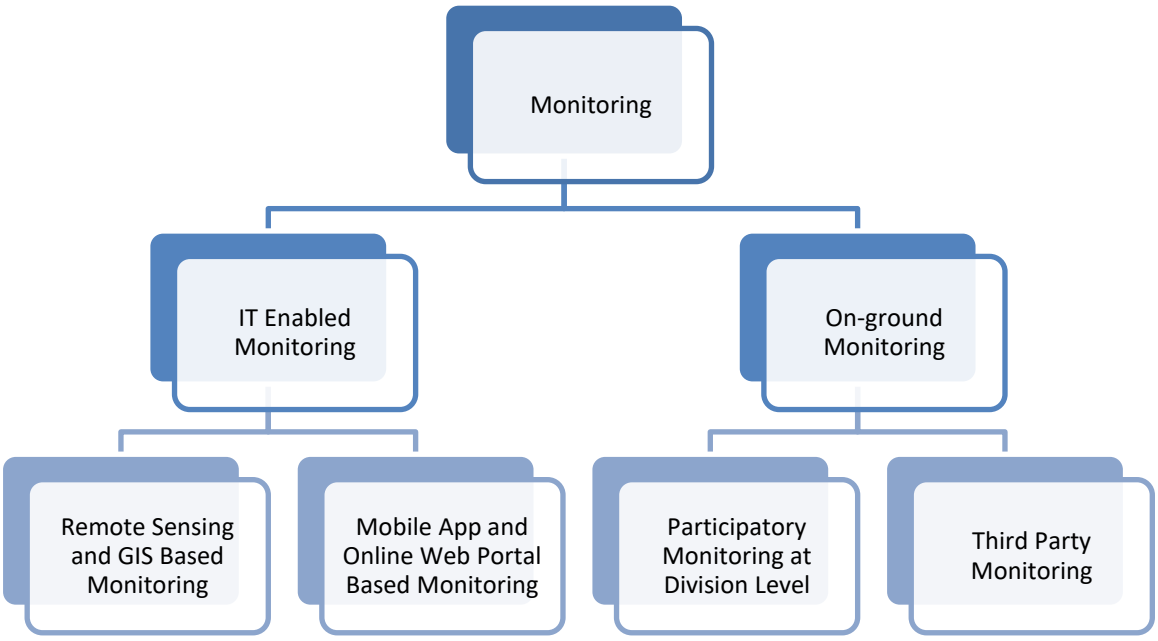


Fig.5. 31- Multi-Tiered Monitoring Mechanism for Proposed Forestry Interventions in Chenab Riverscape

In short, the implementation plan envisaged multi-tiered monitoring mechanism for monitoring progress of the project as well as achievements of objectives. The ICFRE through Himalayan Forest Research Institute (HFRI), Shimla or any other organization selected by the central nodal ministry implementing the project will be responsible for comprehensive monitoring besides state/ local site specific monitoring would be undertaken by the concerned SFD. The monitoring and evaluation of the program will be carried out as per the existing State norms. However, a budgetary provision for developing a comprehensive monitoring programme as well as its implementation has been made which accounts for about 2 to 2.5% of the total cost of the project.

(c) Capacity Development

The world over, the development agenda is being implemented for past several decades by various international/ national/ state/ local governments with mixed success. Often, developmental projects are not yielding desired results and a reasonably high number of projects even fail. One of the primary reasons of failures of major developmental projects in spite elaborate planning and huge investments is the inadequate capacity.

Capacity is *Development: Capacity* has been defined as the ability of people, organizations and society as a whole to manage their affairs successfully; whereas the *capacity development* has been defined as the process whereby people, organizations and society as a whole unleash, strengthen, create, adapt and Maintenanceain capacity over time (UNDG, 2008). Further, national and international agencies engage in addressing global challenges (e.g., land degradation; water crisis; food insecurity; depleting 'natural capital' and loss of biodiversity; poverty; hunger; malnutrition; social issues – gender, equity and peace; and climate change) or contributing towards specific sector or the agenda of development increasingly emphasize on decentralized, bottom up, participatory, science-based, integrated approaches, essentially seeking building alliances, inter-agency cooperation and sectoral convergence. There is now emerging agreement in the development community that capacity development at all levels is of utmost importance, and is the engine of human development. Capacity development starts from the principle that are best empowered to realize their full potential when the means of development are sustainable – home-grown, long-term, generated, and managed collectively by those who stand to benefit. According to (UNDP, 2009), the 'Capacity *is* Development' and the capacity development is about transformations that empower individuals, leaders, organizations and societies. Capacity development is aimed at effective and informed participation in decision making for implementation of any programme towards sustainable development. Capacity development initiatives go much beyond raising awareness of stakeholders and aim at developing the capacity of diverse stakeholder groups to appreciate the multifaceted issues, and their own role within a complex set of actors and dynamic environment. Most agencies aim to bring desired change in policy framework, mindsets, attitudes, perceptions, functional approaches, and foster an enabling environment in view of the emerging requirements. Diverse stakeholder groups at various hierarchical levels depending upon their interests, roles and responsibilities, needs, and expectations require different knowledge, ability, and skills for taking active part and to make meaningful contributions in the participatory processes. In recent time, the concept of capacity development has undergone notable transformation – conceptually, operationally, and institutionally. Conceptually, efforts of capacity development seek an enlarged and broader scope beyond the capacity enhancement of individuals, instead now it also focuses on societal and organizational transformation, thereby, creating appropriate space for and management of dialogues, relationships, collaborations, partnership, knowledge networks, and incentives for efficiency, performance, transparency, accountability, and sustainability. In past, the sole emphasize was on physical targets and outputs. However, in the change scenario, the operational transformation of capacity development emphasizes on processes and mechanisms that lead to desired outcomes, and impact. Institutionally, capacity development initiatives are at the core of the work of the countries and national governments and they are embedded in the national development strategies as well as sub-national developmental plans. Capacity development is central for ensuring ownership of any development plan for effective resource management, empowering communities and Civil Society, scaling up, and sustaining progress overtime.

River Conservation– Intricate Nature: Proposed Forestry Interventions for river restoration aiming Aviral Dhara, Nirmal Dhara and ecological integrity of the river lays emphasis on a

holistic and integrated approach for achieving goals of sustainable land and river ecosystem management, increased forest/ vegetation cover, improved livelihoods and build resilience for climate change. The envisaged thrust of the project is on 'multidisciplinary', 'multispectral', 'multi-stakeholder' and 'multiscale' approach. In order to achieve project goals and objectives, SFDs of concerned States as implementing agencies would need cooperation and collaboration of various line agencies and local communities. Various measures *viz*., plantations in different types of landscapes (i.e., natural, agriculture and urban), conservation interventions (i.e., soil and moisture conservation, riparian and riverine wildlife management, and wetland management) and supporting activities (i.e., policy level interventions, strategic adaptive research and development, participatory monitoring, capacity development, awareness, evaluation and project management) have been planned. The project implementation would require partnering, collaboration and convergence. The intricate nature of river and of the above stated holistic approach towards river conservation and restoration essentially requires capacity development of various target groups.

Objectives of Capacity Development: The logical framework analysis has summarized the vision, goals, and objectives of river conservation and restoration along with envisioned outputs and outcomes. Accordingly, objectives of capacity development lay emphasize on participatory planning involving various line agencies and engaging communities at the grass roots level. Development of soft skills relevant to communication, advocacy, negotiation, conflict resolution, etc. is a prerequisite for varied stakeholders, particularly in case of professionals representing different line agencies, and local communities. Considering the intricate nature of river and associated measures for river restoration, it is proposed to build professional competence and develop skills for science and technology based backstopping. The agenda of capacity development would need to focus on sustainable livelihoods alongside effectively managing and maintaining natural resources as the natural capital. Enhanced capacity for monitoring and evaluation is also proposed. A wide range of stakeholders are expected to be involved in proposed plantation activities in three types of landscapes besides implementation of different conservation interventions. Hence, one of the objectives of capacity development would be to enhance capacity in the field of Forestry Interventions. The holistic approach to river conservation essentially requires sectoral integration, convergence and sustainability. Thus, developing appropriate capacity in these specialized fields is envisaged as one of the objectives. Various objectives for capacity development are presented in **Fig. 5.13**



Fig. 5.32 - Objectives of Capacity Development

Core Modules: The newer generation approaches towards river conservation and restoration emphasize on the basin or riverscape approach wherein the linkages between the upstream and downstream, riverine lotic system and the adjacent riparian zone, surface water, groundwater, environmental flow and aquatic biota matter. The river ecosystem management efforts are regardless of administrative and legal boundaries and require application of different scales.

In view of the above, the capacity development efforts for river conservation and restoration envisage various core modules on; **(a)** river ecology and ecosystem management, **(b)** organizations and project management, **(c)** participatory approaches and sustainable livelihoods, **(d)** science and technology based backstopping, **(e)** cross-cutting issues, convergence and synergies, **(f)** climate change mitigation and adaptation, **(g)**Forestry Interventions, **(h)** monitoring, evaluation and learning documentation, and **(i)** sustainability (**Fig. 5.14 and Fig.5.15**).

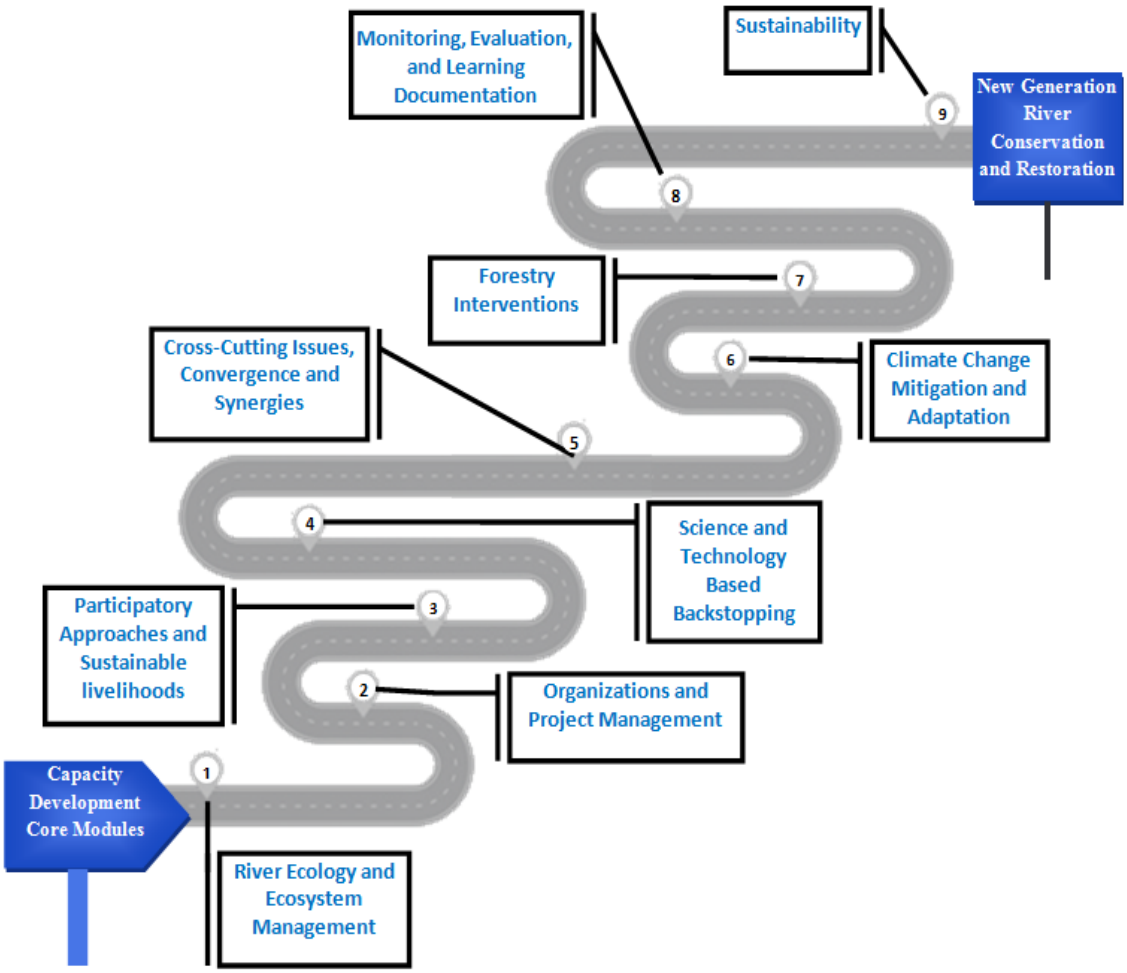


Fig. 5.33 - Capacity Development –Core Modules for River Conservation and Restoration

Target Groups: Broadly, the target audience for capacity development can be grouped at four hierarchical levels *viz*., national, state, division and community (Fig. 5.16). It is essential to target the right people for specific inputs towards capacity development. Potential target audience at different hierarchical levels includes:

- National Level –Policy and decision makers, and professionals of partner organizations
- State Level - Forest officials, professionals of various line agencies, and partner Institutions
- District/ Division Level - Forest frontline staff, and NGOs
- Community Level – CBOs, local communities, farmers, grazers, fishermen, etc.

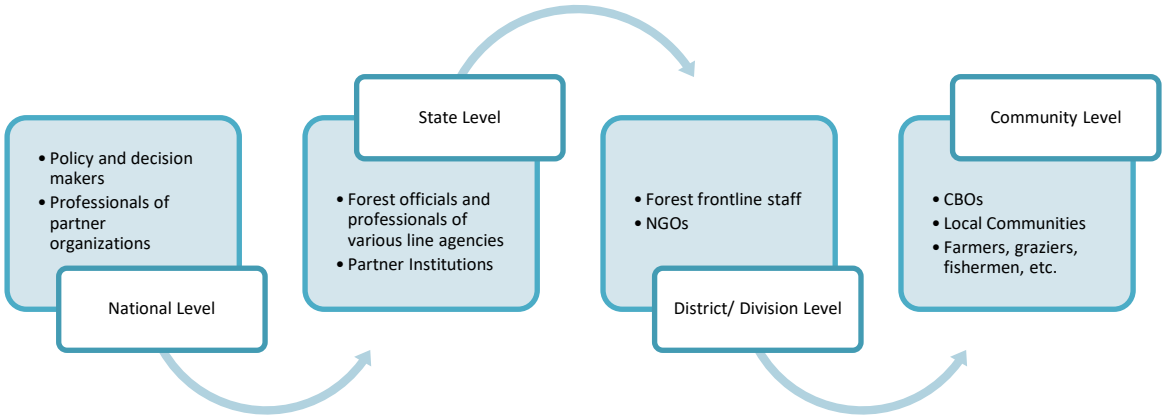


Fig. 5.34 - Capacity Development at Various Hierarchical Levels and Target Groups

Proposed capacity development is expected to improve the knowledge and skills of the professionals, partners, frontline staff of SFDs, local communities and specialized occupational groups.

Trainings, Workshops, Scientific Exchange and Engagement of National/ International Experts: The knowledge and skill development of various target groups can be enhanced through trainings, seminars, workshops, scientific exchange, exposure visits, demonstrations and resource inputs by national and international experts. Theme based short duration trainings (2-3 days) have been planned. Seminar/ Workshops have also been planned. Exposure visits for professionals, frontline staff, local communities and other occupational groups have also been provisioned. The national level partner organization responsible for capacity development would plan and organize for the national level capacity enhancement by organizing Trainings and Orientation Seminar/ Meetings, Scientific Exchange, Field Tours and Overseas Visits for professionals and decision makers. Considering the fact that the discipline of river restoration is relatively new for the country, the national level partner organization also plans to involve select reputed national and international experts, especially in the fields of river conservation and ecological restoration, bio-remediation and bio-engineering methods, climate change mitigation and adaptation, conservation breeding, policy interventions, and advanced technologies relevant to riverscape management so as to avail their resource inputs in endeavors towards knowledge management and national level capacity development. The Trainings, Workshops, Meetings, Exposure Visits, etc. at the state/ division/ community levels will be either conducted in house by the SFDs or outsourced to other relevant specialized organizations or technical agencies having expertise in the relevant field. The cost details towards various activities of capacity development by the national partner organizations are provided in Chapter 7.

Capacity Enhancement through Technology Adoption: It is essential to incorporate appropriate modern technologies and innovations in the endeavor towards river restoration. Thus, capacity enhancement at the national level, national level partner organizations, and

capabilities of field personnel of concerned SFDs is proposed by adopting innovations and modern technologies so as to facilitate efficient implementation of activities envisaged in the DPR. For facilitation of smooth field level operations, the concerned SFDs will require support of physical infrastructure. Accordingly, necessary budget provision has been made to augment and strengthen physical infrastructure including office, computer, RS and GIS, IT and communication, and field equipment. The field staff of SFDs will be provided proper training in the use of Global Positioning System (GPS), mobile app, and other modern field tools relevant to analysis of water quality, sedimentation and runoff, animal monitoring, etc.

(A) Awareness

Despite rivers are lifelines, being worshipped, play an important role in the economic development, forms an integral part of the mythology, and reflect multicultural fabric of the Indian society and ethos, all prominent rivers in the country and their tributaries are in the state of degradation due to the fact that the rural and urban populations living along the river course continue to exploit its resources, contaminate and neglect the ecological concerns of the river and contribute in some form of the disturbance or pollution. Thus, it has been lately realized that the public awareness campaign is a pre-requisite for any planned efforts towards river restoration. In absence of such efforts, any amount of investments and diversity of interventions would not help in the restoration process of degraded rivers.

A public awareness campaign is an effort to build public recognition of a problem through media, messaging, and an organized set of communication tactics. These campaigns target masses and specific groups of people over a period of time so as to try and generate explicit outcomes or achieve predetermined goals. Public awareness campaigns are important as they can help to facilitate policy change and encourage the community to take action. Campaigns also help to inform the community about the declining condition of the river, factors responsible for the current state, and how they affect the overall environment, economy, livelihoods, ecological integrity of the river, and even the human health. Awareness campaigns can also help in drawing attention of the community in such a way that the information and education provided can elicit their support for river restoration and solicit actions to make changes in current use patterns of river resources, lifestyle and behaviour those have been adversely impacting the river and its ecological functioning.

In view of the above, creating awareness and sensitizing the masses on the importance of restoration of river and the role public to play in such efforts, are the priority agenda envisaged as a part of the proposed Forestry Interventions. Awareness campaigns are proposed to be directed primarily towards two broad groups; i) the general public, and ii) the educational institutions, particularly targeting the youth. The SFDs as IAs in concerned states can adopt different approaches and tools for awareness campaigns and sensitizing the masses. These are; use of multimedia, awareness camps, rallies, posters, brochures, pamphlets, booklets, hoardings, mobile vans, audio visual shows, and celebration of important days (e.g., Water Day, Wetlands Day, Wildlife Week, World Environment Day, World Forestry Day, etc.). It is propose that SFDs can organize awareness campaigns in educational institutions (i.e, Schools, Colleges, and Universities) through the NYKS, Eco-clubs, NSS, NCC, Scout and Guide and other appropriate mechanisms approved by the educational authorities both in

government and private institutions. The Civil Society Organizations (CSOs), NGOs and religious organizations are expected to play pivotal role in this priority endeavor. SFDs can prepare video documentaries highlighting ecosystem services offered by the river; declining state and its reasons; and how public can meaningfully contribute towards river restoration by way of planting trees, reducing biotic pressure and various contaminants and widely use them for awareness campaigns.

(B) Evaluation

A strong evaluation plan is a core element of a major, multifaceted project like the present one on proposed forestry intervention for rejuvenation of a river so as to assess the project performance, collect evidence that indicates the extent to which the envisaged outcomes have been achieved, and document what has been the impact of the project to bring desired change. The logical framework matrix has earlier provided details on the range of activities, expected outputs and outcomes, performance and impact indicators along with their means of verification. This information forms the basis to assess the impact of project. The project envisages evaluation, particularly appraisal of annual progress, Mid Term Review (MTR), and Terminal Evaluation (TE).

Third Party External Evaluation: Third party or external evaluation is essential so as to get an independent view of the project activities, performance and impacts. The MTR and TE are proposed as independent evaluations involving External Experts other than those who have been neither the part of the project design and development nor of implementation. The independent evaluations would rely on the criteria developed by the third party involved in the process. However, they would also review the monitoring efforts made by the Implementing Agencies at the State and Division Levels, National Partner Organization, and the Central Nodal Ministry at different stages of the project implementation. The MTR would specifically focus on mid-course corrections so as to accomplish the project goals while the TE is expected not only to focus on documentation of project performance, accomplished outcomes and impacts, but, also provide recommendations for future projects based on learnings. The aim of evaluation is also to share the knowledge gained in project implementation. The National Level Partner Organization is expected to facilitate project evaluation and would require an amount of Rs. 99 Lakhs, while funds for carrying out various activities related to field evaluation by concerned SFDs have been clubbed with the cost of monitoring and details are presented in Chapter 7.

(C) Project Management

Barker and Cole's definition of project states - 'A project is a unique piece of work, with a defined beginning and end'. The effective and efficient management of any project depends on specific goals and well-defined methods to achieve these goals. It is of paramount importance to manage the myriad of activities envisaged under this project for achieving desired goals. Robust and well organized multi-tiered institutional arrangements and convenient implementation mechanism including the uninterrupted and even flow of projected funds to State Level Implementation Agencies is essentially required considering the innate constraints of limited working seasons, long gestation periods of planting

species, and restricted time frame for most of proposed project activities/ works. In view of this, setting-up of Project Steering Committees (PSCs) at national and State Levels have been planned. The more elucidated description of institutional arrangements and mechanism for programme implementation has been given in Chapter 6. The wide use innovative techniques and application of modern technologies has set the new standards for project implementation and management (Conaway and Brabets, 2008). Therefore, the best usage of information technology (IT) enabled mobile app is envisioned for the hassle-free and smooth implementation of different project activities, keeping records/ documents, periodic progress review, monitoring, evaluation and overall effective management of the project.

Chapter 6

Implementation – Mechanism and Sustainability

6.1 Project Implementation – The Components and Partnership Arrangements

India needs to ensure water security in terms of both quantity and quality through sustainable management of available water resources. In view of that, the country's important document 'Strategy for New India @ 75' emphasizes that by 2022 - 23, India's water resources management strategy should facilitate water security to the extent that meets the requirements of water for life, agriculture, economic development, ecology and environment (NITI Aayog, 2018). The larger vision is intended to be realized by attaining the different sectoral goals including provision of adequate safe drinking water, sufficient water for sanitation and live-stock, adequate water for irrigation (*Har Khet Ko Pani*) and improved water-use efficiency (*more crop per drop*), water to industries, and to ensure clean and continuous flow (*Aviral* and *Nirmal Dhara*) of the National River and all the other major rivers along with their tributaries. The strong commitment of the Government of India to materialize its broad vision is evidently endorsed in D.O. Letter No. 11(1)/ 2017 – WR Vol.- I, dated 06 June, 2018 issued by the CEO, NITI Aayog, New Delhi to all the Chief Secretaries/ Administrators of all States/ UTs. This official correspondence assertively and explicitly set forth GoI's decision to launch the major mission for the revitalization of important lotic *systems*, and modalities for its effective implementation on ground by making optimal use of the different community oriented schemes and programmes of the government already going on in water sector. The letter lays down the instructions that the Department of Rural Development (DoRD) would lead this ambitious programme under the guidance of NITI Aayog and also work out stipulations for merger of largest social security programme of the country i.e. MGNREGS with other schemes/programmes of Central Ministries/ Departments *viz.*, MoEF&CC, DoAC, MoWR, MoPR, DoLR, and the State Governments.

India is endowed with a network of many rivers and their tributaries providing sustainable livelihoods, economic prosperity to very large riverine communities and ecological stability to the vast geographical stretch of the country. Appreciating the immense importance and worth of these amazing gifts of nature to us, the holistic programme to improve the state of rivers and revitalize major Indian rivers and their tributaries by way of source augmentation and conservation of rivers. In line with the instructions and directives by the NITI Aayog, the National Afforestation and Eco-Development Board (NAEB) under the MoEF&CC has assigned the major task to ICFRE and its institutes to prepare the DPRs of eight (08) major rivers of the country including the five (05) for tributaries of Indus River basin. The present DPR for rejuvenation of Chenab River is also part of this mammoth task. National Afforestation and Eco-Development Board (NAEB) has also consented to provide the monetary assistance for formulation of the project and recommended the use of widely acclaimed Ganga DPR as a prototype during the current assignment. The National Mission

for Clean Ganga (NMCG) is a registered society under the Ministry of Jal Shakti (MoJS) and act as the implementation arm of National Ganga River Basin Authority (NGRBA). The NMCG has provided financial support for formulation and implementation of Ganga DPR under the *Namami Gange* Programme. Conversely, for the implementation of project formulated in the present DPRs, the MoEF&CC may either decide to make use of its own funds or request any other Central Ministry/ National or International Agency to implement as well as to provide requisite funds for execution of project activities. Alternatively, the MoEF&CC may decide to implement the specific component(s) of the project and implement the whole programme in partnership with other Ministries/ Agencies. Four core components of programme implementation envisaged under the project is illustrated in the following figure (Fig. 6.1)

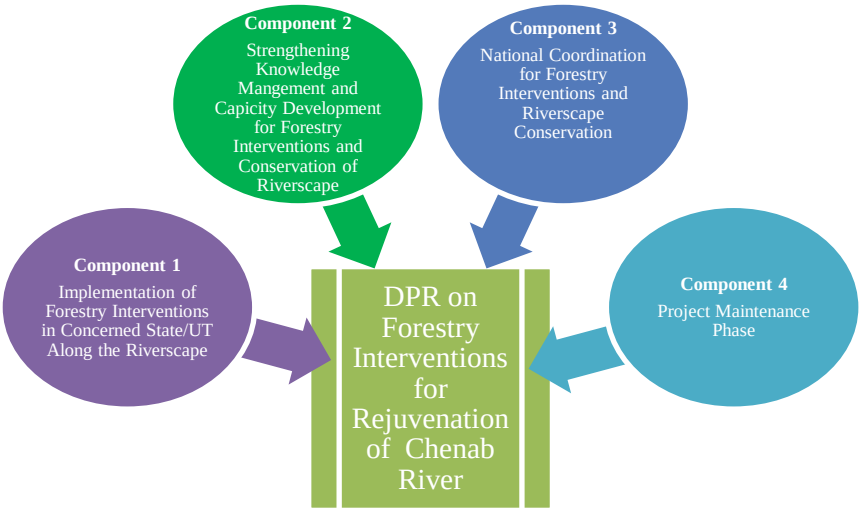


Fig.6. 1- Four Components of the Project

Component 1: Implementation of Forestry Interventions in concerned State and UT of Chenab Riverscape

The Component 1 of the Project is precisely concerned with the proposed Forestry Interventions in concerned State and Union Territory (UT) along the course of Chenab River. Further, three specific sub-components are incorporated in this component: (i) the proposed 'Forestry Interventions in three lower order sub-zones' delineated within the riverscape *viz.*, (a) Natural Landscape (NL), (b) Agriculture Landscape (AL), and (c) Urban Landscape (UL) adopting appropriate plantation treatment models; (ii) 'Conservation Interventions'; and (iii) 'Supporting Activities'. Apart from the massive plantation proposals in three types of landscapes within the riverscape, the sub-components on Conservation Interventions seek to reinforce the plantation works by major inputs in the form of soil and water conservation, riparian and riverine wildlife management, and wetland management. Similarly, the 'Theme Plans' signify those 'Supporting Activities' which are essential and supportive in nature for the overall success of major project on Forestry Interventions and needs to be carried out by concerned State and UT. Prominent proposed supporting activities include: (a) policy level interventions; (b) concurrent research and development; (c) participatory monitoring; (d) capacity development; (e) awareness; and (f) evaluation. Further, in order to ensure

effective implementation, coordination, and monitoring of the state-wide project activities, support for the establishment and smooth running of the State level Project Management Units (SPMUs) in concerned State and UT also provisioned as apart of this Component. The schematic summary of the sub-components and various planned activities are given in Fig. 6.2.

It is envisaged in the project that the State Forest Department (SFD) of concerned State/Union Territory i.e., Himachal Pradesh and Jammu and Kashmir UT will be solely responsible for carrying out the plantation interventions and other allied activities in three types of landscapes as incorporated in the Component (1) of the project. Therefore, it implies that the SFDs of concerned State/UT would be the key Implementing Agencies (IAs) for this major component. The Chapter-4 has already provided an insight on the organizational structure, mandate, functions, and activities, schemes, past experiences of SFDs in afforestation, forest management, protected area management, biodiversity conservation and improvement of rural livelihoods. Obviously, the SFDs is the relevant department related to proposed activities under the Component-1 as they offer most suitable organizational setup and institutional framework for execution of a major project of this nature. The hierarchical organizational structure; well laid physical infrastructure and procedures for programme execution, communication, expenditure, accounting, auditing; and monitoring are added characteristics of SFDs and thus, they make the right choice for effective implementation of the proposed programme. As a general principle, micro- watershed constitute the basic hydrological unit of conservation interventions and quite often, the management units in the SFDs have been carved out on the basis of natural micro-watershed boundaries and such mechanism makes it convenient for planning, implementation, monitoring, and evaluation of the likely impacts of proposed activities at the micro-watershed levels. The Territorial Army and Civil Society Organizations (i.e., NYKS, NSS, Youth and Eco Clubs, Mahila Mandals, NGOs, etc.) are important partners in execution of proposed activities as planned in the DPR and also to replicate the reputed earlier community led initiatives in connection with the restoration of rivers and riverine ecosystems. Other than that, to make the best use of domain specific knowledge and technologies, active involvement of Agriculture Department, Pollution Control Board and Municipal Corporation/ Municipal Board can be taken specifically for execution of project activities particularly on agricultural and urban landscapes including plantations, SMC works, and establishment of pollution abatement measures and structures.

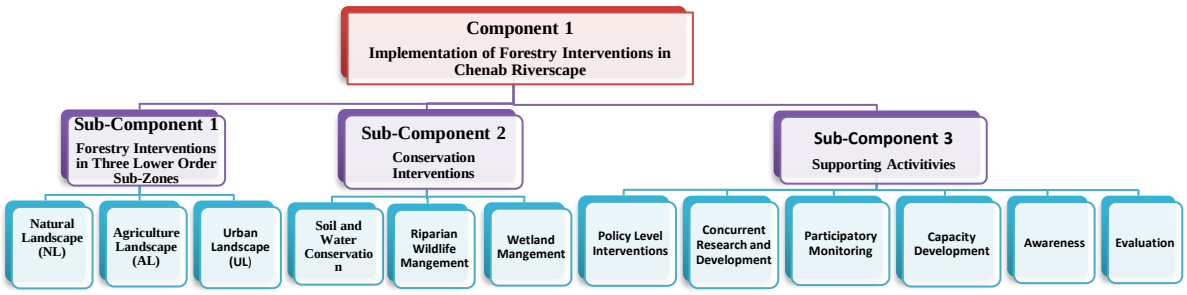


Fig.6. 2- Project Component on Forestry Interventions and Proposed Activities

Component 2: Strengthening Knowledge Management and Capacity Development for Forestry Interventions and Conservation of Riverscape

The earlier Chapters of the DPR deeply explicated the multi-dimensional and dynamic facets of river ecosystems and appropriately bring out the importance of rivers and their watersheds for providing innumerable goods and services, economic prosperity, and ecological stability all across the country. The appropriate reviews underpin the resilient interconnectedness between forests and rivers, and also provide elaborated information about the developmental and anthropogenic activities causing huge damage to the ecological structure and function of river ecosystems. Rivers are the major source of renewable fresh water and contain some of the highest levels of biodiversity on earth. Threats to rivers have become severe for both securing human water supply and maintaining aquatic biodiversity. Worldwide, most of the rivers are under plight due to human influences and thereby the manifold benefits from these freshwater natural resources have also decreased in a parallel manner. The state of rivers is a major cause of concern especially for human beings and other organisms largely dependent on aquatic resources for their survival. In developing countries like India, the scenario is even more complex and severe due to competing demands of different production sectors. Multiple and competing values for water at a time are increasing, water resources are dwindling and water quality is deteriorating. There is a need for radical change in management of river with consideration of past experiences in governance of water-stressed systems from around the world (Grafton *et al*., 2012). Equally important is to develop improved understanding of important flow-ecology relationships (Bunn and Arthington, 2002) and implement workable methods for determining the ecological flow requirements of the rivers (Poff *et al*., 2010; Pahl-Wostl *et al*., 2013). By and large, river conservation requires harmony and

interaction among scientists, policy and decision makers, and agencies using river and water resources. Better understanding of forest-river linkages and their intricacies is also very important for getting desirable results for river conservation programmes. In Indian context, all the major rivers are facing enormous challenges for their sustainable management. As streams and rivers are among the most endangered ecosystems, there is a priority need for comprehensive approaches to evaluate the historic and current state of rivers and their environment, comprehend causative factors responsible for their present state and concerted efforts to restore them. There is an evident paradigm shift in management approaches of river ecosystems and it is changing fast. This has rapidly moved from the 'river development' to 'river conservation' and now to 'river restoration'. In fact, the river science is in its nascent stage and is relatively a new discipline in our country. However, efforts are on in this direction. Positive outcomes from any such effort aimed at river restoration or river conservation are unlikely unless evidence and science based holistic strategies are actively involved in planning, assessment, management and development of rivers and policies relevant to river conservation and restoration. Moreover, in the emerging scenario of transparency in public policy, and essential requirements of comprehensive environmental impact assessment, and integrated planning for conservation of water resources, there are several expectations from multidisciplinary sciences. The expected best available science in efforts towards river restoration should be based on six broad criteria: (a) relevance, (b) inclusiveness, (c) objectivity, (d) transparency and openness, (e) timeliness, and (f) peer review. In light of the description and facts given above, the component two of the project purposes to integrate science into policy framework, planning process and viable management plans for better decision making process which can ultimately strengthen the intensive efforts aimed at restoration and management of freshwater resources particularly the rivers of the country.

HFRI, Shimla has taken a lead in preparation of present DPR adopting a multistep approach involving active participation of stakeholders, exhaustive consultations, and following a scientific planning process using RS and GIS based geospatial analysis for the riverscape, multidisciplinary review on the riverscape environment, and extensive field level data collection by the concerned SFDs in the data formats prescribed by the institute. HFRI is a reputed and established learning seat in the fields of natural resource management, forestry research education, particularly relevant to the Himalayan environment; those have direct relevance to the river ecosystems. Thus, it is of utmost importance that HFRI is not only involved as a National Level Partner Organization for facilitating monitoring, evaluation, and capacity development as proposed in the present DPR, but also be entrusted the responsibility of major task to serve as the Knowledge Management/ Learning Center and to undertake concurrent research related activities essential for conservation and restoration of the Himalayan Rivers. HFRI will also play a pivotal role in building desired national capacity for demonstrating the strong linkages between diverse forests in the Himalaya and river ecosystems. The Component 2 specifically seeks to support the dissemination of improved knowledge by strengthening the Knowledge Management Center and capacity development required for conservation of Himalayan Riverscapes within the country by offering best practices for Forestry Interventions and varied conservation measures as envisaged in the

DPR. In addition, the Knowledge Management Center (HFRI) is expected to contribute towards envisaged intervention and activities relevant to policy, advocacy, outreach, monitoring, evaluation, and capacity development. In order to accomplish this, the national level partner organisation meant for the knowledge management and capacity development would need to establish a Project Facilitation Unit (PFU) for effective coordination with participating State and UT and the Central Nodal Ministry supporting the implementation of the programme.

The knowledge management would require a range of strategies and practices so as to identify, create, represent, distribute, and enable adoption of insights and experiences. Such insight and experiences comprise knowledge, either embodied in individuals or embedded in organisational processes or practices. An organisation seeking to become a Knowledge Management Center would primarily require: People, Processes, Innovations and Technologies (Fig. 6.3). People are the key to the success of a Knowledge Management Programme in an organisation. The collective multidisciplinary knowledge in the organisation would play an important role in dealing with the complexities of Himalayan Rivers. It is essential that a culture of active experimentation through involvement of all concerned is encouraged, and trust and relationships among the members is build. The 'institution building' is complex and continuum process. It has to be holistic – have to go beyond organization management and development, and involves the process of developing people, and streamlining various systems, improving style of functioning, developing a positive climate, and promote organizational culture of professional and non-hierarchical relationships. Innovations and technologies are enabler in acknowledge management programme. Remote Sensing and GIS tools, information technology (i.e., mobile apps, and web portals), automatic meteorological and hydrological equipment for measurement of river flow and rate of sedimentation, and applications of Unmanned Aerial Vehicles (UAVs), camera traps, satellite telemetry, etc. are some of the emerging technologies. These can be used for various purposes *viz.,* planning, management and monitoring. The internet and World Wide Web would not only connect people, but also connect them to various databases being maintained across the globe.

Component 3: Scaling Up, Replication in Additional Sites and Maintenance Phase

The present DPR primarily incorporates the implementation of Forestry Interventions on selected sites along the main course of the river and its tributaries in Himachal Pradesh and Jammu and Kashmir UT. The Component 3 plans to support the scaling up and replication of planned efforts in additional sites/ tributaries besides primarily, supporting the maintenance phase of various types of plantations raised in later years (3^{rd}, 4^{th} and 5^{th} years) of the Phase I i.e., Implementation Phase.

Component 4: National Coordination for Forestry Interventions and Riverscape Conservations

In general, major Indian River systems involve more than one State and UT as the basin of the river and its tributaries are spread across the multiple states. Thus, programmes related to river management and restoration requires national level coordination for proposed Forestry

Interventions and various conservation efforts among the participating States/UTs located along the course of main channel and its tributaries. As such, the Ministry of Jal Shakti (MoJS) is the Central Nodal Ministry for all aspects of management of water resources including river development and restoration of rivers. However, several other ministries are also involved for specific components/needs. Thus, the Component 4 envisaged national level coordination for Forestry Interventions and river restoration and visualizes varied activities *viz.*, (a) establishment of the River Decision Support and Management Information System (RDS & MIS); (b) facilitating activities relevant to policy and legal interventions, riverscape level coordination, monitoring and impact evaluation; and (c) administering the implementation of major project on Forestry Interventions. In order to accomplish this, the Component 4 specifically envisages the establishment of a Project Management Unit (PMU) at the Nodal Ministry Level. The PMU at the Nodal Ministry would handle the programme implementation, coordination among involved State and UT, partner organizations at the National and State level besides extending support for the finances required for the project execution.

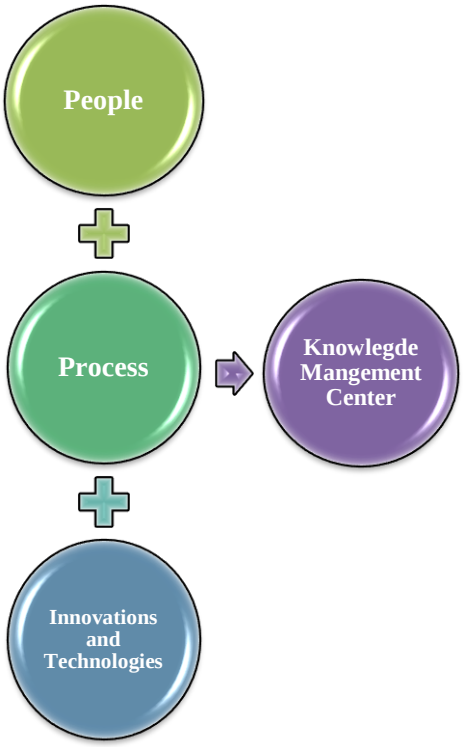


Fig.6. 3- Three Fundamental Features for the Knowledge Management Center (KMC)

6.2 Institutional and Implementation Arrangements

Practically, a multi-tiered mechanism is proposed for the smooth implementation of project at National, State, Division, and Local levels. Accordingly, institutional arrangements at these levels are envisaged for the effective and successful implementation of a major project of this kind. At the apex level, the identified Central Nodal Ministry will provide the overall policy

guidance and the supervision of the project at the national or the riverscape level. The PMU established at the Central Nodal Ministry will not only ensure timely release of funds, but would also be responsible for overseeing and coordinating the efforts at the National or Riverscape level. The concerned SFDs of involved State/UT within the riverscape will be the primary Implementing Agencies (IAs) at the State, Division, and local levels. However, SFDs would be able to involve other partners (i.e., the Agriculture/Urban Development Departments, NYKs, NSS, select NGOs, etc.) for programme implementation in different landscapes. Each SFD at the State level will establish the PMU for effective implementation of the project across the State/ Divisions/ Ranges and even at the Panchayat/Community levels. In addition, the National Level Partner Organization (HFRI, Shimla) will be responsible for facilitation, concurrent research, monitoring, evaluation, and capacity development with the support of Project Facilitation Unit (PFU). Details of institutional arrangements at different hierarchical levels are provided below:

6.2.1 Project Management Unit (PMU) at the Nodal Ministry

The MoEF&CC is expected to be the Central Nodal Ministry for implementation of project. However, other releated ministries (e.g., MoJS & MoRD) may also join and collaborate with the central Nodal Ministry for the purpose and provide/ arrange required financial resources. Once the GoI decides about the Central Nodal Ministry and entrust the task to implement the project planned in the present DPR, then designated Central Nodal Ministry would require to establish the PMU, specifically for performing various functions relevant to project overseeing, advice, steering, coordination, programme approval, policy level interventions, budget allocations, fund flow, monitoring, and evaluation.

The PMU at the central nodal ministry will be headed by an Addl. Secretary/ Joint Secretary level officer who will be designated as the Project Director (PD). The PD will be supported by a small project management team of existing and project staff on contract to support various activities related to coordination, technical supervision, communication, project administration, procurement, financial control and management, report preparation, monitoring, and evaluation. The PD will be assisted by a Senior Project Scientists (for Policy Intervention/ Riverscape Conservation/ Communication), one Junior Project Scientists (for Forestry/ Riverscape Conservation/ Monitoring and Evaluation), One Project Managers (for RDS & MIS/ Administration/ Procurement/ Finance and Audit), one Project Assistant, two Office Assistants, and two Attendants (Fig. 6.4).The PMU will carry out the following tasks relevant to the financial control and management:

i) Annual budgetary provision for the project and monitoring of project expenditure against allocated budget.
ii) Approval of Annual Plan of Operations (APOs)/ Work Plan and budgets.
iii) Coordination and ensuring sufficient and timely fund flow to concerned State and UT implementing agency (IAs) and national partner organisation for activities at the riverscape level and for national capacity development activities, respectively.

iv) Regular financial reporting of the project at all levels and compilation of quarterly financial reports and annual financial statements of the project
v) Ensuring internal audits and annual external audit of the project by the CAG

In order to make the PMU fully functional, necessary budget provisions for its establishment, office equipment beside recurring costs on salary and wages, office expenses, travel, workshops/ seminars, meetings, publications, dissemination, and miscellaneous expenditures and contingency have been made. Further, adequate budget provisions for capacity development, planning and conduct of national level seminars/ workshops, and coordination, review meetings, etc. have also been made so as to make the working of PMU effective in its mandate.

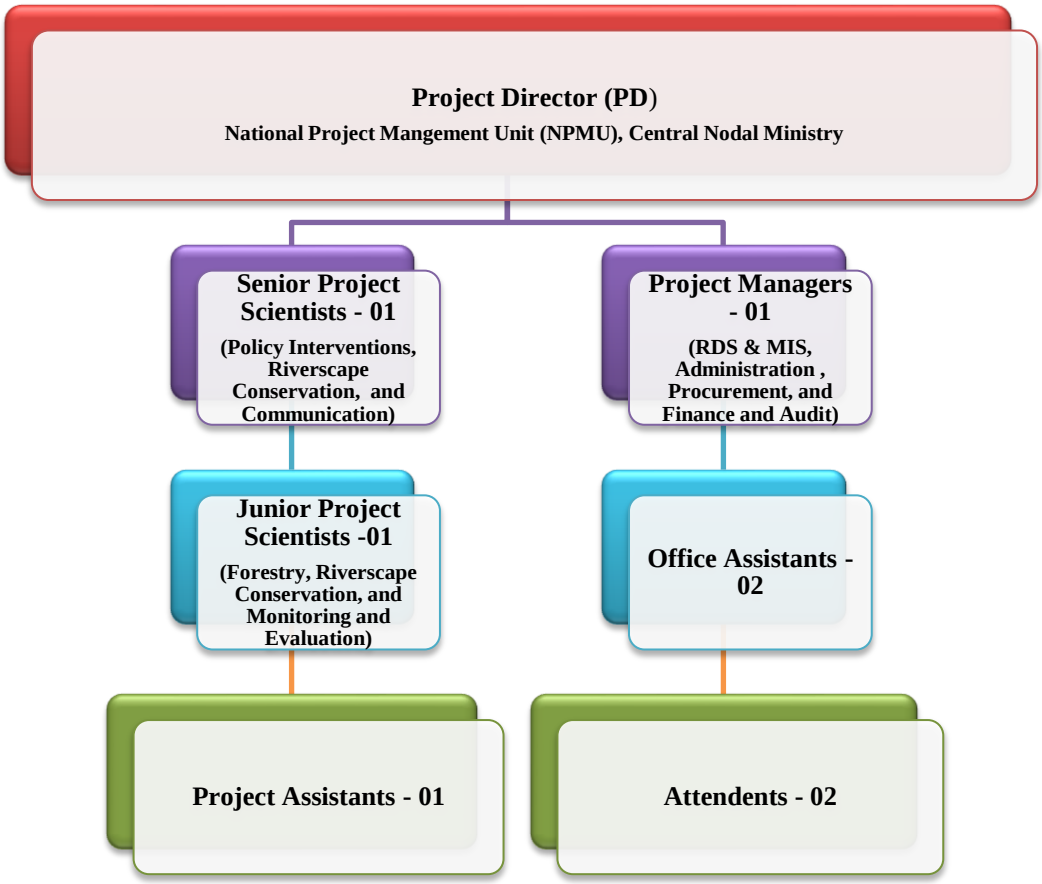


Fig.6. 4- The Hierarchical Organisation of the Project Management Unit (PMU) at the Central Nodal Ministry

6.2.2 Project Facilitation Unit

Project Facilitation Unit at the National Level Partner Organization (HFRI, Shimla) for Knowledge Management and Enhancement of National Capacity for Forestry Interventions and Riverscape Conservation

HFRI, Shimla, as one of the regional institutes of ICFRE owing to its expertise in the ecology of the Himalayan environment, natural resource management, and the Himalayan forestry besides its strategic location, multidisciplinary team, having long experience in dealing with cumulative environmental impact assessments of Himalayan Rivers, and well-laid infrastructure, has been proposed to undertake the major responsibility as the National Level Partner Organization for effective implementation of this priority project on river restoration (i.e., forestry and conservation interventions aiming for *Aviral* and N*irmal dhara*, ecological integrity and restoration of river health), liaisoning with Central Nodal Ministry and Implementing Agencies at the state level, concurrent research and development, science and technology based back-stopping, capacity development, monitoring, and evaluation. For this purpose, the HFRI would need to establish a Project Facilitation Unit (PFU), headed by the Nodal Officer (NO) of the project at a senior level (Scientist – G or CCF level officer). He/ she will be supported by River Coordinator (RC). The NO and RC will be assisted in theirfunctions by one Senior Project Scientist (for Forest Policy and Law/ Forest Ecology/ Forest Hydrology/ River Ecology and Conservation/ Ecosystem Services/ Climate Change), one Junior Project Scientists (for Forest Biodiversity/ Bio-remediation and Bio-filteration/ Aquatic Ecology/ Remote Sensing and GIS/ Agroforestry/ SMC and Bio-engineering), one Project Associate (for Forestry Research/ Communication and Conservation Education/ Ecosystem Monitoring/ Forestry Training), one Project Assistant, one Office Assistant, and one Attendant (Fig. 6.5). In order to make the PFU effective and fully functional, provisions for its establishment, engagement of contractual technical and office staff, recurrent expenses towards salary and wages, travel, procurement of office/ computer, IT, and RS and GIS/ laboratory/ field equipment, research and monitoring, capacity development, development of learning material and dissemination, advocacy and outreach, and evaluation has been made. In addition, budget provisions for institutional charges and contingent expenses have also been made. Further, adequate budgetary provisions for organisation and conduct of activities related to seminar/ workshops/ meetings, exposure visits to demonstration sites, scientific exchange and overseas visits, engagement of National and International Experts on specific themes, impact evaluation, etc. have also been incorporated in the proposed budget of the project for facilitating the functioning of PFU, Knowledge Management Center at the national partner organisation without stopping.

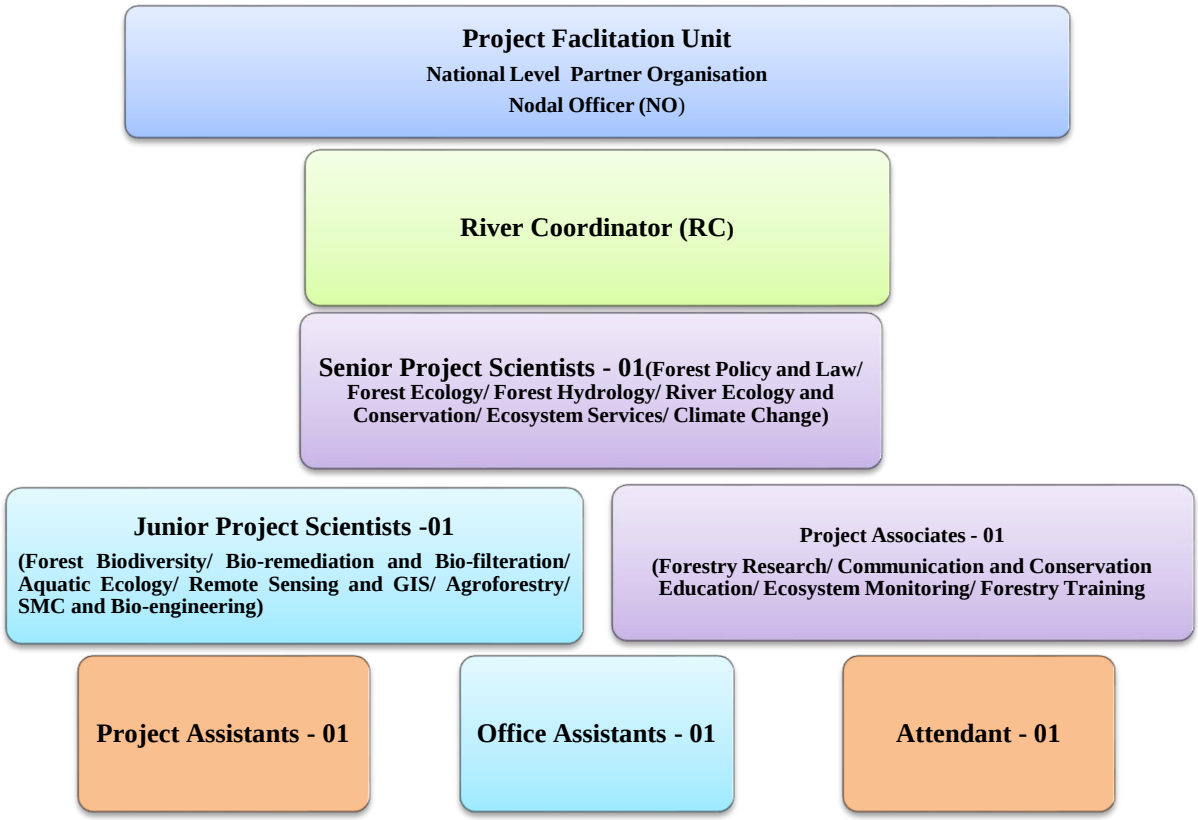


Fig.6. 5- The Proposed Organisational Structure of the Project Facilitation Unit (PFU) at the National Level Partner Organisation on Knowledge Management and Capacity Development

6.2.3 Project Management Unit(s) at SFDs in Concerned State and UT

The SFDs in concerned State /UT along the course of river would be the primary IAs for proposed Forestry Interventions in the riverscape and they are expected to carry out extensive activities (i.e., plantations, conservation interventions, and supporting activities at three hierarchical levels *viz*., State, Division, and Local Communities. Thus, a provision of Project Management Unit (PMU) at each SFD has been made so as to facilitate, coordinate, and manage envisaged project activities through 15 Territorial Forest Divisions within the State of Himachal Pradesh and Jammu and Kashmir UT. The PMU in the involved State and UT will be headed by the Addl. PCCF/ CCF level officer and designated as the Project Executive Director (PED) while the CF level officer designated as Project Executive Officer (PEO) would assist the PED. The DFOs/ DCFs of 2 Forest Divisions of Himachal Pradesh and 14 Forest Divisions of Jammu and Kashmir UT will be responsible for actual implementation of proposed Forestry Interventions and other allied activities envisaged in the DPR. The existing Forest Development Agencies (FDAs) operating at Divisions/ District level or any other appropriate suitable State specific mechanism could be utilized for implementation of the project at the field level while Joint Forest Management Committees (JFMCs)/ Ecodevelopment Committees (ECs)/ Biodiversity Management Committees (BMCs) / Gram Panchayats or other relevant bodies need to be involved in field level execution at the local/

community level. The State/UT specific PMU will avail the existing Government Officers/ staff besides select contractual employees for the project tenure. The contractual staff will include four Project Managers (one each for Project Administration and Procurement/ Project Finance/ Project Audit/ Project Database and Communication) and would be engaged for the project duration.

6.3 Implementation and Fund Flow Mechanism

Generally, effective implementation of project of this nature requires sufficient, systematic, and timely flow of funds to the implementing agencies. In view of the importance, complexity, multi-dimensional nature, miscellaneous proposed activities, involvement of various stakeholders and multiple agencies in the current DPR project, a well-organized implementation mechanism is certainly needed for execution of the programme across the extensive stretch of riverscape. So, it is planned to set up two high level Project Steering Committees i.e., one at the National Level in the Central Nodal Ministry and referred as the 'National Programme Steering Committee (NPSC)', while other at the State level in concerned SFDs of the involved State/UT within the riverscape is named as the 'State Programme Steering Committee (SPSC)'.

(i) National Level Programme Steering Committee (NPSC)

The multi- member NPSC will be chaired by the Secretary of the concerned Central Nodal Ministry and the Member Secretary would be the NPD. The Committee is expected to have different members including senior officials of the MoEF&CC; Ministry of Jal Shakti, Agriculture, AYUSH, Youth Affairs and Sports, Tribal Development, Rural Development, Urban Development, Panchayati Raj, and Tourism; PCCFs and HoFFs of concerned State and UT or their representatives; Director/ Nodal Officer of the National Partner Organisation (HFRI). Thus, the NPSC is expected to have about 20 members or so. The NPSC shall meet twice in a year at appropriate time for considering and approving the APOs submitted by the concerned SFDs. The funds against the approved APOs of the State and UT shall be transferred by the NPMU to respective SFDs. The national level PFU will follow its own mechanism of governance and if required will have its Monitoring and Steering Committee for overseeing the project. Details on institutional arrangements, implementation mechanism at the State and field levels, and constitution of SPSC in concerned States/UT are presented in Fig. 6.6.

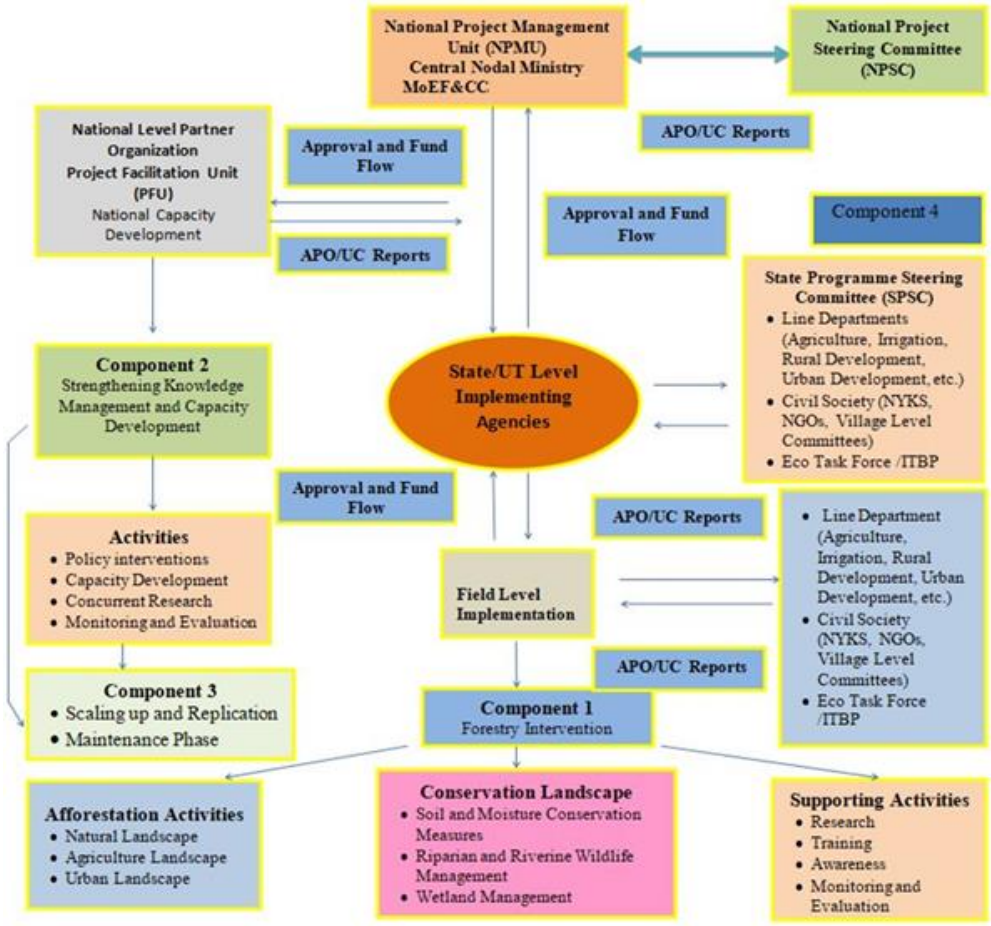


Fig.6. 6- Hierarchical Institutional Arrangement and Mechanism for Project implementation

(ii) State Level Programme Steering Committee (SPSC)

In analogy with the National Level NPSC, the State Forest Department (SFD) of the concerned state/UT will also have the State Level SPSC. The existing framework of the State Forest Development Agency (SFDA) at the State Level or any other similar/ equivalent agency will be used for transferring and parking of funds at the State level and to be released on the approval of the SPSCs. On approval by the SPSC, the matching funds will be transferred to SPMU, an exclusive State Level PMU for further allocation to concerned Divisions as per the respective APOs, dully approved by the SPSC. At the Circle/ District Level a Circle Project Implementation Committee (CPIC) will be constituted under the Chairpersonship of the Conservator of Forests (CF) with concerned DFO as the Member Secretary or as designated by the Principal Chief Conservator of Forests (HoFF) so as to ensure a transparent and accountable mechanism for implementation of activities as proposed in present DPR. Various works related to proposed Forestry Interventions in the riverscape could be implemented in close association and involvement of the Village Panchayat/JFMC level setup. SPMU is proposed to perform the implementation in Himachal Pradesh and Jammu region of Jammu and Kashmir UT. The SPMUs shall be responsible for all the directions, operations, and control of Forestry Interventions at the State level through SPSC. The SPSC shall be chaired by the Principle Secretary Forest/ PCCF and HoFF while at the

State level Project Executive Director (PED) shall be the Member Secretary. Besides this, the committee shall have representatives of various Line Departments/ Agencies, Civil Society, NGOs, etc. The meeting of SPSC shall be held in a year for sanctioning the APOs submitted by Divisions and steering the project implementation activities across the concerned State/UT.

(iii) Implementation at District/ Division Level:

The Civil Society functional at the Division/ District Level shall be involved for programme execution at the field level. The District Level Implementing Committee (DLIC) shall be constituted for programme execution while having the CF as the Chairperson and the concerned DCF/ DFO as the Member Secretary along with the representation of District level Line Agencies/ Departments as well as the Civil Society. The concerned DFO as the Member Secretary who is also the Chief Executive Officer of this FDA wherever in existence and functional shall submit APOs for Forestry Interventions as envisaged in the project in consultations with the representatives of Line departments, NGOs, and other Civil Societies who shall be invited by DFO and involved every time in the consultation process. The SPMU will scrutinise the APOs received from concerned DFOs and ensure timely approval by the SPSC, with or without necessary changes, for further submission to the NPSC at the Central Nodal Ministry. Upon approval of the APO by the NPSC, the funds shall be transferred against the APO to an account separately maintained by the respective SFDs for implementation of the project envisaged in the present DPR. Likewise, separate accounts shall be opened by each of the DFOs at the Division Level so as to exclusively operate planned Forestry Interventions as proposed/ envisaged in the DPR. DFOs will ensure that there is no mixing up of expenses/ accounts of any other nature with the account specifically opened for the purpose of present project. The SPSC shall authorise SFDA to transfer funds against approved APOs to accounts opened by Divisions specifically for the purpose. Financial expenses, creation and management of assets, incurring overhead expenditures, etc. shall be as per the provision of extant GFR and/ or any rules/ guidelines framed by the Central and State Governments in this regard from time to time. The SFD or any other Implementing Partner Department/ Agency as well as the Civil Society shall be responsible for achieving the objectives/targets while maintaining proper documents and accounts besides accountability and transparency. The PMUs of concerned SFDs will allocate funds to these agencies for actual implementation in the areas under their command or arrange to allocate new areas. Further, setup under the Ministry of AYUSH will be involved for works related to afforestation/plantation, conservation and sustainable harvest of Medicinal and Aromatic Plants (MAPs). The State/ District and Field Level formations under the NYKS of the Ministry of Youth Affairs and Sports, such as Youth Clubs/ Eco-Clubs/ Mahila Mandals and leading CSOs will also be actively involved not only in plantation works, but also in awareness campaign and other activities relevant to this project. The concerned SFD/ SPMU will work out the detailed mechanism as per the specific requirements and prevailing conditions and dully brought MoUs on record. In fact, a substantial part of budget allocation envisaged for awareness programme under the project will be used by these State level and Local level organisations/ formations indicated above. SPMUs will invite proposal and APOs from AYUSH, NYKS, for consideration by the concerned SPSC. On approval, signing of

MoU, and timely funds will be released to the concerned agency for carrying out the particular works/ activities.

(iv) Execution at Field Level

Once the APO submitted by the Division approved and works allotted, the respective work shall be executed with active involvement of JFMCs and/ or other CSOs in the area. In case, the works are entrusted to JFMCs/ CSOs for execution, the cashbook and account so maintained by them in turn shall be submitted to the concerned DFO who will ensure that the works have been done in accordance with the physical and financial parameters prescribed. The accounts as well as the bank account for transactions for the purpose of execution of work carried out as per the present DPR shall be maintained separately. The Measurement Books (MBs) for such activities recorded through JFMCs or CSOs of the SFDs shall be maintained by the concerned officials of the SFDs while the JFMCs shall submit Unitization Certificate (UC) dully verified by RFOs and Completion Certificates (CCs) to the concerned DFO.

For the works to be executed by the other Line Departments, NGOs, and other Community Based Organizations (CBOs), the DFOs shall convey the approved APOs to concerned officials of the respective Department/ Agency, and also release corresponding funds to them. The responsibility of execution shall completely rest with the Line Department/ Agency and they shall be maintaining MBs at their own level and submit account for the same to the DFO. These works shall be inspectedjointly by the concerned field staff of SFDs with the executing Department/ Agency and inspection report submitted to DFO. DFO who is the Member Secretary of District Level Implementing Agency (DIC) specifically constituted for implementation of the present project, shall make electronic fund transfer to the executing agency to facilitate timely implementation of envisaged works. SFDs will maintain records for individual site with all the activities logged in immediately as and when carried out along with the expenditure incurred on the standard forms being used by respective SFD. The UCs and CCs compiled at State Level PMU shall be submitted to the NPMU at the Central Nodal Ministry for monitoring.

The SFD will form new JFMCs for programme implementation, if required and deemed fit. Concerned SPSCs, SPMUs and DFOs will ensure adequate involvement and participation of other recognized CSOs like NYKS, NSS, NCC, NGOs, Mahila Mandals, Self Help Groups, (SSFs), etc. In areas where none of these CSOs exists or are not feasible for any justifiable reason, the DFO may opt for executing the works departmentally with the help of any other active Civil Society in the area.

The expenditure incurred is auditable as per the Government of India Rules/ Procedures and/ or as per the specifications provided by the Central Nodal Ministry or even the prominent financial agency supporting the project.

(v) Budget

The State Forest Department (SFDs) of the concerned State/UT are compulsorily required to carry out the internal monitoring of the project activities for which necessary budget provisions have been made in this regard. Twenty five per cent (25%) of the actual works carried out will have to be essentially monitored. The mechanism of such monitoring shall be finalized by the concerned SPSC which will also lay down the procedure for submission of UCs to the Central Nodal Ministry along with the approved APO for various works during the next year. Based on APO as well as UC for the amount released during the previous year, the Central Nodal Ministry/ NPMU shall release the funds after obtaining the approval of the NPSC.

6.4 Risk Assessment

The river ecosystem and forest ecosystems are intensely linked to each other and influenced by a lot of variables. Invariably, forestry activities are exposed to many threats and vulnerabilities caused by natural and anthropogenic factors (i.e., snowfall, rainfall, temperature, humidity, landslides, livestock grazing, deforestation, forest fires, invasive and alien species, pest attacks, developmental activities, etc.). While some of these factors can be managed to an extent, others are beyond the scope of human interventions. Therefore, the occurrence of most likely risks cannot be negated in the implementation of Forestry Interventions for improvement of the ecological health of Chenab River ecosystem. Broadly, these risks can be classified into biotic (biological) and abiotic (physical) categories on the basis of contributory factors/causes as tabulated below (Table- 6.1).

Table:6. 1 - Biotic (biological) and abiotic (physical) categories on the basis of contributory factors

S.No.	Risk Factors	Implications/ Measures
A.	**Biotic Risks**	
1.	Grazing of plantations by domestic livestock and wild herbivores, migratory sheep and goat, etc. in harsh climatic conditions and upper reaches can adversely impact plantation efforts at any stage.	Caused potential damage to the plantation during the establishment stage. Proper fencing of plantation area, and watch and ward, and awareness can reduce the damage.
2.	Pest and disease attacks	Sometimes cause immense damage to nursery stock and plantation area. Difficult to manage as use of pesticides ultimately leads to contamination of water sources.
3.	Illicit cutting of raised plantations in far-flung areas and densely populated regions.	Cause excessive damage to the plantations. Effective fencing, watchfulness, and awareness can reduce the damage.
4.	Recurrent incidents of natural and	Cause excessive damage to the planation at

	human induced forest fires.	early stages. Large scale awareness campaign, creation and maintenance of fire lines, watch and ward, use of Early Warning Systems (EWS) can control the incidents of forest fires.
5.	Degradation of aquifers and deterioration of other catchment characteristics due to rash anthropogenic influences.	Disrupts the naturally available settings largely conducive for establishment of plantations. Effective and inclusive approaches and awareness can be employed to check degradation of land resources as well as surface and ground water resources including aquifers, streams, rivers, etc.
B.	**Abiotic Risks**	
1.	Climatic factors - precipitation (i.e., rains/ snowfall, hailing, etc.)	Timing of planting activities in consonance with rainfall is important for survival of plantations. Appropriate rainfall is required for better establishment of plantations. Inconsistent precipitation patterns characterized by scanty rains, torrential rains, prolonged dry spells, and heavy snowfall affect the plantations badly. Selection of suitable species capable of withstanding the irregular precipitation patterns, and additional means of watering can be utilised against these unpredictable events.
2.	Climatic factors– Low/High Temperatures /Frost	Low temperatures in upper catchment areas of the riverscape are likely to affect the plantations. Similarly, high temperature/ may lead to drying up of seedlings and root stock. Frost causes huge damage to the saplings. The losses due to these risks are mostly unmanageable.
3.	Physical/ Edaphic factors (i.e., Loose strata, soil erosion, landslides, steep slopes, etc.)	Fragile mountainous terrain, rocky surfaces, glacial activity, and frequent landslides in the upper reaches will make implementation activities difficult and also affect the survival of plants. The problem of soil erosion and landslides is more aggravated due to human influences. Suitable SMC measures/activities in the catchment areas, species selection and use of Quality Planting Stock (QPM) are useful to limit the risk factors.

Any one or a combination of several risk factors may affect the survival and growth of Forestry Interventions. Therefore, the SFDs shall consider all possible following interventions to minimize above risks:

i) Use of quality planting stock of suitable age and size. Tall nursery plants of tree species have been proven to reduce several risk factors to great extent.

ii) Timely nursery raising and ensuring that planting materials are supplied for plantation activities in time without causing transit damages to the planting stock.

iii) Well planned advance works and in-time plantation activities supplemented by use of bio-fertilizers, organic manures and compost, mulching, etc. can bring down risk levels to a great extent.

iv) Adequate fencing and protection from cattle and wild herbivores will get rid of the risk of grazing and browsing. The local communities need to be sensitized and mobilized to reduce the biotic risks.

Even though, all attempts shall be made to minimize the risks involved, much of the progress is left to nature in forestry. Vagaries of nature in the form of climatic and edaphic extremities pose the largest threat to proposed Forestry Interventions in Chenab Riverscape.

6.5 Mid-Course Learning and Adaptation

Multiple activities ranging from afforestation to institutional plantation have been proposed in the present DPR. Though, the Forestry Interventions have been envisaged on the basis of comprehensive strategies and inclusive approaches, but as elaborated in the preceding section, there is every possibility that vulnerability characteristics, several risk factors, unforeseen forces of nature will tend to impact the activities proposed in the DPR. New ideas and designs are likely to evolve from lessons learnt as execution makes progress in the field. Such type of learning will make the DPR reasonably flexible. The physical and financial norms of such adaptive activities during the course of implementation shall be in consonance with the norms accepted by the concerned SFDs or as per the Schedule Rates of Work of SFDs / other partner Departments. The necessary detailing of these activities will have to be particularly stated in the APOs and executed by the DFOs/ Partner Organizations only after obtaining approval from the SPMU. If need be, special approval may be given by the State Level Project Executive Director so as to make the implementation of works/ activities certain and well in time considering the seasonal constraints.

6.6 Monitoring and Evaluation of Outcomes/ Results

Monitoring of activities and periodic evaluation are integral part of the project implementation. Mainly, two types of monitoring are envisaged during the implementation phase. These are: (i) monitoring of project performance in terms of project objectives, activities, targets, outcomes, and outputs; and (ii) ecological and socio-economic monitoring in terrestrial and aquatic, ecosystems. The illustration of different measurable monitoring indicators has been given in Table 6.2.

Table:6. 2- Measurable Indicators for Monitoring and Review Mechanism

S. No.	Ecological Indicators	Socio-Economic Indicators
1.	Area covered under plantations in different landscapes (in ha.)	Extent of employment generation (Man days Generated)
2.	Survival rates of plants (in per cent)	Per capita income of the impacted population
3.	Growth performance of plants *viz*., height and collar diameter, etc.	Forest based livelihood generation activities
4.	Biomass production on the intervention sites (t/ha/year).	Dependency of local population on forest resources
5.	Stock quality of planting materials and plantation as per the suggested models	Biotic pressure on forests/ grasslands/ wetlands and protected areas
6.	Extent of soil and moisture conservation works (in m^3)	Availability of fodder to the affected population
7.	Silt load/ rate of sedimentation in select locations in the implementation area	Availability of medicinal plants
8.	Monitoring of quality of water of some locations across the river stretch (BOD measurements).	Awareness, Extension and publication (i.e. workshops, trainings, pamphlets, brochures, etc.)
9.	Population estimates of select RET faunal species	
10.	Potential to generate Carbon Credit from plantation in three landscapes over a span of 20 years	
11.	Sediment reduction through forestry intervention over a span of 10 /20 years.	
12.	Contribution made by the Forestry Interventions on different landscapes to Carbon Stock in 10/20 years.	

Plantation activities make the core activity of the proposed Forestry Interventions by adopting varied plantation/ treatment models in natural, agriculture, and urban landscapes within the Riverscape. Accordingly, a bulk amount of the total budget outlay has been provisioned for this important activity. Considering the significance of plantation activities for the overall success of the project, in house monitoring has been envisaged and to be carried out by the IAs i.e., the concerned SFDs. Thus, 25% of the actual works carried out will have to be mandatorily monitored. The DPR has made adequate provisions for the required budget for monitoring of plantations as well as other interventions as envisaged in the project. The DPR also envisions actual field level annual monitoring at three hierarchical levels of SFDs/ IAs by way of monitoring of 40-50% plantation sites by the concerned CFs, 20-25% sites by

DFOs, and 10-12% ACFs. The SPMU in consultation with the SPSC shall finalize the mechanism for proposed 25% in house monitoring. The SPSC will also lay down the procedure for submission of UCs to the NPMU based at the Central Nodal Ministry along with the approved APO for the proposed works in the next year and the budget estimates. The NPMU would release the funds for the next year after the NPSC has considered the UCs and APO and approved release of funds.

SFDs have provided preliminary information proposed sites for plantations in field data formats submitted to HFRI, Shimla along with GPS locations for the preparation of present DPR. Site details have been incorporated in GIS/ Google Earth maps. As per the old and well established traditional practice of documentation, SFDs are required to maintain 'Nursery Journal', 'Plantation Journals' and 'Journals for Other Interventions' meticulously. As per the existing system and laid procedures, these journals contain all requisite information on plantations, selected sites, geographical coordinates, site sketch and map, details of activities carried out and expenditure on plantations, weeding, tending, gap filling, and maintenance as well as the chronology of natural (i.e., flood, drought, etc.) and man-made (i.e., fire) events, if any impacting plantations adversely. As already stated, the DPR envisages actual monitoring of plantations at three hierarchical levels and proper recording of site level observations in the Plantation Journals. As a first step, SFDs are required to place a sign board at the plantation site indicating the name of the scheme, area covered, and other details on planted species and their numbers. Necessary budget provisions for this purpose have been made in the cost norms under the head of contingency of various proposed Forestry Interventions.

The logical framework developed incorporating these vital aspects of project monitoring provide an insight for monitoring of project performance at the National/ State/ Local Levels. The logical framework also provides verifiable indicators and appropriate means. Project outcomes (i.e., biological, socio-economic, and institutional) will measure the impact of project interventions against the baseline developed during the Year-1 of implementation. The National Level Partner Organization (HFRI) will facilitate project monitoring and evaluation of outcomes/ results through consultative process with leading scientific organizations and effective coordination with the Nodal Ministry, State Level IAs and CSOs. Outcome indicators include: (a) adoption and implementation of community driven, climate resilient, ecosystem management approaches, (b) improved forest cover in natural landscapes and TOFs, (c) reduced biotic pressure, enhanced regeneration, and productivity of degraded forests/ grasslands, (d) conservation and sustainable harvests of medicinal and aromatic plants, (e) effective conservation of terrestrial/ aquatic/ coastal biodiversity within PAs/ forests/ production landscape units, (f) local communities deriving social and economic benefits from the various measures such as protection and conservation, extensive plantations including planting of economic and fruit trees, soil and moisture conservation works, development of small and micro enterprises, (g) herbal gardens, (h) enhanced nature/ forest/ river/ wetland based ecotourism, (i) initiatives for mainstreaming biodiversity concerns in production sectors, (j) enhanced capacity and awareness, and (k) science based effective management interventions and actions for forest-river resources and knowledge management. The project lays greater emphasis on participatory monitoring by communities and CSOs.

The National Level Partner Organization would involve concerned experts and organizations to develop an integrated, long-term ecological and socio-economic monitoring programme during the first year and baseline information generated for evaluation of project impact in future. The long-term ecological and socio-economic monitoring programme will be appropriately executed periodically depending upon the intensity of monitoring decided for each of the variable/ species. Additional studies and evaluations would be supported at each of the landscape category type, river and its tributaries to supplement the participatory impact monitoring programme. Local Universities, Expert Scientific Organizations, and CSOs will be involved in specialized monitoring planned for the project.

Apart from that, HFRI (National Partner Organization) will undertake and facilitate supervision missions in consultation and coordination with the NPMU based at the Central Nodal Ministry so as to review the progress made in execution of the project besides the well-structured and designed Mid Term Review (in third year) and the Terminal Evaluation (last quarter of fifth year of project implementation) by the Third Party/ External Experts selected by the PMU of the Nodal Ministry.

6.7 Sustainability, Replication, and Cost Effectiveness

The aspects of sustainability and replication in future of lessons learned in the project are vital for river rejuvenation and conservation efforts in the country. These aspects are described and emphasized below:

6.7.1 Sustainability

The geo-spatial analysis of the riverscape carried out during the preparatory phase of the present DPR provided an insight on sites characterization for proposed Forestry Interventions and various envisaged treatments. Utilizing this vital insight, Forestry Interventions have been proposed as per site conditions. The selected sites are of higher significance for protection and restoration as well as the efforts for protection and conservation of sites of high biodiversity values. Accordingly, the project is likely to generate global biodiversity benefits i.e., improved forest cover, increased diversity of species, carbon sequestration, and enhanced ecosystem services besides improved livelihoods. The project has been developed adopting ecosystem approach targeting forest-river linkages, complexities, andconservation at the riverscape level to serve the objectives of clean and continuous flow of water in Chenab River andalso to restore the ecological integrity of River Ecosystem. In this way, the project is expected to directly contribute to ecological sustainability.

6.7.2 Replication

The project envisaged providing an explicit learning and replication strategy to build the capacity for adopting riverscape conservation approaches. It has planned for comprehensive

monitoring and periodic evaluation so as to facilitate envisaged up-scaling and replication of efforts.

6.7.3 Cost Effectiveness

The project would encourage the development of empirical methods, holistic approaches, and optimum practices for participatory riverscape conservation. As stated above, it will explicitly promote replication of practices so as to enhance ecological integrity of river ecosystem. The project has planned proposed Forestry Interventions in natural, agriculture, and urban landscapes using past experiences and each of the treatment model has been carefully designed considering various aspects (i.e., site characteristics, slope, erosion, etc.) and accordingly cost norms have been worked out on the basis of acceptable cost of establishment of plantation and maintenance cost in succeeding three years. In long run, the project will be highly cost effective as it is likely to develop and augment nationwide broad understanding and capacity enhancement on riverscape conservation and eventually improve the ecological health of rivers and also reinvigorate the goods and services network of river ecosystem.

Chapter 7

Project Budget and Schedule

7.1 Project Budget

The projected financial outlay of the Phase 1 on Project Implementation of five-year duration is Rs. **318.17** Crore. The projected budget outlay of Phase II (Maintenance Phase) of five-year duration is Rs. **58.10** Crore. As mentioned above, the project includes four broad based components. Accordingly, financial cost of each of these four components is summarized below:

7.2 Project Outlay: Component and Activity Wise

The Principal Component-A: Implementation of Forestry Interventions in Chenab Riverscape

An amount of Rs. 318.17 Crore, which is 82.59 % of the overall project budget, is provisioned for principal component A. This includes total Rs. 310.77 Crore for Forestry Interventions in three landscapes and Conservation intervention (Sub-component A.1 and A.2) which include Rs. 198.89 Crore for component A.1, Rs.73.71 Crore for component A.2 and whereas, Rs. 16.92 crore is provisioned for supporting activities (Sub-component A.3).

Component -A: the Sub-component (**A.1**) on plantations and various treatment models in three types of landscapes within the riverscape is the largest in terms of its spread, extent and quantum of funds provisioned. Rs. 198.89 crore is provisioned for Forestry Interventions in three landscapes, which is 52.86% of total budget outlay of the project. Amongst three landscapes, the obvious emphasis is on Natural Landscapes, thus a sum of Rs.144.10 Crore has been provisioned for proposed afforestation/ reforestation activities in natural landscapes in Chenab Riverscape. The projected budget outlay for proposed plantations in natural landscapes accounts for 38.30 % of the Sub-components. The projected budget outlays for agriculture and urban landscapes are of the tune of Rs. 2.71 Crore and Rs. 52.08 Crore or 0.72 % and 13.84%, respectively of the envisaged cost of the Sub-component.

The second Sub-component on 'Conservation Interventions' (**A.2**) includes three major types of interventions/ activities. These are: (a) soil and moisture conservation measures, (b) riverine and riparian wildlife management, and (c) wetland management. Rs 73.71 Crore are provisioned for this subcomponent, which is 19.59 % of total budget outlay. Of this, the budget outlay for SMC is Rs. 51.87 Crore, which is 13.78 % allocation of the funds provisioned for Component A. Budget outlay provisioned for Riverine and Riparian Wildlife Management and Wetland Management is 21.84 Crore, which is 5.80 % of total budget of component A.

The third Sub-component (**A.3**) pertaining to 'Supporting Activities' is to be executed by concerned State /UT level IAs. This Sub-component includes seven broad based activities *viz*., (a) Policy Level Interventions, (b) Research Activities, (c) Capacity Development, (d) Awareness, (e) Participatory Monitoring, (f) Cost of PMUs of Two State Level Implementing Agencies, (g) Evaluation and (h) Contingency and Miscellaneous Activities. A budget of 16.92 Crore or 5.44 % of the component A or 4.50% of total budget proposed to the concerned States/ UT has been provisioned for carrying out various supporting activities for five-year period (**Table 7.1**).

The Component-B: 'Strengthening Knowledge Management and enhancement of national capacity for forest hydrology, Forestry Interventions, and conservation and restoration of rivers would require a sum of Rs. 10.45 Crore or 2.78% of the overall project outlay. The highest budget amounting Rs. 4.49 Crore has been provisioned for cost of PFU, while budget of Rs.3.16 Crore has been provisioned for Research and Development, while 1.18 Crore, 1.26 Crore, 1.26 Crore, 0.45 Crore, 0.46 Crore, 0.99 have been envisaged for policy level interventions, capacity development, Scientific exchange, awareness, Monitoring and Evaluation respectively.

The Component – C on the Phase II of the project of five-year duration for maintenance of plantations raised during Phase I of the project has also been planned. The Phase II would also include limited activities related to replication of efforts in additional tributaries/areas and scaling up of the planned effort. A sum of Rs. 58.10 Crore or 15.44% of the total project financial outlay has been envisaged specifically for the Component – C on 'Maintenance Phase'.

The Component – D pertains to project management at the national level which would include the establishment of National Project Management Unit (NPMU) at the Central Nodal Ministry with the responsibility to oversee, steer and manage this priority project. A sum of Rs. 18.20 Crore, representing 4.84 % of the overall budget over a period of five-year during the Phase I has been provisioned. Thus, it is clear that the major portion of project budget outlay is meant for field level activities incorporating proposed Forestry Interventions, conservation interventions and supporting activities to be implemented in concerned State and UT.

A total of 16 Territorial Forest Divisions and 4 Wildlife Divisions in Chenab Riverscape, will carry out proposed activities relevant to Forestry Interventions within the riverscape. A total of 8872.2 ha area of three landscapes (Table 7.2), 235 ha area of Riverine and Riparian wildlife management and wetland management and 620860 m^3 extent of soil and moisture conservation in Chenab Riverscape is envisioned to be treated under the various Forestry Interventions (Table 7.1 and Table 7.3). The details of proposed sites for Forestry Interventions are annexed (Annexures : 11 - 13).

The consent for the availability of the land for proposed Forestry Interventions have been obtained from the PCCF & HoFF, Himachal Pradesh (Annexure-14) and PCCF & HoFF, Jammu and Kashmir UT (Annexure-15).

Table: 7.1– Project Budget Outlay - Component/ Activity Wise Budget Allocation

Sr. No.	Component/ Activity	Amount (Rs. in Crore)	Allocation (%)	Allocation Phase I (%)
A.	**Implementation of Forestry Interventions in Two States of Riverscape (A1+ A2+ C1+C3)**	310.77	82.59	85.68
A.1	**Plantations and Treatment Models in Three Categories of Landscape**	**198.89**	52.86	62.51
A.1.1	Natural Landscapes	144.10		
A.1.2	Agriculture Landscapes	2.71		
A.1.3	Urban Landscapes	52.08		
A.2	**Conservation Interventions**	**73.71**	19.59	23.17
A.2.1	Soil and Moisture Conservation	51.87		
A.2.2	Riverine and Riparian Wildlife Management	19.73		
A.2.3	Wetland Management (Natural and Artificial)	2.11		
A.3	**Supporting Activities**	**16.92**	4.50	5.32
A.3.1	Policy Level Interventions	0.16		
A.3.2	Research Activities	1.15		
A.3.3	Capacity Development	5.05		
A.3.4	Awareness	1.77		
A.3.5	Participatory Monitoring	0.74		
A.3.6	Cost of PMUs of Two State Level Implementing Agencies	7.56		
A.3.7	Evaluation	0.45		
A.3.8	Contingency and Miscellaneous Activities	0.04		
B.	**Strengthening Knowledge Management and National Capacity for Forestry Interventions and Conservation of Riverscapes**	**10.45**	2.78	3.29
C.	**DPR – Phase II (Maintenance phase) Including Scaling Up and Replication of Successful Models of Forestry Interventions**	**58.10**	15.44	
C.1	Maintenance Cost of A.1 and A.2 (Cost of Phase II)	24.54	6.52	
C.2	Maintenance Cost of A.3, B and D	19.93	5.30	
C.3	Scaling Up and Replication of Successful Models of Forestry Interventions (5% of A.1 & A.2)	13.63	3.62	
D.	**National Coordination for Forestry Interventions and Riverscape Conservation**	**18.20**	4.84	5.72
	Total Phase I (A+B+D)	**318.17**		100.00
	Total Project Cost (Phase I+II) (A+B+C+D)	**376.27**	100.00	

Note: In the proposed budget for H P and J&K UT Implementing Agencies, 5% of total budget of phase I will be added in phase II for Scaling Up and Replication of Successful Models.

Table: 7.2– Proposed Budget Allocation for Various Plantation and Treatment Models in Three Types of Landscapes

A. Natural Landscapes						
State/ UT	**No. of Sites**	**Area (ha)**	**Phase I (Project Implementation)**		**Phase II (Maintenance Phase)**	**Total Cost**
			Establishment Cost (Rs. in Crore)	**Maintenance Cost (Rs. in Crore)**	**Maintenance Cost (Rs. in Crore)**	**(Rs. in Crore)**
Himachal Pradesh	27	476	11.89	1.48	3.51	16.87
Jammu and Kashmir UT	257	7605	104.55	26.20	18.78	149.53
Total	**284**	**8081**	**116.44**	**27.68**	**22.29**	**166.40**
B. Agriculture Landscape						
State/ UT	**No. of Sites**	**Area (ha)**	**Phase I (Project Implementation)**		**Phase II (Maintenance Phase)**	**Total Cost**
			Establishment Cost (Rs. in Crore)	**Maintenance Cost (Rs. in Crore)**	**Maintenance Cost (Rs. in Crore)**	**(Rs. in Crore)**
Himachal Pradesh	12	74	0.12	0.19	0.015	0.33
Jammu and Kashmir UT	84	558	0.91	1.48	0.13	2.52
Total	**96**	**632**	**1.03**	**1.67**	**0.145**	**2.85**
C. Urban Landscape						
State/ UT	**No. of Sites**	**Area (ha)**	**Phase I (Project Implementation)**		**Phase II (Maintenance Phase)**	**Total Cost**
			Establishment Cost (Rs. in Crore)	**Maintenance Cost (Rs. in Crore)**	**Maintenance Cost (Rs. in Crore)**	**(Rs. in Crore)**
Himachal Pradesh	9	17.5	2.67	1.71	0.02	4.40
Jammu and Kashmir UT	114	141.7	29.32	18.38	0.67	48.38
Total	**123**	**159.2**	**31.99**	**20.09**	**0.69**	**52.78**
Grand Total (A + B + C)	**503**	**8872.2**	**149.46**	**49.44**	**23.13**	**222.03**

Table:7. 3– Budget Allocation for Proposed Activities under the Sub-Component (A.2) on Conservation Interventions

Activity	Himachal Pradesh			Jammu and Kashmir UT			Total of Two State/ UT		
	No. of Sites	Extent	Total Cost (Rs. in Crore)	No. of Sites	Extent	Total Cost (Rs. in Crore)	No. of Sites	Extent	Total Cost (Rs. in Crore)
Soil and Moisture Conservation (Extent in m^3)	98	97260	8.24	549	523600	43.63	647	620860	**51.87**
Riverine and Riparian Wildlife Management (Extent in ha)	2	50	5.00	14	160	16	16	210	**21**
Wetland Management (Extent in ha)	1	10	0.90	2	15	1.35	3	25	**2.25**
Total Cost on Proposed Conservation Interventions in Chenab Riverscape									**75.12**

Table:7. 4- Proposed Budget Allocation under the Sub-Component (A.3) on Supporting Activities

Sr. No.	Activity	States		Grand Total (Rs. in Crore)
		Himachal Pradesh (Rs. in Crore)	Jammu and Kashmir UT (Rs. in Crore)	
1.	**Policy Level Interventions**	0.06	0.11	**0.17**
2.	**Research**	1.08	0.78	**1.86**
3.	**Capacity Development**	1.44	3.61	**5.05**
4.	**Awareness**	0.22	1.55	**1.77**
5.	**Participatory Monitoring**	0.38	0.78	**1.17**
6.	**Project Management**	3.83	6.31	**10.14**
7.	**Evaluation**	0.79	1.43	**2.22**
8.	**Contingency and other Expenses**	0.02	0.03	**0.05**
Total Cost – Supporting Activities		**7.82**	**14.60**	**22.43**

Table:7. 5– Proposed Budget for Strengthening Knowledge Management and Capacity Enhancement by the National Level Partner Organization – HFRI, Shimla

Sr. No.	Item	Year												Cost (Rs. in Crore)
		Phase I						Phase II						
		I	II	III	IV	V	**Total**	VI	VII	VIII	IX	X	**Total**	
A)	**Recurring Cost**													
A.1	Cost of PFU - Salary and Wages, Equipment, Office Expenses and Management, Travel, Vehicle and POL, Audits, etc.,	0.71	0.64	0.66	0.69	0.72	**3.42**	0.24	0.23	0.21	0.20	0.19	**1.07**	**4.49**
A.2	Inputs for Policy Level Interventions	0.14	0.15	0.16	0.16	0.17	**0.79**	0.18	0.00	0.00	0.00	0.21	**0.39**	**1.18**
A.3	Strategic Adaptive Research and Development	0.36	0.37	0.39	0.41	0.43	**1.96**	0.22	0.23	0.24	0.25	0.26	**1.19**	**3.16**
A.4	Knowledge Management and Capacity Development	0.14	0.15	0.16	0.16	0.17	**0.79**	0.09	0.09	0.10	0.10	0.11	**0.48**	**1.26**
A. 5	Scientific Exchange, Exposure Visits, and Engagement of International and National Consultants	0.14	0.15	0.16	0.16	0.17	**0.79**	0.09	0.09	0.10	0.10	0.11	**0.48**	**1.26**
A. 6	Inputs for Awareness	0.14	0.07	0.07	0.07	0.07	**0.43**	0.02	0.00	0.00	0.00	0.00	**0.02**	**0.45**
A.7	Monitoring - Project, and Ecological and Socio-economic	0.07	0.06	0.06	0.05	0.05	**0.29**	0.04	0.04	0.03	0.03	0.03	**0.17**	**0.46**
A. 8	Project Evaluation			0.20			**0.20**	0.34				0.45	**0.79**	**0.99**
	Sub Total Recurring Cost (A)	**1.71**	**1.59**	**1.85**	**1.72**	**1.79**	**8.66**	**1.21**	**0.67**	**0.68**	**0.68**	**1.35**	**4.60**	**13.26**

Sr. No.	Item	Year												Cost (Rs. in Crore)
		Phase I						Phase II						
		I	II	III	IV	V	**Total**	VI	VII	VIII	IX	X	**Total**	
B)	**Non-Recurring Cost**													
B.1	Incorporation of Advance Technology	0.07	0.06	0.06	0.05	0.05	0.29	0.02	0.00	0.00	0.00	0.00	**0.02**	**0.31**
B.2	Permanent Equipment	0.07	0.04	0.02	0.01	0.00	0.14	0.00	0.00	0.00	0.00	0.00	**0.02**	**0.16**
	Sub Total Non-Recurring Cost (B)	**0.14**	**0.10**	**0.08**	**0.06**	**0.05**	**0.43**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.47**
C.	**Total (Recurring and Non- Recurring Costs) A+B**	**1.85**	**1.69**	**1.93**	**1.78**	**1.84**	**9.09**	**1.24**	**0.68**	**0.69**	**0.69**	**1.35**	**4.65**	**13.74**
D.	**Institutional Charge @ 15%**	0.28	0.25	0.29	0.27	0.28	1.36	0.19	0.10	0.10	0.10	0.20	**0.70**	**2.06**
E.	**Grand Total (C+D)**	**2.13**	**1.94**	**2.22**	**2.05**	**2.12**	**10.45**	**1.43**	**0.78**	**0.79**	**0.79**	**1.56**	**5.34**	**15.80**

Table:7. 6– Proposed Budget for Project Management Unit at the Central Nodal Ministry

Sr. No.	Item	Year												Grand Total Cost (Rs. in Crore)
		Phase I						Phase II						
		I	II	III	IV	V	**Total**	VI	VII	VIII	IX	X	**Total**	
A)	**Recurring Cost**													
A.1	Cost of PMU - Salary and Wages, Equipment, Office Expenses and Management, Travel, Vehicle and POL, Audits, etc.,	1.24	0.96	1.00	1.04	1.10	**5.34**	0.35	0.33	0.31	0.29	0.28	**1.55**	**6.88**
A.2	Inputs for Policy Level Interventions	0.37	0.39	0.41	0.43	0.45	**2.06**	0.45	0.00	0.00	0.00	0.52	**0.98**	**3.04**
A.3	National Decision Support and	0.50	0.52	0.55	0.58	0.60	**2.75**	0.32	0.29	0.26	0.23	0.21	**1.30**	**4.04**

Sr. No.	Item	Year												Grand Total Cost (Rs. in Crore)
		Phase I						Phase II						
		I	II	III	IV	V	**Total**	VI	VII	VIII	IX	X	**Total**	
	Management Information System													
A.4	Scientific Exchange, Exposure Visits, and Engagement of International and National Consultants	0.62	0.65	0.68	0.72	0.75	**3.43**	0.68	0.31	0.31	0.31	0.31	**1.92**	**5.35**
A.5	Inputs for National Level Awareness	0.37	0.39	0.41	0.43	0.45	**2.06**	0.41	0.39	0.36	0.34	0.33	**1.83**	**3.88**
A.6	Project Monitoring and Evaluation			0.32			**0.32**	0.53				0.69	**1.22**	**1.54**
Sub Total Recurring Cost (A)		3.11	2.92	3.37	3.20	3.36	**15.95**	2.74	1.31	1.24	1.18	2.33	**8.79**	**24.74**
B) Non-Recurring Cost														
B.1	Incorporation of Advance Technology	0.37	0.34	0.30	0.27	0.24	**1.53**	0.24	0.00	0.00	0.00	0.00	**0.24**	**1.77**
B.2	Permanent Equipment	0.37	0.19	0.09	0.05	0.02	**0.72**	0.01	0.01	0.01	0.01	0.01	**0.03**	**0.76**
Sub Total Non-Recurring Cost (B)		0.75	0.52	0.39	0.32	0.27	**2.25**	0.25	0.01	0.01	0.01	0.01	**0.28**	**2.53**
C.	**Grand Total (Recurring and Non-Recurring Costs) A+B**	**3.85**	**3.44**	**3.76**	**3.52**	**3.63**	**18.20**	**2.99**	**1.31**	**1.25**	**1.18**	**2.34**	**9.07**	**27.27**

Table:7. 7– Proposed Budget Allocation to the State Level and Union Territory Level Implementing Agencies

Sr. No.	Activity	State/ UT		Grand Total (Rs. in Crores)
		Himachal Pradesh (Rs. in Crores)	Jammu and Kashmir UT (Rs. in Crores)	
1.	**Natural Landscape**	16.87	149.50	166.40
2.	**Agriculture Landscape**	0.33	2.52	2.85
3.	**Urban Landscape**	4.40	48.38	52.78
4.	**Conservation Intervention**	14.14	60.98	75.12
5.	**Supporting Activities**	7.82	14.60	22.43
Grand Total		**43.56**	**275.98**	**319.58**

Table:7. 8– Model/ Activity Wise Area and Cost for Forestry Intervention along Chenab River Basin

State	Landscape	Model/Activity	Area (ha)	Area (m^3)	Cost (Rs. in Crore)
Himachal Pradesh	Natural	CN/HP/NL/01 Cold Desert Greening	232	-	10.81
		CN/HP/NL/02 Cold Desert Conservation	10	-	0.41
		CN/HP/NL/03 - Alpine Conservation	-	-	-
		CN/HP/NL/04 Sub Alpine Enrichment	98	-	2.14
		CN/HP/NL/05 - Temperate Conifer Forest	-	-	-
		CN/HP/NL/06 Temperate Mixed Forest	78	-	2.38
		CN/HP/NL/07 Pasture and Grazing Land Development	18	-	0.41
		CN/HP/NL/08 Protection Model for Natural Regeneration	40	-	0.72
	Agriculture	CN/HP/AL/01 Plants distribution to Stakeholders	60	-	0.15
		CN/HP/AL/02 Block plantation by Stakeholders	14	-	0.18
	Urban	CN/HP/UL/01 - Riverfront Development	1.50	-	3.71
		CN/HP/UL/02 - Institutional and Industrial Estate Plantation	16	-	0.69
	Conservation Intervention	CN/HP/CI/01 - Brushwood Interventions	-	12,460	0.37

		CN/HP/CI/02 - Dry Stone Activities)	-	28,860	5.19
		CN/HP/CI/03 - Crate Wire Activities	-	950	0.43
		CN/HP/CI/04 - Water Ponds	-	54,420	1.90
		CN/HP/CI/05 - Silt Detention Dam Type Activities	-	570	0.34
		CN/HP/CI/06 - Riverine and Riparian Wildlife Management	50	-	5.00
		CN/HP/CI/07 - Wetland Management	10	-	0.90
Jammu and Kashmir	Natural	CN/JK/NL/01 - Sub Alpine Conservation	-	-	-
		CN/JK/NL/02 - Sub-Alpine Enrichment	-	-	-
		CN/JK/NL/03 - Dry Temperate Conifer Forest Enrichment	-	-	-
		CN/JK/NL/04 - Temperate Conifer Forest	118	-	3.43
		CN/JK/NL/05 - Temperate Mixed Forest	1178	-	35.00
		CN/JK/NL/06 - Pasture and Grazing Land Development	50	-	0.99
		CN/JK/NL/07 - Himalayan Chir Pine Forest	642	-	16.82
		CN/JK/NL/08 - Himalayan Mixed Forest	198	-	5.02
		CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	999	-	25.31
		CN/JK/NL/10 - Eradication of Lantana (> 50%)	15	-	0.39
		CN/JK/NL/11 - Control/ Removal of Invasive Species or <50% Lantana	45	-	1.08
		CN/JK/NL/12 -Protection Model for Natural Regeneration	3620	-	56.93
		CN/JK/NL/13 -Fire Protection Model	740	-	4.58
	Agriculture	CN/JK /AL/01 - Boundary Plantation Model	452	-	1.14
		CN/JK /AL/02 - High Density Block Plantation	106	-	1.38
	Urban	CN/JK /UL/01 - Bioremediation and Bio-filtration	13	-	3.22
		CN/JK /UL/02 – Riverfront Development	6.60	-	16.34
		CN/JK/UL/03 – Institutional Plantation	112.40	-	4.82
		CN/JK /UL/04 - Eco Park Development	9.70	-	24.01
	Conservation	CN/JK/CI/01 - Brushwood	-	102280	3.07

	Intervention	Interventions			
		CN/JK /CI/02 - Dry Stone Activities	-	125130	22.52
		CN/JK /CI/03 - Crate Wire Activities	-	10690	4.81
		CN/JK /CI/04 - Water Ponds	-	279770	9.79
		CN/JK /CI/05 - Silt Detention Dam Type Activities	-	5730	3.44
		CN/JK /CI/06 - Riverine and Riparian Wildlife Management	160	-	16.00
		CN/JK /CI/07 - Wetland Management	15	-	1.35
		Total	**9107.20**	**6,20,860**	**297.17**

7.3 Budget Outlay- Forest Divisions

A total of 20 Forest Divisions falling in Chenab riverscape will participate and carry out activities relating to Forestry Interventions including plantations, conservation interventions and supporting activities. Of these, sixteen are territorial forest divisions and four are wildlife divisions. Overall budget outlay for 20 Forest Divisions of Chenab Riverscape has been given in State and UT summary of Himachal Pradesh and Jammu and Kashmir UT i.e., Volume II of the Chenab River DPR. The range of budget allocation among 16 Forest Territorial Divisions varies from Rs. 8.05 Crore to Rs. 25.86 Crore over a period of five years of Establishment (Phase –I) and next five years of maintenance (Phase –II.) Whereas, the budget range for 4 wildlife divisions range from Rs 2.90 Crore to Rs 11.35 Crore over a period of 10 years (i.e., Phase I and II).

7.4 Project Schedule

The execution period of five years in Phase I and five years of Phase II of the project has been designed and incorporated in the present DPR. Thus, the total duration for programme implementation including the maintenance phase is of 10-years. At this point of time, it is not clear when the project would start and which will be the first year of programme implementation during Phase I. The Government of India may take its own time to decide the Central Nodal Ministry responsible for the implementation of the project and to allocate required funds for the execution of plan. Various proposed activities have been proposed over five years of the Phase I. The experience illustrates that once the Government of India will accorded its approval for the project and will earmarked required funds, the first year by Implementing Agency (IA) would be largely devoted for project initiation, preparatory works, particularly the establishment of nurseries and commencement of various activities related to conservation interventions and supporting activities. The planting material meant for high altitude Himalayan part of the Chenab riverscape would be ready in nurseries and earliest available by the end of second year of project implementation. Thus, the earliest effective establishment year of plantations would be the third year of Phase I in Chenab Riverscape. Establishment of plantations is proposed in third, fourth and fifth year of Phase I. The Phase II of five-year duration is specifically designed and incorporated for the purpose of maintenance of plantations and other activities. Considering the

fact that most proposed activities are time bound and seasonal in nature, ideally the project initiation after all approvals, budget allocation, etc. should commence in month of April–May so as to allow adequate time for preparatory works, establishment of nurseries, development of planting material for afforestation/ reforestation in lower reaches of the riverscape before the onset of monsoon season in month of July or so in the next year. Thus, careful scheduling of project commencement would be vital for the overall success and effective implementation of envisaged activities. The quantum of activities is expected to be at its peak in third or fourth year of Phase I. The Mid-Term Review (MTR) is proposed in the last quarter of third financial year of the project execution while the Terminal Evaluation (TE) is being envisaged in the third year of the Phase II.

Table:7. 9– Year-Wise Breakup of Extent Coverage of Proposed Forestry Interventions in Chenab Riverscape

Year	Period	Plantation and Treatment Models			Conservation Intervention		
		Natural Landscape (ha)	Agriculture Landscape (ha)	Urban Landscape (ha)	Soil and Moisture Conservation Measures (m^3)	Riverine and Riparian Wildlife Management (ha)	Wetland Conservation (ha)
A. Phase I (Implementation Phase)							
I	Establishment	3999	209	60.56	1,08,250	115	10
II	Establishment	2265	192	54.40	1,11,490	60	15
	Maintenance	2140	276	56.10		115	10
III	Establishment	2899	164	48.70	2,48,100	35	
	Maintenance	3360	468	110.50		175	25
IV	Establishment	1045			96,870		
	Maintenance	6259	632	159.20		210	25
V	Establishment	777			56,150		
	Maintenance	7304	356	103.10		210	25
Total Phase I	**Establishment**	**8081**	**632**	**159.20**	**6,20,860**	**210**	**25**
	Maintenance	**7304**	**632**	**159.20**		**210**	**25**
B. Phase II (Maintenance Phase)							
VI	Establishment						
	Maintenance	5941	164	48.70		95	19
VII	Establishment						
	Maintenance	4658				35	
VIII	Establishment						
	Maintenance	1807					
IX	Establishment						
	Maintenance	757					
X	Establishment						
	Maintenance						
Total Phase II	**Establishment**						
	Maintenance	**5941**	**164**	**48.70**		**95**	**19**
Grand Total Phase I and Phase II	**Establishment**	**8081**	**632**	**159.20**	**6,20,860**	**210**	**25**
	Maintenance	**8081**	**632**	**159.20**		**210**	**25**

**Area is virtual; considered for budgetary provisions for Ist and IInd years*

Table:7. 10- Year-Wise Breakup of Cost for Proposed Forestry Interventions in Chenab Riverscape

Year	Period	Plantation and Treatment Models			Conservation Intervention		
		Natural Landscape (Rs. in Lakhs)	Agriculture Landscape (Rs. in Lakhs)	Urban Landscape (Rs. in Lakhs)	Soil and Moisture Conservation Measures (Rs. in Lakhs)	Riverine and Riparian Wildlife Management (Rs. in Lakhs)	Wetland Conservation (Rs. in Lakhs)
B. Phase I (Implementation Phase)							
I	Establishment	2053.35	46.68	943.20	952.39	368	28
II	Establishment	4064.06	33.66	790	1174.63	192	42
	Maintenance	228.61	25.03	582.96		322	25
III	Establishment	3577.72	32.34	465.64	1598.74	112	
	Maintenance	367.90	45.34	625.64		386.50	53.50
IV	Establishment	1562.39			922.68		
	Maintenance	989.78	61.69	589.17		350	36
V	Establishment	386.78			539.04		
	Maintenance	1181.18	34.88	211.63		242	27
Total Phase I	**Establishment**	**11644.29**	**103.68**	**3198.84**	**5187.50**	**672**	**70**
	Maintenance	**2767.47**	**166.94**	**2008.95**		**1300.50**	**141.50**
B. Phase II (Maintenance Phase)							
VI	Establishment						
	Maintenance	1037.27	14.72	69.85		96	13.50
VII	Establishment						
	Maintenance	721.03				31.50	
VIII	Establishment						
	Maintenance	312.43					
IX	Establishment						
	Maintenance	158.21					
X	Establishment						
	Maintenance						
Total Phase II	**Establishment**						
	Maintenance	**2228.94**	**14.72**	**69.85**		**127.50**	**13.50**
Grand Total Phase I and Phase II	**Establishment**	**11644.29**	**103.68**	**3198.84**	**5187.50**	**672**	**70**
	Maintenance	**4996.41**	**181.66**	**2079.25**		**1428**	**155**

Table:7. 11– Year-Wise Breakup of Extent Coverage of Proposed Forestry Interventions in Himachal Pradesh

Year	Period	Plantation and Treatment Models			Conservation Intervention		
		Natural Landscape (ha)	Agriculture Landscape (ha)	Urban Landscape (ha)	Soil and Moisture Conservation Measures (m^3)	Riverine and Riparian Wildlife Management (ha)	Wetland Conservation (ha)
A) Phase I (Implementation Phase)							
I	Establishment	10	31	5.50	12950	50	
II	Establishment	20	25	6.00	23950		10
	Maintenance	10	31	5.50		50	
III	Establishment	209	18	6.00	38070		
	Maintenance	30	56	11.50		50	10
IV	Establishment	95			12780		
	Maintenance	239	74	17.50		50	10
V	Establishment	142			9510		
	Maintenance	334	43	12.00		50	10
Total Phase I	**Establishment**	**476**	**74**	**17.50**	**97260**	**50**	**10**
	Maintenance	**334**	**74**	**17.50**		**50**	**10**
B) Phase II (Maintenance Phase)							
VI	Establishment						
	Maintenance	466	18	6.00			10
VII	Establishment						
	Maintenance	383					
VIII	Establishment						
	Maintenance	222					
IX	Establishment						
	Maintenance	122					
X	Establishment						
	Maintenance						
Total Phase II	**Establishment**						
	Maintenance	**466**	**18**	**6.00**			**10**
Grand Total Phase I and Phase II	**Establishment**	**476**	**74**	**17.50**	**97260**	**50**	**10**
	Maintenance	**476**	**74**	**17.50**		**50**	**10**

**Area is virtual; considered for budgetary provisions for Ist and IInd years*

Table:7. 12- Year-Wise Breakup of Cost for Proposed Forestry Interventions in Himachal Pradesh

Year	Period	Plantation and Treatment Models			Conservation Intervention		
		Natural Landscape (Rs. in Lakhs)	Agriculture Landscape (Rs. in Lakhs)	Urban Landscape (Rs. in Lakhs)	Soil and Moisture Conservation Measures (Rs. in Lakhs)	Riverine and Riparian Wildlife Management (Rs. in Lakhs)	Wetland Conservation (Rs. in Lakhs)
A) Phase I (Implementation Phase)							
I	Establishment	55.89	5.52	235.40	181.78	160	
II	Establishment	351.89	4.20	15.60	276.78		28
	Maintenance	1.54	2.96	70.62		140	
III	Establishment	340.73	2.40	15.60	237.71		
	Maintenance	4.50	5.40	51.76		95	25
IV	Establishment	319.75			68.46		
	Maintenance	66.11	7.09	43.11		60	16
V	Establishment	120.76			59.54		
	Maintenance	75.58	3.93	5.46		45	12
Total Phase I	**Establishment**	**1189.01**	**12.12**	**266.60**	**824.28**	**160**	**28**
	Maintenance	**147.73**	**19.38**	**170.95**		**340**	**53**
B) Phase II (Maintenance Phase)							
VI	Establishment						
	Maintenance	98.61	1.46	2.34			9
VII	Establishment						
	Maintenance	87.74					
VIII	Establishment						
	Maintenance	83.39					
IX	Establishment						
	Maintenance	81.02					
X	Establishment						
	Maintenance						
Total Phase II	**Establishment**						
	Maintenance	**350.76**	**1.46**	**2.34**			**9**
Grand Total Phase I and Phase II	**Establishment**	**1189.01**	**12.12**	**266.60**	**824.28**	**160**	**28**
	Maintenance	**498.49**	**20.84**	**173.29**		**340**	**62**

Table:7. 13– Year-Wise Breakup of Extent Coverage of Proposed Forestry Interventions in Jammu and Kashmir UT

Year	Period	Plantation and Treatment Models			Conservation Intervention		
		Natural Landscape (ha)	Agriculture Landscape (ha)	Urban Landscape (ha)	Soil and Moisture Conservation Measures (m^3)	Riverine and Riparian Wildlife Management (ha)	Wetland Conservation (ha)
A) Phase I (Implementation Phase)							
I	Establishment	1680	245	50.06	95300	65	10
II	Establishment	950	167	48.40	87540	60	5
	Maintenance	1680	245	50.60		65	10
III	Establishment	2690	146	42.70	210030	35	0
	Maintenance	3330	412	99		125	15
IV	Establishment	950	0		84090		0
	Maintenance	6020	558	141.70		160	15
V	Establishment	635	0		46640		0
	Maintenance	6970	313	91.10		160	15
Total Phase I	**Establishment**	**7605**	**558**	**141.70**	**523600**	**160**	**15**
	Maintenance	**6970**	**558**	**141.70**		**160**	**15**
B) Phase II (Maintenance Phase)							
VI	Establishment	0					
	Maintenance	5475	146	42.70		95	9
VII	Establishment	0					
	Maintenance	4275				35	
VIII	Establishment	0					
	Maintenance	1585					
IX	Establishment	0					
	Maintenance	635					
X	Establishment	0					
	Maintenance	0					9
Total Phase II	**Establishment**	**0**					
	Maintenance	**5475**	**146**	**42.70**		**95**	**9**
Grand Total Phase I and Phase II	**Establishment**	**7605**	**558**	**141.70**	**523600**	**160**	**15**
	Maintenance	**7605**	**558**	**141.70**		**160**	**15**

Table:7. 14- Year-Wise Breakup of Cost for Proposed Forestry Interventions in Jammu and Kashmir UT

Year	Period	Plantation and Treatment Models			Conservation Intervention		
		Natural Landscape (Rs. in Lakhs)	Agriculture Land scape (Rs. in Lakhs)	Urban Landscape (Rs. in Lakhs)	Soil and Moisture Conservation Measures (Rs. in Lakhs)	Riverine and Riparian Wildlife Management (Rs. in Lakhs)	Wetland Conservation (Rs. in Lakhs)
A) Phase I (Implementation Phase)							
I	Establishment	1997.46	41.16	1707.80	770.61	208	28
II	Establishment	3712.17	29.46	774.40	897.85	192	14
	Maintenance	227.07	22.07	512.34		182	25
III	Establishment	3236.99	20.94	450.04	1361.03	112	
	Maintenance	363.40	39.94	573.88		291.50	28.50
IV	Establishment	1242.64			854.22		
	Maintenance	923.67	54.60	546.06		290	20
V	Establishment	266.02			479.50		
	Maintenance	1105.60	30.95	206.17		197	15
Total Phase I	**Establishment**	**10455.28**	**91.56**	**2932.24**	**4363.22**	**512**	**42**
	Maintenance	**2619.74**	**147.56**	**1838.45**		**960.5**	**88.50**
B) Phase II (Maintenance Phase)							
VI	Establishment						
	Maintenance	938.66	13.26	67.51		96	4.50
VII	Establishment						
	Maintenance	633.29				31.50	
VIII	Establishment						
	Maintenance	229.04					
IX	Establishment						
	Maintenance	77.19					
X	Establishment						
	Maintenance						4.50
Total Phase II	**Establishment**						
	Maintenance	**1878.18**	**13.26**	**67.51**		**127.50**	**4.50**
Grand Total Phase I and Phase II	**Establishment**	**10455.28**	**91.56**	**2932.24**	**4363.22**	**512**	**42**
	Maintenance	**4497.92**	**160.82**	**1905.96**		**1088**	**93**

Table:7. 15– Year-Wise Breakup of Projected Cost on Supporting Activities in Chenab Riverscape

Sr. No.	Activity	Year (Rs. in lakh)										Grand Total (Rs. in lakh)
		Phase I					Phase II					
		I	II	III	IV	V	I	II	III	IV	V	
1.	Policy Level Interventions	7.22	3.94	2.48	1.77	1.07	0.56	0.00	0.00	0.00	0.00	**17.04**
2.	Research Activities	23.92	23.31	22.85	22.53	22.33	14.69	14.36	14.12	13.96	13.88	**185.94**
3.	Capacity Development	97.00	98.70	119.64	108.82	80.53	0.00	0.00	0.00	0.00	0.00	**504.69**
4.	Awareness	32.00	33.60	35.28	37.04	38.90	0.00	0.00	0.00	0.00	0.00	**176.82**
5.	Participatory Monitoring	17.99	16.19	14.57	13.12	11.80	10.62	9.56	8.61	7.74	6.97	**117.18**
6.	Cost of PMUs of Two State Level Implementing Agencies	179.91	133.86	140.47	147.41	154.70	59.35	54.46	51.13	48.01	45.07	**1014.37**
7.	Evaluation	0.00	0.00	45.42	0.00	0.00	75.64	0.00	0.00	0.00	101.44	**222.50**
8.	Contingency and Miscellaneous Activities	0.90	0.67	0.70	0.74	0.77	0.30	0.27	0.26	0.24	0.23	**5.07**
Grand Total of Riverscape		**358.94**	**310.27**	**381.41**	**331.43**	**310.10**	**161.16**	**78.65**	**74.12**	**69.95**	**167.59**	**2243.61**

Table:7. 16– Year-Wise Breakup of Projected Cost on Supporting Activities in Himachal Pradesh

Sr. No.	Activity	Year (Rs. in lakh)										Grand Total (Rs. in lakh)
		Phase I					Phase II					
		I	II	III	IV	V	I	II	III	IV	V	
1.	Policy Level Interventions	1.19	0.93	0.97	1.02	1.07	0.56	0.00	0.00	0.00	0.00	5.74
2.	Research Activities	11.87	12.46	13.08	13.74	14.42	7.57	7.95	8.35	8.77	9.20	107.41
3.	Capacity Development	27.00	25.20	34.46	27.78	29.17	0.00	0.00	0.00	0.00	0.00	143.61
4.	Awareness	4.00	4.20	4.41	4.63	4.86	0.00	0.00	0.00	0.00	0.00	22.10
5.	Participatory Monitoring	5.93	5.34	4.81	4.33	3.89	3.50	3.15	2.84	2.55	2.30	38.64
6.	Cost of PMUs of Two State Level Implementing Agencies	59.33	46.35	48.63	51.02	53.53	27.78	26.23	24.75	23.36	22.04	383.02
7.	Evaluation	0.00	0.00	15.43	0.00	0.00	25.89	0.00	0.00	0.00	38.30	79.62
8.	Contingency and Miscellaneous Activities	0.30	0.23	0.24	0.26	0.27	0.14	0.13	0.12	0.12	0.11	1.92
Grand Total		**109.62**	**94.71**	**122.03**	**102.78**	**107.21**	**65.44**	**37.46**	**36.06**	**34.80**	**71.95**	**782.06**

Table:7. 17– Year-Wise Breakup of Projected Cost on Supporting Activities in Jammu and Kashmir UT

Sr. No.	Activity	Year (Rs. in lakh)										Grand Total (Rs. in lakh)
		Phase I					Phase II					
		I	II	III	IV	V	I	II	III	IV	V	
1.	Policy Level Interventions	6.03	3.01	1.51	0.75	0.00	0.00	0.00	0.00	0.00	0.00	**11.30**
2.	Research Activities	12.06	10.85	9.77	8.79	7.91	7.12	6.41	5.77	5.19	4.67	**78.54**
3.	Capacity Development	70.00	73.50	85.18	81.03	51.36	0.00	0.00	0.00	0.00	0.00	**361.07**
4.	Awareness	28.00	29.40	30.87	32.41	34.03	0.00	0.00	0.00	0.00	0.00	**154.72**
5.	Participatory Monitoring	12.06	10.85	9.77	8.79	7.91	7.12	6.41	5.77	5.19	4.67	**78.54**
6.	Cost of PMUs of Two State Level Implementing Agencies	120.58	87.51	91.84	96.39	101.17	31.57	28.23	26.38	24.65	23.03	**631.36**
7.	Evaluation	0.00	0.00	29.99	0.00	0.00	49.75	0.00	0.00	0.00	63.14	**142.88**
8.	Contingency and Miscellaneous Activities	0.60	0.44	0.46	0.48	0.51	0.16	0.14	0.13	0.12	0.12	**3.16**
Grand Total		**249.33**	**215.56**	**259.39**	**228.64**	**202.89**	**95.72**	**41.19**	**38.05**	**35.15**	**95.63**	**1,461.55**

Chapter 8

Potential Benefits of Proposed Forestry Interventions

8.1 Benefits of River Restoration

Rivers provide a variety of ecosystem services which are directly or indirectly utilized by human society for its well-being. The ambit of services attributed to river ecosystems include freshwater for domestic use, livelihoods, agriculture purposes, livestock and fisheries, navigation, tourism, industry use, hydro-power development, so on and so forth to a lot of contributing areas eventually leading to prosperity and ease of livelihoods of people (Emerton and Bos, 2004; Russi *et al.*, 2013). Furthermore, riverine ecosystems play important regulatory functions e.g., support and sustain biodiversity, transport nutrients, dilute pollutants, avert droughts and control floods, etc. These services are inherently linked to different determinants which influence the health of rivers for instance water flow, water quality and ecological status (Finlayson and D'Cruz, 2005). The social and economic benefits derived from healthy rivers can be categorized into provisioning, regulatory, cultural and supporting ecosystem services (MEA, 2005) (Box- 8.1).

Thus, rivers are biologically complex *lotic ecosystems* and very important for society due to myriad services (Postel and Carpenter, 1997; Covich *et al*., 2004). But, the threat to these freshwater resources and associated services is increasing very fast due to number of anthropogenic activities (Giller *et al.*, 2004). Protection of all the vital ecosystems of earth is essential to secure benefits for society on sustainable basis (Ramsar Convention Secretariat, 2010). So, there is growing interest worldwide in the benefits associated with river restoration (Auerbach *et al*., 2014; Lewis *et al*., 2008; Gilvear *et al*., 2013). The globally growing concept of river restoration is important to compensate the damages resulting from over exploitation of freshwater resources (Henry *et al.*, 2002; Ormerod 2003; Palmer *et al.*, 2005).

The phenomenon of river restoration includes the various processes and management measures used to re-establish the natural state and functioning of the river ecosystems for the sustainable use. River restoration includes all the physical and ecological processes put in place to improve the health of the river and also strengthen the ecosystem services provided by rivers. The advantages of river restoration can be recognized in terms of the recovery of some of the important services.

BOX.8.1

CATEGORIZATION OF ECOSYSTEM SERVICES (ESS) OF RIVERS

- PROVISIONING SERVICES: These include freshwater, fish and other foodstuff, and construction materials such as sand, reeds and gravel.
- REGULATING SERVICES: These include different processes e.g. water purification by wetlands, flood and drought regulation and control of soil erosion.
- CULTURAL SERVICES: These are related to nonmaterial values of ecosystems, for example recreational benefits and aesthetic values of aquatic ecosystems.
- SUPPORTING SERVICES: These are necessary for the production of all other ecosystem services, such as primary production, nutrient cycles and storage, water cycles and carbon storage.

(Source: Adapted from MEA, 2005)

8.2 Need for River Restoration in the Context of Chenab River

In some way, the natural state and free flowing character of Chenab River is intact to certain extent particularly in the upper stretches of Himachal Pradesh. As of now, the river ecosystem is secure from the negative impacts of so called development owning to tough terrain and remoteness. Along its course, Chenab River covers a vast area of Jammu and Kashmir UT and the adverse impacts of numerous developmental activities *viz.*, road construction and expansion, hydro-power projects, pollution, urbanization and industrialization are more pronounced in case of the lower stretch of river. Even in higher extents, the marked impacts due to climate change, glacial outbursts, soil erosion, landslides, etc. cannot be understated as these stressors are also equitably responsible for degradation of Chenab River ecosystem. The degradation process is compounded by rapid expansion of agriculture and horticulture activities, deforestation and increased dependence on forest resources. Consequently, there is reduced water availability, decline in quality of water, loss of biodiversity, loss of ecosystem services, fallen utilitarian values, and various other unpredictable threats.

The in-depth review on the river and its environment revealed that a number of human induced activities over a span of past one and half century have gradually harmed the wholeness of Chenab River and altered its natural state (Fig. 8.1). The major characteristic concerns of deterioration of Chenab River and its tributaries include: (i) degraded land and

river ecosystem; (ii) excessive soil erosion, landslides and sedimentation; (iii) reduced e-flow; and (iv) deteriorated water quality.

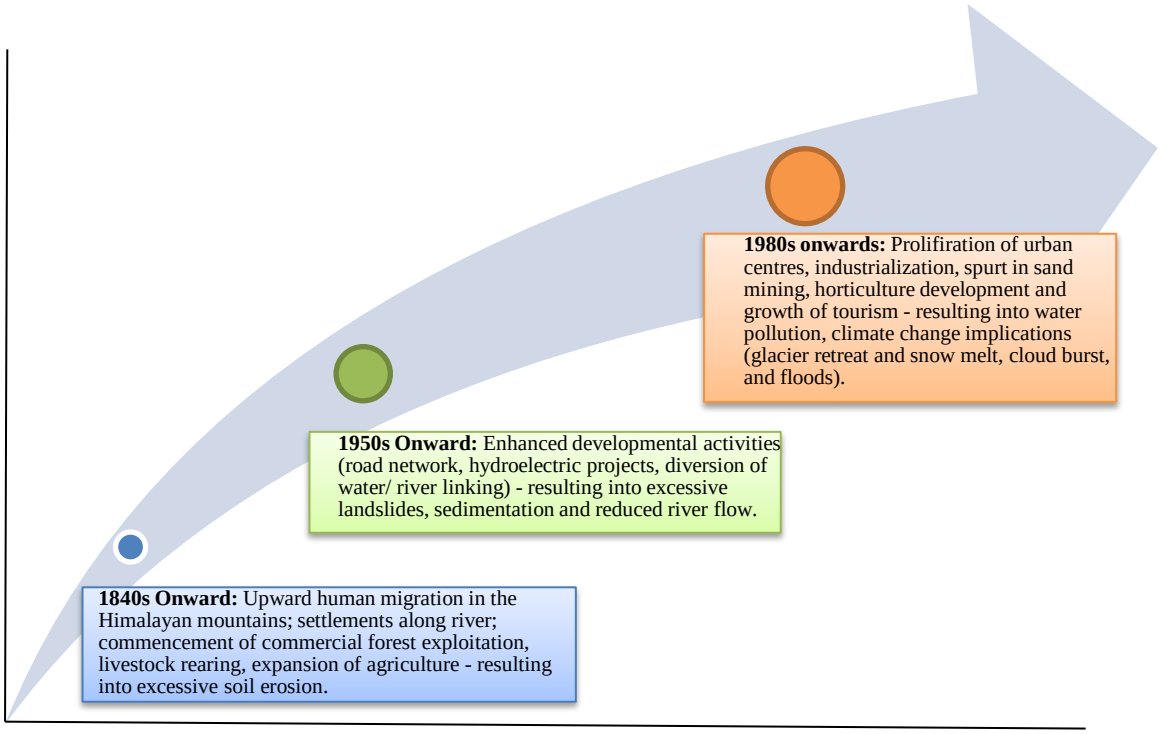


Fig.8. 1 – Gradual Process of Degradation and Growing Impact on the River Ecosystem

8.3 Strategy and Measures for River Restoration

The current DPR has adopted an exhaustive, trans-sectoral, multi-dimensional approach to tackle the major concerns of river degradation as specified above. Several potential measures have been envisaged for concurrent implementation. The proposed restoration strategy includes extensive plantation activities in Natural, Agriculture, and Urban Landscapes within the Riverscape along with appropriate bio-engineering and mechanical measures for soil and water conservation besides riparian and wildlife management, and wetland conservation. Several supporting activities *viz.*, policy level interventions, concurrent research and development, awareness, capacity development, participatory monitoring, and evaluation vital for effective and successful execution of the implementation plan have also been planned.

8.4 Potential Benefits of Proposed Forestry Interventions

The projected endeavors for restoration of Chenab River are exclusively limited to Forestry Interventions aiming for enhancement of forest cover, grassland and wetland management,

reduction in soil erosion, riparian management, and aquatic habitat management. Certainly, several other measures of engineering, hydrological, mechanical, agricultural, and bio-technological nature aiming channel and flow modification, dam removal or retrofitting, bank stabilization, storm water management and flood control, spring/ aquifer management, floodplain reconnection and channelization, channel reconfiguration, management of industrial effluents and urban waste and sewage, management of toxins, etc. are beyond the scope of the present DPR.

In relation to this, different socio-economic benefits and upgraded ecological functions anticipated as a consequence of envisaged extensive Forestry Interventions can be precisely mentioned as given below (Table- 8.1).

Table: 8.1 – Potential Socio-economic Benefits and Improved Ecological Functions as a Result of Proposed Forestry Interventions

Element	Approach to Restoration	Ecosystem Services			
		Provisioning	**Regulating**	**Cultural**	**Supporting**
Catchment	Protection and conservation of natural forests; forest plantations in Natural Landscapes, agroforestry models in Agriculture Landscapes, and development of Eco parks/ plantations in Urban Landscapes; and riparian management	Wood, NTFPs – fuelwood, fiber, fruits, medicinal plants for human consumption; grass, fodder, and grazing for livestock; increased population and enhanced abundance of native flora and fauna including Rare, Endemic and Threatened (RET) species.	Carbon sequestration by forest/ plantation and other vegetation and carbon storage in soils; water storage by forests/ plantations - function of 'Sponge' and water purification; control water temperature; lessens soil erosion, sediment and nutrient run-off; control of invasive and alien species; enhanced fluvial processes, lateral connectivity; and environmental	Aesthetic value of natural forests and riparian zones; benefit to tourism, employment generation, and areas for public recreation.	Increased and improved habitat for biodiversity on land and in stream/ rivers; checking soil erosion, water conservation; and sediment changes.

Element	Approach to Restoration	Ecosystem Services			
		Provisioning	**Regulating**	**Cultural**	**Supporting**
			amelioration.		
Flow regime	Water availability and e-flow	Boosted water availability and enhanced e-flow; affect other services	Alter the timing and delivery of water; improvement in water quality; enhanced longitudinal and vertical connectivity	Increased ecotourism and recreation	Important fish spawning habitat and benthic invertebrates
Habitat	Instream habitat improvement and bank stability	Increase in availability of aquatic fauna; and conserve native species.	Increased oxygenation and sediment flushing of water; reduced diffuse and point source pollution.	Improved aesthetics and environment for recreation	Physical habitat heterogeneity; enhanced biodiversity; Improves and stabilizes physical habitats for breeding; increased richness and abundance of macro-invertebrates, etc.
Water Quality	Improvement in water quality	Supports aquatic fauna and enhancement diversity of native species.	Improvement in instream water quality and reduces competition for resources.	Enhances the economic and social amenity value; and improves the quality of life.	Reduces habitat inhabitance by invasive species and increase in population and abundance of RET species.
Biodiversity	Species management	Increase in availability of native species and other aquatic fauna	Improves water quality and habitats for native species	Improves river health and recreational activities.	Alter aquatic native species distribution and abundance.

(Source: Adopted and Modified from Speed *et al*., 2016)

8.5 Plantation Forests

Forests act as reliable resource base for society by providing timber, fuel wood, fodder, medicinal plants, Non Timber Forest Products (NTFPs) and perform important ecological functions of watershed protection, regulation of water flow, filtration of pollutants, and recharging the ground water level, carbon sequestration and preservation of biodiversity (USDA, 2013).

Traditionally, several goods and services from forest ecosystems have been viewed as free benefits to society. Several ecosystem services provided by forests are difficult to quantify and thus, neither market exists for many of them nor have their values seldom been reflected in market prices. Since long, the valuation system of forests resource was grossly incomplete as little attention was given to develop a comprehensive system for different goods and services supplied by forests (Kengen, 1997a). Despite the immense benefits, forested landscapes have been deforested globally resulting in depletion of forest resources and the services. Degradation of forests has potential consequences for society at the local, regional and global levels (Brown and Pearce, 1994). The rainfall pattern and surface temperatures changes drastically due to deforestation (Miller and Cotter, 2013). Mankind has altered and transformed 40 to 50% of the terrestrial surface of the Earth and appropriates about 20% of the global net primary production (Imhoff *et al.*, 2004). The projections also stress that natural ecosystems are being replaced that provide enormous benefits to human society by plantation forests.

Tree plantations are artificial forests that differ greatly from natural forest ecosystems in terms of their structure, composition and functions. Afforestation through tree plantation is a good tool for environmental restoration. Planting trees lead to increase in rainfall and reduce the surface runoff (Avissar and Otte, 2007). While the area of natural forests is shrinking, tree plantations are expanding at a rapid rate and dominate the landscapes in some regions of the world (Kanninen, 2010). Forest plantation is defined as 'Forest or other 'wooded land of introduced species and in some cases native species, established through planting or seeding'. Forest plantations are divided into two sub groups: 'Productive Plantations' and 'Protective Plantations' (FAO, 2005). Forest plantations mainly intended for the provision of wood, fiber and non-wood products are referred as Productive Plantations while forest Plantations meant for the provision of services such as the protection of soil and water, rehabilitation of degraded lands, combating desertification, etc. are being referred as protective plantations. As per FAO (2005), forests plantations cover about 140 million hectares (Mha) globally, representing about 4% of the global forest area. In 2000, plantations supplied one third of the total demand for industrial round wood. CIFOR (2001) has provided the typology of planted forests as they are not only distinguished by their different purposes but also by their spatial scale, management intensity, structure and ownership. Accordingly, planted forests based on type and purposes have been named as: (a) industrial plantations (i.e., timber, biomass, food); (b) home and farm plantations (i.e., fuelwood, timber, fodder, orchards, forest gardens, etc.); (c) agroforestry plantations (i.e., fuelwood, timber and fodder); and (d) environmental plantations (i.e., windbreaks, soil protection and erosion control, wildlife management, site

reclamation or amenity). In addition, the 'Managed Secondary Forests', where forest composition and productivity is maintained through additional planting or/ and seeding are regarded as a transitional type between plantations and other forest types. This broadening of the definition almost doubles the area of planted forests and estimated to be around 270 Mha, compared to around 140 Mha reported earlier as forest plantations (Kanninen, 2010; Bauhus *et al*., 2010).

In view of the above, proposed forest plantations in Natural Landscapes would fall in the category of 'Protective Plantations', particularly 'Environmental Plantations' as defined by CIFOR, (2001). Some of these plantations are specifically intended as 'Enrichment Plantations' in managed forests through additional planting or/ and seeding. Proposed plantations in Agriculture Landscapes are mainly aimed for the purpose of increase in tree cover in TOFs and subsistence or local sale and for their benefits alongside agriculture production and thus, would fall under the category of agroforestry plantations. Proposed plantations in the Urban Landscapes along roads, railway lines, and canals, and in educational and industrial estates would also fall in the category of environmental plantations. Thus, it is evidently clear that majority proposed plantations in three types of landscapes within the Chenab Riverscape are neither 'Productive' nor 'Commercial' in nature, except a small extent of agroforestry plantations proposed on private lands. Even agroforestry plantations would also immensely help in increasing the tree cover in TOFs

8.5.1 Forest Plantations – Myths and Reality

Notwithstanding, the recognized benefits of forest plantations there are many myths which shroud plantation forestry or fast –wood forestry. The planted forests are believed to cause negative impacts manifested in different forms (Van Wilgen and Richardson, 2012). Cossalter and Pye-Smith, (2003) have attempted to sort facts from fiction, truth from misinformation, as far as fast-wood forestry is concerned. In some situations, fast-wood plantations have caused environmental and social problems and it is a truth that such plantations are a bad thing. Thus, undesirable to some extent; while in other situations, they can yield benefits not just for the economy, but for the environment, and local communities. Growing fast-wood can be an efficient way of producing timber and pulpwood and such plantations can be a profitable investment for the involved companies as well as for the society. However, environmentalists dislike all large-scale mono-cultures, particularly of exotic species as they not only adversely impact the local environment but offer much reduced ecosystem services than natural forests. However, there are genuine concerns and problems related to establishment of forest plantations. But, it is also true that growing trees accrue many benefits to society if forest plantations are carried out sustainably.

8.5.2 Planted Forests - River Flow and Water Conservation

There are growing threats to the availability and quality of water in many parts of the world due to overuse, misuse and pollution and the influence of forests on the water resources is

increasingly felt. In addition to this, the climate change is also affecting the role of forests by altering water flows and influencing the availability of water resources (Bergkamp *et al.*, 2003). Usually, it is fairly assumed that forests are the best for increasing water yield, regulating seasonal flows and ensuring good water quality. The importance of forests and trees to rainfall and water supply include: improvement of water cycle, reduction of runoff, improving the replenishment of the water table, filtration of water pollutants, and control of floods (Ekhuemelo *et al*., 2016). On this basis, it can be concluded that safely expansion of forest cover in the upstream watersheds are effective to increase water availability for multiple uses in downstream areas. Trees have been around for more than 370 million years, and presently there are about 80,000 species, covering 3.5 billion ha area worldwide, including 250 million ha of commercial plantations. Forests provide enormous environmental, social and economic benefits to the society as well as to nations, they affect the hydrological cycle in various ways (UNESCO, 2017). Some forest hydrological scientific studies indicate that the benefits of upstream forests in augmentation of downstream water yield and enhanced flows are wrong. In case of the arid or semi-arid ecosystems, forests are not the greatly responsible for increase downstream water availability the protective role of upstream forest cover has been miscalculated (Bruijnzeel, 2004; Calder, 2005, 2007; Van Dijk and Keenan, 2007). There exists a significant disparity between public and scientific perceptions of the hydrological role of forests and plantations (Calder, 2002). The paper by Vertessy *et al*. (2002) recapitulates the state of knowledge and discusses the development in human understanding of how plantation development affects the water and salt balances of catchment. The study concluded that large scale plantation development will exert additional pressure on a water resource system that is already under considerable stress and also stated that tree planting will reduce river flows and recharge to groundwater. They argued that water used by plantation should be factored into water economy and catchment. Vertessy *et al*. (2002) also stated that the phasing of afforestation is an important factor that would mitigate against the maximal hydrologic impacts being realized. Plantings within a catchment are usually made over a period of years, leading to a mixture of stand ages. In most situations, the full hydrologic effect of plantations is not attained until the stand has reached about 8-15 years of age. Thus, in their opinion, any catchment containing a significant portion of young stands will not exhibit the maximum hydrologic effects of afforestation. Further, they documented that there is also some evidence to indicate that evapotranspiration rates in mature forests stands are lower than in vigorously growing ones with decrease starting to become apparent after 30-35 years. UNESCO (2017) stated that it is now well documented that at local scales of several thousands of hectares, replacement of shallow-rooted vegetation with forest usually reduces stream flow but may improve water quality. There are ample scientific evidences that different plantation species respond differently in use of water. Some use more water than others. Selection of species is critical. It is well documented that exotic species like *Eucalyptus* use more water than pine plantations (Scott *et al*., 2005).

The overall impact on water yield largely depends upon the extent of the catchment planted and the spatial configuration of the trees. It is difficult to reliably detect the effects of runoff if the proportion of the catchment reforested is below a certain threshold because rainfall and the hydrological effect of the catchment surface, soil profile and vegetation vary across

catchments (Keenan and Van Dijk, 2010). Vertessy *et al.* (2003) suggested that planting trees on upper slopes will potentially have much less impact on stream flow than planting same area on lower slopes, at least in water limited environments. Afforestation and catchment has long been promoted to reduce soil erosion, nutrient and sediment input to streams. Surface runoff is a major driver of soil erosion and river pollution. Afforestation/ reforestation can reduce surface runoff and soil erosion (Bruijnzeel, 2004; Sidle *et al.*, 2006). Tree cover alone affords some protection by reducing the direct impact of rainfall, but maximum erosion protection is provided with development of litter layer, understory growth and the surface roughness provided by tree roots. Belts of trees can act as 'Filter Strips', intercepting and transpiring surface runoff and nutrients before they reach the stream (Ellis, 2006). A variety of analytical tools have been developed to assess the potential impact of planted forests on water yield or quality. However, the accuracy and reliability of these models is also constrained by data availability, particularly for soil properties (Scott *et al*., 2005).

The growing literature on the theme of planted forests and water has enhanced the understanding of the interactions between planted forests and water. Certainly, trees tend to use more water than shallow rooted forms of vegetation such as crops, pastures, grasslands or shrublands. However, it is difficult to detect the effect of afforestation on hydrology, if less than 20% of the catchment is planted (Zhang *et al.*, 2006). There are some obvious differences between species in these effects, and impacts can be mitigated through plantations activities such as belt and strip plantings, thinning and managing rotation lengths. In catchments with degraded soils, afforestation may increase infiltration, water storage and stream flow. The impact of afforestation and development of planted forest on minimizing the impact of flooding is likely to be limited to smaller catchments. Planted forest may reduce the frequency of shallow earth movements and landslides, but are not likely to impact on large scale debris flows and earth movements, which are primarily a result of the combination of extreme rainfall and catchment hydrology (Keenan and Van Dijk, 2010).

Assessing the impact of planted forests on water yield and availability will primarily depend on the nature of the catchments, impoundment and water management system and losses due to evaporation and other impacts. Simplistic calculations based on forest evaporation may give a misleading picture of the impacts of plantations on water availability downstream. Thus, Keenan and Van Dijk (2010) and Bauhus *et al*. (2010) concluded that sophisticated decision support tools integrating a process based understanding on forest physiology, geological and hydrological processes and climatic variables can provide more realistic assessments and insight of the potential impact of planted forest on water.

Despite growing literature on the above stated theme of plantations and water, there is evident acute deficiency of relevant literature from a vast country like India. Much of the available insight comes from different parts of the world and may not be relevant considering the complex and violent nature of Himalayan Rivers and the fact that the mountainous tract of the Himalaya was once well covered by diverse and dense forests, except the Trans-Himalayan region. It is only in the past 150 years or so that the forested territories have been impacted by rapidly increasing anthropogenic activities.

8.5.3 Ecosystem Good and Services - Key for Sustainable Plantations

Across different regions of the world, plantations have been successfully used to compensate the losses of deforestation, degradation of aquatic resources (Parrotta *et al*., 1997). Sustainable plantations effectively restore the economic, social or environmental services provided by forests and fresh water ecosystems (Chokkalingam *et al*., 2006; de Jong, 2010). Plantations maintain water and nutrient cycles, checks soil erosion, and provides shelter for biodiversity (Lamb *et al*., 2005; Mansourian *et al*., 2005). There is a growing evidence, knowledge and experience that plantation forests can play varied roles, if appropriately planned, designed and managed. However, there is a need to realize that the benefits and impacts of plantations are highly context specific. Thus, the range of impacts and benefits associated with plantation forests which typically differ from those of other landscape components such as native forests or agricultural lands need to be carefully considered, assessed, agreed upon and managed in a landscape context. One of the major environmental benefits of plantations is that they help in reducing the harvesting pressure on native and semi-natural forests. Societies have the right to expect that plantations will deliver more benefits than costs. Thus, enhancing the ecosystem goods and services plantations can offer to the society is an important facet of plantation forestry (Bauhus *et al*., 2010).

Despite simplicity in structure and shape, and high intensity of management inputs needed, tree plantations can play an important role in addressing and mitigating some of the pressing current global challenges *viz*., land degradation, increasing demands for forest based resources, water availability and conservation, energy, poverty, climate change, or even the loss of biodiversity. Cossalter and Pye-Smith (2003), have documented that where plantations were raised on degraded lands, many ecosystem services were improved. Livelihoods of a considerable population in rural areas depend on the use of degraded land. Thus, restoration through appropriate afforestation measures would provide higher returns (Hunter *et al*., 1998). Ignoring the immediate needs of local communities and replacing their use of land with plantations that could not support and maintain their livelihoods has often led to the failure of many of such projects in the past. Thus, it is essential that local communities are involved right from the planning stage, engaged in various works and their livelihoods are being maintained.

According to FAO (2007), the maintenance and enhancement of ecosystem goods and services of planted forests is central to all principles. Explicitly, intelligent solutions for plantations should feature ecological restoration and aim to achieve optimal productivity of multiple products and services besides they have to be economically beneficial to local communities. Increasingly, there is a growing emphasis that plantations must not be simple or have a narrow focus or the design may not just be concerned with the choice of trees planting species and the arrangement of trees, but with the creation of entire ecological communities and functioning landscapes to meet specific services (Shiyomi and Koizumi, 2001; Kirschenmann, 2007). Options to improve water services from plantations at the landscape scale are largely related to the percentage area under plantation, the specific location of plantations and the protection of soil and waterways. At the landscape level, interspersing

plantations with buffer strips and reserves of native vegetation creates patches with more long term carbon storage than in the plantation stands.

The description given above provide abridged account about the likely advantages of river restoration practices/measures, specifically potential benefits of the proposed Forestry Interventions or planted forests. It also highlighted the different dogmas, misleading assumptions, and actual facts of forest plantations and develops understanding how restoration measures can help in obtaining enhanced ecosystem goods and services as a result of planned strategies.

8.6 Projected Potential Benefits of Proposed Forestry Interventions

India is looking forward to achieve the ultimate objective of having 33% of its geographical area under forests and tree cover in spite of the ever escalating and conflicting demands of other sectors on woodlands (MoEF&CC, 2018). Moreover, in its Nationally Determined Contribution (NDC) targets given to the United Nations Framework Convention on Climate Change (UNFCCC) under Paris Agreement, India is committed for creation of carbon sink equivalents to 2.5 - 3 billion tonnes of $CO_2$by 2030 through additional forest and tree cover.

The dynamic, complex, and inherent linkages between forests and rivers delved deeply in relevant sections of this DPR. The longitudinal, lateral and vertical connectivity existing between these two natural ecosystems have also been highlighted. Besides this, there is enough discourse on the variety of goods and services provided to society by forest and rivers and various detrimental impacts of anthropogenic activities on these unique ecosystems. The present DPR envisioned extensive Forestry Interventions consisting of large scale plantation activities in three Landscapes (Natural, Agriculture and Urban) within the Riverscape, planned conservation interventions and supporting activities for maintaining the ecological integrity of Chenab River ecosystem. Ultimately, the prospective gains from these endeavors would be gauged by improvement in different hydrological characteristics and catchment attributes. There might be considerable addition to the forest cover, less soil erosion and low sedimentation, better water quality, higher environmental flow (*e-flows*), increased water availability, increased urban greens, boosted ecosystem services, improved livelihoods and reasonable contribution for climate change mitigation through carbon-sequestration. More accurately and concisely, the probable gains from proposed Forestry Interventions on Chenab Riverscape can be projected as given below.

8.7 Climate Change mitigation benefits through Forestry Interventions in the Chenab Riverscape

8.7.1 Climate Change

Climate Change is the major global environmental challenge and threat to humanity with lot of implications for freshwater supply, natural ecosystems, food production, health, biodiversity, etc. There is universal consensus among scientific community that climate

change is already happening and the Earth's climate system has drastically changed on both global and regional scales. The concentration of carbon dioxide (CO_2)and other greenhouse gases (GHG's) in the atmosphere has considerably increased over the last century and is set to increase further, the larger proportion of which is resulting from the burning of fossil fuels and the conversion of tropical forests to agriculture (Paustian *et al*., 2000). The amount of anthropogenic CO_2 emitted to the atmosphere, primarily because of expanding use of fossil fuels for energy has risen from pre-ndustrial levels of 280 parts per million (ppm) to over 400 ppm. Intergovernmental Panel on Climate Change (IPCC) stated that "Human influence on the climate system is clear, and recent anthropogenic emissions of GHGs are the highest in history. Recent climate changes have had widespread impacts on human and natural systems" (IPCC, 2014). According to IPCC (2014), globally CO_2 emissions from fossil fuel combustion and industrial processes contributed about 78% of the total GHGs emission increase from 1970 to 2010. An estimated 23% of total anthropogenic GHGs emissions (2007-2016) derived from Agriculture, Forestry and Other Land Use (AFOLU) (IPCC, 2019). The IPCC report on the impacts of global warming of 1.5°C above pre-industrial levels (IPCC, 2018) has highlighted that average global Earth's temperature has increased by about 1°C as compared to pre-industrial level due to anthropogenic activities. In line with increasing trends witnessed in global surface temperature, the average yearly temperature over India for the period 1901 to 2017 has shown significant rising trend of 0.66°C over 100 years. Extreme events like heat waves have risen in past 30 years (MoEFCC, 2017).

8.7.2 Forests for Climate Change Mitigation

Forests play a key role in mitigation of climate change because they act as one of the biggest sinks for sequestration of the atmospheric CO_2 (Streck, 2012; Angelsen and Wertz-Kanounnikoff, 2008). Intrinsically, forests and climate change are directly linked to each other. Forest ecosystem during the process of photosynthesis, absorbs the CO_2 from the atmosphere and releases oxygen into the atmosphere. Role of forests has been increasingly recognized as most cost-effective option for climate change mitigation through carbon captured in biomass and soils. Forests are considered to provide a large climate change mitigation opportunity at relatively lower costs along with other significant co-benefits. Global forests cover around 30% of Earth's surface, spread over about 4 billion hectares of land mass. Forestry mitigation options including reduced deforestation, forest management, afforestation, and agro-forestry are estimated to contribute 0.2-13.8 $GtCO_2$/yr of economically viable abatement in 2030 (IPCC, 2014). Thus managing our forests for carbon storage will help to absorb atmospheric CO_2. Expansion of land under vegetative cover through afforestation and reforestation programs is another important component of forestry activities that could store more and more atmospheric carbon. Forestation implies increasing the amount of carbon stored in vegetation both above and below ground, dead organic matter and medium and long-term wood products (Watson, 1996).

In forest ecosystem, the carbon is stored in the growing stock (i.e., standing trees, herbs, shrubs, etc.) and in the soil. The cutting down of trees and removal of vegetation from the forest ecosystem for fuelwood, timber, fodder, etc. releases the stored carbon in the form of

CO_2. Various anthropogenic activities like burning of fossil fuels, industrial as well as urban growth, deforestation and forest degradation are mainly responsible for increasing the concentration of CO_2 and other GHGs into the atmosphere. The overall contribution from agriculture, forestry and other land use (AFOLU) sector is around one quarter of the global anthropogenic GHGs.

8.7.3 Carbon services of India's forests

Forest is the second-largest land use in India after agriculture. Roughly, 275 million rural people in India depend on forests for at least part of their subsistence and livelihood (World Bank, 2006). As per the India State of Forest Report (ISFR, 2019), the forest cover of the country stood at 712,249 km^2, while it was 708,273 km^2 in 2015 (ISFR, 2017), recording an increase of 3976 km^2 within two years. The total forests and tree cover of the country is 24.56% of its geographical area. The National Forest Policy of India envisages 33% of its geographical area under forests and trees cover.

The Land Use Land Use Change and Forestry (LULUCF) sector was source of CO_2 in the year 1994 accounting for 1.16% of CO_2eq emissions when India submitted its first National Communication (NATCOM) to UNFCCC in 2000 (MoEF, 2004). With its focus on sustainable management of forests, afforestation and regulating diversion of forest lands for non-forest purposes, India has been successful in improving carbon stock in its forests. In 2017, estimated carbon stock in forest was 7,124.676 million tonnes (ISFR, 2019) while in 2015 it was 7082 million tonnes (ISFR, 2017) which is a net increase of 42 million tonnes in country's carbon stocks within two years. Various national programmes and policies have converted India's forests into net sink of CO_2. In its second National Communication, LULUCF sector was a net sink of 17% of total national emissions (MoEF, 2012). India's first biennial update report to UNFCCC has reported that the LULUCF sector was a net carbon sink offsetting 252.5 million tonnes of CO_2e which is 12% of India's total GHGs emission (MoEFCC, 2015). LULUCF sector was a net sink of 301,193 million CO_2e during 2014, registering an increase in the sink activity of the sector. Cropland dominates the CO_2 emissions /removal estimates for India for the year 2014. Forest lands were net sinks and about 12% of India's GHGs emissions were offset by the LULUCF sector (MoEF&CC 2018a). Thus, forestry sector in India is making positive contribution for climate change mitigation.

8.7.4 Fulfilling International Commitments on Climate Change

Fulfilling emission reduction commitments under the United Nations Framework Convention on Climate Change (UNFCCC) and Paris Agreement on Climate Change, Government of India, launched India's National Action Plan on Climate Change (NAPCC) in 2008. In 2015 Government of India Nationally Determined Contributions (NDC) under Paris Agreement committed to create an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 equivalent through additional forests and trees cover by 2030.

(i) National Mission for a Green India (GIM): India'sNational Action Plan on Climate Change (NAPCC) launched in June 2008 identifies several measures that simultaneously advance the country's development and climate change related objectives of adaptation and mitigation. The implementation of the NAPCC is designed to take place through eight National Missions, which form the core of the National Action Plan on Climate Change and incorporate multi-pronged, long-term and integrated strategies for achieving India's key goals in the context of climate change. National Mission for a Green India also known as Green India Mission (GIM) is one of the key missions under NAPCC dealing with mitigation and adaptation of climate change in the forestry sector (MoEF&CC, 2014).

Green India Mission puts the "Greening" in the context of climate change adaptation and mitigation, meant to enhance ecosystem services like carbon sequestration and storage (in forests and other ecosystems), hydrological services and biodiversity; along with provisioning services like fuelwood, fodder, small timber and Non-Timber Forest Produce (NTFP).

The GIM aims at responding to climate change by a combination of adaptation and mitigation measures, which would help in; (i) enhancing carbon sinks in sustainably managed forests and other ecosystems; (ii) adaptation of vulnerable species/ecosystems to the changing climate; and (iii) adaptation of forest dependent local communities in the face of climatic variability. In view of recent global climate negotiations and India NDC Commitments under agreeing to Paris Climate Change Agreement, Government of India is in the process of revising the Objectives and Targets under Green India Mission.

(ii) India's Nationally Determined Contribution (NDC) for Forestry Sector

Under Paris Climate Change Agreement, India has committed to meet its Nationally Determined Contribution (NDC). The Forestry sector goal of NDC beside other goals commits to create an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 equivalent through additional forests and trees cover by 2030. To achieve this, India is determined to continue with its on-going interventions, enhance the existing policies and launch new initiatives in the priority areas *inter alia* full implementation of Green India Mission and other programmes of afforestation. Planned afforestation has been seen as a major mitigation strategy in forestry sector. India is one of the few countries where forest and tree cover have increased in recent years transforming country's forests into a net sink owing to National Policies aimed at conservation and sustainable management of forests.

India's efforts to increase the forests and trees cover have been further augmented by policies like National REDD-plus Strategy (2018a), National Agroforestry Policy (2014), Joint Forest Management Guidelines 1990; National Afforestation Programme, *Namami Gange* Programme, Green Highways Mission, and afforestation under Compensatory Afforestation Fund Management and Planning Authority Act (UNFCCC, 2015). The aforesaid actions are major drivers listed by India in its INDC submitted to UNFCCC to achieve the target of capturing 2.5 to 3 billion tonnes of additional CO_2 equivalent. The recent initiatives of afforestation along the major river basins of the country through Forestry Interventions will further contribute to additional carbon sequestration through afforestation activities.

8.8 Forest Carbon Assessment

Forests are both source and sink of CO_2. A growing forest captures atmospheric carbon and this carbon is released into the atmosphere through activities like deforestation and forest degradation. The climate change mitigation benefit of afforestation/reforestation activities is one of the ecosystem services rendered by trees which are fully measurable, reportable and verifiable. Measurement of forest carbon stocks is a vital part of this unique Ecosystem Services because CO_2 emission reductions and removals by implementing various forestry activities are estimated by measuring changes in the amount of forest carbon, and credits are also issued on the basis of carbon accrued through these actions.

8.8.1Carbon Pools: In a forest ecosystem carbon is stored in different carbon pools

Carbon Pool may be defined as a system that has the capacity to store or release carbon. For the estimation of carbon pools in a forested stand, IPCC (2003) identified five carbon pools as described in **Table 8.2.**

Table: 8.2- Definitions of terrestrial carbon pools (IPCCGPG, 2003)

Pool		**Description**
Living Biomass	Above Ground Biomass	All living biomass above the soil including stem, stump, branches, bark, seeds, and foliage. **Note:** In cases where forest understorey is a relatively small component of the above ground biomass carbon pool, it is acceptable for the methodologies and associated data used in some tiers to exclude it, provided the tiers are used in a consistent manner throughout the inventory time series.
	Below Ground Biomass	All living biomass of live roots. Fine roots of less than (suggested) 2 mm diameter are often excluded because these often cannot be distinguished empirically from soil organic matter or litter.
Dead Organic Matter	Dead wood	Includes all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps ≥ 10 cm in diameter or any other diameter used by the country.
	Litter	Includes all non-living biomass with a diameter less than a minimum diameter chosen by the country (for example 10 cm), lying dead, in various states of decomposition above the mineral or organic soil. This includes the litter, fulvic, and humic layers. Live fine roots (of less than the suggested diameter limit for below-ground biomass) are included in litter where they cannot be distinguished from it empirically.
Soil	Soil Organic Matter	Includes organic carbon in mineral and organic soils (including peat) to a specified depth chosen by the country and applied consistently through the time series. Live fine roots (of less than the suggested diameter limit for below-ground biomass) are included with soil organic matter where they cannot be distinguished from it empirically.

Note:*National circumstances may necessitate slight modifications to the pool definitions used here. Where modified definitions are used, it is good practice to report upon them clearly, to ensure that modified definitions are used consistently over time, and to demonstrate that pools are neither omitted nor double counted.*

Forest carbon stocks in India's Forests and relative percentage proportion of carbon in different pools in forest riverscape State/UT is given in **Table 8.3**. The / ha stock (tonnes/ha) in different carbon pools of Himachal Pradesh, Jammu and Kashmir UT are given in Table 8.3

Table: 8.3- Forest Carbon Stock in the states of Himachal Pradesh and Jammu and Kashmir UT and along with different carbon pools in Million tones

Sr. No.	Carbon Pool	National	Himachal Pradesh	Jammu and Kashmir UT
1.	Aboveground biomass	2,256.533	110.045	170.222
2.	Belowground biomass	700.824	30.745	47.806
3.	Litter	127.902	2.711	3.706
4.	Dead Wood	35.842	2.559	3.813
5.	Soil Organic carbon	4003.575	106.300	1,64.648
	Total	**7,124.676**	**252.360**	**390.195**

(Source: ISFR, 2019)

Table: 8.4- Per ha stock (tonnes/ha) in different carbon pools of Himachal Pradesh and Jammu and Kashmir UT

Carbon Pool	National		Himachal Pradesh		Jammu and Kashmir UT	
	ISFR 2017	ISFR 2019	ISFR 2017	ISFR 2019	ISFR 2017	ISFR 2019
Aboveground biomass	31.59	31.68	46.79	71.30	48.59	72.09
Belowground biomass	9.86	9.84	12.38	19.92	12.94	20.25
Litter	0.43	0.50	1.66	1.76	1.52	1.57
Dead Wood	1.92	1.80	0.49	1.66	0.43	1.62
Soil Organic carbon	56.19	56.21	55.09	68.87	55.09	69.73
Total	**99.99**	**100.03**	**116.41**	**161.51**	**118.72**	**165.51**

(Source: ISFR, 2017, 2019)

8.9 Carbon sequestration benefits of Forestry Interventionsfor Rejuvenation of Chenab Riverscape in Himachal Pradesh and Jammu and Kashmir UT

8.9.1 Potential of production Forestry for Carbon Sequestration in India

The National Forest Policy 1988 envisages bringing one-third of the geographic area of the country under forest tree cover for maintaining ecological balance and environmental

stability. India has been witnessing continuing improvement in existing policies and formulation of new policies, and thus trying to keep pace with the activities and programmes to strive towards achievement of the Country's National Goal of 33% forest/ tree cover as enunciated in National Forest Policy. To realize this goal India has to bring about 109 Mha (33% of its total geographic area) of 328 Mha of land under forest / tree cover. An extent of 4.6 Mha (1.41%) of scrub forests is also available in addition to the forest cover of 69.2 Mha. The difference in existing forest cover and the target area suggests that an additional 30 Mha has to be brought under the tree cover to achieve 33% tree cover as envisaged in National Forest Policy. This can be achieved by establishing plantations on non-forestland and through agro-ecosystems in existing agricultural lands. Forestry Interventions in the Riverscapes of Chenab, Satluj, Jhelum, Beas and Ravi Rivers will further contribute to achieve National Goal of 33% forest and tree cover.

8.9.2 Forest Productivity in India

The potential yield of natural forests in India is ($6m^3$/ha/year). Some of the plantation crops like *Eucalyptus*/poplars are fast growing species, and are planted for maximum volume production. They are expected to yield much higher than the potential yield of natural forests. This has been exemplified in the case of Brazil and South Africa, where actual yield are two and three times, respectively to the potential yields (Brazil: $11m^3$/ha/yr and Republic of South Africa: $7m^3$/ha/yr). The comparison between actual Permanent Sample Plot (PSP) data and actual yield for some of the plantation species has been obtained almost in the range of potential yield (Pande, 1995). However, well managed plantations are expected to gain much higher than potential yield of natural forests. In India, it is expected that correct site and species matching, genetic improvement and adequate tending operations can improve the growth rate of plantations by at least 100 % (FAO, 1995). Newly planted or regenerating forests, in the absence of major disturbances, are likely to continue to uptake carbon for 20 to 50 yrs or more after establishment, depending on species, site conditions and objective of plantations.

(i) Potential of Plant Biomass for carbon abatement: The current productivity of the forests is very poor and ranges between 0.7 and 1.5 m^3/ha/yr as against the world average of 2.1 m^3/ha/yr. The MAI in India can vary between 3t/ha/yr under degraded land conditions to 12 t/ha/yr with genetic improvement and addition of fertilizers (Rawat, 1996). Increase in forest productivity directly indicates an increase in forest biomass and higher carbon sequestration. Despite commendable efforts made in the country towards improvement of planting stock material productivity of plantation is still much low (5-10 m^3/ha/yr). This is attributed to use of unimproved seed/clonal planting material, not matching species with site and poor management practices. The productivity of fast growing tree species of *Acacia, Casuarina, Eucalyptus* and *Populus* has increased from 10 m^3/ha/yr to more than 40 m^3/ha/yr by the use of improved clones, adoption of clonal technology site matching with clones and proper management practices (Kumar *et al*. 2016). Kant (2005) has reported Tree productivity of *Cryptomaria japonica* upto 39 m^3/ha/yr from Himalayan bio-geographic zone and upto $35m^3$/ha/yr for *Gmelina arborea*in North-eastern bio-geographic zone. Kant (2005)

applied Paterson Productivity Index to the 10 bio-geographic zones in the country and developed following scenarios (Table 8.5).

Table: 8.5- Potential productivity of different bio-geographic zones of India

S. No.	Bio-geographic zone	Description	Potential Ecosystem Productivity (m^3/ha/yr)
1	Trans-Himalayan	Ladakh and high altitude zones abutting Tibet, very cold and arid, and sparse alpine vegetation	Unproductive
2	Indian Desert	Thar and Kutch in western India, sandy deserts, seasonal marshes, and sparse thorn forests	1-3
3	Semi-arid zone	Plains of Punjab, Haryana, Gujarat, Eastern Rajasthan, west-central UP, and western MP. Most lands under agriculture, and limited forested area	3-6
4	Himalayan bio-geographic zone	Four distinct biotic provinces of north, west, central and eastern Himalayas Sharp altitudinal differences. Well forested and also degraded in places, rich biodiversity. Tea cultivation in eastern part.	6
5	Deccan Peninsula	Raised land covering 40% of India; bound by Satpura, western ghats and eastern ghats; elevation ranges from 300 - 1000 m in east; and covered by tropical dry and moist forests	6-9
6	Gangetic Plains	Plains of UP, Bihar, West Bengal; most fertile alluvial soils, mostly under crop; and very little forest cover	6-9
7	Northeastern bio-geographic zone	Brahmputra and Barak River valleys and north eastern hills; evergreen and moist deciduous forests, and heavily subjected to shifting cultivation	9-12
8	Coastal region	Coastal belts of west and east coasts, higher rainfall in west, exposure to cyclones in east, and extensive casuarinas plantations on eastern coast. (i) Western Coast	>12
		(ii) Eastern Coast	9-12
9	Western /Eastern Ghats	Moderately high hill range along west coast, eastern side under rain shadow, very rich in bio-diversity and forest cover; large extent under tea, rubber, coffee, cardamom, tapioca; and significant area under protected areas for wild Life (i) Western Ghat	>12
		(ii) Eastern Ghat	9-12
10	Indian Islands	Group of 325 islands in Andaman Sea and also Lakshadweep along west coast; heavy rainfall, warm and humid climate, and extensive forest cover	>12m^3/ha/yr

(Source: Champion and Seth, 1968; Kant, 2004; Lal, 1992; WII, 2000)

8.9.3 Carbon Sequestration from Carbon forestry projects

India is the leading country in carbon forestry in so far as carbon trading under Clean Development Mechanism (CDM) of United Nation Framework Convention on Climate Change (UNFCCC) is concerned. A total of 19 CDM Forestry Projects are registered from India under CDM. Average Reduction (metric tonnes CO_2 per year per ha) by the plantation activities under CDM project in India is in the region of 16 Metric Tonnes of CO_2 /ha/year. However, The estimated CO_2 mitigation the CDM project registered in Himachal Pradesh is expected to capture 10.34 tonnes of CO_2 per ha per annum (Box-8.2). The low carbon mitigation from the project (10.34 tonnes of CO_2 per ha per annum) as compared to National average (16 Metric Tonnes of CO_2 /ha/year is attributed to the nature of landscape where this project was implemented.

(i) Market Potential of Forestry Interventions for Climate Change Mitigation

Role of forest plantations has been increasingly recognized as most cost effective option for climate change mitigation through carbon captured in biomass and soils. Carbon offset opportunities include reforestation, afforestation, farm forestry and improved soil management practices. Fulfilling their emission-limitation commitments under the Kyoto Protocol of UNFCCC, industrialized countries can claim credit for carbon captured in developing countries by executing afforestation and reforestation (AR) projects under Clean Development Mechanism (CDM) projects. Further, Government of India in its Nationally Determined Contributions (NDC) to UNFCCC also committed to create an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 equivalent through additional forest and tree cover by 2030.

Among the various carbon standards, the CDM was the only one to see a decline in volume in recent years. The CDM was initially created as a compliance standard under the Kyoto Protocol, but the program faces an uncertain future that will be decided by upcoming negotiations of the Paris Agreement. Many CDM project developers have turned to the voluntary markets to try and find buyers (Forest Trends, 2019).

Among the leading voluntary carbon markets Verra develops and manages standards that help the private sector, countries, and civil society achieve ambitious sustainable development and climate action goals. One of Verra's standard programs, the Verified Carbon Standard (VCS) program allows certified projects to turn their GHG emission reductions and removals into tradable carbon credits. Since its launch in 2006, the VCS Program has grown into the world's largest voluntary GHG program. Outside of the Kyoto, LULUCF credits have been traded in voluntary market and voluntary carbon standard (VCS) is by far the largest standard in voluntary market.

Presently, The World Bank is among the few buyers of CDM forestry credits. With expiry of Kyoto Protocol and its replacement by new market mechanism under Paris Climate Change Agreement, there is still large uncertainty about the forest carbon market. CDM is likely to be replaced under new Mechanism called Sustainable Development Mechanism with new set of rules and regulations.

Box 8.2: Case Studies of Himachal Pradesh CDM – A/R Projects

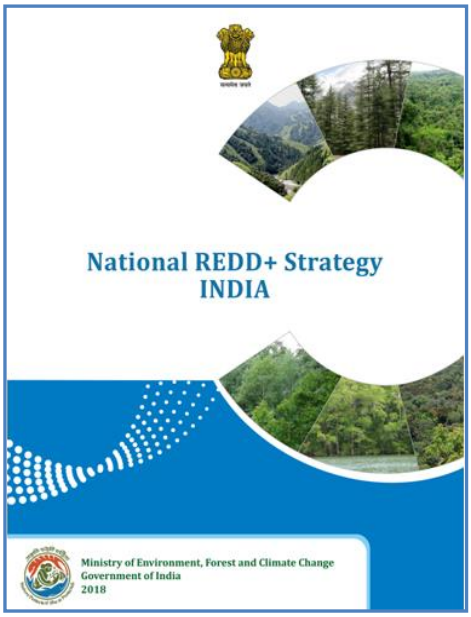
Himachal Pradesh as a good example of CDM Afforestation Reforestation project *registered*with *UNFCCC as* 'Himachal Pradesh Reforestation Project – Improving Livelihoods and Watersheds'.The project implemented in Himachal Pradesh, India. The Mid-Himalayan Watershed Development Project (MHWDP) was implemented in the Siwalik hills between 600 - 1800 m amsl, and covers 11 watershed divisions in 10 districts. The project is spread over an area of 2,22,951 ha and covers the catchmentsof major rivers i.e., Ravi, Beas, and Sutlej of Northern India. The project has been developed through a series of consultations with MHWDP and its stakeholder constituents namely, Forest Department, Government of Himachal Pradesh, local Gram Panchayats (GPs) and the World Bank. The project seeks to implement A/R CDM activities on 4,003.07 ha of degraded lands in the watersheds of Mid-Himalayan region. The four guiding principles of the project were: (i) Adoption of native and locally preferred tree species for reforestation, (ii) Involvement of the local Gram Panchayats and small and marginal farmers in reforestation activities that will strengthen the ongoing watershed interventions, (iii) Facilitation of technical, financial and capacity development support from MHWDP to reforestation activities, and iv) Distribution of carbon revenue to the village community (GP and farmers).

Many of the project activities such as protection and management would involve participation of local panchayats and their delegated Committees. The A/R CDM project is developed under the umbrella of the World Bank funded MHWD Project and expected to sequester 828,016tCO_2-eq of tCERs over the first crediting period of 20-years. The estimated emission reductions are 41400 metric tonnes of CO_2 equivalent per annum. The estimated CO_2 mitigation from the project is expected to be 10.34 tonnes of CO_2 per ha per annum.

8.9.4 REDD+ Potential for enhancement of Forest carbon stocks

Reducing Emission from Deforestation and Forest Degradation in developing countries (REDD) along with conservation, sustainable management of forests and enhancement of forest carbon stocks is collectively referred to as REDD+. UNFCCC agreements on REDD+ "Encourages developing country Parties to contribute to mitigation actions in the forest sector by undertaking the activities, i.e., *(a) Reducing emissions from deforestation; (b) Reducing emissions from forest degradation; (c) Conservation of forest carbon stocks; (d) Sustainable management of forest;* and *(e) Enhancement of Forest Carbon Stock.* REDD+ is now widely recognized as financial incentive to the communities for their contribution in reducing GHG emissions from forests by encouraging aforesaid activities.

(i) Scope of REDD+ under Forestry Interventions: There is ample scope and opportunities for integrating REDD+ initiative with the Community Managed Forest and Joint Forest Management (JFM). Promoting and integrating REDD+ actions in JFM activities to increase sequestration of carbon stock will meet both national objectives of Climate Change mitigation and international obligations as a responsive member of international community.



(ii) India's National REDD+ Strategy: India's National REDD+ Strategy builds upon existing national circumstances which have been updated in line with India's National Action Plan on Climate Change, Green India Mission and India's Nationally Determined Contribution (NDC) to UNFCCC. India's National REDD+ Strategy has been aligned with the precepts of the National Forest Policy (NFP). The overarching objective of National REDD+ Strategy is to facilitate implementation of REDD+ programme in the country in conformity with relevant decisions of UNFCCC (MoEF&CC, 2018b).

Enhancement of Forest Carbon Stocks: Among the various REDD+ Activities, Enhancement of Forest Carbon Stocks is one of the REDD+ described in the National REDD+ Strategy. This approach could involve restoring carbon stocks in degraded forests, or creating forests in non-forest areas and approaches may include afforestation, reforestation, restoration through natural regeneration and assisted natural regeneration or planting, rehabilitation, and forest landscape restoration. Thus, in the Indian context, enhancement of carbon stocks could be defined as "Conversion of non-forest or degraded forests to forests through afforestation, reforestation, restoration forestry and forest management practices, leading to enhancement of carbon stocks". Large potential for implementing these activities exists in India. Agroforestry and farm forestry also have a potential to be included under this category of REDD+ activities. National Agroforestry Policy 2014 creates an enabling environment for this action.

New Initiatives like Forestry Intervention in Ganga River under Namami Gange and Forestry Interventions for other major river catchments will contribute towards for Enhancement of Forest Carbon Stocks. This holistic approach of appropriate Forestry Interventions by way of protection, habitat management, afforestation, catchment treatment-soil and moisture conservation work, ecological restoration of vital riparian forest buffer, bio-remediation, improved livelihood of forest dependent communities and forest dwellers, and alternate income generation activities through regulated tourism and awareness for major river catchments has the potential to be developed as REDD+ projects in these river basins. The National REDD+ Strategy recognizes that the enhancement of forest carbon stocks attained through these actions shall also be considered for REDD+ actions.

8.10 Projected Reduction of CO_2 by Forestry Intervention in Chenab Riverscape in Himachal Pradesh and Jammu and Kashmir UT

Rejuvenation efforts of the Chenab River in Himachal Pradesh and Jammu and Kashmir UT through Forestry Interventions will attempt to plant trees on 8101.40 ha of identified diverse landscapes on either side of the river. The expected CO_2 mitigation benefits from the proposed Forestry Interventions have been estimated following the IPCC (2003) Good Practice Guidance by using following formula:

C= [V x D x BEF] x (1+R) x CF]

Where:

C= Carbon stock in Biomass (tonnes C)

V= Stand volume (m^3 ha^{-1})

D= Basic wood density (tonnes d.m m^{-3}). These values have been taken from Kaul et al. (2009)

BEF= Biomass expansion factor (Default). These values have been taken from Kaul *et al*. (2009)

R= Root shoot ratio (Default) These values have been taken from Kaul *et al*. (2009)

CF= Carbon Fraction (Default value of 0.47 (IPCC 2006) has been considered.

Carbon in the biomass has been converted into CO_2 eq by multiplying with 44/12.

The estimated CO_2 capture by the plantations raised under Forestry Interventions in the Chenab Riverscape for 20 years and 10 years are presented in **Table 8.6.** Assuming a modest productivity of plantations at 5 m^3/ha/ year, the CO_2 captured by the plantations raised under the project will be capable of capturing **7.43** metric tonnes of CO_2 eq /ha/year which will be equal to **11,42,537.32** tonnes of CO_2/year for the entire project area. The expected CO_2 reduction for 20 years period will be **1.14** million tonnes of CO_2eq and expected CO_2 reduction for 10 years will be 0.896 for the entire project area.

Thus,Forestry Intervention for enhancing tree cover in the Chenab Riverscape will also serve a major mode of CO_2 mitigation, and will continue to make positive contribution towards climate change mitigation at local and regional scales. The estimate has been based on the assumption that the plantation shall be maintained for a minimum of 20 years with usual harvesting at scheduled intervals.It has also been assumed that plantation will attain 80% of its peak biological potential productivity in 10 years period.

The proposed plantation raised under the Forestry Interventions will also contribute in capturing significant amount of CO_2 i.e., the GHG mainly responsible for global warming and will thus contribute towards climate change mitigation among other co-benefits of the proposed plantations. The DPR intends to develop plantations for the purpose of seeking carbon credits under available market or non market mechanisms. The agency executing the interventions shall explore the possibility of registering these plantations for the purpose of carbon credits under existing market/ non - market mechanisms under UNFCCC or any other robust carbon standards such as Verified Carbon Standards (VCS). One tones of

CO_2equivalent will generate one carbon credit. Thus, the proposed Forestry Interventions in Chenab Riverscape have a potential to generate **11,20,000 CER (Certified Emission Reductions)** over a span of 20 years and 8,96,000 CER (Certified Emission Reductions) over a span of 10 Years.

Table: 8.6- Estimated CO_2 capture by the plantations raised under Forestry Interventions in the Chenab Riverscape

Landscape NL= Natural Landscape, AL= Agriculture Landscape	**Proposed area under Plantations (ha.)**	**Mean Wood density (Mg/cu.m)***	**Estimated Biomass assuming productivity of 5 m^3/ha/yr****	**BEF*****	**Ratio of below ground biomass to above ground biomass***	**Estimated CO_2Reduction (metric tonnes CO_2 Eq/ha/yr)**	**Estimated CO_2Reduction (metric tonnes CO_2 Eq/yr**	**Estimated CO_2Reduction (metric tonnes CO_2 Eq/yr(20 yrs)**
1	2	3	4	5	6	7	8	
Himachal Pradesh								
NL= Natural Landscape	436.00	0.47	2.35	1.52	0.28	7.87	3,431.32	68,626.40
AL= Agriculture landscape	74.00	0.47	2.35	1.52	0.28	7.87	582.38	11,647.60
NR= Natural Regeneration	40.00	0.47	2.35	1.52	0.28	7.87	314.80	6,296.00
UL=Urban Landscape (Institutional Plantation)	16.00	0.47	2.35	1.52	0.28	7.87	125.92	2,518.40
A. Total	**566.00**					**7.87**		**89,088.40**
Jammu and Kashmir UT								
NL= Natural Landscape	3,245.00	0.43	2.15	1.51	0.25	6.99	22,682.55	4,53,651.00
AL= Agriculture landscape	558.00	0.43	2.15	1.51	0.25	6.99	3,900.42	78,008.40
NR= Natural Regeneration	3620	0.43	2.15	1.51	0.25	6.99	2,5303.80	5,06,076.00
UL= Urban Landscape (Institutional Plantation)	112.40	0.43	2.15	1.51	0.25	6.99	785.67	15,713.52
B. Total	**7,535.40**					**6.99**		**10,53,448.92**
Total (A+B)	**8,101.40**					**7.43**		**11,42,537.32**

* Values taken from Kaul *et al.* (2009); ** A conservative productivity rate of 5m^3/ha/year has been considered assuming that the plantations will be maintained for at least 20 years with usual harvesting/rotation schedule, and *** BEF= Biomass Expansion Factor

8.11 Potential benefits in terms of water quality and quantity improvement from Plantation and Soil and Moisture Conservation Measures in Chenab Riverscape

The Himalayan Rivers carry the highest sediment loads due to many natural and human induced factors. The climate change is also altering hydrological regimes and posing greater threat to this river ecosystem. In this scenario, forest catchments can play important role in regulating water flow, influencing the availability of water resources and maintaining the water quality (Bergkamp *et al.,* 2003). Therefore, the relationship between forests and water is a significant issue that must be given high priority.

Watershed service provided by forest ecosystems is gaining acceptance with increased understanding of bio-physical modelling in the research and policy area. These forested catchments provide a high proportion supply of the water for domestic, agricultural, industrial and ecological needs in both upstream and downstream areas. In addition, it also addresses many environmental problems caused by changes in aspects of the hydrological cycle in terms of water demand and quality. However, forest managers are facing challenges in implementing scientific management of forest catchment areas due to lack of recognition of the multi-sectoral forest benefits including regulation provision of water resources. It is also important to understand the 'Green Water'role in the hydrological cycle. Green Water refers to the water available in the soil for plants and released to the atmosphere through a process called transpiration. To address this challenge, there is an urgent need for formulating an effective plan for restoration and rejuvenation of the forest catchments of major rivers in India.

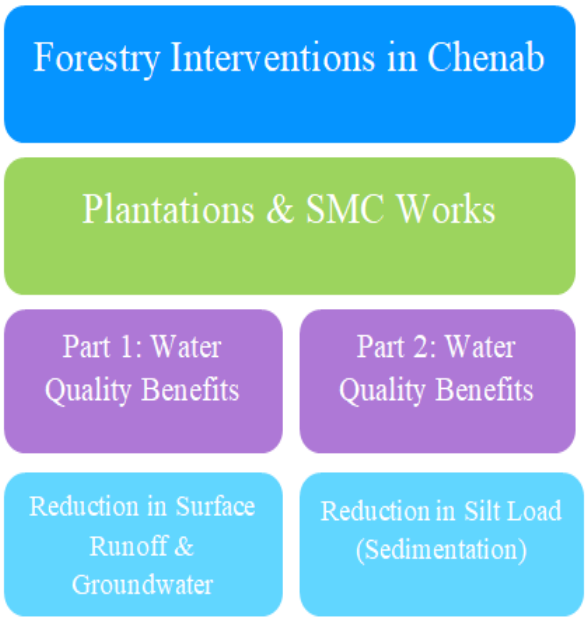


Fig.8. 2- Benefit Assessment Framework

This project is one of the important steps of the Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India (GoI) towards addressing this issue. The overall benefit assessment framework of the forestry intervention plan proposed in the Chenab Catchment area will have 2 components namely, Water Quantity and Water Quality **(Fig.8.2)**.

- The first component will conservatively estimate the green water benefits of the proposed plantation and SMC works in the Chenab Sub-basin using SCS Curve Number Method and Groundwater Estimation Committee Methodology, 2015 respectively .
- Second component will quantify the reduction of Silt load (Sedimantation reduction) in the Chenab Sub-basin from the Forestry Interventions.

Chenab River is the main River of the Chenab River-Basin. The other tributaries are Tawi, Miyurnalla, Chandra and Bhaga Rivers, etc. The total catchment area is 29,326 km^2 which covers part of Himachal Pradesh and Jammu and Kashmir UT.

8.11.1 Component 1: Water Quantity Benefit Assessment

Under component 1, the proposed Forestry Interventions in Chenab Riverscape Area has two major parts namely, 1) Plantations and 2) Soil and Moisture Conservation works **(Table 8.7).** The quantitative benefits of the activities are assessed in the following sections.

Table: 8.7- Proposed Forestry Interventions Activities in the Chenab Riverscape, Himachal Pradesh and Jammu and Kashmir UT

State/UT	Riverscape area(ha)	Plantation Area (ha)	Estimated Excavation(Cu.Mt)
Jammu and Kashmir UT	21,57,103	7,535.0	5,23,600
Himachal Pradesh	7,75,544	566.00	97,260
Total	**29,32,647**	**8,101.40**	**6,20,860**

A: Reduction of Surface runoff and recharge from the Plantation Activities
Conceptual Model for Assessment: Water Balance Model

The Water balance is based on the law of conservation of mass which states that any change in the water content of a given soil volume during a specified period must equal the difference between the amount of water added to the soil volume and the amount of water withdrawn from it. It helps to quantify the relationships between precipitation, surface and groundwater runoff, evaporation, transpiration, and aquifer drafts, and provides a framework for future planning of sustainable exploitation of the available water resources.

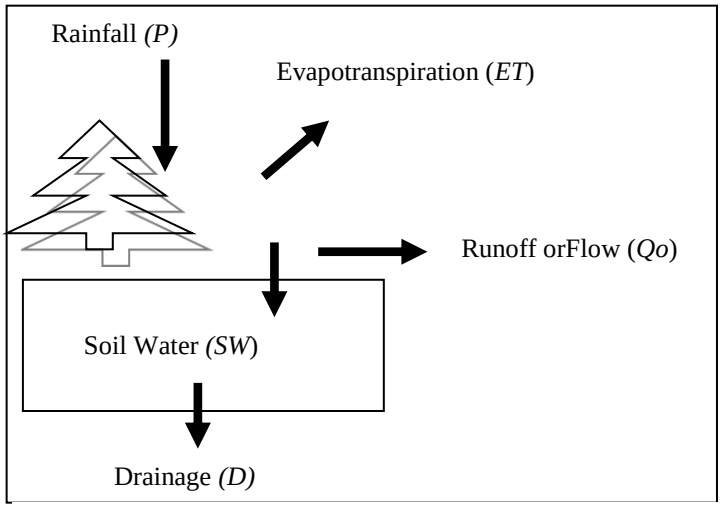


Fig.8. 3- Water Balance Model

The water balance of a forest basin can be determined by calculating the input, output, and storage changes of water. The major input of water is from precipitation and major output is runoff. A complete water balance model (Fig. 8.3) may contain four sub-modeling systems describing the hydrologic cycle, namely, an atmospheric water balance sub-system; a surface water balance sub-system; a soil water balance sub-system; and a groundwater balance sub-

system (Equation 1). Depending upon the focus of the analysis, each sub-system can be modeled separately.
The general water balance equation is as follows.

Equation 1

$G+P = Qdsro + Qb + ET + \Delta Sg$

Where, *P = Precipitation; G = Glacial Inflow;* Q_{dsro}*= Direct surface runoff;* Q_b *= Base flow;* E_t *= ET = Evapo-transpiration;* S_g *= Change in groundwater storage (in soil or the bedrock / ground water);*

Assumptions

1. Inflows from precipitation and glacial inflows would remain same for both scenarios.
2. Evapo-transpiration (ET) is the sum of evaporation and plant transpiration from the surface to the atmosphere. Evapo-transpiration is an important part of the water cycle. However, for understanding benefits, it is excluded from the calculations showing casing how Forestry Interventions can reduce surface runoff and improve recharge. In addition, it is also important to note that the ET values in the forests are much higher than that of other land uses but provides ecological functions such as carbon storage, nutrient cycling, water and air purification, soil protection, microclimatic benefits and maintenance of habitat.
3. From the hydro-geological point of view, it is observed that the groundwater occurs in confined (restricted) setting in joints, cracks, fissures, and fractures moving to deeper levels in the weathered zones. As the eastern and south-east part of the basin has already been overexploited in terms of CGWB classification and very low inter aquifers transfers between complex Basaltic Zones and Alluvial Plains, the changes in groundwater storage (ΔSg) is considered zero for computational purposes.

Equation 2

- Changes in Water Balance = Without Forestry Interventions – With Forestry Interventions

- Changes in Surface Runoff (Without Forestry Interventions Q_{dsro} - With Forestry Interventions Q_{dsro}) = Changes in base flow(With Forestry Interventions Q_b - Without Forestry Interventions Q_b

Estimating Changes in Surface Runoff = (Without Forestry Interventions Q_{dsro} - With Forestry Interventions Q_{dsro}

There are many methods offered for Rainfall Runoff Modeling. Soil Conservation Services and Curve Number (SCS–CN) technique is one of the primogenital and simplest method for Rainfall Runoff Modeling (Kumar *et al.,* 2017). The surface water outflow from the Riverscape Area will be estimated by the Soil Conservation Service Curve Number (SCS-CN) model. The SCS-CN model is based on the single parameter Curve Number (CN) which

depends on the land use, land cover, soil type and the antecedent moisture conditions prevailing in the catchment. The direct surface runoff has been estimated using the SCS-CN model given in Equation 3 and 4.

Equation 3

$$Q = \frac{(P - I_a)^2}{(P - I_a + S)} \; for P > I_a \; ; and \;\; Q = 0, \; for P \le I_a$$

Equation 4

$$S = \frac{25400}{CN} - 254$$

where, P = rainfall; Q = direct surface runoff (mm); S = potential retention (mm); CN = curve number; I_a= initial abstraction;

Step 1: Annual Rainfall (P)

The annual rainfall varies from 800 to 1000 mm in Jammu and Kashmir UT region and 400 to 600 mm in Himachal Pradesh. The average annual rainfall in Chenab River Basin has been taken between years 1971-2004 and given below (indiawris.gov.in)

State/UT	Riverscape Area (ha)	Plantation Area (ha)	Rainfall (mm)
Jammu and Kashmir UT	21,57,103	7,535.40	1,334
Himachal Pradesh	7,75,544	566.00	
Total	**29,32,647**	**8,101.40**	

P= 1,334 mm,

Step 2: Assessing CN = Curve number

CN value for soils (Hawkins *et al.*, 2002) having high infiltration rates and for more than 58 mm precipitation conditions, and Antecedent Moisture Conditions (AMC-III) are provided below.

Land Use	AMC	CN Value
Forest	AMC III	45
Barren/Waste/Agriculture	AMC III	77

Step 3: Calculation of (S) Potential Retention (mm)

It is defined as the potential maximum retention after runoff begins. 'S' aggregates all variations in the runoff response because of land use, soils, soil moisture, or rainfall pattern, duration, or intensity, and any other variation into one variable.

S = **Potential Retention(mm)** retention (mm)	**With Forestry Interventions**	**Without Forestry Interventions**
S=(25400/*CN*)-254	310.4 mm	75.87mm

Step 4 Initial Abstraction (I_a)

The initial abstraction consists mainly of interception, infiltration during early parts of the storm, and surface depression storage. The initial abstraction (Ia) is some fraction of the potential maximum retention (S). Where in $\lambda = 0.2$ adopted as a standard value for general soils. Initial Abstraction parameters are given below.

Land use	**WithForestry Interventions**	**WithoutForestry Interventions**
Ia =λ S	S62 mm	15.174 mm

Step 5: Direct Surface runoff (DSRO)

Direct Surface Runoff (DSRO) is the rain that runs off during the rain event as overland flow or in the vegetation cover above a soil.

DSRO	**With Forestry Interventions**	**Without Forestry Interventions**
$Q_{dsro} = (P - I_a)^2 / P - I_a + S$	1,022.49	1,247.08

Q = Direct Surface Runoff (mm)

Step 6: Reduction in Surface Runoff and Changes in Base Flow

Base Flow consists of water that infiltrates into the soil and travels laterally down slope through upper soil layers, and groundwater flow that infiltrates and travels through the aquifer. The proposed Forestry Interventions will reduce surface runoff and increase groundwater recharge, which in turn increase the base flow. The changes in the base flow caused by plantation activity can also be called as Green Water.

B: Groundwater Recharge from SMC Measures

Changes in Base flow Q_b (Green Water/ Reduction in Runoff)

= Area * (Without Forestry Interventions **Q_{dsro}** -WithForestry Interventions **Q_{dsro})**

= 8,101.4 ha (1,247.08 mm- 1,022.49 mm)

= 1,819.49ham

= **18.19 MCM**

Estimating groundwater recharge is important to measure effectiveness for water conservation measures. However, a site specific modeling approaches to forecast groundwater recharge typically requires observed historic data to assist calibration. It is generally not possible to physically observe groundwater recharge activities spreading over large areas. However, the Ground Water Resource Estimation Committee (CGWB GEC-2015) Methodology provides a simple assessment framework for the estimation of ground water recharge due to Soil Moisture Works (SMC). In the present study, this methodology will be employed to project groundwater recharge from the proposed SMC activities.

Assessment Framework

Recharge due to Water Conservation Structures is estimated based on the following formula **(GEC 2015)**

Equation 5 :

RWCS =GS*RF

Where:

- RWCS = Recharge due to Water Conservation Structures
- RF = Recharge Factor
- GS= Gross Storage = Storage Capacity x No. of Fillings

Step1: Estimating Gross Storage

Storage Capacity: AWSA* H *Efficiency* Number of fillings

- AWSA = Storage potential created through excavation
- Effeciency = Efficiency of the structures
- Number of Fillings= Number of fillings during the rainfall season
- H = Height

Conservative Assumption

- SMC Activities proposed in the Riverscape Plan
- Efficiency: = 50% ; Recharge due to Check Dams and *Nallah* Bunds can be taken as 50% of gross storage (assuming annual de-silting maintenance exists) considering leakages and other factors

- Number of fillings assumed to be considering 30- 50 rainy days in the Chenab River Basin
- **SMC Excavation Quantity** = AWSA x Height
- Multiplier factor of 2 applied for calculating the Storage Potential from Area under SMC

Table: 8.8- SMC activities under Forestry Interventions in Chenab Riverscape

State/ UT	Area under SMC works ('000 Cubic Meter)	Storage potential created through excavation ('000 Cubic Meter)	Number of Fillings	Efficiency	Gross Storage ('000 Cubic Meter)
Jammu and Kashmir UT	523.60	1,047.2	8	50%	4,188.80
Himachal Pradesh	97.26	194.52	8	50%	778.08
Total					**4,966.88**

Step 2: Recharge Factor

Expected Groundwater Recharge = Gross storage * Recharge Factor

RF = Recharge Factor as per GEC, 2015 norms

State	Gross Storage ('000 Cubic Meter)	Recharge Factor (%)	Expected Groundwater recharge Recharge ('000 Cubic Meter)
Jammu and Kashmir UT	4,188.80	10%	418.88
Himachal Pradesh	778.08	10%	77.80
Total			**496.68**

Total Groundwater Recharge =4,96,680 Cubic Meters

Expected Groundwater Recharge from the SMC structures is 0.5 MCM

Step 3: Expected Groundwater Recharge

In total, the Forestry Interventions activities will conserve 18.69MCM water annually.

Table: 8.9- Potential Benefits of Forestry Interventions for Water Quantity in Chenab Riverscape , Himachal Pradesh and Jammu and Kashmir UT

Sr. No.	Forestry Interventions	Benefits (in MCM Million Cubic Meter)
1.	Water Savings through Plantations	18.19
2.	Ground Water Recharge through SMC Measures	0.5
	Total	**18.69**

8.11.2 Component 2: Water Quality

Water quality of Chenab River Basin is excellent. It deteriorates slightly towards downstream, due to heavy abstraction and discharge of pollutants, but remains very much within permissible limits. Figure 8.4 shows schematic representation of some of the main influences on water quality within a river basin (Owens., 2008), Water and sediment of the river exhibit seasonal as well as spatial variability, which is contributed by geological, climatological, and anthropogenic factors. However, many a times, it is difficult to assess the contribution from different sources because of different geological terrain and complex variation in weathering, erosion, transport and anthropogenic activities operating in the river catchment. The legacy data of silt rate provides a realistic estimate for the sediment rates from the basin.

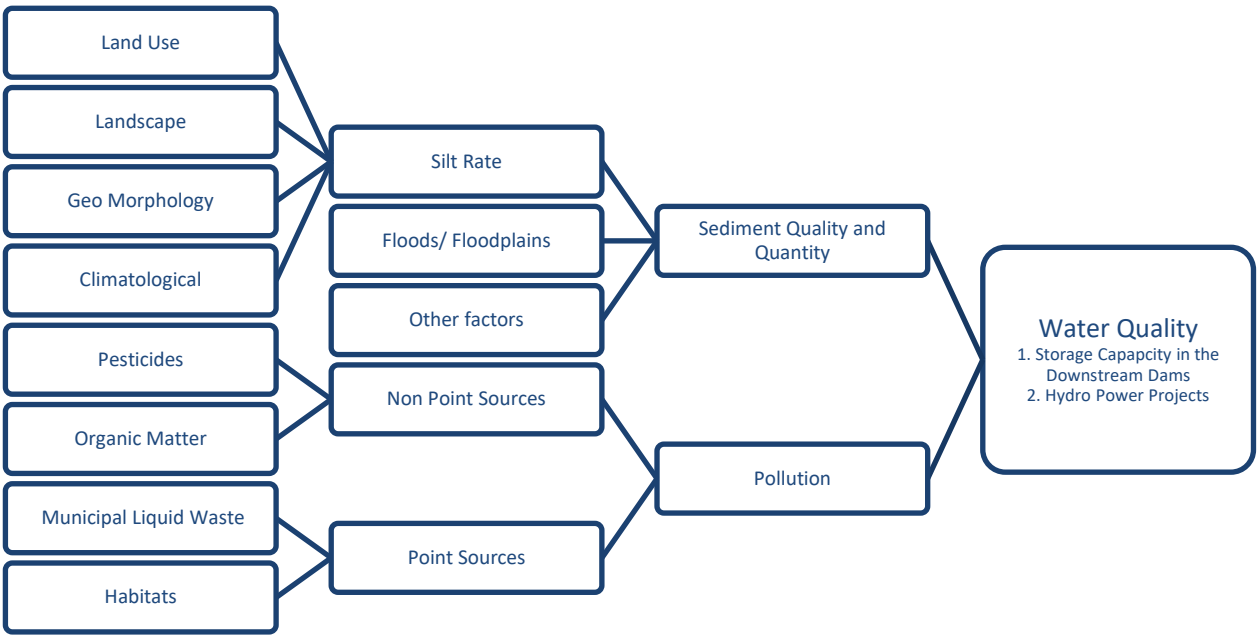


Fig.8. 4- Main influences on water quality

(Source: Owens *et al*.,2008)

As per India-WRIS database, there are 9 surface water quality observation stations installed in the Indus River Basin. These stations provide surface water quality in the basin. As per the monitoring results of 2009, the water quality is excellent, however, organic pollution is the predominant reason of pollution in these water resources. Biochemical Oxygen Demand (BOD) and Colifirm Bacterial Count are the major indicators of extent of water quality degradation.

Role of Forest Catchments: Forest catchments have often been described as 'Sponges' storing rain water and slowly releasing it to maintain groundwater and streams during dry periods (Hamilton and King, 1983).Despite the recognition that trees can improve soil hydraulic conductivity and reduce overland water flow (Sandstrom, 1998), their contribution towards groundwater recharge and improvement of water quality is often understated. In the long term, one of the most important ways in which forest catchments can influence water quality is through their effect on absorbing rainfall variability and seasonal climate variations. It is one of the key factors that influences sediment yield from a given basin. If lands are degraded and soils are unstable, rainstorms can lead to heavy sedimentation from river sheds. Under any given condition, forest catchments have an important impact in reducing sediment yield from watersheds (Conroy *et al.*, 2001).

The Indus River Basin is one of the most depleted basins in the world (Sharma *et al.*, 2010). During certain periods of the year, water even does not really reach the sea any more, making it a closed basin (Molle *et al.*, 2010). Rapid population growth, increasing urbanization and industrialization, environmental degradation, inefficient water use and poverty (economic

water shortage) are the prominent challenges in sustainable water resource management in the said region.

Flooding, erosion and high sedimentation in the region lead to rise of riverbeds between their embarkments and also impacting the capacity of reservoirs. The rehabilitation of some forest watersheds can dramatically reduce the rate at which sediments are delivered to a reservoir. These sediment yields will be calculated by standard extrapolation techniques from previous measurements (Trimble, 1999)

Equation 6:

Sediment load= Catchment area * Sediment Factor * Trap Efficiency

Step 1: Catchment Area

The Chenab River Basin covers an area of 29,32,647 km^2 (ha), Out of this, 8101.40 ha area is selected for the plantation activities in the proposed DPR. The detail is given is below.

Riverscape Area of the Chenab River Basin

State/ UT	Riverscape Area (ha)	Intervention through afforestation (Plantation) Area (ha)
Jammu and Kashmir UT	21,57,103	7,535.40
Himachal Pradesh	7,75,544	566.00
Total	**29,32,647**	**8,101.40**

Step 2: Sediment Factor

The evaluation of sediment inflow has been always difficult because the sediment content varies considerably for a same river according to the flow and the season. In addition, it also requires complex sediment modeling based on the land use assumptions; besides requires huge time and resources for measurement. Further, the results cannot be very precise and there would be associated uncertainties. However, based on the sedimentation legacy data at the project locations, most reliable sedimentation assessments may be provided (CWC, 2015). The average siltation rate in Chenab River Basin is given below.

State/ UT	Major Reservoir	Observed Sediment Rate
Jammu and Kashmir UT	Baira Reservoir	0.159
Himachal Pradesh		

(Source: CWC Compendium on silting of reservoirs in India, 2015)

Step 3: Trap Efficiency

The rate of sediment production in the catchment area and the actual rate of silting depends on many other factors *viz*., gradation of silt, maintenance of structures, etc. Therefore, we conservatively estimate 90% efficiency of the CAT activities. The envisaged Forestry Interventions will reduce 11,592 Cubic Meters of sedimentation annually **(Table 8.10), hence, water quality of the basin will be improved.**

Table: 8.10- Estimated Sediment Reduction Through Forestry Interventions in Chenab Riverscape

State/UT	Sedimentation Factor (000' Cub M/ km^2 Yr)	Trap Efficiency	Total CAT Intervention Area km^2	Sedimentation ('000 Cubic Mt/Yr)
Jammu and Kashmir UT	0.159	0.9	75.35	10.78
Himachal Pradesh	0.159	0.9	5.66	0.81
Total	**0.159**	**0.9**	**81.01**	**11.59**

**Assumption: Plantation area has been considered as Intervention Area for the above calculations*

The Forestry Interventions will reduce **11,592** Cub Meters of sedimentation annually**.**

Monitoring Framework

Component	Parameters	Indicators	Timeframe	Rationale
Water Quantity	Water Augmentation through Plantation Activities	Normalized Difference Vegetation Index (NDVI)	Annual	Precise monitoring of improvement in the recharge rates from the Forestry Interventions is only possible with the availability of historical hydrographs from the Piezometers, recordings from the River Gauzing Stations and Forestry Interventions implemented at the landscape level. Therefore, it is not possible to directly measure these indicators in the present context. However, for all practical purposes, NDVI and NDWI can be used as proxy indicators for monitoring the benefits of the Forestry Interventions
	Groundwater Recharge from SMC Measures	Normalized Difference Water Index (NDWI)	Pre & Post Monsoon	
Water Quality	Silt Rates	NDVI & NDWI		

The **Normalized Difference Vegetation Index** (NDVI) quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs).

The NDWI is known to be strongly related to the plant **water** content. It is therefore a very good proxy for plant **water** stress. The NDWI is a satellite-derived **index** from the Near-Infrared (NIR) and Short Wave Infrared (SWIR) channels.

8.12 Livelihood Generation through Forestry Interventions in Chenab Riverscape

North-Western Himalayan region is a treasure trove of Medicinal and Aromatic Plant Resources (MAP) due to wide range of altitudes, topography and climatic conditions. Himalayan herbs in fact have received unprecedented attention world over mainly due to their uniqueness and high medicinal value. Medicinal and aromatic plants sector has traditionally occupied an important position in the socio-cultural, spiritual and medicinal arena of rural and tribal lives in the region. They have traditional rights to collect medicinal herbs as Minor Forest Produce (MFP) in designated forestland (Anderson, 1886), and have been an important source of income to the natives (Dobriyal *et al*., 1997; Tondon, 1997; Badola*et al.*, 1998; Badola, 2002).

Non-Timber Forest Products (NTFPs) or Minor Forest Products cover all forest products other than Major Forest Products. For the sake of convenience in dealing with the subject, minor forest products of commercial importance in India may be divided into the following classes: (1) Fibers and flosses; (2) Grasses (Other than oil-producing grasses), bamboos and canes; (3) Essential oils (including oil-yielding species); (4) Oil seeds; (5) Tans and dyes; (6) Gums, resins, and oleo-resins; (7) Drugs, spices, poisons and insecticides; (8) Edible products; and (9) Minerals and miscellaneous products (FRIC,1972).

The natural resources in forest provide food, fodder, medicine, clothes, house building materials to human civilization. It is estimated that of the 275 million poor rural people in India about 27 % of the total population depend on NTFPs for at least part of their subsistence and cash livelihoods (Malhotra and Bhattacharya, 2010; Bhattacharya and Hayat, 2009). This dependency is particularly intense for half of India's 89 million tribal populations who live in forest fringe areas. According to an estimate, the NTFP sector alone is able to create about 10 million workdays annually in the country (Anonymous, 2011). NTFPs contribute about 20 to 40% of the annual income of forest dwellers who are mostly disadvantageous and landless communities with a dominant population of tribals. It provides critical subsistence during lean seasons, particularly for primitive tribal groups such as hunter gatherers and the landless. Most of the NTFPs are collected and used/sold by women, so it has a strong linkage to women's financial empowerment in the forest-fringe areas (Anonymous, 2011). In view of their ever increasing demand, there is urgent need to grow and propagate the species. It will help not only in fulfilling the demands but will eventually NTFPs in particular and biodiversity in general. For calculating the estimated values of medicinal plants, average value per hectare from various publications of Meena and Shukla, 2003; NMPB, 2004; Samant *et al*., 2008; and Singh, *et al*., 2013 were consulted. In Temperate to Alpine zone, the average value per hectare is assumed after taking survival rate as 60%. The harvesting of plants is taken as 50% after a rotation period of 3.5 years, in 7^{th} year 50% of the remaining part of 3.5 year and in 10^{th} year 40% of the remaining part of 7^{th} year. In Tropical and Sub-tropical areas, the crop harvesting has to be done after a rotation period of 1.5 year.

The different forestry/plantation models in Chenab DPR have been envisaged including traditional/ native species of trees, grasses and NTFPs for rejuvenating Chenab River and its tributaries through Forestry Interventions.

Since in most of the high temperate medicinal plants rotation period is 3.5 years. If sustainable harvest practices and beating up of medicinal plants in the intervention areas are followed, two more harvesting i.e., 7^{th} year and 10^{th} year can be obtained. The estimated income from growing, selling and extracting NTFPs from plantation forests in Chenab River Basin is given in **Table 8.11**

Table: 8.11- Estimated income generated through NTFPs in Himachal Pradesh and J&K UT

(Rs. In Lakhs)

S. No.	State / UT	Model	Model No.	No. of Herbacious medicinal plants	Area in Ha	Rate Per Ha	Estimated income after 3.5 years (in Lakhs)	Estimated income after 7 years (in Lakhs)	Estimated income after 10 years (in Lakhs)	G rant Total of Income (in Lakhs)
1	Himachal Pradesh	Sub-Alpine Enrichment	CN/HP/NL/04	800	63	3200	2.02	1.01	0.81	3.83
2	Himachal Pradesh	Temperate Mixed Forests	CN/HP/NL/06	1200	58	4800	2.78	1.39	1.11	5.29
Total (A)					**121**		**4.80**	**2.40**	**1.92**	**9.12**
1	Jammu and Kashmir UT	Temperate Conifer Forest	CN/JK/NL/04	1600	118	6400	7.55	3.78	3.02	14.35
2.	Jammu and Kashmir UT	Temperate Mixed Forest	CN/JK/NL/05	1600	683	6400	43.71	21.86	17.48	83.05
Total (B)					**701**		**51.26**	**25.63**	**20.51**	**97.40**
G. Total (A+ B)					**822**		**56.06**	**28.03**	**22.43**	**106.52**

The potential benefits anticipated from the Forestry Interventions in different Landscapes and Soil and Moisture Conservation measures envisaged in the Chenab Riverscape across Himachal Pradesh and Jammu and Kashmir UT can be projected as given below (Table 8.12).

Table: 8.12- Potential Benefits from Proposed Forestry Interventions in Chenab Riverscape

Sr. No.	Potential Benefits	Quantity (in 20yrs)	Quantity (in 10yrs)
A)	**Biomass, Carbon Stock, CO_2 Reduction and Carbon Credit**		
1	Biomass Production in Natural, Agriculture and Urban Landscapes (t/ha/year)	2.15	1.72
2	Total Biomass Production from 8,101.40 ha areas of three landscapes (Tonnes)	17,418.01	13,934.40
3	Contribution to Carbon Stock from 8,101.40 ha areas of three landscapes (Tonnes)	8,186.46	6,549.16
4	Estimated CO_2 Reduction from Forestry Interventions in three landscapes (8,101.40 ha) (metric tonnes CO_2eq/ha/year)	7.43	5.94
5	Estimated CO_2 Reduction from Forestry Interventions in three landscapes (8,101.40 ha) (metric tonnes CO_2 eq/ year)	11,42,537.32	91,4,029.85
6	CO_2 Captured by the three landscapes (8101.40 ha) capable of capturing metric tonnes of CO_2 eq /ha/year	7.43	5.94
7	The expected CO_2 reduction from plantation in (million tonnes of CO_2 eq.)	1.14	0.91
8	Potential to generate carbon credit from plantation in three landscape (million tonnes)	1.14	0.91
B)	**Water Quality and Quantity**		
9	Water Quantity: Conservation of water through Forestry Interventions (Million Cubic Meter/year)	18.69	
10	Water Quality: Estimated sediment reduction through Forestry Interventions('000 m^3/Year)	11.59	
C)	**Income generated through NTFPs's (in Lakhs)**		
11	The estimated benefit from NTFP's i.e., herbaceous medicinal plants from 8,101.40 ha area of Natural Landscape in Chenab Riverscape after ten years (Rs. in Lakhs) 106.52		
D.	**Man-Days to be Generated**		
12	Generation of Employment from Plantation Activities and Other Conservation Interventions (Total man days in Phase I and Phase	92,87,717	

*One tones of CO_2eq is one credit or 1 CER. Therefore the estimated Carbon credit potential for 20 years will be 1120000CER (CER=Certified Emission Reductions) and 896000 CER (Certified Emission Reductions) over a span of 10 Years ** assuming 80% of the potential productivity in 10 years

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J&K Pollution Control Board	www.jkspcb.nic.in
NITI Aayog	www.niti.gov.in
Science Daily	www.sciencedaily.com
Wikimedia Commons	wikimedia.org :Indus river
Daily Excelsior	www.dailyexcelsior.com
National Council of Educational Research and Training	www.ncert.nic.in
Water Information	www.waterinfo.net
Centro Internazionale	www.civiltacqua.org
India Water Portal	www.indiawaterportal.org
South Asia Network on Dams, Rivers and People	www.sandrp.in
Himachal Pradesh State Pollution Control Board, Shimla	www.hppcb.nic.in
National Institute of Hydrology, Roorkee	www.nihroorkee.gov.in
Central Water Commission	www.cwc.gov.in/water-info
Census India	www.censusindia.gov.in
Himachal Pradesh Power Corporation Limited, Shimla	www.hppcl.in
Economics and Statistics Department Himachal Pradesh	www.himachal.nic.in
USGS Science for Changing world	www.earthexplorer.usgs.gov
Himachal Pradesh Forest Department	www.hpforest.nic.in
Ministry of Environment Forests and Climate Change	www.moef.gov.in
Indian Geo-Platform of Indian Space Research Organization (ISRO)	www.bhuvan.nrsc.gov.in
Meteorological Centre, Shimla	www.weathershimla.nic.in
Department of Agriculture, Himachal Pradesh	www.hpagriculture.com
Himdhara, Environment Research and Action Collective	www.himdhara.org
Institute of Integrated Himalayan Studies, HPU Shimla	www.hpuniv.ac.in
CSIR-IHBT Palampur	www.ihbt.res.in
Himachal Pradesh Department of Environment Science and Technology	www.desthp.nic.in
Himachal Pradesh Council for Science Technology and Environment	www.himcoste.hp.gov.in
Himachal Pradesh State Biodiversity Board	www.hpbiodiversity.gov.in
Forest Survey of India	www.fsi.nic.in
Botanical Survey of India	www.bsi.gov.in

Zoological Survey of India	www.zsi.gov.in
Department of Horticulture Himachal Pradesh	www.hpagrisnet.gov.in
ENVIS Center on Wildlife and Protected Area	www.wiienvis.nic.in
Central Ground Water Board	www.cgwb.gov.in

ANNEXURES

Annexure: 1- Logical Frameworks Analysis- The Chenab Riverscape Management

Project Strategy	**Objectively Verifiable Indicators**				
Project Objectives and Outcomes	**Project Output**	**Target**	**Indicator**	**Source of Verification**	**Risks and Assumptions**
Project Goal - 1	**Riverscape Management:** Aiming a holistic riverine landscape (riverscape) approach for sustainable management of Chenab River, its banks, or its riparian areas, within its fluvial system.				
Outcome - l: Creation of an enabling environment for climate resilient, sustainable terrestrial, aquatic (river and wetlands), and floodplain ecosystem management.	**Project Objective 1:** To promote an enabling environment for sustainable land and river ecosystem-based management approaches focusing on reduced soil erosion, enhanced forest/ vegetation cover in the buffer zone, enhanced connectivity and e-flow, and ecological rejuvenation of Chenab River and its tributaries.				
	Output. l Enhanced levels and enabling environment created for: Multi-sector convergence, alliances, and integration; Favorable national and state level policies (forests, agriculture, animal husbandry, watershed management, river management, tribal welfare, infrastructure	The target is to create an enabling environment wherein multiple agencies/ sectors working for various production sectors converge and adopt climate resilient and sustainable approaches of land and ecosystem management by mainstreaming biodiversity concerns. Various concerned sectors also work together so as to	Integration and convergence of line agencies and various production sectors initiated and notable progress made. Communities mobilized and their active engagement ensured. Biodiversity concerns mainstreamed in production sectors. Gaps and inadequacies in various policies reviewed and actions initiated	Periodic reports, proceedings of consultative process (workshops, meetings, seminars, etc.). Mid-term and final independent evaluations.	Lack of enthusiasm on the part of stakeholders, inadequate sectoral integration, and lack of community participation in the implementation of existing and proposed policies and laws relating to conservation might hinder the promotion of local decision making and also their active engagement in the conservation

	development, and tourism) those reflect principles of climate resilience, sustainable land and ecosystem management, and mainstreaming biodiversity concerns in production sectors	address gaps and inadequacies in realizing global and national policy objectives relevant to environment, biodiversity, water resources, climate change, and sustainable development.	to address them.		agenda. Participation of communities particularly marginalized groups is weak due to a fear that their access to natural resources is going to be curtailed or restricted in ways that reduce the income they can derive. Conservation and local community needs might create difficulty in achievement of intended outcomes. Sectoral departments/ agencies are reluctant, not open to integrate/ cooperate for climate resilient and sustainable land and ecosystem management approaches. Project benefits are not captured

					by intended beneficiaries due to lack of adequate measures, transparency, and appropriate compensation measures. Inadequate and inaccurate flow of information may result in misconceptions about the project and hence lead to opposition/ non-participation by some agencies and CSOs Sectors/ agencies primarily responsible for reduced e-flows are rigid, and continue with conventional approaches resulting into fragmentation of rivers, reduced e-flows, and decline in water quality.
	Output - 1.2 Capacity of government	Capacity of agencies, government	Training need assessment carried out.	Periodic reports, appraisal of	The concept and need of sustainable

	officials and civil society organizations is developed in promoting community driven, climate resilient, sustainable land and ecosystem approaches, and holistic approach to management of river ecosystem.	officials and CSOs for sustainable land and ecosystem management, ecological rejuvenation and ecological integrity of river ecosystem is built.	Appropriate training learning material developed. Planned awareness and specialized training programmes on priority themes for various target groups successfully organized. Number of government staff and CSO representatives trained in climate resilient ecosystem management approaches.	training schedules, learning material and feedback obtained from trainee participants. Mid-term and final independent evaluations.	land and ecosystem management, and climate and its likely impact are not well appreciated by CBOs/ different sectors and agencies. The implementing agencies are new to the subject and expected outputs and outcomes and also widespread with limited financial management and technical capacity. Lack of interest and support for conservation might result in limited use of training facilities and opportunities. There are flaws in training need assessment and

					designing appropriate training programmes. Thus, trainings are not appealing and having desired impact.
Project Goal-2	***Aviral Dhara, Nirmal Dhara,* Ecological Rejuvenation and Biodiversity Conservation:** Aim to address the drivers and stressors of river ecosystem and promote sustainable use by balancing ecological needs with livelihood needs.				
***Outcome - 2*:**	**Project Objective 2:** To carry out appropriate Forestry Interventions to restore river connectivity, enhance e-flow, improve water quality, and conserve the terrestrial and aquatic biota within the Chenab riverscape.				
Inter-agency and civil society driven, climate resilient approaches for appropriate forestry and other interventions demonstrated in adequate extents of natural, agriculture, and urban landscapes of the riverscape.	**Output 2.l** Plans to reduce/ check erosion in the mountainous region and floodplains of Chenab and its tributaries by appropriate soil and moisture conservation works and development of optimal strategy for riverbed mining. Sites of landslides are adequately treated and stabilized.	Various soil and moisture conservation strategies and works in target extent of 620860 m^3 proposed to be implemented.	Reduced erosion in the hilly tract, reduced and stabilized landslides, decreased bank erosion, and reduced sedimentation rate. Enhanced moisture regime and flow in streams and rivers	Appraisal of reports on soil and moisture conservation works undertaken, site visits and field observations and assessments, monitoring reports on sedimentation.	Occurrence of natural calamities (e.g. cloudburst, flood, drought, earthquake, landslides, etc). Increase in biotic pressure and enhanced developmental activities (hydropower and road networks) in upstream area without adequate catchment area treatment.
	Output 2.2 Plans for restored and sustainably managed	Forestry Interventions by way of various plantations under different	Reduced biotic pressure on forests and improved regeneration.	Field level assessments and verification.	Non-availability of suitable nursery techniques, planting

	forest lands, agriculture lands in targeted villages and Forestry Interventions in urban environment for improved forest/ vegetation cover achieved. Enhanced assisted natural regeneration through improved protection and other measures.	treatment models to be undertaken. Plantations in 8081 ha natural landscapes, 632 ha in agriculture landscapes, and 159.2 ha in urban landscapes are established and maintained.	Improved forest cover in forest lands and TOFs in two States. Reduction in fuel wood extraction pressure on surrounding forests. Increase in average fodder yields, livestock grazing pressure reduced. Perennial vegetation cover increased on degraded lands. Private/community lands mobilized for reviving forest cover, enhancement of ecosystem health and services. Rejuvenation and renovation of existing community-based watershed structures	Periodic reports on plantation works carried out. Biennial assessment on forest cover by FSI for two States	material, inadequacies in plantation works i.e. preparation of plantation site, excavation of pits, poor quality of planting material, inadequate protection and constraints of watering, damage by livestock/ wildlife, etc. Non-availability of lands (natural/ agriculture/ urban) for plantations and non-committal and inadequate support of local communities/ farmers/ urban agencies. Occurrence of natural calamities (e.g. cloudburst, flood, drought, etc.).
	Output 2.3 Plans for improved	Strategies for improved PA management	Improved protected area management Increased	Appraisal of periodic reports and reports of	Increased biotic pressure and adverse impact of

	protected area management by implementing appropriate protection strategies, habitat management (e.g. weed control and water management), research and monitoring inputs, and enhanced capacity	implemented, weed control works undertaken, research on priority themes planned and undertaken. Periodic ecological and socio- economic monitoring carried out. Training of frontline/ PA staff and other stakeholders planned and implemented.	diversity and abundance of species. Enhanced conservation values (e.g. catchment value, carbon sequestration, environmental amelioration, etc.). Reduced human-wildlife conflict.	mid-term and terminal evaluation. Report on Management Effectiveness Evaluation (MEE) for respective PAs. Reports on ecological and socio-economic monitoring.	developmental projects. Increased human-wildlife conflict and non- compatible land use in surrounding lands. Inadequate support of local communities and their engagement. Occurrence of natural calamities (e.g. cloudburst, flood, drought, earthquake, landslides, etc).
	Output 2.4 Plans for improved management of prominent wetlands in the riverscape by protection, restoration, zoning, habitat management, and wise use of wetland resources.	Improved wetland management and sustainable use of wetland resources implemented.	Improved and effective management of wetlands accomplished. Wetland habitats restored, effective zone planning accomplished and sustainable wise use of wetland resources promoted.	Periodic reports, appraisal of conservation/ management plans. Site visits and field level assessments. Questionnaire survey and stakeholder consultations.	Enhanced biotic pressure, waste disposal, and more effluents, unsustainable harvests, natural calamity (flood and heavy siltation). Inadequate support of local communities.
	Output 2.5 Plans for improved riverfronts and development of eco-parks.	Riverfronts and eco-parks to be developed.	Improved riverfronts, effective eco-parks, reduced erosion.	Site visits and observations, periodic reports.	Non-compatible land use in surrounds of riverfronts/ river, enhanced biotic pressure

					on eco-parks, damage of riverfronts by excessive floods and mass congregation.
	Output 2.6 Plans for development of forest and river-based ecotourism.	Forest and river/ water resource-based ecotourism.	Healthy forests and rivers/ water resources are maintained. Reduced biotic pressure, ecologically sustainable, and socio-economically viable tourism developed.	Appraisal of periodic reports and ecotourism plans. Site visits and field assessments. Feedback from tourists.	Natural resources are depleted and degraded. Uncontrolled and unregulated mass congregation and adverse impacts.
Project Goal -3	**Improved Ecosystem Services and Sustainable Livelihoods**: This goal aims to specifically seek enhanced ecosystem services and sustainable livelihoods.				
	Project Objective 3: To promote improved ecosystem services and support sustainable livelihood opportunities for local communities, particularly forest dwellers and fishermen.				
Outcome 3: Enhanced ecosystem services from natural (forest, river, and wetland ecosystems), agroecosystem and urban landscapes	**Output 3.l** Plans for reduced traditional forest dependence, developed alternate income generation activities, improved livelihoods, and facilitate establishment of viable Small and Micro-Enterprises (SMEs).	Reduced traditional forest dependence and alternate income generation options developed. Improved livelihoods and well-established small and micro-enterprises.	Sustainable livelihoods by way of improved/ enhanced natural resources, effective social institutions, better physical assets, enhanced incomes, improved and skilled human resource, reduced vulnerability, well established SMEs. Change in proportion of project participants who are living above the poverty line.	Household surveys, periodic reports, field level assessments, evidences on reduced conflicts, etc.	Enhanced and frequent natural calamities, external market forces and impact of globalization, neglect and over exploitation of natural resources by local communities.

			Increase in earnings of families from involvement in sustainable management of degraded forestlands. Number of women participants in SMEs increased. Curtailment of distressed migrations. Number of SMEs operationalized.		
Outcome 4: Sustainable livelihoods, particularly of forest dwellers and fishermen	**Output 3.2** Plans for enhanced levels of protection, conservation, and sustainable harvests of medicinal and aromatic plants and development of herbal gardens.	Conservation and sustainable harvests practices implemented for *in situ* and *ex situ* conservation of medicinal and aromatic plants.	Diversity, abundance, and productivity of medicinal and aromatic plants in wild are enhanced. Herbal gardens developed.	Appraisal of periodic reports, site visits, and field level assessments.	Inadequate marketing strategies and mechanisms. Fluctuating market demands, supply, and market rates.
Project Goal - 4	**Effective Implementation, Knowledge Management, and Innovative Approaches**: This goal aims to ensure effective implementation of the project, knowledge management, development of innovative approaches (nursery techniques, afforestation, bio-filters and bioremediation), and adopt modern technology				
Outcome 5: Capacities for adaptive	**Project Objective 4:** To adopt, integrate and implement innovative approaches and modern technology for rejuvenation of Chenab and its tributaries, knowledge management, enhanced capacity, and monitoring and evaluation.				

management, learning, and replication of project lessons are developed					
	Output 4.l Plans developed for integrated, science based, and community-based monitoring and assessment of impacts, as well as periodic evaluation of the project.	Improved research and monitoring capacity targeted. Adaptive management approach being implemented.	Improved research infrastructure, well designed monitoring system, enhanced scientific capacity, and effective documentation and dissemination of research and monitoring findings. Local level monitoring mechanisms setup. Learnings on best practices and models disseminated within and outside project villages.	Project/ research and monitoring reports. Peer reviewed publications, databases, improved natural resource management.	Inadequate support for research and monitoring, lack of incentives, inordinate delays in research permissions, isolationist approach of research and monitoring, inadequate management oriented research.
	Output 4.2 Plans for documentation of lessons learned and preparation of information dissemination products for wider audiences and applicability.	Innovative approaches for adaptive management of natural resources, particularly river ecosystem targeted. Successful implementation of community driven management of natural	Successful and effective NRM and river management. Documentation of successful approaches in project design, development, and implementation. Case study on best practices developed.	Reports and periodic evaluation. Case studies and lessons learned, publications, and other documents.	Ineffective research and monitoring and adaptive management approaches. Lack of support for scaling up of riverscape conservation approaches.

		resources and river ecosystems implemented.			State level implementing agencies and partner organizations lack capacity to coordinate and monitor project effectively and ensure timely fund flows to landscape/ plantation/ treatment sites

Annexure: 2- Proforma for Natural Landscape

PREPARATION OF DETAILED PROJECT REPORT (DPR) FOR REJUVENATION OF INDUS RIVER BASIN THROUGH FORESTRY INTERVENTIONS

PROFORMA OF DATA COLLECTION FOR PROPOSED SITE HIMALAYAN FOREST RESEARCH INSTITUTE, SHIMLA, HIMACHAL PRADESH

(INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN-248006)

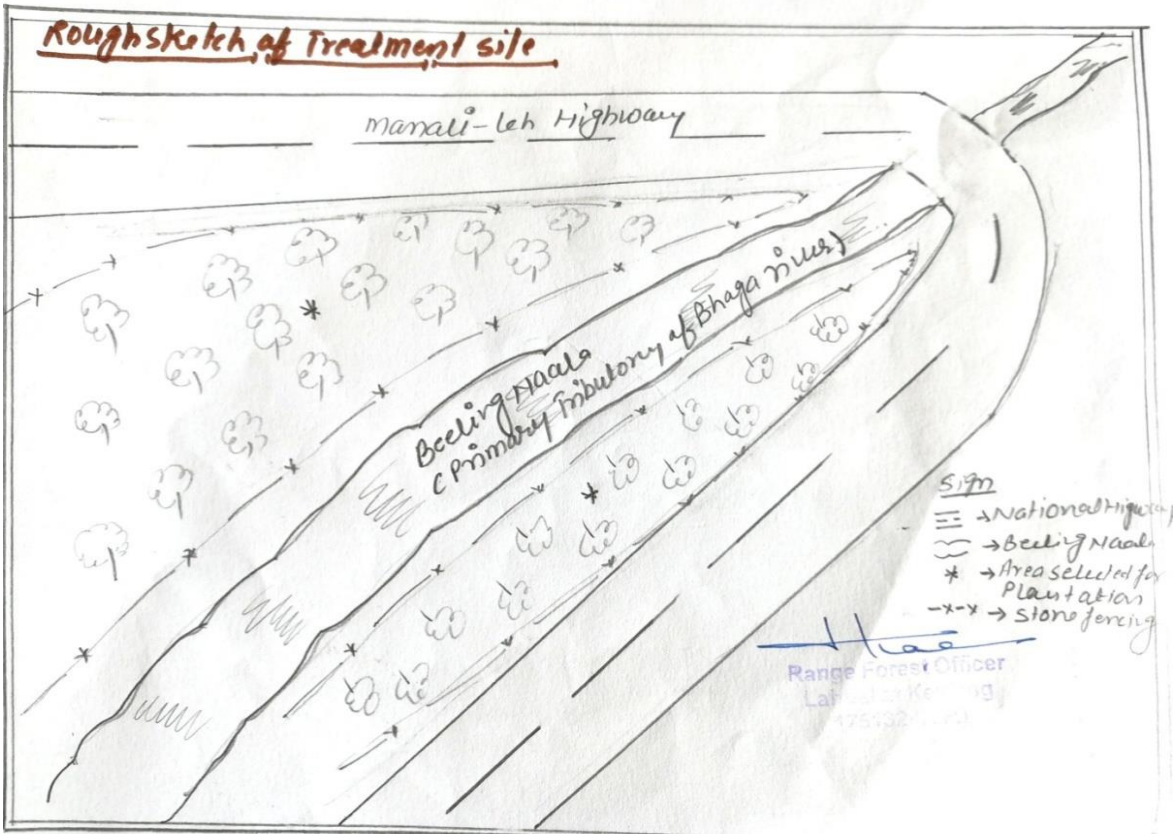
A. FORESTRY INTERVENTIONS	**NATURAL LANDSCAPE**
B. MODEL NO.	**CN/ NL/ HP/ 01**

C. TREATMENT SITE (DETAILS)		
1.	NAME OF SITE	Beeling *Nallah*
2.	AREA (IN HECTARE)	3 ha
D. GEOGRAPHICAL DETAILS		
1.	Name of River	Satluj **Chenab ●** Ravi Beas Jhelum
2.	State	**Himachal Pradesh ●** Punjab Jammu and Kashmir
3.	District	Lahaul and Spiti
4.	Forest Circle	Kullu
5.	Forest Division	Lahaul
6.	Forest Range	Keylong
7.	Forest Block	Bhaga
8.	Forest Beat	Keylong
9.	Development Block Name	Keylong
10.	Tehsil	Keylong
11.	Panchayat	Keylong
E. BASELINE DATA		
1.	Current Status of Flora and Fauna	*Artemisia brevifolia* and *Taraxacum officinalis*
2.	Current land use	Forest Land
3.	Legal Status of land	Forest Land
4.	Geology and Soil type	Hilly area and sandy soil
5.	Slope	Steep
6.	Aspect	Southern
7.	Average Annual Rainfall (in mm)	172
8.	Special features of the site e.g.,	Landslide and Avalanche point

	fire prone / landslides / mining areas / avalanche, etc.				
9.	Distance from Road (Approximate)	5 m (Roadside)			
10.	Distance from Main River with Name of the river (Approximate)	400 m, Bhaga River			
11.	Distance from Main Tributary with name of tributary (Approximate)	3m, Beeling *Nallah*			
12.	Suggestive species for plantation	Willow (*Salix fragilis, S. alba*), *Robinia pseudoacacia*, *Populus ciliata*			
13.	Pit Size	0.45 m x 0.45 m x 0.45 m			
14.	Details of Fencing works, if required before plantation	300 rft Stone Fence Wall			
15.	Details of Soil Moisture and Conservation works, if required before plantation				
16.	Planting Cost including nursery cost (Approximate)	2,76,000 Planting Cost + 56,727 Nursery Cost = 3,32,727 (Total Cost)			
17	Maintenance Cost of plantation with years (Approximate)	Ist year = 1,36,118 2nd year =96,845 3rd year =50,672 4th year =27,272 5th year = 27,272			
18.	Remarks, if any				
19.	GPS coordinates of the site at all the corners (As per the shape of site, minimum 4 points are required)	1. N : 32° 34’49.57” E: 77° 00’49.53” Ele (m) :	2. N : 32° 34’43.22” E: 77°00’52.75” Ele (m) :	3. N : 32° 34’36.64” E: 77° 00’54.69” Ele (m) :	4. N : 32° 34’35.71” E: 77°00’49.77” Ele (m) :
		5. N : 32° 34’43.39” E: 77° 00’49.34” Ele (m) :	6. N : 32° 34’49.09” E: 77°00’48.07” Ele (m) :	7. N : E: Ele (m) :	8. N : E: Ele (m) :
F. ROUGH SKETCH OF TREATMENT SITE / MAP (AS AN ATTACHMENT)		Enclosed			
G. CURRENT PHOTOGRAPH (AS AN ATTACHMENT)		Enclosed			

Current Photograph





Annexure:3 - Proforma for Agricultural Landscape

A. FORESTRY INTERVENTIONS	Agriculture Landscape
B. MODEL NO.	

C. TREATMENT SITE (DETAILS)		
1.	**Name of site**	Dehran village
2.	**Area (In Hectare)**	4 ha
D. GEOGRAPHICAL DETAILS		
1.	**Name of River**	Satluj **Chenab●** Ravi Beas Jhelum
2.	**State**	Himachal Pradesh Punjab **Jammu & Kashmir●**
3.	**District**	Doda
4.	**Forest Circle**	Chenab Circle
5.	**Forest Division**	Bhaderwah
6.	**Forest Range**	Kellar
7.	**Forest Block**	Paryote
8.	**Forest Beat**	Paryote - I
9.	**Development Block Name**	Khellani
10.	**Tehsil**	Doda
11.	**Panchayat**	Sassi
E. BASELINE DATA		
1.	**Current Status of Flora and Fauna**	Coniferous (Deodar & Kail)spp. *and Quercus* spp.
2.	**Current land use**	Agriculture Land
3.	**Legal Status of land**	Private (revenueland)
4.	**Geology and Soil**	Loamy soil

	type	
5.	**Slope**	Slopy area
6.	**Aspect**	Western
7.	**Average Annual Rainfall (in mm)**	80-100 mm
8.	**Special features of the site e.g.** **fire prone / landslides / mining areas / avalanche etc.**	Landslide prone area
9.	**Distance from Road (Approximate)**	2 km away from road
10.	**Distance from Main River with Name of the river (Approximate)**	30 km away from river Chenab
11.	**Distance from Main Tributary** **with name of tributary (Approximate)**	1km away from main tributary i.e., Dehran nallah
12.	**Suggestive species for plantation**	Coniferous and souil binding species
13.	**Pit Size**	0.45 m x 0.45 m x 0.45 m
14.	**Details of Fencing works, if required before plantation**	-
15.	**Details of Soil Moisture and** **Conservation works, if required before plantation**	
16.	**Planting Cost**	30,000

	including nursery cost (Approximate)				
17	**Maintenance Cost of plantation with years (Approximate)**	10,000			
18.	**Remarks, if any**	Needs soil and moisture conservation			
19.	**GPS coordinates of the site at all the corners (As per the shape of site, minimum 4 points are required)**	1. N: 33^{o}04’43” E: 75^{o}32’09” Ele (m) :	2. N : 33^{o} 04’47” E: 75^{o}32’14” Ele (m) :	3. N : 32^{o} 34’36.64” E: 75^{o} 32’15” Ele (m) :	4. N : E: Ele (m) :
		5. N : E: Ele (m) :	6. N : E: Ele (m) :	7. N : E: Ele (m) :	8. N : E: Ele (m) :
F. Rough sketch of treatment site / map (as an attachment)					
G. Current photograph (as an attachment)		Attached			

Annexure: 4 - Proforma for Urban Landscape

A. FORESTRY INTERVENTIONS	Urban Landscape
	a. Bioremediation and Bio-filtration **b. River Front Development & Ecotourism●** c. Eco Park Development d. Institutional and Industrial Plantation **e.** Any Other (Please Specify……..)

C. TREATMENT SITE (DETAILS)						
1.	**Name of site**	Mahomayr 66-Bahu				
2.	**Area (In Hectare)**	2 ha				
D. GEOGRAPHICAL DETAILS						
1.	**Name of River**	Satluj	**Chenab●**	Ravi	Beas	Jhelum
2.	**State**	Himachal Pradesh		Punjab	**Jammu & Kashmir●**	
3.	**District**	Jammu				
4.	**Forest Circle**	-				
5.	**Forest Division**	Urban Forestry				
6.	**Forest Range**	Sunjwan				
7.	**Forest Block**	Sunjwan				
8.	**Forest Beat**	Bandi				
9.	**Development Block Name**	Bandi				
10.	**Tehsil**	Jammu				
11.	**Panchayat**					
E. BASELINE DATA						
1.	**Current Status of Flora and Fauna**					

2.	**Current land use**	Forest Land
3.	**Legal Status of land**	Forest Land
4.	**Geology and Soil type**	
5.	**Slope**	
6.	**Aspect**	
7.	**Average Annual Rainfall (in mm)**	1200 mm
8.	**Special features of the site e.g.** **fire prone / landslides / mining areas / avalanche etc.**	Broad Leaved Forest
9.	**Distance from Road (Approximate)**	2 km away from road
10.	**Distance from Main River with Name of the river (Approximate)**	300 m Tawi River
11.	**Distance from Main Tributary** **with name of tributary (Approximate)**	300 m Tawi River
12.	**Suggestive species for plantation**	Fence using B.A Barbed Wire having 7 strands with every 8th pole
13.	**Pit Size**	1.6 m x 1.6 m
14.	**Details of Fencing works, if required before plantation**	7000 rft fencing
	Details of Soil Moisture and	

15.	**Conservation works, if required before plantation**				
16.	**Planting Cost including nursery cost (Approximate)**				
17	**Maintenance Cost of plantation with years (Approximate)**				
18.	**Remarks, if any**	Needs soil and moisture conservation			
19.	**GPS coordinates of the site at all the corners (As per the shape of site, minimum 4 points are required)**	1. N : 33^{o}04’6.02” E: 75^{o}54’8.95” Ele (m) :	2. N : 32 44”11.08 E: 74^{o}53’25.74” Ele (m) :	3. N : 32^{o} 43’42.51” E: 32^{o} 43’42.51” Ele (m) :	4. N : 32^{o} 43’50.73” E: 74^{o} 54’4.61” Ele (m) :
		5. N : E: Ele (m) :	6. N : E: Ele (m) :	7. N : E: Ele (m) :	8. N : E: Ele (m) :
F. Rough sketch of treatment site / map (as an attachment)		Attached			
G. Current photograph (as an attachment)		-			

Annexure: 5- Proforma for Urban Landscape

A. OTHER INTERVENTIONS	a. Wetland Management (Natural and Atrificial) b. Wildlife Management c. Riparian Wildlife Mangement **d. Soil and Water Conservation●** e. Moraine Mangement f. Any Other (Please Specify……..)
B. MODEL NO.	

C. TREATMENT SITE (DETAILS)		
1.	**Name of site**	Tong-Tong
2.	**Area (In Hectare)**	5 ha
D. GEOGRAPHICAL DETAILS		
1.	**Name of River**	Satluj **Chenab●** Ravi Beas Jhelum
2.	**State**	**Himachal Pradesh●** Punjab Jammu & Kashmir
3.	**District**	Lahaul & Spiti
4.	**Forest Circle**	Kullu
5.	**Forest Division**	Lahaul
6.	**Forest Range**	Keylong
7.	**Forest Block**	Bhaga
8.	**Forest Beat**	Keylong
9.	**Development Block Name**	Keylong
10.	**Tehsil**	Keylong
11.	**Panchayat**	Keylong
E. BASELINE DATA		
1.	**Current land use**	Forest Land

3.	**Legal Status of land**	Forest Land			
4.	**Geology and Soil type**	Sandy Soil			
5.	**Slope**	-			
6.	**Aspect**	-			
7.	**Average Annual Rainfall (in mm)**	172 mm			
8.	**Special features of the site e.g.** **fire prone / landslides / mining areas / avalanche etc.**	Slopy Area having Sandy Soil			
9.	**Distance from Road (Approximate)**	15 m			
10.	**Distance from Main River with Name of the river (Approximate)**	400 m,Bhaga River			
11.	**Distance from Main Tributary** **with name of tributary (Approximate)**	100 m,Beeling Nallah			
18.	**Remarks, if any**	-			
19.	**GPS coordinates of the site at all** **the corners (As per the shape of site, minimum 4 points are required)**	1. N : 32°34’19.42” E: 77°00’55.72” Ele (m) :	2. N : 32 34”21.44 E: 77°00’54.59” Ele (m) :	3. N : 32° 34’23.86” E: 77°00’53.91” Ele (m) :	4. N : 32° 34’23.72” E: 77°00’55.00” Ele (m) :
		5.	6.	7.	8.

		N : E: Ele (m) :	N : E: Ele (m) :	N : E: Ele (m) :	N : E: Ele (m) :
F. Rough sketch of treatment site / map (as an attachment)		Attached			
G. Current photograph (as an attachment)		Attached			

Annexure: 6 - Description of Soil Types within the Chenab Riverscape

Sr. No.	Soil Types	Characteristics
1.	Aquic Dystric Eutrochrepts	--
2.	Dystric Eutrochrepts	Soil on valley mild slope lands.
3.	Dystric Fluventic Eutrochrepts	--
4.	Fluventic Cryochrepts	--
5.	Fluventic Eutrochrepts	Coarse loamy, mixed, non-acidic, hyperthermic soils
6.	Fluventic Ustochrepts	--
7.	Fluventic Ustorhents	--
8.	Lithic Cryorthents	Poorly developed soils, semi-permanent snow, bank is simply a thin sandy A-horizon over a C- horizon.
9.	Lithic Udorthents	These soils have a lithic contact within 50 cm of the surface and some of them have high biological activity above the lithic contact.
10.	Mollic Udorthents	--
11.	Typic Cryochrepts	--
12.	Typic Cryorthents	--
13.	Typic Dystrochrepts	Sandy skeletal, mixed mineralogy soils, parent material is volcanic ash- influenced loess over residium from granite.
14.	Typic Eutrochrepts	--
15.	Typic Udifluvents	--
16.	Typic Udorthents	Found on moderate to steep slopes, are slightly to moderately eroded and moderate to strong stony.
17.	Typic Ustifluvents	Very deep imperfectly drained fine soils occurring on level to nearly level active alluvial plain with loamy surface & moderate flooding.
18.	Udic Ustochrepts	Coarse- loamy soils derived from mixed alluvium or residium weathered from sandstone and shale.
19.	Udic Ustorthents	--
20.	Non Soil	--

Annexure:7- List of Recommended Plant Species with Uses for Planting in Natural, Agriculture and Urban Landscapes in Himachal Pradesh

Botanical Name	Common/ Local Name (s)	Habit	Uses
Abies pindrow(Royle ex D.Don) Royle	Tosh/ Chilla/ Fir/Badlu	Tree	Construction, medicine and fuel.
Acer acuminatum Wall. ex D.Don	Kainjali/Kainjala	Tree	Wood used for agricultural implements and fodder.
Achillea millifolium (Wimm. & Grab.) Gremli	Gondana/Chabu / Shugumentog	Herb	The dark blue essential oil kills the larvae of the mosquitos.
Aconitum heterophyllum Wall. ex Royle	Atish	Herb	Migraines, headaches, vomiting, piles, burning sensation, etc.
Aesculus indica (Wall. ex Cambess.) Hook.	Pangar, Bankhor, Kandur/ Hunakdun	Tree	Used in traditional Indian medicine for the treatment of some skin diseases and rheumatism.
Agropyron sp.		Grass	Couch grass has been used as a diuretic in cases of bladder catarrh and bladder/kidney stones.
Agrostis gigantean Roth	Black bent/Redtop	Grass	Fodder and soil conservation.
Agrostis munroana Aitch. & Hemsl.		Grass	Fodder and soil conservation.
Agrostis pilosula Trin.		Grass	Fodder and soil conservation.
Ainsliaea aptera DC.	Karu buti	Herb	Roots are dried and crushed in a pestle mortar in a small quantity of water, 2-3 g of paste are then taken orally 3-4 times with lukewarm water to relieve stomachache, constipation and acute fever.
Allium carolinianum DC.	Lo-adh	Herb	Flavouring agent andedible.
Allium humile Kunth	Pareeni	Herb	Wild onion has economic value. Used for spices.
Alnus nepalensis D.Don	Kunis, Puzala, Kosh	Tree	Bark for dye and tannin, wood for bedsteads and for hooked sticks in old bridges.
Alnus nitida (Spach) Endl.	Kosh	Tree	The bark is alterative, astringent, cathartic, febrifuge and tonic. Used for fuel-wood and soil conservation

Alopecurus aequalis Sobol.		Grass	The whole plant is antiphlogistic, depurative and diuretic. It is used in the treatment of oedema, chickenpox and snakebites; fodder.
Angelica glauca Edgew.	Chora/ Chaura/ Chonra	Herb	Used in the treatment of various skin diseases, bites of poisonous animals, fever, rhinitis, gastric and psychiatric disorders; Spices.
Arnebia benthamii Wall. ex G.Don	Ratanjot	Herb	Used in preparation of sherbet (syrup) and jam useful in various diseases of tongue, throat, fever and cardiac disorders. Also used in skin diseases and hair tonic.
Arnebia euchroma (Royle) I.M.Johnst.	Dimok/ Ratanjot/ Dymong	Herb	Used in the treatment of measles, mild constipation, burns, frostbite, eczema, dermatitis, etc.
Artemisia maritima L.	Khamchu/ Phurang/ Kunja/ Shuomao/ Neerchuo/ Seski/ Nyurcha/ Garpeg/ Sensi	Herb	Used as anti-malarial, anti-diabetic, hepatoprotective, cytotoxic, anti-tumour and soil conservation.
Arundinella nepalensis Trin.		Grass	Soil stabilizer and fodder.
Arundinella pumila (Hochst.) Steud.		Grass	Soil stabilizer and fodder.
Azadirachta indica A.Juss.	Neem	Tree	Medicinal and fuel.
Bauhinia variegata L.	Kachnar	Tree	Food (edible), fodder, fuel, fibre, gum, tannin, medicinal (diarrhoea, astringent, skin disease), nitrogen fixer.
Berberis jaeschkeana C.K.Schneid.	Kaymali/ Jaeschke's Barberry	Shrub	Stem and root extracts used in medicine and fruits edible.
Berberis pseudumbelata R.Parker	Kirmali/ Pakkad	Shrub	Stem and root extracts used in medicine and fruits edible.
Berberis spp.	-	Shrub	Used as remedy for swollen and sore eyes, broken bones, wounds, gonorrhea, curative piles, unhealthy ulcers, acute conjunctive and in chronic opthalmia.
Bergenia ciliata (Haw.)		Herb	Root juice is used to treat coughs

Sternb.			and colds, haemorrhoids, asthma and urinary problems.
Bergenia stracheyi (Hook.f. & Thomson) Engl.	Shamlot	Herb	Root is used as a tonic in the treatment of fevers, diarrhea and pulmonary affections.
Betula utilis D.Don	Bhojpatra/ Bhuj	Tree	Treatment of various ailments and diseases such as skin disinfectant.
Bothriochloa parviflora (R.Br.) Ohwi		Grass	Soil conservation and fodder.
Bothriochloa pertusa (L.) A.Camus		Grass	Soil conservation and fodder.
Brachypodium sylvaticu m (Huds.) P.Beauv.		Grass	Used as a fodder and a graze for livestock.
Bromus himalaicus Stapf		Grass	Used as a fodder and a graze for livestock.
Bromus ramosus Huds		Grass	The plant is used in Bach flower remedies.
Calamagrostis montana		Grass	Fodder.
Calamagrostis spp.		Grass	Used as cough-medicine for women and children.
Capparis spinosa L		Shrub	Edible.
Caragana brevifolia Kom.		Shrub	Fuel.
Cedrus deodara (Roxb. ex D.Don) G.Don	Devdar	Tree	Timber, cedar oil, medicinal, fuel and religious.
Chrysopogon gryllus (L.) Trin.		Grass	For control of soil erosion.
Cicer microphyllum Benth.	Jangli chana	Grass	Edible and fodder.
Cinnamomum tamala (Buch.-Ham.) T.Nees & Eberm.	Mitha patter/Taj pata/ Gurupatraj	Tree	Use as mouth freshener and bark is used for making decoction in treatment of internal heat of heart diseases.
Colutea nepalensis Sims		Shrub	Soil fertility.
Cornus macrophylla Wall.	Karchan	Tree	Edible, fuel and fodder.
Corylus jacquemontii Decne	Thangi	Tree	Nuts edible, fodder and fuel.
Cotoneaster acuminatus Wall. ex Lindl.	Ruins	Shrub	Fodder and fuel.
Cotoneaster bacillaris Wall. ex Lindl	Ruins	Shrub	Edible, fodder, fuel, agriculture tools, ornamental and their

			attractive habit.
Crataegus songarica C. Koch		Tree	Edible, fodder and fuel.
Cycas spp.		Shrub	Ornamental.
*Cymbopogon distans (*Nees ex Steud.) W.Watson		Grass	Medicinal herb, oil, perfume and soil erosion.
Dactylis glomerata L.		Grass	Soil erosion and fodder.
Dactylorhiza hatagirea (D.Don) Soó	Angbolakpa/ Sanchu/ Hathpanja/ Hathajadi/ Salmpanja/ Salam Panja	Herb	Folk remedy for tumors, kidney & bladder ailments.
Danthonia cachemyriana Jaub. & Spach		Grass	Fodder and soil erosion.
*Danthonia cumminsii*Hook.f.		Grass	Fodder and soil erosion.
Daphne papyracea Wall. ex G. Don		Shrub	Main source of raw material for the production of lokta paper, and a hand-made paper from Nepal.
Debregeasia hypoleuca (Hochst. ex A.Rich.) Wedd.	Tasara/ Siaru	Shrub	Fodder and edible fruit.
Debregeasia longilfolia (Burm.f.) Wedd.	Siaru/ Tasara	Shrub	Fodder, fibre, and edible fruit.
Desmodium elegans DC.	Kathu	Shrub	Fodder and fuel.
Diospyros spp		Tree	Edible.
Drepanostachyum falcat um (Nees) Keng f.		Shrub	Fodder, makes bamboo items, etc.
Elaeagnus conferta Roxb.		Shrub	Edible and fuel.
Ephedra gerardiana Wall. ex Stapf		Shrub	Medicinal.
Eragrostis spp.		Grass	Fodder.
Eremurus himalaicus Baker		Herb	Edible.
Erianthus rufipilus Griseb.		Grass	Fodder and soil erosion.
Erianthus spp.		Grass	Aggressive grass that has been sold in nurseries for use as an ornamental grass in gardens, and for stabilizing soil to prevent

			erosion.
Festuca pratensis Huds.		Grass	Used as an ornamental grass in gardens and is also an important forage crop.
Festuca valesiaca Schleich. ex Gaudin		Grass	Used as ornamental.
Fraxinus xanthoxyloides (G.Don) Wall. ex A.DC		Tree	Fuel, agriculture tools and fodder.
Geranium wallichianum D.Don ex Sweet	Porulue	Herb	Medicinal and fodder.
Hedychium spicatum Sm.	Spiked Ginger Lily	Herb	Stomach ailments, skin disease and throat disorder.
Heracleum candicans Wall. ex DC..	Pudadei/ Dundu/ Raswal	Herb	Spices, flavoring, aphrodisiac, tonic, colic, digestive, antipyretic, diaphoretic, itching, skin disorders, etc.
Hippophae rhamnoides ssp. *turkestanica* Rousi.	Sarla/ Chharma	Shrub	Edible, medicinal, fuel and agriculture tools.
Hippophae salicifolia D.Don	Chuk/ Tarwa	Tree	Firewood, fodder, medicinal, edible fruit agriculture tools, soil fertility, house building etc.
Hyoscyamus niger L.	Thangdum-langtang-tse/ Dhandhura	Herb	Henbane is used in Homeopathic medicine.
Hypericum oblongifolium Choisy		Shrub	Used as a treatment for numerous ailments, including hepatitis, gastric ulcers and bee stings.
Hyssopus officinalis L.		Herb	Medicinal.
Inula cuspidata (Wall. ex DC.) C.B.Clarke		Shrub	Medicinal.
Indigofera heterantha Brandis	Kathi/ Sakina	Shrub	Branches are used in basket making and in making twig bridges, fuel and fodder.
Inula racemosa Hook.f.		Herb	Medicinal.
Juglans regia L.	Akhrot/ Thanna/ Dun	Tree	Leaves are used to treat skin ailments and purify the blood, Kernel edible, die, timber, etc.
Juniperus polycarpos K.Koch		Tree	Senescence, fuel and timber.
Koeleria spp.		Grass	Whole plant has astringent properties. In folk medicine is applied externally to the skin in the form of poultice to heal the wound

			and fodder.
Ligustrum nepalense Wall.		Tree	Ornamental.
Lonicera hypoleuca Decne.	Karmeo/ Kharmu	Shrub	Fodder and fuel.
Lonicera quinquelocularis Hard.	Taknoi	Shrub	Fuel, fodder, walking stick and fruits edible.
Lonicera spp.		Shrub	Fuel, fodder and edible.
Magnolia grandiflora L.		Tree	Ornamental.
Malus pumila Mill.		Tree	Edible and fuel.
Mangifera indica L.	Mango	Tree	Fruit, fuel and medicinal.
Melilotus spp.		Grass	Fodder and soil fertility.
Michelia champaca L		Tree	Ornamental.
Murraya paniculata (L.) Jack		Shrub	Edible and fuel.
Myricaria elegans Royle		Shrub	Fodder and fuel.
Myricaria germanica (L.) Desv.		Shrub	Fodder and fuel
Neolitsea pallens D. Don) Momiy. & H. Hara		Tree	The bark and leaves are used for treatment of fractures. The powdered leaf is used for dusting the cut surface of coconut inflorescences in the process of toddy tapping.
Phytolacca acinosa Roxb.		Herb	Root is antiasthmatic, antibacterial, antidote, antifungal, antitussive, diuretic, expectorant, laxative and vermifuge and edible.
Picea smithiana (Wall.) Boiss.	Rai	Tree	Timber and fuel
Picrorhiza kurroa Royle ex Benth.	Honglen/ Kutki/ Karu	Herb	Used to treat lever ailments, upper respiratory tract, reduce fevers, dyspepsia, chronic diarrhea, and scorpion sting.
Pinus garardiana Wall. ex D.Don	Chilgoza	Tree	Edible, fuel and timber.
Pinus wallichiana A.B.Jacks.	Kail/ Himalayan Blue Pine	Tree	Used in construction, crates, household purposes.
Platanus orientalis L.	Oriental plane tree	Tree	Fresh leaves are bruised and applied to the eyes in the treatment of ophthalmic. Ornamental.
Poa annua L.	Annual bluegrass	Grass	Used for making lawns and gardens and fodder.

Poa pratensis L.	Kentucky bluegrass/ Meadow-grass	Grass	Used in lawns and gardens. Fodder.
*Polygonatum cirrhifolium (*Wall.) Royle	Salam Mishri	Herb	Used in the treatment of loss of vigour, pain in the kidneys and hips, swelling and fullness in the abdominal region and edible.
Polygonatum verticillatum (L.) All.	Salam Mishri	Herb	Extensively used to cure various health troubles as cardio-tonic, antiperiodic, demulcent, diuretic, energizer, aphrodisiac, sedative, hypoglycemic, antitumor, pain reliever, general tonic, nervine tonic etc and edible.
Populus alba L.	Poplar/ Phrast	Tree	It is used internally in the treatment of rheumatism, arthritis, gout, lower back pains and timber.
Populus ciliata Wall. ex Royle	Poplar/ Phrast	Tree	Timber and fodder.
Populus spp.		Tree	Fodder and timber.
Prinsepia utilis Royle	Bhekhal	Shrub	As a treatment for rheumatism and muscular pain caused by hard work. Edible oil from kernels.
Prunus cerasoides Buch.-Ham. ex D.Don	Paja	Tree	Used to treat vomiting, nausea and gastritis, fruits edible and religious.
Prunus cornuta (Wall. ex Royle) Steud.	Jammu/ Cherry/Kurun	Tree	Edible fruits.
Prunus spp.		Tree	Edible.
Rheum australe D. Don	Chukeri ke todhi/Revandchini	Herb	The root is anti-cholesterolemic, antiseptic, antispasmodic, antitumor, aperient, astringent, cholagogue, demulcent, diuretic, laxative, purgative, stomachic and tonic.
Rheum moorcroftianum Royle	Pawan	Herb	It is commonly used for the management of renal function disorders, hyperlipidemia, cancer and improves the memory in senile patients.
Rheum webbianum Royle		Herb	Medicinal and edible.
Ribes alpestre Wall. ex		Shrub	Fruit edible.

Decne.			
Ribes himalense Royle ex Decne.		Shrub	Fruit edible.
Ribes orientale Desf.		Shrub	Fruit edible.
Rosa macrophylla Lindl.	Kantha	Shrub	Fruit edible.
Rosa sericea Wall. ex Lindl.		Shrub	Fruit edible.
Rosa moschata Herrm.		Shrub	Fruit edible.
Rosa webbiana Wall. ex Royle	Shyabala	Shrub	Fruit edible.
Rubus biflorus Buch.-Ham. ex Sm.		Shrub	Fruit edible.
Rubus foliosus Weihe		Shrub	Fruit edible.
Rubus niveus Thunb.		Shrub	Fruit edible.
Saccharum spontaneum L.		Grass	Fodder and soil conservation.
Salix alba L.		Tree	Bark is used for pain, including headache, muscle pain, menstrual cramps, timber and making cricket bats.
Salix daphnoides Vill.		Tree	Fodder and fuel.
Salix denticulata Andersson		Shrub	Fodder and fuel.
Salix fragilis L.	Beli	Tree	Fodder, fuel and timber.
Salix tetrasperma Roxb.		Tree	Used to treat ailments such as diabetes, fever, piles, epilepsy, rheumatism, swellings, stones in bladder, wound, ear pain, dysentery, cough and cold. Fodder and fuel.
Saussurea costus (Falc.) Lipsch.	Kuth	Herb	For the treatment of various ailments, like asthma, inflammatory diseases, ulcer and stomach problems.
Selinum tenuifolium Salisb.	Bhootkeshi	Herb	Used to treat rheumatism and kidney disease.
Setaria glauca (L.) P.Beauv.		Grass	It is regarded as a fairly good green fodder for cattle.The grains of the wild as well as cultivated

			types are used as food.
Sinopodophyllum hexandrum (Royle) T.S. Ying	Tandik/ Demobkusu/ Bankakri/ Omosheya	Herb	Used as a purgative and also for treatment of vaginal warts, treatment of cancers. Root paste is applied on ulcers, cuts and wounds. Fruits are edible.
Skimmia laureola Franch.		Shrub	Leaves used for the treatment of headache and smallpox as well as for freshness.
Spiraea canescens D.Don		Shrub	The leaves and flowering stems are alterative, anti-inflammatory, antiseptic, aromatic, astringent, diaphoretic, diuretic, stomachic and tonic, and ornamental.
*Stipa roylei (*Nees) Duthie		Grass	The bulb is antiasthmatic, antirheumatic, febrifuge, galactogogue, haemostatic, ophthalmic and oxytocic and fodder.
Syringa emodi Wall. ex Royle		Shrub	Used as folk medicine.
Taxus wallichiana Zucc.		Tree	Anti-cancerous, cold, cough, fever and pain. Ornamental.
Thamnocalamus spathiflorus (Trin.) Munro		Shrub	Fodder, makes bamboo items, etc.
Trifolium pretense L.		Grass	Fodder.
Trifolium repens L.		Grass	Fodder.
Trillium govanianum Wall. ex D.Don		Herb	Roots are used to stop postpartum bleeding.
Ulmus villosa Brandis ex Gamble		Tree	Fodder.
Ulmus wallichiana Planch.	Bren	Tree	Fodder, fuel and medicinal.
Valeriana jatamansii Wall.	Nihani/ Tagar/ Shivjadi/ Sugandhbala	Herb	It is used as a remedy for hysteria, hypochondriasis, nervous unrest and emotional stress.
Viburnum grandiflorum Wall. ex DC.		Shrub	Edible, fuel and medicinal
Viola canescens Wall.	Vanksha	Herb	Use to relieve cold and cough. Flowers are also added in tea preparation.

Annexure- 8- List of Recommended Plant Species with Uses for Planting in Natural, Agriculture and Urban Landscapes in Jammu and Kashmir UT

Botanical Name	Common/ Local Name (s)	Habit	Uses
Abies pindrow (Royle ex D.Don) Royle	Fir/ Budloo/ Raan	Tree	Construction.
Acacia catechu (L.f.) Willd.	Khair	Tree	Used for diarrhea, dysentery, bleeding, indigestion and cancer. People apply catechu directly to the skin for skin diseases.
Acer acuminatum Wall. ex D.Don		Tree	Wood used for agricultural implements and fodder.
Acer caesium Wall. ex Brandis	Kanjal	Tree	The juice of the bark is used externally to treat muscular swellings, boils and pimples.
Acer pictum Thunb.	Knzal/ Trikanna	Tree	Fodder and fuel.
Aconitum heterophyllum Wall. ex Royle	Patrishi/ Patress/ Atis	Herb	Migraines, headaches, vomiting, piles, burning sensation, etc.
Aconitum violaceum Jacquem. ex Stapf		Herb	The plant is used in traditional Tibetan medicine.
Adina cordifolia(Roxb.) Benth. & Hook.f. ex B.D.Jacks.		Tree	Medicinal and fuel.
Aegle marmelos (L.) Corrêa	Bill	Tree	Medicinal, edible and the fruit pulp is used to prepare delicacies like murabba, puddings and juice.
Aesculus indica (Wall. ex Cambess.) Hook.	House Chest Nut/ Benkhor	Tree	It is used in traditional Indian medicine for the treatment of some skin diseases and rheumatism.
Agropyron spp.		Grass	Couch grass has been used as a diuretic in cases of bladder catarrh and bladder/kidney stones.
Agrostis gigantea Roth		Grass	Fodder and soil conservation.
Agrostis munroana Aitch. & Hemsl.		Grass	Fodder and soil conservation.
Agrostis pilosula Trin.		Grass	Fodder and soil conservation.
Ainsliaea aptera DC.	Tito Butee	Herb	Roots are dried and crushed in a pestle mortar in a small quantity of water, 2-3 g of paste are then taken orally 3-4 times with lukewarm water to relieve stomachache,

			constipation and acute fever.
Ajuga bracteosa Wall. ex Benth.	Joraon	Herb	The juice of the root is used in the treatment of diarrhea and dysentery.
Albizia lebbek (L.) Benth.	Kala Siris/ Sareen	Tree	Fodder, fuel and timber.
Albizia procera (Roxb.) Benth.	Safed siris	Tree	Fodder, fuel and timber.
Alstonia scholaris (L.) R. Br.		Tree	Ornamental.
Allium humile Kunth	Wild Onion	Herb	Wild onion has economic value. Used for spices.
Allium stracheyi Baker		Herb	Medicinal.
Alnus nitida (Spach) Endl.	Chaamp	Tree	Fuel and timber.
Alopecurus aequalis Sobol.	Orange foxtail	Grass	The whole plant is antiphlogistic, depurative and diuretic. It is used in the treatment of oedema, chickenpox and snakebites.
Angelica glauca Edgew.	Chora/ Choru	Herb	Used in the treatment of various skin diseases, bites of poisonous animals, fever, rhinitis, gastric and psychiatric disorders. Spices.
Anthocephalus kadamba (Roxb.) Miq.		Tree	Medicianl.
Apluda mutica L.		Grass	Fodder and soil conservation.
Araucaria araucana (Molina) K.Koch		Tree	Ornamental.
Arnebia benthamii (Wall. ex G.Don) I.M.Johnst.	Kahjuban/ Ratanjot	Herb	Used in preparation of sherbet (syrup) and jam useful in various diseases of tongue, throat, fever and cardiac disorders. Also used in skin diseases and hair tonic.
Arundinella nepalensis Trin.		Grass	Soil conservation
Arundinella pumila (Hochst.) Steud.		Grass	Soil conservation.
Arundo donax L.	Nad/ Nal	Grass	Used for condylomata and indurations of the breast.
Azadirachta indica A.Juss.		Tree	Medicinal, fuel and timber.
Bambusa arundinacea Willd.		Bamboo	Fodder and bamboo items.

Bauhinia retusa Poir.		Tree	Fodder and fuel.
Bauhinia variegata L.	Kachnar	Tree	Edible and fodder.
Berberis aristata DC.	Kareel Kaimbul/ Kambel/ Daruharidra	Shrub	Medicinal, edible and fuel.
Berberis lycium Royle	Kaimal/ Kamblu/ Daruhaldi/ Khaaray/Simlu/ Resaunt/ Kavelli	Shrub	Medicinal, edible and fuel.
Berberis spp.	Darwhaldi/ Dandledar/ Kaodachh	Shrub	Used as remedy for swollen and sore eyes, broken bones, wounds, gonorrhea, curative piles, unhealthy ulcers, acute conjunctive and in chronic opthalmia.
Bergenia ciliata(Haw.) Sternb.	Sapdotri/ Zakham-a-hayat	Herb	The root juice is used to treat coughs and colds, haemorrhoids, asthma and urinary problems.
Bergenia stracheyi (Hook.f. & Thomson) Engl.	Dhad Kopdi	Herb	The root is used as a tonic in the treatment of fevers, diarrhea and pulmonary affections.
Betula alnoides Buch.-Ham. ex D.Don	Bhojpatra/ Burza	Tree	Inner bark is edible and is used for making cakes and bread.
Betula utilis D.Don	Bhurj/ Bhojpatra/ Birch	Tree	Treatment of various ailments and diseases such as skin disinfectant.
Bignonia spp.		Shrub	Ornamental.
Boehmeria rugulosa Wedd.		Tree	Fodder, edible.
Boerhavia diffusa L.	Punarnava	Grass	Popular in Ayurveda, this herb is known for its anti-inflammatory and analgesic properties.
Bothriochloa intermedia (R.Br.) A.Camus	Plains lovegrass	Grass	Protect degenerative diseases and maintain youthfulness, vigor and vitality.
Bothriochloa pertusa (L.) A.Camus		Grass	Fodder
Bougainvillea spp.		Shrub	Ornamental.
Brachypodium sylvaticum (Huds.) P.Beauv.	wood false brome	Grass	Widely used as a fodder and a graze for livestock.
Bromus himalaicus Stapf	Smooth Brome	Grass	Widely used as a fodder and a graze for livestock.
Bromus ramosus Huds.	Hairy Brome	Grass	The plant is used in Bach flower

			remedies.
Butea monosperma (Lam.) Taub.	Pulah/ Palash	Tree	Religious, fuel.
Calamagrostis montana (Gaudich.) DC.		Grass	Fodder.
Calamagrostis emodensis Griseb.		Grass	Fodder.
Callistemon citrinus (Curtis) Skeels		Tree	Ornamental.
Carissa opaca Stapf ex Haines		Shrub	Edible and fuel.
Cassia fistula L.	Krangal/ Amaltass	Tree	Medicinal and fuel.
Cedrus deodara (Roxb. ex D.Don) G.Don	Deodar	Tree	Timber tree.
Celtis australis L.	Brimij/ Khirak	Tree	The decoction can also be used to astringe the mucous membranes in the treatment of diarrhea, dysentery and peptic ulcers. It is good fodder tree.
Chrysopogon fulvus (Spreng.) Chiov.	Dholu/Goria	Grass	Used for erosion control, lawns, forage and medicines.
Chrysopogon gryllus (L.) Trin.	Dhaple ghans	Grass	For control of soil erosion.
Chrysopogon serrulatus Trin.	Bhadraksh	Grass	Used as for the treatment of hypertension, renaldiseases and used as diuretic, anthelmintic, disinfectant, antispasmodic, carminative, deodorant.
Cinnamomum tamala (Buch.-Ham.) T.Nees & Eberm.		Tree	Medicinal, edible.
Cornus macrophylla Wall.	Arhew	Tree	Edible, fodder, fuel, etc.
Cornus oblonga Wall.	Oblong-Petal Dogwood	Shrub	Used principally to reduce heavy menstrual bleeding and unusually active secretions.
Corylus jacquemontii Decne.	Bhotiya Badam/ Virin	Tree	The nuts of all hazels are edible, fodder, etc.
Cotoneaster acuminatus Wall. ex Lindl.		Shrub	Fodder and fuel.
Cotoneaster bacillaris Wall. ex Lindl.	Dhalke phool/Leun	Shrub	Garden shrubs, grown for their attractive habit and decorative

			fruit.
Cryptomeria japonica (Thunb. ex L.f.) D.Don	Sugi	Tree	The wood is strongly rot resistant, easily worked for house building.
Cupressus torulosa D.Don	Himalayan Cypress	Tree	Traditionally used in cold and cough. Ornamental.
Cycas spp.		Shrub	Ornamental.
Cymbopogon citratus (DC.) Stapf		Grass	Medicinal, soil erosion, etc.
Cymbopogon distans (Nees ex Steud.) W.Watson	Malabar Grass/ Lemongrass	Grass	Used as a medical herb and in perfumes, soil erosion.
Cymbopogon jwarancusa (Jones) Schult.		Grass	Oil, soil erosion, etc.
Cymbopogon martini (Roxb.) W.Watson	Gandhabel	Grass	Used as traditional medicine its oils are used to treat rheumatism, hair loss, arthritis, lumbago and spasms. The essential oil is a strong fungicide.
Cyperus rotundus L.	Dheela	Grass	Medicinal, edible.
Dactylis glomerata L.	Cat Grass	Grass	It is a folk remedy for tumors, kidney and bladder ailments, fodder.
Dactylorhiza hatagirea (D.Don) Soó	Salam panja/ Hathpanja	Herb	It is used as a nervine tonic and aphrodisiac.
Dalbergia sissoo DC.	Shisham/ Tali	Tree	Timber.
Danthonia cachemyriana Jaub. & Spach		Grass	Fodder and soil erosion.
Danthonia cumminsii Hook.f.	Wallaby Grass	Grass	Ornamental and soil erosion.
Daphne papyracea Wall. ex G. Don	Indian Paper Plant	Shrub	Main source of raw material for the production of lokta paper, a hand-made paper from Nepal.
Debregeasia longifolia (Burm.f.) Wedd.		Shrub	Fruits edible, fodder, etc.
Debregeasia hypoleuca (Hochst. ex A.Rich.) Wedd.		Shrub	Fruits edible, fodder, etc.
Delonix regia (Hook.) Raf.		Tree	Ornamental.
Dendrocalamus hamiltonii Nees & Arn.		Tree	Making bamboo brakes.

ex Munro			
Dendrocalamus strictus (Roxb.) Nees	Bans or bamboo	Tree	Making bamboo brakes.
Deschamsia spp.		Grass	Fodder and soil erosion.
Desmodium elegans DC.	Shemar	Shrub	Fodder and fuel.
Desmodium gangeticum (L.) DC.		Shrub	Fodder, medicinal, etc.
Deutzia corymbosa R.Br. ex G.Don	Clustered Coelogyne	Shrub	The plant is known to clear heat and toxins, activate blood circulation, promote diuresis and relieve stranguria.
Deutzia staminea R.Br. ex Wall.	Clustered Coelogyne	Shrub	The plant is known to clear heat and toxins, activate blood circulation.
Dichanthium annulatum (Forssk.) Stapf	Palain	Grass	Fodder and soil erosion.
Digitaria cruciata (Nees) A.Camus		Grass	Fodder and soil erosion.
Diospyros Montana Roxb.		Tree	Edible fruits.
Dodonaea viscosa (L.) Jacq.	Saintha	Shrub	Soil conservation.
Drepanostachyum falcat um (Nees) Keng f.		Shrub	Fodder, makes bamboo items, etc.
Eichhornia crassipes (Mart.) Solms	Water Hyacinth,		Bio-remediation.
Elaeagnus conferta Roxb.		Shrub	Edible furit, fuel, etc.
Eragrostis nigra Nees ex Steud.		Grass	Fodder.
Eremurus himalaicus Baker	Prezdar/ Kaahlu	Herb	Edible.
Erianthus filifolius Nees ex Steud.	Pink Feather Grass	Grass	Fodder, soil erosion, Aggressive grass that has been sold in nurseries for use as an ornamental grass in gardens, and for stabilizing soil to prevent erosion.
Erianthus rufipilus Griseb.	Sarkanda/Salam Ghas	Grass	Fodder, soil erosion.
Eulaliopsis binata (Retz.) C.E.Hubb.	Bubbeain	Grass	Making brooms, fodder and soil erosion.

Euonymus spp.	Dadul/ Dharua	Shrub	Wood is traditionally used for the making of spindles for spinning wool. Ornamental.
Euphorbia pulcherrima Willd. ex Klotzsch		Shrub	Ornamental.
Festuca arundinacea Schreb.	Tall fescue	Grass	Used as an ornamental grass in gardens.
Festuca pratensis Huds.	Foxtail chess	Grass	Used as an ornamental grass in gardens and is also an important forage crop.
Festuca valesiaca Schleich. ex Gaudin	Volga fescue	Grass	Used as ornamental.
Ficus benghalensis L.	Bohar/ Peepal	Tree	Fodder, edible, religious, etc.
Ficus racemosa L.	Rumble	Tree	Fodder, edible, etc.
Ficus rumphii Blume		Tree	Fodder, edible.
Fraxinus micrantha Lingelsh.		Tree	Timber, agriculture tools.
Fraxinus xanthoxyloides (G.Don) Wall. ex A.DC.		Tree	Agriculture tools.
Fritillaria roylei Hook.	Sheethkar	Herb	The bulb is antiasthmatic, antirheumatic, febrifuge, galactogogue, haemostatic, ophthalmic and oxytocic.
Geranium wallichianum D.Don ex Sweet	Gul-e-snobar/ Suchaphull	Herb	Garden worthy plant.
Ginkgo biloba L.	Bal Kumari	Tree	Used to treat altitude sickness (prevention), cerebral vascular insufficiency, cognitive disorders and dementia, ornamental
Grevillea robusta A.Cunn. ex R.Br.		Tree	Ornamental, fuel.
Grewia optiva J.R.Drumm. ex Burret	Dhaman/ Taman	Tree	Fuel, fodder, fiber, edible, etc.
Haldina cordifolia (Roxb.) Ridsdale		Tree	Fodder, timber.
Hedychium spicatum Sm.	Kapur Kachri	Herb	Stomach ailments, etc.
Heracleum candicans Wall. ex DC.	Cow Parsnip/ Churu/ Mirkul/ Krandel/ Hakhabuel	Herb	Spices, flavoring, aphrodisiac, tonic, colic, digestive, antipyretic, diaphoretic, itching, skin disorders, etc.

Heteropogon contortus (L.) P.Beauv. ex Roem. & Schult.	Lambagha/ Bunched Spear Grass	Grass	Planted for erosion control and re-vegetation of degraded habitats, fodder.
Hierochloe laxa Hook.f.		Grass	Fodder.
Holoptelea integrifolia Planch.		Tree	Ornamental, fuel.
Hymenodictyon excelsum (Roxb.) Wall.		Tree	Fuel.
Hyoscyamus niger L.	Black Henbit/ Henbane/ Bajerbhang/ Murg jawain	Herb	Henbane is used in Homeopathic medicine.
Hypericum oblongifolium Choisy	Hypericum	Shrub	Used as a treatment for numerous ailments, including hepatitis, gastric ulcers and bee stings.
Indigofera heterantha Brandis	Kathi/Himalayan Indigo	Shrub	The branches are used in basket making and in making twig bridges.
Inula cuspidata(Wall. ex DC.) C.B.Clarke		Shrub	Medicinal.
Jacaranda mimosifolia D.Don		Tree	Ornamental.
Juglans regia L.	Walnut/ Akhrot	Tree	The leaves are used to treat skin ailments and purify the blood, edible, dye.
Justicia adhatoda L.		Shrub	Medicinal.
Kigelia pinnata (Jacq.) DC.		Tree	Ornamental.
Koeleria spp.	June Grass	Grass	The whole plant has astringent properties. In folk medicine is applied externally to the skin in the form of poultice to heal the wound, fodder.
Lannea coromandelica (Houtt.) Merr.	Kembal	Tree	Fuel.
Litsea chinensis Lam.		Tree	Oil, fuel.
Lyonia ovalifolia (Wall.) Drude	Angeri	Tree	The young leaves and buds are toxic, but they are used externally as an infusion to treat skin diseases and external parasites, fuel.
Maesa indica (Roxb.) A. DC.		Shrub	Fodder, fuel.

Magnolia grandiflora L.	Him champa/ Bull Bay	Tree	Ornamental.
Mallotus philippensis (Lam.) Müll.Arg.	Kamila/ Kembal	Tree	Fodder, fuel, miscellaneous etc.
Michelia champaca L.		Tree	Ornamental.
Melia azedarach L.	Drek/ Drenk	Tree	Fodder, timber.
Morus alba L.	Toot/ Tut	Tree	Used in traditional Chinese medicine to treat asthma, bronchitis, edema, and diabetes. Fodder and silkworm production. Used in traditional Chinese medicine to treat asthma, bronchitis, edema, and diabetes. Fodder and silkworm production, edible.
Murraya paniculata (L.) Jack		Shrub	Edible.
Murraya koenigii (L.) Spreng.	Drenkeri	Shrub	Edible.
Myrica esculenta Buch.-Ham. ex D. Don		Tree	Edible, medicinal, etc.
Myrsinea africana L.		Shrub	Making brooms.
Nelumbo nucifera Gaertn.	Kamal		Ornamental.
Neolitsea pallens D. Don) Momiy. & H. Hara	Chirchira	Tree	The bark and leaves are used for treatment of fractures. The powdered leaf is used for dusting the cut surface of coconut inflorescences in the process of toddy tapping, oil.
Nerium indicum Mill.	Gandila/ Lalkaner/ Kaner	Shrub	It is bitter, acrid, anthelmintic, adaptogenic, analgesic, aphrodisiac anticancer and anti-inflammatory, ornamental.
Neyraudia arundinacea (L.) Henrard		Grass	Fodder, soil erosion.
Nyctanthes arbor-tristis L.	Parijat/ Shefali	Shrub	Used in various ailments like fever, enlargement of the spleen, malaria, blood dysentery, cough and gastritis, ornamental.
Nymphoides cristata (Roxb.) Kuntze			Edible, ornamental.
Olea spp.	Kua/ Kahu	Tree	Fodder, fuel, medicinal, edible.

Olea ferruginea Wall. ex Aitch.	Kua/ Kahu	Tree	Medicinal, religious.
Oroxylum indicum (L.) Kurz		Tree	Medicinal, religious.
Panicum maximum Jacq.		Grass	Fodder and soil conservation.
Parrotiopsis jacquemontiana (Decne.) Rehder	Hatab/Parrotia/ Poa	Shrub	Used for skin infections and in wound healing.
Phleum pretense L.	Alpine Cat Tail	Grass	Used in small amounts as part of a new hay fever vaccine.
Phragmites karka (Retz.) Trin. ex Steud.	Doka-Ghas/ Kilak	Grass	Concoction of reed roots was believed to bring the fever away via increased urination and also help to restore body fluid, fodder, soil erosion.
Phyllanthus emblica L.		Tree	Medicinal, edible fluid.
Phytolacca acinosa Roxb.	Brand/ Saranugun/Himalayan Pokeberry	Herb	The root is antiasthmatic, antibacterial, antidote, antifungal, antitussive, diuretic, expectorant, laxative and vermifuge, edible.
Picea smithiana (Wall.) Boiss.	Spruce	Tree	Timber, fuel.
Picrorhiza kurrooa Royle	Kour/ Kaur/ Kuru/ Honglen/Kutki	Herb	Used to treat disorders of the liver and upper respiratory tract, chronic diarrhea, and scorpion sting.
Pinus gerardiana Wall. ex D.Don		Tree	Edible, medicinal, fuel, timber.
Pinus roxburghii Sarg.	Chir	Tree	Timber, resin, oleoresin, medicinal, fuel, etc.
Pinus wallichiana A.B.Jacks.	Kail/Himalayan Blue Pine	Tree	Used in construction, crates, household purposes, fuel.
Pistacia integerrima J. L. Stewart ex Brandis	Kakarsinghi	Tree	Medicinal, fodder.
Platanus orientalis L.	Oriental plane/Bouin	Tree	The fresh leaves are bruised and applied to the eyes in the treatment of ophthalmic. Ornamental.
Plectranthus rugosus Wall. ex Benth.	Salai	Shrub	Medicinal, bee flora.
Poa annua L.	Annual Bluegrass	Grass	Used for making lawns and gardens.
Poa pratensis L.	Smooth Brome	Grass	Used in lawns and gardens, Fodder.

Polyalthia longifolia (Sonn.) Thwaites		Tree	Ornamental.
Polygonatum cirrhifolium (Wall.) Royle	Coiling Leaf Polygonatum/ Mahmeda	Herb	Used in the treatment of loss of vigour, pain in the kidneys and hips, swelling and fullness in the abdominal region, edible.
Polygonatum multiflorum (L.) All.	Ra-mnye	Herb	Medicinal, edible.
Polygonatum verticillatum (L.) All.	Salam dana, mishri, Mitha-dodhu	Herb	Extensively used to cure various health troubles as cardio-tonic, antiperiodic, demulcent, diuretic, energizer, aphrodisiac, sedative, hypoglycemic, antitumor, pain reliever, general tonic, nervine tonic etc., edible.
Pongamia pinnata (L.) Pierre		Tree	Medicinal and timber.
Populus spp.		Tree	Fodder, timber.
Potamogeton spp.		Herb	Water purification.
Prinsepia utilis Royle	Bhekhal	Shrub	As a treatment for rheumatism and muscular pain caused by hard work. Edible oil from kernels.
Prunus cerasoides Buch.-Ham. ex D.Don	Padam/ pajja	Tree	Used to treat vomiting, nausea and gastritis, fodder, edible.
Prunus cornuta (Wall. ex Royle) Steud.	Zum/ Himalayan Bird Cherry	Tree	Edible fruits.
Punica granatum L.	Darhuni/ Anar/ Daru	Tree	Medicinal, edible.
Pyrus pashia Buch.-Ham. ex D.Don	Kainth/ Wild pear	Tree	It is used in gastrointestinal disorders, fever and headache, sweating of body. Edible fruits.
Quercus baloot Griff.		Tree	Fodder, fuel.
Quercus floribunda Lindl. ex A.Camus		Tree	Fodder, fuel, timber, etc.
Quercus oblongata D.Don	Oak/ Banj	Tree	Fodder, fuel, timber, etc.
Quercus semecarpifolia Sm.	Kharsu	Tree	Fodder, fuel, etc.
Rheum australe D. Don	Chukri/ Padshah/Pambchalan	Herb	The root is anti-cholesterolemic, antiseptic, antispasmodic, antitumor, aperient, astringent, cholagogue, demulcent, diuretic,

			laxative, purgative, stomachic and tonic.
Rheum moorcroftianum Royle	Rhubarb/ Pambechalan	Herb	It is commonly used for the management of renal function disorders, hyperlipidemia, cancer and improves the memory in senile patients.
Ricinus communis L.	Arnid	Shrub	Oil.
Rosa macrophylla Lindl.		Shrub	Edible.
Rosa moschata Herrm.	Karir/Ban Gulab	Shrub	Used for the treatment of abdominal spasm and diarrhea, edible.
Rosa sericea Wall. ex Lindl.		Shrub	Edible.
Rosa spp.		Shrub	Ornamental.
Rubus foliolosus Hal csy		Shrub	Edible.
Rubus niveus Thunb.	Chhanchh	Shrub	Edible.
Saccharum munja Roxb.	Khar	Grass	Fodder, soil erosion.
Saccharum spontaneum L.	Kai	Grass	Fodder, soil erosion.
Salix spp.	Bed	Tree	Fodder, fuel, timber, etc.
Sapindus mukorossi Gaertn.	Reetha	Tree	Medicinal etc.
Saraca asoca (Roxb.) Willd.		Tree	Medicinal, ornamental.
Saussurea costus (Falc.) Lipsch.	Kuth/ Kuste Himid/ Chobi-i-qut	Herb	For the treatment of various ailments, like asthma, inflammatory diseases, ulcer and stomach problems.
Scirpus grossus L.f.	Kaseru/ Club-rush		Bioremediation.
Selinum tenuifolium Salisb.	Leaf Milk Parsley	Herb	Used to treat rheumatism and kidney disease.
Selinum vaginatum C.B. Clarke	Bhoot kesi	Herb	Medicinal and soil conservation.
Sesbania sesban (L.) Merr.		Tree	Ornamental.
Setaria glauca (L.) P.Beauv.	Bandra/ Bankauni	Grasses	Fodder.
Sinopodophyllum hexandrum (Royle) T.S. Ying	Tandik/ Demobkusu/ Bankakri/ Omosheya	Herb	Used as a purgative and also for treatment of vaginal warts, treatment of cancers. Root paste is applied on ulcers, cuts and

			wounds. Fruits are edible.
Spiraea canescens D.Don	Dhakk	Shrub	The leaves and flowering stems are alterative, anti-inflammatory, antiseptic, aromatic, astringent, diaphoretic, diuretic, stomachic and tonic, ornamental.
Spirodela polyrrhiza (L.) Schleid.		Herb	Bio-remediation.
Sporobolus diandrus (Retz.) P.Bauv.		Grasses	Fodder.
Stipa roylei (Nees) Duthie	Stipa	Grasses	The bulb is antiasthmatic, antirheumatic, febrifuge, galactogogue, haemostatic, ophthalmic and oxytocic, fodder.
Syringa emodi Wall. ex Royle	Himalayan Lilac	Shrub	Medicine.
Syzygium cumini (L.) Skeels	Jamun	Tree	Medicinal, edible, fuel, beverage.
Syzygium venosum DC.		Tree	Medicinal, edible, fuel.
Taxus wallichiana Zucc.	Thuno/ Madhuparni	Tree	Anti-cancerous, cold, cough, fever and pain. Ornamental.
Tecoma stans (L.) Juss. ex Kunth		Shrub	Ornamental.
Tephrosia hamiltonii Gamble	Sarapunkha	Shrub	Plant is anthelmintic, alexiteric, restorative and antipyretic.
Terminalia arjuna (Roxb. ex DC.) Wight & Arn.	Arjun	Tree	Medicinal.
Terminalia bellirica (Gaertn.) Roxb.	Bahera/ Bheda	Tree	Medicinal, edible, fodder, miscellaneous.
Terminalia chebula Retz.	Harar	Tree	Medicinal, edible, fodder, miscellaneous.
Themeda anathera (Nees ex Steud.) Hack.	Loonder Grass	Grasses	Fodder and soil conservation.
Themeda arundinacea (Roxb.) A.Camus		Grasses	Fodder and soil conservation.
Thuja orientalis L.		Tree	Ornamental.
Thysanolaena maxima (Roxb.) Kuntze	Bamboo Grass	Grass	Fodder, soil erosion and soil conservation, broom making.
Tinospora cordifolia (Willd.) Miers	Giloe	Shrub	Medicinal.
Toona ciliata M.Roem.	Toon	Tree	Timber, miscellaneous.
Toona sinensis (Juss.)		Tree	Fodder, timber, miscellaneous.

M.Roem.			
Trifolium pretense L.	Red clover	Grasses	Fodder, soil fertility.
Trifolium repens L.	White clover/ Chopati	Grasses	Fodder, soil fertility.
Trillium govanianum Wall. ex D.Don	Himalayan Trillium/ Nagchhatri	Herb	Medicinal.
Typha angustata Bory & Chaub.	Petz	Herb	Bio-remediation.
Ulmus wallichiana Planch.	Brari/ Kain/ Himalayan Elm	Tree	Fodder, fuel, medicinal, timber
Valeriana jatamansi Jones	Mushkbala	Herb	Hysteria, hypochondriasis, nervous unrest and emotional stress, senescens.
Viburnum cotinifolium D. Don	Kulmosh	Shrub	Edible, fodder, fuel.
Viburnum nervosum D. Don	Molo/Kulmach	Shrub	Medicinal as a blood purifier.
Viola canescens Wall.	Bunafsha	Herb	Medicinal.
Vitex negundo L.	Bana/ Banha	Shrub	Medicinal, biofencing, etc.
Withania somnifera (L.) Dunal	Ashwagandha	Shrub	Medicinal
Woodfordia fruiticosa (L.) Kurz	Dhain	Shrub	Medicinal, fuel, dye, etc.
Zanthoxylum armatum DC.	Timbru/ Tejphal	Shrub	Rheumatism and skin diseases; chilblains, cramp in the leg, varicose veins and varicose ulcers. Also used as spice.
Ziziphus jujuba Mill.	Ber	Shrub	Edible.
Ziziphus nummularia Lam.		Tree	Edible.

Annexure: 9- Model-Wise List of Recommended Plant Species for Planting in Natural, Agriculture and Urban Landscapes in Himachal Pradesh

Botanical Name	Natural Landscape							Agriculture Landscape		Urban Landscape	
	Himachal Pradesh							Himachal Pradesh		Himachal Pradesh	
	1	2	3	4	5	6	7	1	2	1	2
Abies pindrow (Royle ex D.Don) Royle	✓			✓	✓						
Acer acuminatum Wall. ex D.Don						✓					
Achillea millifolium L.		✓	✓								
Aconitum heterophyllum Wall. ex Royle		✓	✓	✓	✓						
Aesculus indica Wall. ex Cambess.						✓					
Agropyron sp.			✓								
Agrostis gigantean Roth			✓								
Agrostis munroana Aitch. & Hemsl.			✓				✓				
Agrostis pilosula var. alpestris (Hook.f.) Veldkamp			✓								
Ainsliaea aptera DC.			✓								
Allium carolinianum DC.		✓									
Allium humile Kunth			✓	✓							
Alnus nepalensis D.Don						✓					
Alnus nitida (Spach) Endl.						✓					
Alopecurus aequalis Solol.							✓				
Alopecurus nepalensis Trin. ex Steud.							✓				
Angelica glauca Edgew			✓	✓	✓	✓					

Arnebia benthamii Wall. ex G.Don			✓	✓							
Arnebia euchroma (Royle) I.M.Johnst.		✓									
Artemisia maritima L.		✓		✓							
Arundinella nepalensis Trin.							✓				
Arundinella pumila (Hochst.) Steud.							✓				
Bauhinia variegata L.										✓	
Berberis jaeschkeana C.K.Schneid.					✓			✓			
Berberis pseudumbellata R.Parker					✓						
Berberis spp.										✓	
Bergenia ciliate (Haw.) Sternb.					✓	✓					
Bergenia stracheyi (Hook.f. & Thomson) Engl.				✓	✓						
Betula utilis D.Don	✓			✓							
Bothriochloa intermedia (R.Br.) A.Camus							✓				
Bothriochloa pertusa (L.) A.Camus							✓				
Brachypodium sylvaticum (Huds.) P.Beauv.			✓								
Bromus himalaicus Stapf			✓								
Bromus ramosus Huds			✓								
Calamagrostis montana (Gaudich.) DC.			✓								
Calamagrostis spp.							✓				
Capparis spinosa L.	✓	✓									
Caragana brevifolia Kom.	✓	✓									
Cedrus deodara (Roxb. ex D.Don) G.Don					✓	✓				✓	✓
Chrysopogon gryllus(L.) Trin.							✓				
Cicer songaricun DC.		✓									
Cinnamomum tamala (Buch.-Ham.)										✓	

T.Nees & Eberm.											
Colutea nepalensis Sims	✓	✓									
Cornus macrophylla Wall.						✓					
Corylus jacquemontii Decne					✓			✓	✓	✓	✓
Cotoneaster acuminatus Wall. ex Lindl.					✓	✓					
Cotoneaster bacillaris Wall. ex Lindl					✓	✓					
Crataegus songarica C. Koch					✓						
Cycas spp.										✓	
*Cymbopogon distans (*Nees ex Steud.) W.Watson							✓				
Dactylis glomerata L.		✓	✓				✓				
Dactylorhiza hatagirea (D.Don) Soó		✓	✓	✓							
Danthonia cachemyriana Jaub. & Spach		✓	✓				✓				
*Danthonia cumminsii*Hook.f.			✓								
Daphne papyracea Wall. ex G. Don					✓	✓					
Debregeasia hypoleuca (Hochst. ex A.Rich.) Wedd.						✓					
Debregeasia longilfolia (Burm.f.) Wedd.						✓					
Desmodium elegans DC.					✓						
Diospyros spp.								✓	✓		
Drepanostachyum falcatum (Nees) Keng f.					✓	✓					
Elaeagnus conferta Roxb.						✓					
Ephedra gerardiana Wall. ex Stapf	✓	✓									
Eragrostis spp.		✓									
Eremurus himalaicus Baker		✓		✓							
Erianthus rufipilus Griseb.							✓				
Erianthus sp.			✓								

Festuca pratensis Huds.		✓	✓				✓				
Festuca valesiaca Schleich. ex Gaudin			✓								
Fraxinus micrantha Lingelsh.			✓								
Fraxinus xanthoxyloides (G.Don) Wall. ex A.DC.					✓						
Geranium wallichianum D.Don ex Sweet			✓	✓	✓						
Hedychium spicatum Sm.						✓					
Heracleum candicans Wall. ex DC.		✓	✓	✓	✓	✓					
Hippophae rhamnoides ssp. *Turkestanica* Rousi.	✓	✓			✓			✓			
Hippophae salicifolia D.Don	✓			✓				✓			
Hippophae spp.										✓	
Hyoscyamus niger L.		✓									
Hypericum oblongifolium Choisy					✓	✓					
Hyssopus officinalis L.		✓									
Indigofera heterantha Brandis					✓						
Indogofera spp.										✓	
Inula cuspidata (Wall. ex DC.) C.B.Clarke					✓	✓					
Inula racemosa Hook.f.		✓	✓								
Juglans regia L.					✓			✓	✓		✓
Juniperus polycarpos K.Koch	✓			✓						✓	✓
Koeleria spp.		✓	✓				✓				
Ligustrum nepalense Wall.										✓	
Lonicera hypoleuca Decne.	✓										
Lonicera quinquelocularis Hard.					✓	✓					
Lonicera spp.										✓	
Magnolia grandiflora L.										✓	✓

Malus pumila Mill.								✓	✓		
Mangifera Indica L.										✓	
Melilotus spp.		✓									
Michelia champaca L.										✓	
Murraya paniculata (L.) Jack										✓	
Myricaria elegans Royle	✓										
Myricaria germanica (L.) Desv.	✓										
Neolitsea pallens (D. Don) Momiy. & H. Hara						✓					
Palm spp.										✓	
Phytolacca acinosa Roxb.					✓						
Picea smithiana (Wall.) Boiss.				✓	✓	✓					
Picrorhiza kurroa Royle ex Benth.		✓		✓	✓						
Pinus garardiana Wall. ex D.Don											✓
Pinus wallichiana A.B.Jacks.	✓			✓	✓	✓				✓	✓
Platanus orientalis L.											✓
Platanus spp.										✓	
Poa annua L.		✓	✓				✓				
Poa pratensis L.		✓	✓				✓				
Polygonatum cirrhifolium (Wall.) Royle			✓	✓	✓	✓					
Polygonatum verticillatum (L.) All.			✓	✓	✓	✓					
Populus alba L.	✓										
Populus ciliata Wall. ex Royle	✓				✓						
Populus spp.								✓	✓	✓	✓
Prinsepia utilis Royle					✓	✓					
Prunus cerasoides Buch.-Ham. ex D.Don						✓					
Prunus cornuta (Wall. ex Royle) Steud.				✓		✓					

Prunus spp.								✓	✓	✓	✓
Rheum australe D. Don		✓	✓								
Rheum moorcroftianum Royle			✓								
Rheum webbianum Royle		✓						✓			
Ribes alpestre Wall. ex Decne.	✓	✓									
Ribes himalense Royle ex Decne.	✓	✓									
Ribes orientale Desf.	✓	✓									
Rosa macrophylla Lindl.					✓	✓		✓			
Rosa sericea Wall. ex Lindl.					✓	✓		✓			
Rosa spp.										✓	
Rosa webbiana Wall. ex Royle	✓	✓									
Rubus biflorus Buch.-Ham. ex Sm.						✓					
Rubus foliosus Weihe						✓					
Rubus niveus Thunb.						✓					
Saccharum spontaneum L.							✓				
Salix alba L.	✓										
Salix daphnoides Vill.	✓			✓							
Salix denticulata Andersson		✓			✓						
Salix fragilis L.	✓										
Salix spp.								✓	✓	✓	✓
Salix tetrasperma Roxb.	✓										
Saussurea costus (Falc.) Lipsch.			✓								
Selinum tenuifolium Salisb.			✓	✓							
Setaria glauca (L.) P.Beauv.							✓				
Sinopodophyllum hexandrum (Royle) T.S. Ying			✓		✓	✓					

Skimmia laureola Franch.					✓						
Spiraea canescens D.Don										✓	
Stipa roylei (Nees) Duthie			✓								
Syringa emodi Wall. ex Royle					✓						
Taxus wallichiana Zucc.					✓	✓				✓	
Thamnocalamus spathiflorus (Trin.) Munro					✓						
Trifolium pretense L.		✓	✓				✓				
Trifolium repens L.							✓				
Trillium govanianum Wall. ex D.Don					✓	✓					
Ulmus villosa Brandis ex Gamble											✓
Ulmus wallichiana Planch.						✓					✓
Valeriana jatamansii Wall.					✓	✓					
Viburnum grandiflorum Wall. ex DC.					✓	✓					
Viola canescens Wall.						✓					
Viola serpens Wall. ex Ging.					✓						

Annexure: 10- Model-Wise List of Recommended Plant Species for Planting in Natural, Agriculture and Urban Landscapes in Jammu and Kashmir UT

Botanical Name	Natural Landscape											Agriculture Landscape		Urban Landscape			
	Jammu and Kashmir UT											Jammu and Kashmir UT		Jammu and Kashmir UT			
	1	2	3	4	5	6	7	8	9	10	11	1	2	1	2	3	4
Abies pindrow (Royle ex D.Don) Royle		✓	✓														
Acacia catechu (L.f.) Willd.									✓	✓	✓	✓	✓				
Acer acuminatum Wall. ex D.Don		✓															
Acer caesium Wall. ex Brandis		✓															
Acer pictum Thunb.		✓															
Acer spp.					✓												
*Aconitum heterophyllum*Wall. ex Royle	✓	✓	✓	✓	✓												
Aconitum violaceum Jacquem. ex Stapf	✓																
Adina cordifolia (Roxb.) Benth. & Hook.f. ex B.D.Jacks.											✓						
Aegle marmelos (L.)							✓		✓	✓	✓	✓	✓				

Corrêa																	
Aesculus indica (Wall. ex Cambess.) Hook.					✓												
Agropyron spp.	✓					✓		✓									
Agrostis gigantean Roth	✓						✓	✓	✓								
Agrostis munroana Aitch. & Hemsl.	✓																
Agrostis pilosula Trin.	✓																
Agrostis spp.						✓						✓					
Ainsliaea aptera DC.	✓																
Ajuga bracteosa Wall. ex Benth.					✓												
Albizia lebbek sensu auct.								✓	✓						✓		
Albizia procera (Roxb.) Benth.									✓								
Albizia spp.							✓			✓	✓		✓			✓	✓
Alstonia scholaris (L.) R. Br.							✓	✓	✓	✓	✓				✓	✓	✓
Allium humile Kunth	✓	✓															
Allium stracheyi Baker			✓														
Alnus nitida (Spach) Endl.			✓		✓												
Alopecurus aequalis Sobol.						✓											
Alopecurus nepalensis Trin. ex Steud.						✓											

Angelica glauca Edgew.		✓	✓	✓	✓												
Anthocephalus kadamba(Roxb.) Miq.																✓	
Apluda mutica L.										✓	✓						
Araucaria araucana (Molina) K.Koch																✓	✓
Arnebia benthamii (Wall. ex G.Don) I.M.Johnst.	✓	✓															
*Arundinella nepalensis*Trin.						✓				✓	✓						
Arundinella pumila (Hochst.) Steud.						✓											
Arundo donax L.							✓	✓	✓	✓	✓						
Azadirachta indica A.Juss.							✓		✓							✓	
*Bambusa arundinacea*Willd.										✓							
Bambusa spp.							✓		✓		✓	✓	✓		✓		
Bauhinia retusa Poir.								✓									
Bauhinia spp.												✓	✓				
Bauhinia variegate L.							✓	✓	✓	✓	✓						
Berberis aristata DC.							✓	✓									
Berberis lycium Royle							✓	✓	✓								
Berberis spp.					✓												
Bergenia ciliata (Haw.) Sternb.				✓	✓												

Bergenia stracheyi (Hook.f. & Thomson) Engl.		✓															
Betula alnoides Buch.-Ham. ex D.Don					✓												
Betula utilis D.Don		✓															
Bignonia spp.															✓		✓
Boehmeria rugulosa Wedd.									✓								
Boerhavia diffusa L.							✓	✓	✓	✓	✓						
Bothriochloa intermedia (R.Br.) A.Camus							✓	✓	✓								
Bothriochloa pertusa (L.) A.Camus						✓	✓	✓	✓								
Bothriochloa parviflora (R.Br.) Ohwi						✓											
Bougainvillea spp.															✓		✓
Brachypodium sylvaticum (Huds.) P.Beauv.	✓																
Bromus himalaicus Stapf	✓																
Bromus ramosus Huds.	✓																
Butea monosperma (Lam.) Taub.															✓		✓
Calamagrostis montana (Gaudich.) DC.	✓																
Calamagrostis spp.						✓		✓	✓								

Calamagrostis emodensis Griseb.							✓									
Callistemon citrinus (Curtis) Skeels															✓	✓
Carissa opaca Stapf ex Haines							✓	✓	✓							
Cassia fistula L.											✓		✓		✓	✓	
Cedrus deodara (Roxb. ex D.Don) G.Don			✓	✓	✓											
Celtis australis L.			✓						✓	✓	✓					
Chrysopogon fulvus (Spreng.) Chiov.								✓	✓							
Chrysopogon gryllus (L.) Trin.						✓										
Chrysopogon serrulatus Trin.							✓	✓	✓	✓	✓					
Cinnamomum tamala (Buch.-Ham.) T.Nees & Eberm.							✓	✓	✓							
Cornus macrophylla Wall.					✓											
Cornus oblonga Wall.				✓												
Corylus jacquemontii Decne.		✓														
Cotoneaster acuminatus Wall. ex Lindl.					✓											
Cotoneaster bacillaris				✓	✓											

Wall. ex Lindl.																	
Cryptomeria japonica(Thunb. ex L.f.) D.Don																✓	✓
Cupressus torulosa D.Don				✓													
Cycas spp.															✓		
Cymbopogon citratus (DC.) Stapf										✓	✓						
Cymbopogon distans (Nees ex Steud.) W.Watson						✓											
Cymbopogon jwarancusa (Jones) Schult.								✓									
Cymbopogon martini (Roxb.) W.Watson							✓	✓	✓								
Cyperus rotundus L.														✓			
Dactylis glomerata L.	✓					✓											
Dactylorhiza hatagirea (D.Don) Soó	✓	✓															
Dalbergia sissoo DC.									✓	✓	✓	✓	✓		✓		✓
Danthonia cachemyriana Jaub. & Spach	✓																
Danthonia cumminsii Hook.f.	✓																

Daphne papyracea Wall. ex G. Don				✓	✓												
Debregeasia longifolia(Burm.f.) Wedd.				✓	✓												
Debregeasia hypoleuca (Hochst. ex A.Rich.) Wedd.								✓	✓								
Delonix regia (Hook.) Raf.															✓	✓	✓
Dendrocalamus hamiltonii Nees & Arn. ex Munro							✓		✓	✓							
Dendrocalamus spp.											✓	✓	✓				
Dendrocalamus strictus (Roxb.) Nees							✓		✓	✓							
Deschamsia spp.										✓	✓						
Desmodium elegans DC.				✓			✓	✓									
Desmodium gangeticum (L.) DC.								✓	✓								
Deutzia corymbosa R.Br. ex G.Don								✓									
Deutzia staminea R.Br. ex Wall.					✓			✓									
Dichanthium annulatum (Forssk.) Stapf							✓			✓	✓						

Digitaria cruciata (Nees) A.Camus							✓										
Diospyros Montana Roxb.							✓		✓	✓	✓						
Dodonaea viscosa (L.) Jacq.					✓												
Drepanostachyum falcatum (Nees) Keng f.						✓											
Eichhornia crassipes (Mart.) Solms														✓			
Elaeagnus conferta Roxb.								✓									
Eragrostis nigra Nees ex Steud.										✓	✓						
Eremurus himalaicus Baker	✓	✓			✓												
Erianthus filifolius Nees ex Steud.							✓	✓	✓								
Erianthus rufipilus Griseb.	✓					✓	✓	✓	✓								
Erianthus spp.	✓																
Eulaliopsis binata (Retz.) C.E.Hubb.							✓	✓	✓	✓	✓						
Euonymus spp.																	✓
Euphorbia pulcherrima Willd. ex Klotzsch															✓		
Festuca arundinacea							✓	✓	✓								

Schreb.																	
Festuca pratensis Schreb.	✓					✓	✓	✓	✓								
*Festuca valesiaca*Schleich. ex Gaudin	✓																
Ficus benghalensis L.							✓	✓	✓	✓						✓	
Ficus racemosa L.							✓	✓	✓	✓							
Ficus rumphii Blume							✓	✓	✓	✓							
Fraxinus micrantha Lingelsh.					✓												
Fraxinus xanthoxyloides (G.Don) Wall. ex A.DC.			✓														
Fritillaria roylei Hook.	✓	✓															
Geranium wallichianum D.Don ex Sweet	✓	✓	✓	✓	✓												
Ginkgo biloba L.															✓	✓	
Grevillea robusta A.Cunn. ex R.Br.															✓		
Grewia optiva J.R.Drumm. ex Burret							✓	✓	✓	✓	✓	✓	✓				
Haldina cordifolia (Roxb.) Ridsdale									✓	✓							
Hedychium spicatum Lodd.				✓	✓												
Heracleum candicans Wall. ex DC.	✓	✓	✓	✓	✓												

Heteropogon contortus (L.) P.Beauv. ex Roem. & Schult.							✓	✓	✓	✓	✓						
Hierochloe laxa Hook.f.										✓	✓						
*Holoptelea integrifolia*Planch.							✓	✓	✓	✓	✓						
Hymenodictyon excelsum (Roxb.) Wall.									✓								
Hyoscyamus niger L.		✓															
Hypericum oblongifolium Choisy				✓	✓												
Indigofera heterantha Brandis				✓				✓									
Inula cuspidata (Wall. ex DC.) C.B.Clarke				✓													
Jacaranda mimosifolia D.Don															✓	✓	✓
Juglans regia L.					✓							✓	✓				
Justicia adhatoda L.							✓	✓	✓								
Kigelia pinnata (Jacq.) DC.															✓	✓	✓
Koeleria spp.						✓											
Lannea coromandelica (Houtt.) Merr.									✓				✓				
Litsea chinensis Lam.										✓							
Lyonia ovalifolia (Wall.) Drude					✓		✓	✓									

Maesa indica (Roxb.) A. DC.							✓	✓	✓								
Magnolia grandiflora L.															✓		✓
Mallotus philippensis (Lam.) Müll.Arg.							✓		✓	✓	✓		✓				
Michelia champaca L.															✓		✓
Melia azedarach L.												✓	✓				
Morus alba L.									✓		✓						
Morus spp.												✓	✓				
Murraya paniculata (L.) Jack							✓										
Murraya koenigii (L.) Spreng.							✓	✓	✓								
Myrica esculenta Buch.-Ham. ex D. Don					✓					✓							
Myrsine Africana L.							✓										
Nelumbo nucifera Gaertn.														✓			
Neolitsea pallens (D. Don) Momiy. & H. Hara					✓												
Nerium indicum Mill.															✓		✓
Neyraudia arundinacea (L.) Henrard								✓	✓								
Nyctanthes arbor-tristis L.							✓	✓	✓						✓		✓

Nymphaea spp.														✓			
Olea ferruginea Wall. ex Aitch.			✓		✓			✓									
Oroxylum indicum (L.) Kurz									✓	✓							
Panicum maximum Jacq.										✓	✓						
Parrotiopsis jacquemontiana (Decne.) Rehder					✓												
Phleum pretense L.							✓	✓	✓	✓	✓						
Phragmites karka (Retz.) Trin. ex Steud.							✓	✓	✓	✓	✓						
Phyllanthus emblica L.							✓	✓	✓	✓	✓	✓	✓				
Phytolacca acinosa Roxb.		✓		✓													
Picea smithiana (Wall.) Boiss.			✓	✓	✓												
Picrorhiza kurroa Royle ex Benth.	✓	✓	✓	✓													
Pinus gerardiana Wall. ex D.Don			✓														
Pinus roxburghii Sarg.							✓										
Pinus wallichiana A.B.Jacks.		✓	✓	✓	✓												
Pistacia integerrima J. L. Stewart ex Brandis								✓				✓	✓				

Platanus orientalis L.															✓	
Plectranthus rugosus Wall. ex Benth.					✓											
Poa annua L.	✓					✓										
Poa pratensis L.	✓					✓	✓	✓	✓							
Polyalthia longifolia (Sonn.) Thwaites														✓	✓	✓
Polygonatum cirrhifolium (Wall.) Royle		✓			✓											
Polygonatum multiflorum (L.) All.	✓	✓														
Polygonatum verticillatum (L.) All.	✓	✓	✓	✓	✓											
Pongamia pinnata (L.) Pierre														✓	✓	✓
Populus spp.												✓	✓			
Potamogeton spp.														✓		
Prinsepia utilis Royle				✓	✓											
Prunus cerasoides Buch.-Ham. ex D.Don					✓											
Prunus cornuta(Wall. ex Royle) Steud.		✓														
Punica granatum L.							✓	✓								
Pyrus pashia Buch.-Ham. ex D.Don							✓	✓	✓	✓	✓					
Quercus baloot Griff.			✓													

Quercus floribunda Lindl. ex A.Camus					✓												
Quercus oblongata D.Don					✓		✓	✓									
Quercus semecarpifolia Sm.		✓			✓												
Rheum australe D. Don	✓																
Rheum moorcroftianum Royle	✓																
Ricinus communis L.							✓	✓	✓								
Rosa macrophylla Lindl.				✓	✓												
Rosa moschata Herrm.								✓	✓								
Rosa sericea Wall. ex Lindl.				✓	✓												
Rosa spp.															✓		✓
Rubus foliolosus Hal csy					✓												
Rubus niveus Thunb.					✓												
Saccharum munja Roxb.									✓								
Saccharum spontaneum L.						✓											
alix spp.												✓	✓			✓	✓
Sapindus mukorossi Gaertn.									✓	✓	✓						
Saraca asoca (Roxb.)															✓	✓	✓

Willd.																	
Saussurea costus (Falc.) Lipsch.	✓																
Scirpus grossus L.f.														✓			
Selinum tenuifolium Salisb.	✓	✓	✓														
Selinum vaginatum C.B. Clarke			✓														
Sesbania sesban (L.) Merr.															✓	✓	✓
Setaria glauca (L.) P.Beauv.						✓	✓	✓									
Sinopodophyllum hexandrum (Royle) T.S. Ying	✓	✓	✓		✓												
Spiraea canescens D.Don					✓												
Spiraea spp.															✓		✓
Spirodela polyrrhiza (L.) Schleid.														✓			
Sporobolus diandrus (Retz.) P.Bauv.										✓	✓						
Stipa roylei (Nees) Duthie	✓																
Syringa emodi Wall. ex Royle				✓													
Syzygium venosum DC.															✓		✓

Syzygium cumini (L.) Skeels								✓	✓	✓	✓						
Taxus wallichiana Zucc.				✓	✓												
Tecoma stans (L.) Juss. ex Kunth														✓			
Tephrosia hamiltonii Gamble							✓	✓	✓								
Terminalia arjuna (Roxb. ex DC.) Wight & Arn.									✓	✓	✓						
Terminalia bellirica (Gaertn.) Roxb.								✓	✓	✓	✓						
Terminalia chebula Retz.									✓	✓	✓						
Terminalia spp.												✓	✓				
Themeda anathera (Nees ex Steud.) Hack.						✓	✓	✓	✓								
Themeda arundinacea (Roxb.) A.Camus										✓	✓						
Thuja sp.															✓	✓	
Thuja orientalis L.																	✓
Thysanolaena maxima(Roxb.) Kuntze							✓	✓	✓	✓	✓						
Tinospora cordifolia (Willd.) Miers							✓	✓	✓								
Toona ciliata M.Roem.								✓		✓	✓						
Toona sinensis (Juss.)								✓									

M.Roem.																	
Trifolium pretense L.	✓					✓											
Trifolium repens L.	✓					✓				✓	✓						
*Trillium govanianum*Wall. ex D.Don		✓	✓	✓	✓												
Typha angustata Bory & Chaub.														✓			
Ulmus wallichiana Planch.					✓		✓										
Valeriana jatamansi Jones			✓	✓	✓												
Viburnum cotinifolium				✓													
Viburnum nervosum D. Don					✓												
Viola canescens Wall.			✓	✓	✓												
Vitex negundo L.							✓	✓	✓								
Withania somnifera (L.) Dunal								✓									
Woodfordia fruticosa (L.) Kurz							✓	✓	✓								
Zanthoxylum armatum DC.					✓			✓	✓								
Ziziphus jujuba Mill.							✓		✓								
Ziziphus mauritiana Lam.									✓								
Ziziphus spp.								✓									

Annexure:11- Model-Wise/ Activity-Wise Lists of Forest Divisions for Forestry Interventions

Model	Divisions	Area (ha/ m^3)
A-Himachal Pradesh		
(a) Natural Landscape		
CN/HP/NL/01 - Cold Desert Greening	Lahaul	222
	Pangi	10
CN/HP/NL/02 - Cold Desert Conservation	Lahaul	10
CN/HP/NL/03 - Alpine Conservation	-	0
CN/HP/NL/04 - Sub-Alpine Enrichment	Lahaul	20
	Pangi	78
CN/HP/NL/05 - Temperate Conifer Forest	-	0
CN/HP/NL/06- Temperate Mixed Forest	Lahaul	5
	Pangi	73
CN/HP/NL/07 - Pasture and Grazing Land Development	Pangi	18
CN/HP/NL/08 -Protection Model for Natural Regeneration	Lahaul	20
	Pangi	20
(b) Agriculture Landscape		
CN /HP/AL/01 - Boundary Plantation Model	Lahaul	30
	Pangi	30
CN /HP/AL/02 -Block Plantation Model	Lahaul	8
	Pangi	6
(c) Urban Landscape		
CN/HP/ UL/01 - Riverfront Development	Lahaul	1
	Pangi	0.5
CN/HP/ UL/02 - Institution Plantation	Lahaul	8
	Pangi	8
(d) Soil and Moisture Interventions(m^3)		
CN/HP/CI/01 - Brushwood Interventions	Lahaul	6170
	Pangi	6290
CN/HP/CI/02 - Dry Stone Interventions & Activities	Lahaul	14590
	Pangi	14270
CN/HP/CI/03- Crate Wire Interventions & Activities	Lahaul	440
	Pangi	510
CN/HP/CI/04 - Water Ponds	Lahaul	27170
	Pangi	27250
CN/HP/CI/05 - Silt Detention Dams	Lahaul	330
	Pangi	240
(d) Conservation Interventions		
CN/HP/CI/06 - Riverine and Riparian Management	Spiti Wildlife Division	20

	Chamba Wildlife Division	30
CN/HP/CI/07 - Wetland Management	Spiti Wild Life Division	10
B- Jammu & Kashmir		
(a) Natural Landscape		
CN/JK/NL/01 - Sub Alpine Conservation	-	0
CN/JK/NL/02 - Sub-Alpine Enrichment	-	0
CN/JK/NL/03 - Dry Temperate Conifer Forest Enrichment	-	0
CN/JK/NL/04 - Temperate Conifer Forest	Doda	35
	Ramban	48
	Bhaderwah	35
CN/JK/NL/05 - Temperate Mixed Forest	Batote	218
	Bhaderwah	78
	Doda	236
	Kistwar	45
	Mahore	240
	Marwah	60
	Rajouri	06
	Ramban	195
	Ramnagar	80
	Udhampur	20
CN/JK/NL/06 - Pasture and Grazing Land Development	Ramban	10
	Ramnagar	40
CN/JK/NL/07 - Himalayan Chir Pine Forest	Batote	125
	Bhaderwah	25
	Doda	10
	Jammu	14
	Kishtwar	05
	Mahore	195
	Nowshera	25
	Rajouri	120
	Ramban	65
	Ramnagar	30
	Reasi	08
	Udhampur	20
CN/JK/NL/08 - Himalayan Mixed Forest	Batote	50
	Bhaderwah	05
	Kishtwar	15
	Rajouri	08
	Ramban	20

	Ramnagar	70
	Udhampur	30
CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Bhaderwah	85
	Doda	10
	Jammu	159
	Kishtwar	15
	Mahore	80
	Nowshera	101
	Rajouri	66
	Ramban	35
	Ramnagar	50
	Reasi	375
	Udhampur	05
	Urban Forestry	18
CN/JK/NL/10 - Eradication of *Lantana* (> 50%)	Bhaderwah	10
	Udhampur	05
CN/JK/NL/11 - Control/ Removal of Invasive Species or <50% *Lantana*	Bhaderwah	15
	Ramnagar	30
CN/JK/NL/12 - Protection Model for Natural Regeneration	Batote	210
	Bhaderwah	320
	Doda	330
	Jammu	230
	Kishtwar	370
	Mahore	210
	Marwah	270
	Nowshera	220
	Rajouri	270
	Ramban	250
	Ramnagar	300
	Reasi	330
	Udhampur	310
CN/JK/NL/13 - Fire Protection Model	Batote	50
	Bhaderwah	35
	Doda	70
	Jammu	70
	Kishtwar	40
	Mahore	45
	Marwah	30
	Nowshera	80
	Rajouri	60
	Ramban	50

	Ramnagar	100
	Reasi	50
	Udhampur	60
(b) Agriculture Landscape		
CN /JK/AL/01 - Boundary Plantation Model	Batote	30
	Bhaderwah	30
	Doda	40
	Jammu	30
	Kishtwar	30
	Mahore	30
	Marwah	30
	Nowshera	30
	Rajouri	30
	Ramban	40
	Ramnagar	62
	Reasi	30
	Udhampur	40
CN /JK/AL/02 - Block Plantation Model	Batote	07
	Bhaderwah	06
	Doda	07
	Jammu	06
	Kishtwar	07
	Mahore	06
	Marwah	06
	Nowshera	07
	Rajouri	06
	Ramban	07
	Ramnagar	28
	Reasi	07
	Udhampur	06
(c) Urban Landscape		
CN/JK/UL/01 - Bio-remediation and Bio-filtration	Batote	1
	Bhaderwah	1
	Doda	1
	Jammu	1
	Kishtwar	1
	Mahore	1
	Marwah	1
	Nowshera	1
	Rajouri	1
	Ramban	1
	Ramnagar	1
	Reasi	1

	Udhampur	1
	Urban Forestry	1
CN/ JK /UL/02 - Riverfront Development	Batote	0.1
	Bhaderwah	0.4
	Doda	0.2
	Jammu	0.5
	Kishtwar	0.2
	Mahore	0.4
	Marwah	0.6
	Nowshera	0.1
	Rajouri	0.2
	Ramban	0.7
	Ramnagar	1.9
	Udhampur	0.3
	Urban Forestry	1
CN/JK/ UL/03 - Institution Plantation	Batote	8
	Bhaderwah	8
	Doda	8
	Jammu	8
	Kishtwar	8
	Mahore	5
	Marwah	8
	Nowshera	5
	Rajouri	8
	Ramban	8
	Ramnagar	14.4
	Reasi	8
	Udhampur	8
	Urban Forestry	8
CN/ JK/ UL/04 - Eco-park Development	Batote	0.3
	Bhaderwah	1
	Doda	0.1
	Jammu	0.6
	Kishtwar	0.5
	Mahore	1.5
	Marwah	0.2
	Nowshera	0.4
	Rajouri	0.6
	Ramban	0.7
	Ramnagar	1.7

	Udhampur	0.7
	Urban Forestry	1.4
(d) Soil and Moisture Interventions (m^3)		
CN/JK/CI/01 - Brushwood Interventions	Batote	2490
	Bhaderwah	9700
	Doda	2450
	Jammu	7990
	Kishtwar	2940
	Mahore	2470
	Marwah	2490
	Nowshera	39060
	Rajouri	5240
	Ramban	4230
	Ramnagar	3270
	Reasi	11790
	Udhampur	2440
	Urban Forestry	5720
CN/ JK /CI /02 - Dry Stone Activities	Batote	1730
	Bhaderwah	13820
	Doda	1710
	Jammu	3290
	Kishtwar	1680
	Mahore	1370
	Marwah	1390
	Nowshera	61740
	Rajouri	7900
	Ramban	4980
	Ramnagar	2450
	Reasi	18250
	Udhampur	1380
	Urban Forestry	3440
CN/ JK /CI /03 - Crate Wire Activities	Batote	1430
	Bhaderwah	940
	Doda	910
	Kishtwar	1380
	Mahore	1160
	Marwah	1150
	Nowshera	710
	Ramban	700
	Ramnagar	940

	Reasi	230
	Udhampur	1140
CN/JK /CI/04 - Water Ponds	Bhaderwah	32180
	Doda	1680
	Jammu	6210
	Nowshera	151480
	Rajouri	20280
	Ramban	10680
	Ramnagar	3330
	Reasi	46260
	Urban Forestry	7670
CN/JK /CI /05 - Silt Detention Dam Type Activities	Batote	620
	Bhaderwah	530
	Doda	530
	Kishtwar	760
	Mahore	650
	Marwah	630
	Nowshera	380
	Ramban	400
	Ramnagar	500
	Reasi	130
	Udhampur	600
(d) Conservation Interventions		
CN/JK/CI /06 - Riverine and Riparian Management	Chenab Wildlife Division	60
	Jammu Wildlife Division	100
CN/JK/CI /07 - Wetland Management	Jammu Wildlife Division	15

Annexure: 12- List of Sites of Chenab Riverscape in Himachal Pradesh

S.No.	Model	State/ UT	District	Division	Sitename	Range	Block	Beat	Area (ha)	Latitude	Longitude
A) Himachal Pradesh											
i) Natural Landscape											
1	CN/HP/NL/06 – Temperate Mixed Forest	Himachal Pradesh	Chamba	Pangi	Bindrabani	Killar	B/Bani	B/Bani	10	31.5892	78.2775
2	CN/HP/NL/04 - Sub-Alpine Enrichment	Himachal Pradesh	Chamba	Pangi	Chandani Dhar	Purthi	Purthi	Rei	25	32.90478	76.73222
3	CN/HP/NL/01 - Cold Desert Greening	Himachal Pradesh	Chamba	Pangi	Goshti Dhar (Bumbal R.F)	Purthi	Purthi	B/Bumbal	10	32.95883	76.4545
4	CN/HP/NL/04 - Sub-Alpine Enrichment	Himachal Pradesh	Chamba	Pangi	Karyani Beat	Killar	Bindrabani	Bindrabani	20	33.06325	76.42589
5	CN/HP/NL/06 – Temperate Mixed Forest	Himachal Pradesh	Chamba	Pangi	Kiryani	Killar	Killar	Karyani	20	33.06325	76.42589
6	CN/HP/NL/04 - Sub-Alpine Enrichment	Himachal Pradesh	Chamba	Pangi	Moujhi Moujhi	Sach	Sach	Kaban	10	32.975	76.5497
7	CN/HP/NL/04 - Sub-Alpine Enrichment	Himachal Pradesh	Chamba	Pangi	Sach-1	sach	sach	sach	5	32.995	76.4397
8	CN/HP/NL/06 – Temperate Mixed Forest	Himachal Pradesh	Chamba	Pangi	Shalla R.F	Purthi	Purthi	B/Bumbal	18	32.96238	76.43847
9	CN/HP/NL/07 - Pasture and Grazing Land Development	Himachal Pradesh	Chamba	Pangi	Shalla R.F.	Purthi	Purthi	B/Bumbal	18		
10	CN/HP/NL/04 - Sub-Alpine Enrichment	Himachal Pradesh	Chamba	Pangi	Shalla R.F.	Purthi	Purthi	B/Bumbal	18	32.96238	76.43847
11	CN/HP/NL/06 – Temperate Mixed Forest	Himachal Pradesh	Chamba	Pangi	Thandal R.F.	Purthi	Purthi	Purthi	25	33.09889	76.48278
12	CN/HP/NL/04 - Sub-	Himachal	Lahaul	Lahaul	Beeling	Keylong	Bhaga	Keylong	5	32.58044	77.01376

	Alpine Enrichment	Pradesh	Spiti		*Nallah*						
13	CN/HP/NL/04 - Sub-Alpine Enrichment	Himachal Pradesh	Lahaul Spiti	Lahaul	Chhaling DPF	Udaipur	Miyar	Urgose	15	32.85875	76.80867
14	CN/HP/NL/01 - Cold Desert Greening	Himachal Pradesh	Lahaul Spiti	Lahaul	chowkhang	Pattan	Lower Pattan	Chowkhang	30	32.68656	76.79467
15	CN/HP/NL/01 - Cold Desert Greening	Himachal Pradesh	Lahaul Spiti	Lahaul	Gawazang 1	Keylong	Chandra	Kardang	5	32.55278	76.995
16	CN/HP/NL/01 - Cold Desert Greening	Himachal Pradesh	Lahaul Spiti	Lahaul	Gurdhar (Puthang)	Udaipur	Miyar	Karpat	5	32.837	76.75964
17	CN/HP/NL/06 – Temperate Mixed Forest	Himachal Pradesh	Lahaul Spiti	Lahaul	Rogling	Pattan	Upper Pattan	Muling	5	32.571345	77.032324
18	CN/HP/NL/02 - Cold Desert Conservation	Himachal Pradesh	Lahaul Spiti	Lahaul	Shiti Nalla (Dutizang)	Keylong	Chandra	Sissu	10	32.45528	77.12639
19	CN/HP/NL/01 - Cold Desert Greening	Himachal Pradesh	Lahaul Spiti	Lahaul	Sitti *Nallah* RFQ Urgium	Keylong	Chandra	Koksar	20	32.45167	77.12053
20	CN/HP/NL/01 - Cold Desert Greening	Himachal Pradesh	Lahaul Spiti	Lahaul	Thani DPF	Udaipur	Miyar	Urgose	82	32.86742	76.84611
21	CN/HP/NL/01 - Cold Desert Greening	Himachal Pradesh	Lahaul Spiti	Lahaul	Thorang Nalla - I	Keylong	Chandra	Gondhla	5	32.52444	77.01417
22	CN/HP/NL/01 - Cold Desert Greening	Himachal Pradesh	Lahaul Spiti	Lahaul	UPF Shansha	Pattan	U/ Pattan	Shansha	50	32.62614	76.90381
23	CN/HP/NL/01 - Cold Desert Greening	Himachal Pradesh	Lahaul Spiti	Lahaul	UPF Warpa	Pattan	Upper Block	Tandi Beat	25	32.60783	76.95303
24	CN/HP/NL/08 - Protection Model for Natural Regeneration	Himachal Pradesh	Chamba	Pangi	Pangi				10	31.5892	78.2775
25	CN/HP/NL/08 - Protection Model for Natural Regeneration	Himachal Pradesh	Chamba	Pangi	Pangi 2				10	31.5892	78.2775
26	CN/HP/NL/08 - Protection Model for Natural	Himachal Pradesh	Lahaul Spiti	Lahaul	Lahaul				10	32.6192	77.3784

	Regeneration										
27	CN/HP/NL/08 - Protection Model for Natural Regeneration	Himachal Pradesh	Lahaul Spiti	Lahaul	Lahaul 2				10	32.6192	77.3784
ii) Agriculture Landscape											
28	CN/HP/AL/01 - Boundary Plantation Model	Himachal Pradesh	Chamba	Pangi	Pangi				12	31.5892	78.2775
29	CN/HP/AL/02 - Block Plantation Model	Himachal Pradesh	Chamba	Pangi	Pangi				3	31.5892	78.2775
30	CN/HP/AL/01 - Boundary Plantation Model	Himachal Pradesh	Chamba	Pangi	Pangi(2)				10	31.5892	78.2775
31	CN/HP/AL/02 - Block Plantation Model	Himachal Pradesh	Chamba	Pangi	Pangi(2)				2	31.5892	78.2775
32	CN/HP/AL/01 - Boundary Plantation Model	Himachal Pradesh	Chamba	Pangi	Pangi(3)				8	31.5892	78.2775
33	CN/HP/AL/02 - Block Plantation Model	Himachal Pradesh	Chamba	Pangi	Pangi(3)				1	31.5892	78.2775
34	CN/HP/AL/01 - Boundary Plantation Model	Himachal Pradesh	Lahaul Spiti	Lahaul	Lahaul				12	32.6192	77.3784
35	CN/HP/AL/02 - Block Plantation Model	Himachal Pradesh	Lahaul Spiti	Lahaul	Lahaul				4	32.6192	77.3784
36	CN/HP/AL/01 - Boundary Plantation Model	Himachal Pradesh	Lahaul Spiti	Lahaul	Lahaul(2)				10	32.6192	77.3784
37	CN/HP/AL/02 - Block Plantation Model	Himachal Pradesh	Lahaul Spiti	Lahaul	Lahaul(2)				3	32.6192	77.3784
38	CN/HP/AL/01 - Boundary Plantation Model	Himachal Pradesh	Lahaul Spiti	Lahaul	Lahaul(3)				8	32.6192	77.3784
39	CN/HP/AL/02 - Block Plantation Model	Himachal Pradesh	Lahaul Spiti	Lahaul	Lahaul(3)				1	32.6192	77.3784
iii) Urban Landscape											
40	CN/HP/UL/02 - Institution	Himachal	Chamba	Pangi	Pangi				2	31.5892	78.2775

	Plantation	Pradesh									
41	CN/HP/UL/02 - Institution Plantation	Himachal Pradesh	Chamba	Pangi	Pangi(2)	0			3	31.5892	78.2775
42	CN/HP/UL/02 - Institution Plantation	Himachal Pradesh	Chamba	Pangi	Pangi(3)	0			3	31.5892	78.2775
43	CN/HP/UL/01 - Riverfront Development	Himachal Pradesh	Chamba	Pangi	Sach				0.5	31.5892	78.2775
44	CN/HP/UL/01 - Riverfront Development	Himachal Pradesh	Lahaul Spiti	Lahaul	Koksar				0.5	32.6192	77.3784
45	CN/HP/UL/02 - Institution Plantation	Himachal Pradesh	Lahaul Spiti	Lahaul	Lahaul				2	32.6192	77.3784
46	CN/HP/UL/02 - Institution Plantation	Himachal Pradesh	Lahaul Spiti	Lahaul	Lahaul(2)	0			3	32.6192	77.3784
47	CN/HP/UL/02 - Institution Plantation	Himachal Pradesh	Lahaul Spiti	Lahaul	Lahaul(3)	0			3	32.6192	77.3784
48	CN/HP/UL/01 - Riverfront Development	Himachal Pradesh	Lahaul Spiti	Lahaul	Tandi	0			0.5	32.6192	77.3784
iv) Consevation Intervention (SMC)											
S.No.	**Model**	**State/ UT**	**District**	**Division**	**Sitename**	**Range**	**Block**	**Beat**	**Area (m^3)**	**Latitude**	**Longitude**
49	CN/HP/CI/01,02,03,05	Himachal Pradesh	Chamba	Pangi	Aghoi Slide	Sach	Sach	Hillour	670	32.9861	76.5389
50	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Aghoi Slide-2	Sach	Sach	Hillour	970	32.9864	76.5436
51	CN/HP/CI/01,02,03,05	Himachal Pradesh	Chamba	Pangi	B/Bumbal R.F	Purthi	Purthi	B/Bumbal	950	32.92135	76.43915
52	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Bayalum Nalla near Chinan Adhwari Hudan	Killar	Killar	Killar	1000	33.10203	76.48861

					Bhatori						
53	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Bindrabani	Killar	Bindrabani	Bindrabani	1010	33.085	76.39472
54	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Chalasari	Sach	Sach	Hillour	1040	32.9894	76.5772
55	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Changli Ghar, PUN to Village	Killar	Bindrabani	Punto	1040	33.06968	76.39849
56	CN/HP/CI/01,02,03,05	Himachal Pradesh	Chamba	Pangi	Dhanala *Nallah*	Sach	Sach	Kaban	730	32.9781	76.5125
57	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Dharwas (anch nalla)	Killar	Dharwas	Dharwas	1010	33.13857	76.40887
58	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Dharwas(Chaholi GHAR)	Killar	Dharwas	Dharwas	1030	33.12601	76.39344
59	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Dharwas(Chaloli Nalla)	Killar	Dharwas	Dharwas	1000	33.12964	76.39694
60	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Dharwas, Degriee II Forest (DPF)	Killar	Dharwas	Dharwas	1060	33.12521	76.3883
61	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Faram Nalla	Killar	Killar	Killar	1010	33.10663	76.49979
62	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Godhan Nalla at Parmar (F.L)	Killar	Killar	Phindru	1040	33.03	76.47389
63	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Gugu Gharat	Killar	Bindrabani`	Pregran	1070	33.085	76.39444
64	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Hillu	Sach	Sach	Kuth	1080	33.02	76.6042
65	CN/HP/CI/01,02,04	Himachal	Chamba	Pangi	Jumph Nalla	Killar	Killar	Phindru	1030	33.022668	76.432447

		Pradesh			(Banghi R.F)						
66	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Khilmi DPF Along Kumar Nalla	Killar	Killar	Phindru	1030	33.02278	76.46667
67	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Khinan-1	Sach	Sach	Sach	1020	33.025	76.48
68	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Khinan-2	Sach	Sach	Sach	1010	33.0247	76.4792
69	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Kundla Nalla	Purthi	Aiog	Kulal	1060	32.95486	76.42106
70	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Lower and Upper side of Mahlu Nalla Pul	Killar	Killar	Killar	970	32.08361	76.4175
71	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Luj R.F	Killar	Dharwas	Luj	1030	33.138984	76.355042
72	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Manjwas, Punto Village	Killar	Bindra Bani	Punto	1010	33.06636	76.39359
73	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Marth Yalu	Killar	Bindrabani	Pregran	1040	33.085	76.39472
74	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Mehort DPF	Pangi	Dharwas	Luj	1040	33.1325	76.34694
75	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Moujhi *Nallah*	Sach	Sach	Kaban	1010	32.9781	76.5358
76	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Neeldhar R.F	Purthi	Ajog	Ajog	1010	32.91528	76.45806
77	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Pangu R.F	Purthi	Ajog	Pangu	980	32.88833	76.46639
78	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Phindpar *Nallah*	Sach	Sach	Mindhal	1050	32.985932	76.418704

79	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Purthi D.P.F.	Purthi	Purthi	Purthi	950	32.92333	76.46361
80	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Purthi Nalla (Purthi D.P.F)	Purthi	Purthi	Purthi	940	32.92342	76.49192
81	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Rei RF	Purthi	Purthi	Rei	960	32.96167	76.46608
82	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	RElam *Nallah*	Sach	Sach	Mindhal	990	32.9803	76.425
83	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Ritho Ghar	Purthi	Ajog	Kulal	1000	32.95833	76.42917
84	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Rohnu Dhank (Ajog R.F)	Purthi	Ajog	Ajog	970	32.93933	76.45373
85	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Sach-2	Sach	Sach	Sach	980	32.9922	76.4439
86	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Sach-3	Sach	Sach	Sach	1010	33.0028	76.4381
87	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Sahali *Nallah*	Sach	Sach	Hillour	1040	32.9856	76.5269
88	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Saichu	Sach	Sach	Kuth	1050	32.9853	76.5636
89	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Saichu (2)	Sach	Sach	Hillour	1040	32.9872	76.5633
90	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Shour R.F	Purthi	Purthi	Shour Beat	960	32.88177	76.47256
91	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Shouruni R.F (Uthru Nalla)	Purthi	Purthi	Shour	1010	32.90564	76.47035
92	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Sural (2)	Killar	Dharwas	Sural	980	33.14245	76.4656

93	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Sural (3)	Killar	Dharwas	Sural	920	33.14374	76.46125
94	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Sural (4)	Killar	Dharwas	Sural	980	33.14349	76.45697
95	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Sural (5)	Killar	Dharwas	Sural	900	33.14348	76.44734
96	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Thandai Dhar	Purthi	Purthi	Purthi	920	33.05917	76.73444
97	CN/HP/CI/01,02,04	Himachal Pradesh	Chamba	Pangi	Twan	Sach	Sach	Kuth	960	33.0219	76.6122
98	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Aghar (River Bank)	Tindi	Tindi	Tindi	920	32.75617	76.45933
99	CN/HP/CI/01,02,03,05	Himachal Pradesh	Lahaul Spiti	Lahaul	Beeling Nalla	Keylong	Bhaga	Keylong	660	32.5805	77.01362
100	CN/HP/CI/01,02,03,05	Himachal Pradesh	Lahaul Spiti	Lahaul	Bhara Nalla	Tindi	Tindi	Tindi	670	32.75614	76.45788
101	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Bhara Nalla	Tindi	Tindi	Bhujund	1020	32.75614	76.45788
102	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Bhujund Nalla (Merge Point of River)	Tindi	Tindi	Bhujund	960	32.77771	76.43653
103	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Bhujund Nalla (Merge Point of River)	Tindi	Tindi	Bhujund	990	32.77771	76.43653
104	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Bror Nalla	Tindi	Tindi	Tindi	1020	32.75773	76.44812
105	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Dhandal Nalla	Tindi	Salgran	Kurched	1050	32.76329	76.52949
106	CN/HP/CI/01,02,04	Himachal	Lahaul	Lahaul	Goshal	Pattan	Upper	Muling	1040	32.55056	76.97556

		Pradesh	Spiti		(Tandi Sangam)		Pattan				
107	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Gwazang (Bhaga River Side)	Keylong	Chandra	Kardang	1080	32.5625	77.00417
108	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Harsar Nalla (Right Bank)	Tindi	Salgran	Salgran	1060	32.70237	76.49964
109	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Harsar Nalla Left Bank	Tindi	Tindi	Tindi	1070	32.74043	76.48276
110	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Hootu Nalla	Tindi	Tindi	Bhujund	1000	32.7458	76.48051
111	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Jhootu Nalla	Tindi	Tindi	Bhujund	1040	32.7458	76.48051
112	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Kamring Nala left hand side from village	Pattan	Lower Pattan	Mooring	1030	32.65586	76.81408
113	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Lindoor	Pattan at Jahlma	Lower Pattan	Jahlma	1000	32.64809	76.87206
114	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Lohani Nalla	Tindi	Tindi	Bhujund	1040	32.7476	76.47055
115	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Lohani Nature Park	Tindi	Tindi	Bhujund	1030	32.74878	76.46802
116	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Lohani Nature Park (1)	Tindi	Tindi	Bhujund	1050	32.74878	76.46802
117	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Lohani Nursery (Stone Fencing)	Tindi	Tindi	Bhujund	1040	32.74977	76.46756
118	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Lote Nalla	Pattan	Upper Pattan	Tandi	1020	32.60444	76.94222

119	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Madgran Nalla	Udaipur	Udaipur	Madgran	1060	32.7464	76.6217
120	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Melling Nalla	Pattan	Upper Pattan	Tandi Beat	1010	32.61714	76.89867
121	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Nainghar	Pattan	Lower Pattan	Chowkh ang	1050	32.73072	76.86119
122	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Pagal *Nallah*	Keylong	Chandra	Koksar	1010	32.46472	77.1625
123	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Peukar Nalla	Keylong	Chandra	Kardang	1030	32.55778	77.07139
124	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Prashori Nalla	Tindi	Tindi	Bhujund	1040	32.73339	76.43458
125	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	R.F.9 Urgium	Keylong	Chandra	Koksar	1010	32.43611	77.16639
126	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Rashel DPF Jobrang	Pattan at Jahlma	L/Pattan	Jobrang	960	32.60889	76.89417
127	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Salgran Nalla	Tindi	Salgran	Salgran	1030	32.73969	76.54731
128	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Salkot	Udaipur	Udaipur	Salpat	1080	32.7567	76.6086
129	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Salpat Nalla	Udaipur	Udaipur	Salpat	1030	32.7311	76.6433
130	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Shakas Nalla	Keylong	Bhaga	Stingari	1050	32.57306	77.03694
131	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Shaksh Nalla	Keylong	Bhaga	Keylong	990	32.57081	77.03513
132	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Shansha Nalla, Braham Nalla	Pattan	Upper Pattan	Shansha	1000	32.62517	76.87986
133	CN/HP/CI/01,02,04	Himachal	Lahaul	Lahaul	Sissu Nalla	Keylong	Chandra	Sissu	1020	32.48667	77.13444

		Pradesh	Spiti								
134	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Sitli Nalla R.F - 9 uragium	Keylong	Chandra	Koksar	940	32.46	77.13861
135	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Surnali Nalla	Tindi	Tindi	Bhujund	990	32.76229	76.45336
136	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Swanchi Luenpa	Keylong	Bhaga	Keylong	1000	32.58384	77.0074
137	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Tandi Tolang Nalla	Pattan	Upper Block	Tandi Beat	960	32.57064	76.97042
138	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Tedhe Padhar (Lohani)	Tindi	Tindi	Bhujund	930	32.74748	76.46952
139	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Thorang Nalla - II	Keylong	Chandra	Gondhla	910	32.52389	77.01639
140	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Tong Tong	Keylong	Bhaga	Keylong	890	32.57206	77.01548
141	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Tozing	Pattan	Upper Block	Tandi Beat	1040	32.57425	76.96831
142	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Tundru Nalla	Tindi	Tindi	Bhujund	1000	32.76086	76.44324
143	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Tundru Nalla	Tindi	Tindi	Bhujund	960	32.76086	76.44324
144	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	UPF Nainghar	Pattan	Lower Pattan	Chowkh ang	950	32.72544	76.85467
145	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Yang Thang UPF	Pattan	L/Pattan	Jhalman	1030	32.65796	76.85293
146	CN/HP/CI/01,02,04	Himachal Pradesh	Lahaul Spiti	Lahaul	Yarkital Lumpa	Keylong	Bhaga	Keylong	940	32.58852	77.00912

V) Other Intervention											
S.No.	**Model**	**State/ UT**	**District**	**Division**	**Sitename**	**Range**	**Block**	**Beat**	**Area (ha)**	**Latitude**	**Longitude**
148	CN/HP/CI/06	Himachal Pradesh	Chamba	Chamba Wildlife Division	Sechu Tuan *Nallah* Wildlife Sanctuary				30	31.5892	78.2775
149	CN/HP/CI/07	Himachal Pradesh	Lahaul Spiti	Spiti Wildlife Division	Chander Tal (Ramsar Site)(2)				10	32.4824	77.6157
150	CN/HP/CI/06	Himachal Pradesh	Lahaul Spiti	Spiti Wildlife Division	Chandratal Wildlife Sanctuary				20	32.4824	77.6157

Annexure: 13- List of Sites of Chenab Riverscape in Jammu and Kashmir UT

S.No.	Model	State/ UT	District	Division	Sitename	Range	Block	Beat	Area (Ha)	Latitude	Longitude
A) Jammu and Kashmir UT											
Natural Landscape											
1)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Doda	Bhaderwah	62/Bh Kahal Jugser	Bhalesh	Neeli	Kahal Jugser	10	32.93977	75.97004
2)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Bhaderwah	Bagerni	Kellar	Paryote	Paryote-I	8	33.14028	75.52528
3)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Bhaderwah	Brehlla	Kellar	Ghuraka	Sharora-Ist	15	33.05381	75.67617
4)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Bhaderwah	Chinalla	Chinalla	Chinalla-I	Kundi/Goshti	30	33.10394	75.73306
5)	CN/JK/NL/04 - Temperate Conifer Forest	Jammu & Kashmir	Doda	Bhaderwah	Dehran Nalah	Kellar	Paryote	Paeyote-II	10	33.08444	75.54
6)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Bhaderwah	Devli Mandir	Kellar	Paryote	Paryote-I	5	33.12472	75.55444
7)	CN/JK/NL/04 - Temperate Conifer Forest	Jammu & Kashmir	Doda	Bhaderwah	Dhayan (Amral Pura)	Bhalesh	Pingal	Dichal	15	33.08506	75.93033
8)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Doda	Bhaderwah	Dhayan (Amrat pura)	Bhalesh	Pingal	Dichhal	15	33.08506	75.93033
9)	CN/JK/NL/04 - Temperate Conifer Forest	Jammu & Kashmir	Doda	Bhaderwah	Dhossa	Bhalesh	Neeli	Dhossa-III	10	32.997	75.96116
10)	CN/JK/NL/10 - Eradication of Lantana (> 50%)	Jammu & Kashmir	Doda	Bhaderwah	Forest Land	Neeru	Padri	Comptt. 7P/N	5		
11)	CN/JK/NL/10 -	Jammu	Doda	Bhaderwah	Forest Land	Neeru	Duggi Ist	Co. No	5		

	Eradication of Lantana (> 50%)	&Kashmir			(1)			6/neeru			
12)	CN/JK/NL/11 - Control/ Removal of Invasive Species or <50% Lantana	Jammu & Kashmir	Doda	Bhaderwah	Forest Land (2)	Neeru	Puneja-I	Katyara 25/Na	5		
13)	CN/JK/NL/11 - Control/ Removal of Invasive Species or <50% Lantana	Jammu & Kashmir	Doda	Bhaderwah	Forest Land (3)	Neeru	Puneja 2nd	44/N	5		
14)	CN/JK/NL/11 - Control/ Removal of Invasive Species or <50% Lantana	Jammu & Kashmir	Doda	Bhaderwah	Forest Land (4)	Neeru	Puneja II	49/N	5		
15)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Doda	Bhaderwah	Jai *Nallah*	Chiralla	Jai IInd	Jai(Co.13 to 37/Jai)	20	33.04292	75.77244
16)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Bhaderwah	Jai Nallar I	Chiralla	Jai 2nd	Jai (CO.13 TO 37/Jai)	20		
17)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Doda	Bhaderwah	Jugnalwar	Chinalla	Jugnalwa r	Jugnalwa r	50	33.66861	75.76977
18)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Doda	Bhaderwah	Kaankai (Banola)	Kellar	Malothi	chilli	10	33.01858	75.59753
19)	CN/JK/NL/08 - Himalayan Mixed Fores t	Jammu & Kashmir	Doda	Bhaderwah	Nepali *Nallah*	kellar	Paryote	Paryote-I	5	33.13389	75.54
20)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Doda	Bhaderwah	Revenue Land	Bhalesh	Pingal	Champal	5	33.06033	75.97181

21)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Doda	Doda	62/bh Dibba Kahal Jugser	Bhalesh	Neeli	Kahal	10	32.93977	75.97004
22)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	85/57 Thatheel Bhagwah	Siraj	Koti	Bhagwah	5		
23)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Bhader Gwadi Com 50/k	Kuntwara	Gundna	Gundna	10	33.226194	75.530606
24)	CN/JK/NL/04 - Temperate Conifer Forest	Jammu & Kashmir	Doda	Doda	Bhathal *Nallah* Co. 6/Kmt.	Kuntwara	Bharath	Bagla	8	33.23463	75.60837
25)	CN/JK/NL/04 - Temperate Conifer Forest	Jammu & Kashmir	Doda	Doda	Buttbuggi *Nallah* Co. 55/Kmt	Kuntwara	Bharath	Bagla	10	33.21601	75.59959
26)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Chakla Dhar G 43/SJ	Siraj Range	Dessa Block	Mulan Beat	10	33.25025	75.36676
27)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Chanderbtan G 41/SJ	Siraj	Dessa	Bhata	10	33.30022	75.46694
28)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Co-73/SJ Tapdaak Manjmi Beat	Siraj	Gadi	Manjmi	5	33.26317	75.47013
29)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Deissa G 26/SJ	Siraj Range	Dessa Block	Mulan	8	33.26691	75.43349
30)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Doda	Doda	Dhossa Co. No: 56/Bh	Bhalesh	Neeli	Dhossa-II	10	33.032216	75.910031
31)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Diesa Malan G 33/34	Siraj Range	Dessa Block	Malan	10	33.26681	75.43357
32)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Draman Co. 53/Kt	Kuntwara	Gundna	Kalihand	8	33.16833	75.6225
33)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Gali G 42/SJ	Siraj	Dessa Block	Bhata Beat	10	33.28343	75.46672

34)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Gangla G 35/SJ	Siraj	Dessa	Bhata	8	33.28356	75.45027
35)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Ghot *Nallah* co. 56/Kmt	Kuntwara	Bharath	Bagla	8	33.251038	75.512879
36)	CN/JK/NL/04 - Temperate Conifer Forest	Jammu & Kashmir	Doda	Doda	Girghat *Nallah*	Kuntwara	Kuntwara	Dashan	8	33.1047	75.335
37)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Gramri Dessa G 34/SJ	Siraj	Dessa	Mulan	8	33.28348	75.45014
38)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Ikhwan G 35/Sj	Siraj	Dessa	Bhata	10	33.30008	75.46671
39)	CN/JK/NL/04 - Temperate Conifer Forest	Jammu & Kashmir	Doda	Doda	Khunu *nallah*	Kuntwara	Bharath	Bagla	8	33.21026	75.59326
40)	CN/JK/NL/04 - Temperate Conifer Forest	Jammu & Kashmir	Doda	Doda	Kunda G 27/SJ	Siraj Range	Dessa Block	Mulan Beat	6	33.28343	75.43336
41)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Kunda G 33/SJ	Siraj	Dessa	Mulan	10	33.28342	75.43342
42)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	L/Tantna Co. 51/kt	Kuntwara	Gundna	Tashnal	10	33.19778	75.63694
43)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Laloor-Batnallah-Co-16/81	Siraj	Dhandhal	Shainkly	5	33.24291	75.45276
44)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Mothla G 35/SJ	Siraj	Dessa	Bhata	8	33.28357	75.45025
45)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Mothla G 42/SJ	Siraj	Dessa	Bhata	10	33.28348	75.46671
46)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Mulan Dessa Co 34/SJ	Siraj	Dessa Block	Mulan Beat	10	33.28343	75.43353
47)	CN/JK/NL/04 - Temperate Conifer Forest	Jammu & Kashmir	Doda	Doda	Mulan Dessa G33/ SJ	Siraj Range	Dessa Block	Mulan	8	33.28341	75.43344

48)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Nagni *Nallah* Co. 57a/Kmt	Kuntwara	Bharath	Bharath	8	33.23568	75.60985
49)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Nelsoo Kulhand	Kuntwara	Kuntwara	Kulhand	8	33.21678	75.56686
50)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Doda	Doda	Panakhar (malu nala) Co. 48/kmt	Kuntwara	Mohatta	Banshal	12	33.20111	75.66861
51)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Jammu	Bandwal	Kalidhar	Panjgrain	jud	15	32.81079	74.58847
52)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Jammu	Bandwal (1)	Kalidhar	Panjgrain	Jud	10	32.81784	74.59651
53)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Jammu	Bjalta 59 Compartment	Bahu	Bajalta	Bajalta Beat	5		
54)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Jammu	Bjalta 60 Compartment	Bahu	Bjalta	Bjalta	5	32.77744	74.97897
55)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Jammu	Garkhal	Kalidhar	Panjgrain	Pargwal	12	32.82655	74.66602
56)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Jammu	Gorkhal (2)	Kalidhar	Panjgrain	Pargwal	12	32.82655	74.66602
57)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Jammu	Jammu Tawi River 6 2 Compartment	Bahu	Bajalta	Bajalta	10	32.78289	74.93225
58)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Jammu	Kanju Peer	Jammu	Nagrota II	Jagti Beat II	5	32.84114	74.9005
59)	CN/JK/NL/09 - Sub-	Jammu	Jammu	Jammu	Karala	Kalidhar	Chowki	Khoradra	20	33.01156	74.78034

	Tropical Dry Deciduous Forest	&Kashmir									
60)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Jammu	Malla Bella	Kalidhar	Panjarian	Pargwal	15	32.82936	74.64654
61)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Jammu	Malla Bella	Kalidhar	Panjgran	Pargwal	12	32.82742	74.64236
62)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Jammu	Jammu	Panjgrain (near bridh ashram)	Jammu	Nagrota I	Jagti	5	32.84417	74.92761
63)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Jammu	Simble laid (Sanerka II)	Jammu	Nagrota I	Jagti	9	32.84064	74.86741
64)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Jammu	Jammu	Simble Laid (Sanerka)	Jammu	Nagrota I	Jagti I	9	32.83756	74.87369
65)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Jammu	Simble Laid (Sanerka) (1)	Jammu	Nagrota I	Jagti I	9		
66)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Jammu	Thungi Morh	Kalidhar	Chowki	Tanda	20	32.98887	74.77666
67)	CN/JK/NL/08 - Himalayan Mixed Forest	Jammu & Kashmir	Jammu	Udhampur	Dhar Radhnote (c46/P)	Panchari	Damnote	Lalli	20		
68)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Jammu	Urban Forestry	Kangote, 24/N	Lamberi	Kalal	Kangota	18	33.12564	74.23581
69)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Kishtwar	Doda	10K Sergori	Thakri	Kisthwar	Kisthwar	20		
70)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Kishtwar	Doda	Bagnari	Thakri	Samsul	Samsul	20		

71)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Kishtwar	Doda	Jugna Kuchhan	Thakri	Horna	Kuchhan	5		
72)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Kishtwar	Kishtwar	Bhamsheroo	Kisthwar	Nagni	Bhumsheroo	5	33.15661	75.81594
73)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Kishtwar	Kishtwar	Bharoti Saroor	Kisthwar	Saroor	Kalchanda	15	33.19003	75.85311
74)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Kishtwar	Kishtwar	Breigsay	Kisthwar	Trigam	Trigam Ist	15		
75)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Kishtwar	Kishtwar	Breigsay	Kisthwar	Trigam	Trigam Ist	15	33.28589	75.79906
76)	CN/JK/NL/08 - Himalayan Mixed Forest	Jammu & Kashmir	Kishtwar	Kishtwar	Cheer Mal	Kisthwar	Kisthwar	Comptt 65/K	15	33.34489	75.77714
77)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Kishtwar	Kishtwar	Paura Chandali	Kishtwar	Saroor	Chamdal Ist	15	33.22678	75.88019
78)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Kishtwar	Marwah	Gurinal Chhatroo	Udil Range	Chhatroo Block	Gurinal	15		
79)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Kishtwar	Marwah	Gurinal Chhatroo (1)	Udil Range	Chhatroo Block	Gurinal	15	33.42472	75.61436
80)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Kishtwar	Marwah	Gurinal Chhatroo (2)	Udil Range	Chhatroo Block	Gurinal	10	33.40334	75.62063
81)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Kishtwar	Marwah	Palmar, Ekhalla	Dachhan	Jkhala	Palmar Co 39b/D	20	33.40622	75.73092
82)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Nowshera	154/ N Katera	Lamberi	Rajal	Katera	16	33.18348	74.26686
83)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Nowshera	154/N katera	Lamberi	Rajal Block	Katera	16	33.18348	74.26686
84)	CN/JK/NL/09 - Sub-Tropical Dry	Jammu & Kashmir	Rajouri	Nowshera	Androoth	Nowshera	Androoth	Androoth	8	33.251	74.20425

	Deciduous Forest										
85)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Nowshera	Bravi Nalla	Sunder Bani	Dharamsal	Dharamsal 39/D	6	33.11681	74.45703
86)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Nowshera	Brevi Comptt: 27/B (Ballei Nalla)	Sunder Bani	Dharamsal	Brevi comptt: 27/D	5	33.13354	74.45026
87)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Nowshera	Brevi Nalla	Sunder Bani	Dharamsal	Dharamsal comptt. 29/D	5	33.13358	74.45006
88)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Nowshera	Brevi Nalla	Sunder Bani	Dharamsal	Dharamsal comptt. 28/D	5	33.13348	74.45017
89)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Rajouri	Nowshera	Nadyala	Nowshera	Chingus	Chattayatri	20	33.26526	74.22735
90)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Nowshera	Nowshera	Nowshera	Nowshera	Nowshera	5	33.15139	74.20533
91)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Nowshera	Panais (Mangal devi), 28/N	Lamberi	Kalal	Mangle devi	11	33.08875	74.33353
92)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Nowshera	Pothagala (Berss) Comptt: 27/D	Sunder Bani	Dharamsal	Bress Comptt. 27/D	7	33.15383	74.49308
93)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Rajouri	Nowshera	Pothagala (Breri) Comptt: 60/D	Sunder Bani	Dharmasal	Kallar	5	33.15108	74.48825
94)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Nowshera	Salahari (Lower Hartkal) Co,	Sunder Bani	Dharmasal	Salahari (comptt 54/D)	6	33.11699	74.50886

					54/D						
95)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Nowshera	Salaheri Comptt: 53/D	Sunder Bani	Dharamsal	Salaheri	6	33.10016	74.50008
96)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Nowshera	Salaheri CoNo/54/D	Sunder Bani	Dharmsal	Salaheri comptt 54/D	5	33.049293	74.490661
97)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Rajouri	300 m comptt. 122/K	Kalakote	Kalakote	Tatapani	6	33.25008	74.41668
98)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Rajouri	Bagalyan/ Baurani	Kandi	Budhal-A		5	33.40001	74.53348
99)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Rajouri	Bathuni (2)	Rajouri	Bathuni	Bathuni	20	33.31694	74.30004
100)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Rajouri	Rajouri	Chotanr/ Dhorimall/ Nandom	Kandi	Budhal-B	Kandi-A	50	33.38353	74.50001
101)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Rajouri	Comptt. 120 k 300m	Kalakote	Kalakote	Tatapani	6	33.25009	74.40007
102)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Rajouri	Darkeri (Poundal) Comptt. No. 147/k	Kalakote	Kalakote	Sadda 'B'	8	33.2668	74.45026
103)	CN/JK/NL/08 - Himalayan Mixed Forest	Jammu & Kashmir	Rajouri	Rajouri	Kalaban-co.no. 80/R	Rajouri	Kotli	Kotli-B	8	33.51693	74.26689
104)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Rajouri	Khark Comptt. 115/K (1)	Kalakote	Kalakote	Tatapani	5	33.16667	74.40006
105)	CN/JK/NL/05 -	Jammu	Rajouri	Rajouri	Khark	Kalakote	Kalakote	Tatapani	6	33.16667	74.40006

	Temperate Mixed Forest	&Kashmir			Comptt. No. 115/K						
106)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Rajouri	Kharu comptt. 45/4	Kalakote	Kalakote	Tatapani	6	33.16687	74.4
107)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Rajouri	Lehri Comptt. 99k	Kalakote	Sialsui	Khadadian-B	5	33.21686	74.33352
108)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Rajouri	Rajouri	Palti/ Darman/ Marg	Kandi	Budhal A	Samote-A	50	33.36669	74.55019
109)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Rajouri	Rajouri	Phagla	Kandi	Dhangari	Dhangari	20	33.31668	74.38344
110)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Rajouri	Rajouri	Solki Comptt. 160/k	Kalakote	Dhaleri	Solki	5	33.15013	74.41684
111)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Ramban	Batote	Bastalla Comptt: 576/G	Gandhri	Kanga	Kanga	5	33.25139	75.14167
112)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Ramban	Batote	Bhornd Co. 49/G	Gandhri	Kanga	Gugwarl	5	33.23744	75.21306
113)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Ramban	Batote	Budhi Marri Cimpartment: 1/BHC	Batote	Shivgarh	Chakwa	20	33.13781	75.33081
114)	CN/JK/NL/08 - Himalayan Mixed Forest	Jammu & Kashmir	Ramban	Batote	Dhalwas compartment: 23b/BHC	Batote	Sanasar	Dhalwas	20	33.16646	75.31488
115)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Ramban	Batote	Kanga Comptt: 55/G	Gandhri	Kanga	Kanga	20	33.22389	75.17308
116)	CN/JK/NL/07 -	Jammu	Ramban	Batote	Kanga	Gandhri	Kanga	Kanga	30		

	Himalayan Chir Pine Forest	&Kashmir			Comptt: 56/G (Dharamkund)						
117)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Batote	Kothi/ Belyani Berth. Co. 68/G	Gandhri	Bhatri	Bhatri	25	33.33606	75.16136
118)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Batote	Kurmail *Nallah* (Co.74/mRT)	Mormat	Bulandpur	Baggar	14	33.13334	75.36683
119)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Batote	Malohri Passi (Co 13a/Marmat)	Marmat	Dedni	Hual Beat	25	33.13334	75.46671
120)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Batote	Masrola 66b/G	Gandhri	Bhatri	Bhatri	25	33.19442	75.18011
121)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Batote	Naghal Nalla	Marmat	Dedni	Hind Beat	30	33.00005	75.45005
122)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Batote	Neeha *Nallah* (CO. 72/ Mormat)	Mormat	Bulandpur	Baggar	18	33.11673	75.36685
123)	CN/JK/NL/08 - Himalayan Mixed Forest	Jammu & Kashmir	Ramban	Batote	Peerah-I (Compartment:- 28/Batote)	Batote	Sanasar	Sakini	30	33.17658	75.30772
124)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Ramban	Batote	Pernote	Gandhri	Kanga	Pernote	15	33.24344	75.20272
125)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Batote	Rakhjaro Compartment 12/BHC	Batote	Batore	12/BHC	40	33.12568	75.33172
126)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Batote	Soli Co. 75/G and 76/G	Gandhri	Bhatri	Tanger	25	33.18278	75.18583
127)	CN/JK/NL/07 - Himalayan Chir Pine Fo	Jammu & Kashmir	Ramban	Batote	Tauger (73/G Comptt:)	Gandhri	Kanga/Bhatri	Tanger	30	33.20272	75.16153

	rest										
128)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Batote	Trungal *Nallah* (CO. 71/ Mormat)	Mormat	Bulandpur	Baggar	16	33.11688	75.38345
129)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Ary Marg Co. 35/BNL	Banihal	Mohu	Mangit 'a'	5	33.43775	75.09547
130)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Bagroo (Dal) Co. 27/R	Ramban	Bhingara	Paristan - 'B'	5	33.30606	75.30685
131)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Ramban	Ramban	Balli Co. 47/R	Ramban	Rajgarh	Dhandrath - A	15	33.21061	75.28061
132)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Bozla *Nallah* Co. 23/R	Banihal	Mohu	Buzla-'a'	15	33.41681	75.11853
133)	CN/JK/NL/04 - Temperate Conifer Forest	Jammu & Kashmir	Ramban	Ramban	Chul-Nari Com 38/BNL	Banihal	Mohu	Mangit 'a'	30	33.42675	75.11088
134)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Dad-Dhara, Ekhalla	Dachhan	Ekhalla	Ekhalla, 38 b/D	20	33.43689	75.72947
135)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Ramban	Ramban	Digdol Co.390/R	Ramban	Ramban	Digdol - A	5	33.29708	75.18128
136)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Dikhal Com. 30/R	Ramban	Bhingara	Bhingara	5	33.31595	75.29858
137)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Ekhalla, Palmar	Dachhan	Jkhalla	Palmar Co. 39/D	15	33.40411	75.71813
138)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Falsel/ Hochak Co. 18/R	Ramban	Pogal	Pogal-B	45	33.239849	75.238919
139)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Ramban	Ramban	Gangnoo (Ramsoo)	Banihal	Sarbagni	Sarbagni - B	10	33.34731	75.17803
140)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Googli Co. 17/R	Pogal	Pogal A	Pogal A	30	33.58472	75.52033

141)	CN/JK/NL/04 - Temperate Conifer Forest	Jammu & Kashmir	Ramban	Ramban	Guari Com-31/R	Ramban	Bhingara	Bhingara	5	33.3262	75.27617
142)	CN/JK/NL/06 - Pasture and Grazing Land Development	Jammu & Kashmir	Ramban	Ramban	Hammer Paasi Co. 26/R	Banihal	Bhangha ra	Bhanghar a 'B'	10	33.30014	75.32774
143)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Kanchil Ukhril Darin Co 33/R	Ramban	Bhangha ra	Bhanghar a 'B'	5	33.32626	75.26664
144)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Karihal Co. 11/R	Ramban	Neel	Neel-C	20	33.30543	75.30809
145)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Khil Nala Co 34/R	Ramban	Bhangara	Bhangara 'B'	5	33.32316	75.25951
146)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Ramban	Ramban	Khooni *Nallah* 38R	Ramban	Ramban	Digdol - A	30	33.31684	75.19147
147)	CN/JK/NL/08 - Himalayan Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Khoura	Banihal	Sarbagni	Trigam - A	5	33.34628	75.15653
148)	CN/JK/NL/08 - Himalayan Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Kunchi Ukhril Co. 34/R	Banihal	Bhangha ra	Bhanghar a 'B'	5	33.32615	75.25318
149)	CN/JK/NL/08 - Himalayan Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Opposite Chapran (Com. 31/R)	Banihal	Bhingara	Bhingara	5	33.32771	75.27642
150)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Palmar, Ekhalla (1)	Dachhan	Jkhalla	Palmar Co. 39/D	20	33.40622	75.72559
151)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Ramban	Ramban	Panthyal Co. 38/R	Ramban	Ramban	Digdol - A	20	33.32257	75.19734
152)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Ramban	Ramban	Ramsoo	Banihal	Sarbangn i	Sarbagni - A	20	33.33547	75.19264

153)	CN/JK/NL/08 - Himalayan Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Thanoli *Nallah* 47/R	Ramban	Rajgarh	Dhandrath - A	5	33.33169	75.26425
154)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Ramban	Ramban	Thatha (Co. 70/R)	Ramban	Rajgarh	Rajgarh 'B'	5		
155)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Reasi	Mahore	Chillad 104/Ar	Mahore	Kanthan	Mattote	10	33.2228	74.9027
156)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Reasi	Mahore	Chural (Co/33/Ar)	Mahore	Bhudan	Shajrer	30	33.2794	74.8726
157)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Reasi	Mahore	Dada(Co.134 /Ar)	Mahore	Budhan	Shajru	45	33.27687	74.86142
158)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Reasi	Mahore	Dhamsal 92/Ar	Mahore	Kanthan	Judda	30	33.2931	74.8157
159)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Mahore	Drarot (Co. 89/Ar)	Mahore	Kanthan	Surukote	60	33.3057	74.7712
160)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Mahore	Judda Co 93/Ar	Mahore	Kanthan	Judda	20	33.2763	74.8227
161)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Reasi	Mahore	Kouni Compartment 50/GG	Gulbargh	Deval	Manjikote	30		
162)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Reasi	Mahore	Krud Comptt; 2/44	GULABGARH	MAHORE	MAHORE	30	33.29613	74.86703
163)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Reasi	Mahore	Lancha (118/Ar)	Mahore	Budhan	Lancha	30	33.2498	74.9564
164)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Reasi	Mahore	Lancha 116/Ar	Mahore	Budhan	Lancha-I	30	33.2275	74.951
165)	CN/JK/NL/07 - Himalayan Chir Pine Fo	Jammu & Kashmir	Reasi	Mahore	Malaic comptt.2/GG.	Gulabgarh	Mahore	Mahore	30	33.29567	74.83978

	rest										
166)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Reasi	Mahore	Malla Comptt.5 GG.	Mohore	Gulabgarh	Sarh	30	33.3157	74.90789
167)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Reasi	Mahore	Nambal Compartment 68/GG	Gulabagarh	Shergari	Shergari	40		
168)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Reasi	Mahore	Pir ki gali Compartment 66/GG	Gulabgarh	Shergari	Shergari	40	33.40303	74.70112
169)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Reasi	Mahore	Thuroo (co 109/Ar)	Mahore	Thuroo	Thuroo	30	33.2687	74.8605
170)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Aas, Nallion, Tarmoda *Nallah*, Aas Node	Reasi	Bhomag	Salal	20	33.13178	74.83
171)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Badawan, Bidda Co. 32/R	Reasi	Reasi	Mari	5	33.11375	74.80711
172)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Bodhi Dhar	Kotra	Bhoga	Bhoga-II	20	33.03861	74.86825
173)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Chinkah	Thakarakote	Thakarakote	Panassa II	20		
174)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Chourakote, Sersunowan, Zero Morh, Sermeghan	Reasi	Reasi	Bakkal	20	33.13708	74.91336
175)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Kanka Dabbad	Katra	Bhaga	Bhabber-Ii	10	33.02253	74.86828

176)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Kans Brahmna	Thakrakote	Talwara	Talwara II	20	33.06328	75.78406
177)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Khankhor, Ghiyala Co. 35/R	Reasi	Reasi	Mari	20	33.07546	74.89019
178)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Kharooni Garat, Goswan. Co. 36/R	Reasi	Reasi	Mari	40	33.08114	74.88423
179)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Kheral	Thakrakote	Talwaraa	Talwara 49 c/th	20	33.06747	75.74978
180)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Lamsera, Beat-Bakkal	Reasi	Bomaghi	Bakkal Beat	20	33.13344	74.91136
181)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Panarsa	Katra	Bhaga	Bhaga-I	10	33.05011	74.80003
182)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Panassa	Jhakrekote	Chinkah	Panassa I	20		
183)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Samakh (Surjandhar) Co 13/R	Reasi	Bhomagh	Nagote	60	33.11993	74.98128
184)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Sarma, Mari co. 34/R	Reasi	Reasi	Mari	20	33.11067	74.85293
185)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Reasi	Reasi	Soldi	Kalra	Bhaga	Bhaga-II	20	33.03236	74.86794
186)	CN/JK/NL/09 - Sub-Tropical Dry	Jammu & Kashmir	Reasi	Reasi	Soosla, Bidda	Reasi	Reasi	Beat-Mori	20	33.11116	74.80563

	Deciduous Forest										
187)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Reasi	Reasi	Surjandhar, Co. 18a/R and 18b/R	Reasi	Bomagh	Nagote	8	33.13991	74.97624
188)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Udhampur	Ramnagar	North Range				80		
189)	CN/JK/NL/06 - Pasture and Grazing Land Development	Jammu & Kashmir	Udhampur	Ramnagar	North Range 2				40		
190)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Udhampur	Ramnagar	North Range 3				30		
191)	CN/JK/NL/08 - Himalayan Mixed Forest	Jammu & Kashmir	Udhampur	Ramnagar	South Range				70		
192)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Udhampur	Ramnagar	South Range 2				50		
193)	CN/JK/NL/11 - Control/ Removal of Invasive Species or <50% Lantana	Jammu & Kashmir	Udhampur	Ramnagar	South Range 3				30		
194)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Udhampur	Udhampur	Goth Comptt 67/P	Panchari	Chailodhera	Chailodhera	10	33.2258	75.2883
195)	CN/JK/NL/05 - Temperate Mixed Forest	Jammu & Kashmir	Udhampur	Udhampur	Kathala Comptt 66/P	Panchari	Chailodhra	Chailodhra	20	33.1547	75.1885
196)	CN/JK/NL/09 - Sub-Tropical Dry Deciduous Forest	Jammu & Kashmir	Udhampur	Udhampur	Lalli Nahala co 48/P	Panchari	Damnote	Lalli	5	33.0953	75.0248
197)	CN/JK/NL/08 - Himalayan Mixed Forest	Jammu & Kashmir	Udhampur	Udhampur	Radhnote Nalah	Panchari	Damnote	Lalli	10	33.1266	75.0375

198)	CN/JK/NL/10 - Eradication of Lantana (> 50%)	Jammu & Kashmir	Udhampur	Udhampur	Thanthi Nahala Co 50/P	Panchari	Damnote	Sari	5	33.0929	75.0177
199)	CN/JK/NL/07 - Himalayan Chir Pine Forest	Jammu & Kashmir	Udhampur	Udhampur	Thark Comptt. 68/P	Panchari	Chailodhra	Chailodhra	10	33.157	75.1423
200)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Doda	Bhaderwah	Bhadarwah				100	32.983	75.711
201)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Doda	Bhaderwah	Bhadarwah				35	32.983	75.711
202)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Doda	Bhaderwah	Bhadarwah 2				110	33.3116	75.7662
203)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Doda	Bhaderwah	Bhadarwah 3				110	33.3116	75.7662
204)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Doda	Doda	Doda				120	33.1457	75.548
205)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Doda	Doda	Doda				70	33.1457	75.548
206)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Doda	Doda	Doda 2				110	33.1457	75.548
207)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Doda	Doda	Doda 3				100	33.1457	75.548
208)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Jammu	Jammu	Jammu				70	32.7266	74.857
209)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Jammu	Jammu	Jammu 2				80	32.7266	74.857

210)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Jammu	Jammu	Jammu 3				70	32.7266	74.857
211)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Jammu	Jammu	Jammu 1				80	32.7266	74.857
212)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar				140	33.3116	75.7662
213)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar				40	33.3116	75.7662
214)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar 2				130	33.3116	75.7662
215)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar 3				100	33.3116	75.7662
216)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Kishtwar	Marwah	Marwah				100	33.3116	75.7662
217)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Kishtwar	Marwah	Marwah				30	33.3116	75.7662
218)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Kishtwar	Marwah	Marwah 2				90	33.3116	75.7662
219)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Kishtwar	Marwah	Marwah 3				80	33.3116	75.7662
220)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Rajouri	Nowshera	Nowshera				100	20.5937	78.9629
221)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Rajouri	Nowshera	Nowshera				80	20.5937	78.9629

222)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Rajouri	Nowshera	Nowshera 2				70	20.5937	78.9629
223)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Rajouri	Nowshera	Nowshera 3				50	20.5937	78.9629
224)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Rajouri	Rajouri	Rajouri				100	33.3716	74.3152
225)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Rajouri	Rajouri	Rajouri				60	33.3716	74.3152
226)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Rajouri	Rajouri	Rajouri 2				90	33.3716	74.3152
227)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Rajouri	Rajouri	Rajouri 3				80	33.3716	74.3152
228)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Ramban	Batote	Batote				90	33.1216	75.3216
229)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Ramban	Batote	Batote				50	33.1216	75.3216
230)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Ramban	Batote	Batote 2				70	33.1216	75.3216
231)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Ramban	Batote	Batote 3				50	33.1216	75.3216
232)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Ramban	Ramban	Ramban				100	33.2427	75.2392
233)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Ramban	Ramban	Ramban				50	33.2427	75.2392

234)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Ramban	Ramban	Ramban 2				80	33.2427	75.2392
235)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Ramban	Ramban	Ramban 3				70	33.2427	75.2392
236)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Reasi	Mahore	Mahore				45		
237)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Reasi	Mahore	Mahore 1				60		
238)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Reasi	Mahore	Mahore 2				80		
239)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Reasi	Mahore	Mahore 3				70		
240)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Reasi	Reasi	Reasi				120	33.0804	74.8364
241)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Reasi	Reasi	Reasi				50	33.0804	74.8364
242)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Reasi	Reasi	Reasi 2				110	33.0804	74.8364
243)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Reasi	Reasi	Reasi 2				100	33.0804	74.8364
244)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Udhampur	Ramnagar	North Range				80		
245)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Udhampur	Ramnagar	North Range				50		

246)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Udhampur	Ramnagar	North Range 2				40		
247)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Udhampur	Ramnagar	North Range 3				30		
248)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Udhampur	Ramnagar	South Range				70		
249)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Udhampur	Ramnagar	South Range				50		
250)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Udhampur	Ramnagar	South Range 2				50		
251)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Udhampur	Ramnagar	South Range 3				30		
252)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Udhampur	Udhampur	Udhampur				130	32.916	75.1416
253)	CN/JK/NL/13 - Fire Protection Model	Jammu & Kashmir	Udhampur	Udhampur	Udhampur				60	32.916	75.1416
254)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Udhampur	Udhampur	Udhampur 2				100	32.916	75.1416
255)	CN/JK/NL/12 - Protection Model for Natural Regeneration	Jammu & Kashmir	Udhampur	Udhampur	Udhampur 3				80	32.916	75.1416
ii)	**Agriculture Landscape**										
256)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Doda	Bhaderwah	Bhaderwah				12	32.983	75.711

257)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Doda	Bhaderwah	Bhaderwah				3	32.983	75.711
258)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Doda	Bhaderwah	Bhaderwah(2)				10	32.983	75.711
259)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Doda	Bhaderwah	Bhaderwah(2)				2	32.983	75.711
260)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Doda	Bhaderwah	Bhaderwah(3)				8	32.983	75.711
261)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Doda	Bhaderwah	Bhaderwah(3)				1	32.983	75.711
262)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Doda	Doda	Doda				18	33.1457	75.548
263)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Doda	Doda	Doda				4	33.1457	75.548
264)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Doda	Doda	Doda (2)				12	33.1457	75.548
265)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Doda	Doda	Doda (2)				2	33.1457	75.548
266)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Doda	Doda	Doda (3)				10	33.1457	75.548
267)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Doda	Doda	Doda (3)				1	33.1457	75.548
268)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Jammu	Jammu	Jammu				3	32.7266	74.857
269)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Jammu	Jammu	Jammu				12	32.7266	74.857

270)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Jammu	Jammu	Jammu (2)				2	32.7266	74.857
271)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Jammu	Jammu	Jammu (2)				10	32.7266	74.857
272)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Jammu	Jammu	Jammu (3)				1	32.7266	74.857
273)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Jammu	Jammu	Jammu (3)				8	32.7266	74.857
274)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar				4	33.3116	75.7662
275)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar				12	33.3116	75.7662
276)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar (2)				2	33.3116	75.7662
277)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar (2)				10	33.3116	75.7662
278)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar (3)				1	33.3116	75.7662
279)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar (3)				8	33.3116	75.7662
280)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Kishtwar	Marwah	Marwah				3	33.3116	75.7662
281)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Kishtwar	Marwah	Marwah				12	33.3116	75.7662
282)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Kishtwar	Marwah	Marwah(2)				2	33.3116	75.7662

283)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Kishtwar	Marwah	Marwah(2)				10	33.3116	75.7662
284)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Kishtwar	Marwah	Marwah(3)				1	33.3116	75.7662
285)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Kishtwar	Marwah	Marwah(3)				8	33.3116	75.7662
286)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Rajouri	Nowshera	Nowshera				12	34.1289	74.8032
287)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Rajouri	Nowshera	Nowshera				4	34.1289	74.8032
288)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Rajouri	Nowshera	Nowshera (2)				10	34.1289	74.8032
289)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Rajouri	Nowshera	Nowshera (2)				2	34.1289	74.8032
290)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Rajouri	Nowshera	Nowshera (3)				8	34.1289	74.8032
291)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Rajouri	Nowshera	Nowshera (3)				1	34.1289	74.8032
292)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Rajouri	Rajouri	Rajouri				3	33.3716	74.3152
293)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Rajouri	Rajouri	Rajouri				12	33.3716	74.3152
294)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Rajouri	Rajouri	Rajouri (2)				2	33.3716	74.3152
295)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Rajouri	Rajouri	Rajouri (2)				10	33.3716	74.3152

296)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Rajouri	Rajouri	Rajouri (3)				1	33.3716	74.3152
297)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Rajouri	Rajouri	Rajouri (3)				8	33.3716	74.3152
298)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Ramban	Batote	Batote				12	33.1216	75.3216
299)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Ramban	Batote	Batote				4	33.1216	75.3216
300)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Ramban	Batote	Batote (2)				10	33.1216	75.3216
301)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Ramban	Batote	Batote (2)				2	33.1216	75.3216
302)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Ramban	Batote	Batote (3)				8	33.1216	75.3216
303)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Ramban	Batote	Batote (3)				1	33.1216	75.3216
304)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Ramban	Ramban	Ramban				4	33.2427	75.2392
305)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Ramban	Ramban	Ramban				18	33.2427	75.2392
306)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Ramban	Ramban	Ramban(2)				2	33.2427	75.2392
307)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Ramban	Ramban	Ramban(2)				12	33.2427	75.2392
308)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Ramban	Ramban	Ramban(3)				1	33.2427	75.2392

309)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Ramban	Ramban	Ramban(3)				10	33.2427	75.2392
310)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Reasi	Mahore	Mahore				12	33.3096	74.8595
311)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Reasi	Mahore	Mahore				3	33.3096	74.8595
312)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Reasi	Mahore	Mahore (2)				10	33.3096	74.8595
313)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Reasi	Mahore	Mahore (3)				8	33.3096	74.8595
314)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Reasi	Mahore	Mahore (3)				2	33.3096	74.8595
315)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Reasi	Mahore	Mahore(2)				1	33.3096	74.8595
316)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Reasi	Reasi	Reasi				12	33.0804	74.8365
317)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Reasi	Reasi	Reasi				4	33.0804	74.8365
318)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Reasi	Reasi	Reasi (2)				10	33.0804	74.8365
319)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Reasi	Reasi	Reasi (2)				2	33.0804	74.8365
320)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Reasi	Reasi	Reasi (3)				8	33.0804	74.8365
321)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Reasi	Reasi	Reasi (3)				1	33.0804	74.8365

322)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Udhampur	Ramnagar	North Range				12		
323)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Udhampur	Ramnagar	North Range				3		
324)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Udhampur	Ramnagar	North Range 2				4		
325)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Udhampur	Ramnagar	North Range 2				10		
326)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Udhampur	Ramnagar	North Range 3				12		
327)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Udhampur	Ramnagar	North Range 3				4		
328)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Udhampur	Ramnagar	South Range				12		
329)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Udhampur	Ramnagar	South Range				4		
330)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Udhampur	Ramnagar	South Range 2				4		
331)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Udhampur	Ramnagar	South Range 2				10		
332)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Udhampur	Ramnagar	South Range 3				12		
333)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Udhampur	Ramnagar	South Range 3				3		
334)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Udhampur	Udhampur	Udhampur				3	32.916	75.1416

335)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Udhampur	Udhampur	Udhampur				18	32.916	75.1416
336)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Udhampur	Udhampur	Udhampur (2)				2	32.916	75.1416
337)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Udhampur	Udhampur	Udhampur (2)				12	32.916	75.1416
338)	CN/JK/AL/02 - Block Plantation Model	Jammu & Kashmir	Udhampur	Udhampur	Udhampur (3)				1	32.916	75.1416
339)	CN/JK/AL/01 - Boundary Plantation Model	Jammu & Kashmir	Udhampur	Udhampur	Udhampur (3)				10	32.916	75.1416
iii)	**Urban Landscape**										
340)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Doda	Bhaderwah	Bhaderwah				2	32.983	75.711
341)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Doda	Bhaderwah	Bhaderwah(2)				3	32.983	75.711
342)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Doda	Bhaderwah	Bhaderwah(3)				3	32.983	75.711
343)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Doda	Bhaderwah	Bhaderwah-1				0.5	32.983	75.711
344)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Doda	Bhaderwah	Bhaderwah-2				0.5	32.983	75.711
345)	CN/JK/UL/01 - Bioremediation and Bio filtration	Jammu & Kashmir	Doda	Bhaderwah	Neeru, Kalnai				1	32.983	75.711
346)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Doda	Bhaderwah	Premnagar				0.1	32.983	75.711
347)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Doda	Bhaderwah	Thatri				0.3	32.983	75.711
348)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Doda	Doda	Doda				2	33.1457	75.548

349)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Doda	Doda	Doda				0.2	33.1457	75.548
350)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Doda	Doda	Doda				0.1	33.1457	75.548
351)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Doda	Doda	Doda (2)				3	33.1457	75.548
352)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Doda	Doda	Doda (3)				3	33.1457	75.548
353)	CN/JK/UL/01 - Bioremediation and Bio filtration	Jammu & Kashmir	Doda	Doda	Lidrari River				1	33.1457	75.548
354)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Jammu	Jammu	Akhnoor				0.5	32.7266	74.857
355)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Jammu	Jammu	Jammu				2	32.7266	74.857
356)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Jammu	Jammu	Jammu				0.3	32.7266	74.857
357)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Jammu	Jammu	Jammu (2)				3	32.7266	74.857
358)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Jammu	Jammu	Jammu (3)				3	32.7266	74.857
359)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Jammu	Jammu	Sidhra				0.2	32.7266	74.857
360)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Jammu	Jammu	Surinsar				0.1	32.7266	74.857
361)	CN/JK/UL/01 - Bioremediation and Bio filtration	Jammu & Kashmir	Jammu	Jammu	Tawi river				1	32.7266	74.857
362)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Jammu	Urban Forestry	Jammu Urban				2	32.7266	74.857
363)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Jammu	Urban Forestry	Jammu Urban				1	32.7266	74.857

364)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Jammu	Urban Forestry	Jammu Urban (2)				3	32.7266	74.857
365)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Jammu	Urban Forestry	Jammu Urban (3)				3	32.7266	74.857
366)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Jammu	Urban Forestry	Jammu Urban-1				0.4	32.7266	74.857
367)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Jammu	Urban Forestry	Jammu Urban-2				0.5	32.7266	74.857
368)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Jammu	Urban Forestry	Jammu Urban-3				0.2	32.7266	74.857
369)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Jammu	Urban Forestry	Jammu Urban-4				0.3	32.7266	74.857
370)	CN/JK/UL/01 - Bioremediation and Bio filtration	Jammu & Kashmir	Jammu	Urban Forestry	Tawi river 2				1	32.7266	74.857
371)	CN/JK/UL/01 - Bioremediation and Bio filtration	Jammu & Kashmir	Kishtwar	Kishtwar	Bhoot *Nallah*				1	33.3116	75.7662
372)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar				2	33.3116	75.7662
373)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar				0.5	33.3116	75.7662
374)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar (2)				3	33.3116	75.7662
375)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Kishtwar	Kishtwar	Kishtwar (3)				3	33.3116	75.7662
376)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Kishtwar	Kishtwar	Paddar				0.2	33.3116	75.7662
377)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Kishtwar	Marwah	BhandarKot				0.2	33.3116	75.7662
378)	CN/JK/UL/01 - Bioremediation and Bio filtration	Jammu & Kashmir	Kishtwar	Marwah	Kiar Nalla				1	33.3116	75.7662

379)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Kishtwar	Marwah	Marwah				2	33.3116	75.7662
380)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Kishtwar	Marwah	Marwah				0.2	33.3116	75.7662
381)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Kishtwar	Marwah	Marwah (Yurod)				0.4	33.3116	75.7662
382)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Kishtwar	Marwah	Marwah(2)				3	33.3116	75.7662
383)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Kishtwar	Marwah	Marwah(3)				3	33.3116	75.7662
384)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Rajouri	Nowshera	Nowshera				2	34.1289	74.8032
385)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Rajouri	Nowshera	Nowshera				0.1	34.1289	74.8032
386)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Rajouri	Nowshera	Nowshera				0.4	34.1289	74.8032
387)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Rajouri	Nowshera	Nowshera (2)				3	34.1289	74.8032
388)	CN/JK/UL/01 - Bioremediation and Bio filtration	Jammu & Kashmir	Rajouri	Nowshera	Nowshera Tawi				1	34.1289	74.8032
389)	CN/JK/UL/01 - Bioremediation and Bio filtration	Jammu & Kashmir	Rajouri	Rajouri	Tawi river 3				1	33.3716	74.3152
390)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Rajouri	Rajouri	Kalakote				0.1	33.3716	74.3152
391)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Rajouri	Rajouri	Rajouri				2	33.3716	74.3152
392)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Rajouri	Rajouri	Rajouri				0.2	33.3716	74.3152
393)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Rajouri	Rajouri	Rajouri				0.5	33.3716	74.3152

394)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Rajouri	Rajouri	Rajouri (2)				3	33.3716	74.3152
395)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Rajouri	Rajouri	Rajouri (3)				3	33.3716	74.3152
396)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Ramban	Batote	Batote				2	33.1216	75.3216
397)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Ramban	Batote	Batote				0.2	33.1216	75.3216
398)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Ramban	Batote	Batote (2)				3	33.1216	75.3216
399)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Ramban	Batote	Batote (3)				3	33.1216	75.3216
400)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Ramban	Batote	Chanderkote				0.1	33.1216	75.3216
401)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Ramban	Batote	Patnitop				0.1	33.1216	75.3216
402)	CN/JK/UL/01 - Bioremediation and Bio filtration	Jammu & Kashmir	Ramban	Batote	Raggi				1	33.1216	75.3216
403)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Ramban	Ramban	Banihal				0.5	33.2427	75.2392
404)	CN/JK/UL/01 - Bioremediation and Bio filtration	Jammu & Kashmir	Ramban	Ramban	Bichlari				1	33.2427	75.2392
405)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Ramban	Ramban	Dharmakund				0.3	33.2427	75.2392
406)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Ramban	Ramban	Ramban				2	33.2427	75.2392
407)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Ramban	Ramban	Ramban				0.4	33.2427	75.2392
408)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Ramban	Ramban	Ramban				0.2	33.2427	75.2392

409)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Ramban	Ramban	Ramban(2)				3	33.2427	75.2392
410)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Ramban	Ramban	Ramban(3)				3	33.2427	75.2392
411)	CN/JK/UL/01 - Bioremediation and Bio filtration	Jammu & Kashmir	Reasi	Mahore	Ans *Nallah*				1	33.3096	74.8595
412)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Reasi	Mahore	Arnas				0.1	33.3096	74.8595
413)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Reasi	Mahore	Arnas				0.1	33.3096	74.8595
414)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Reasi	Mahore	Dharmadi				0.2	33.3096	74.8595
415)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Reasi	Mahore	Katra				0.5	33.3096	74.8595
416)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Reasi	Mahore	Mahore				2	33.3096	74.8595
417)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Reasi	Mahore	Mahore				0.2	33.3096	74.8595
418)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Reasi	Mahore	Mahore (2)				3	33.3096	74.8595
419)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Reasi	Mahore	Reasi				0.3	33.3096	74.8595
420)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Reasi	Mahore	Reasi				0.5	33.3096	74.8595
421)	CN/JK/UL/01 - Bioremediation and Bio filtration	Jammu & Kashmir	Reasi	Reasi	Banganga				1	33.0804	74.8365
422)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Reasi	Reasi	Reasi				2	33.0804	74.8365
423)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Reasi	Reasi	Reasi (2)				3	33.0804	74.8365

424)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Reasi	Reasi	Reasi (3)				3	33.0804	74.8365
425)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Udhampur	Ramnagar	North Range				2		
426)		Jammu & Kashmir	Udhampur	Ramnagar	North Range				0.1		
427)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Udhampur	Ramnagar	North Range				0.1		
428)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Udhampur	Ramnagar	North Range				0.1		
429)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Udhampur	Ramnagar	North Range 2				3		
430)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Udhampur	Ramnagar	North Range 2				0.2		
431)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Udhampur	Ramnagar	North Range 2				0.2		
432)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Udhampur	Ramnagar	North Range 3				2		
433)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Udhampur	Ramnagar	North Range 3				0.4		
434)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Udhampur	Ramnagar	North Range 3				0.4		
435)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Udhampur	Ramnagar	North Range 3				0.4		
436)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Udhampur	Ramnagar	North Range 3				0.5		
437)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Udhampur	Ramnagar	South Range				2		
438)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Udhampur	Ramnagar	South Range				0.1		
439)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Udhampur	Ramnagar	South Range				0.1		

440)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Udhampur	Ramnagar	South Range 2				3		
441)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Udhampur	Ramnagar	South Range 2				0.2		
442)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Udhampur	Ramnagar	South Range 2				0.3		
443)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Udhampur	Ramnagar	South Range 3				2		
444)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Udhampur	Ramnagar	South Range 3				0.5		
445)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Udhampur	Ramnagar	South Range 3				0.5		
446)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Udhampur	Udhampur	Chenani				0.1	32.916	75.1416
447)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Udhampur	Udhampur	Mansar				0.2	32.916	75.1416
448)	CN/JK/UL/01 - Bioremediation and Bio filtration	Jammu & Kashmir	Udhampur	Udhampur	Tawi, Devak				1	32.916	75.1416
449)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Udhampur	Udhampur	Udhampur				2	32.916	75.1416
450)	CN/JK/UL/02 - Riverfront Development	Jammu & Kashmir	Udhampur	Udhampur	Udhampur				0.2	32.916	75.1416
451)	CN/JK/UL/04 - Eco-park Development	Jammu & Kashmir	Udhampur	Udhampur	Udhampur				0.5	32.916	75.1416
452)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Udhampur	Udhampur	Udhampur (2)				3	32.916	75.1416
453)	CN/JK/UL/03 - Institution Plantation	Jammu & Kashmir	Udhampur	Udhampur	Udhampur (3)				3	32.916	75.1416

iv)	Conservation Intervention										
S.No.	**Model**	**State/ UT**	**District**	**Division**	**Sitename**	**Range**	**Block**	**Beat**	**Area (m^3)**	**Latitude**	**Longitude**
454)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Amar Singh Pura	Bhalesh	Kilhotran	Thaloran	950		
455)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Amar Singh Pura (Jhaloran Top)	Bhalesh	Kilhotran	Thaloran	940	32.98338	75.90894
456)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Bagerni-1st	Kellar	Paryote	Paryote-I	890	33.13944	75.52917
457)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Bani Co. 55/Bh	Bhalesh	Neeli	Dhosa-III	950	33.00274	75.9498
458)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Banshoh(Beya)	Kellar	Malothi	Chilli	900	33.02614	75.59439
459)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Banshon	Kellar	Malolhi	Chilli	940	33.02622	75.59397
460)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Bhaderwah	Kellar	Malothi	Gajoth	920	33.04028	75.59947
461)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Bhaderwah	Kellar	Malothi	Gajoth	890	33.04028	75.59947
462)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Bhagratha	Kellar	Malothi	Malothi - II	940	33.06742	75.58056
463)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Bhaourwah	Kellar	Malothi	Gajoth	870	33.04078	75.60189
464)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Bhatai Lohar	Kellar	malothi	malothi-II	930	33.06547	75.57628
465)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Bhatai Upper	Kellar	Malothi	Malothi-II	890	33.06631	75.57222
466)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Bhazartha	Kellar	Malothi	Malothi-II	890	33.07083	75.57594
467)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Chakka	Neeru	Dandi	Co. 56/Neeru	940	32.98206	75.7045

468)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Champal	Bhalesh	Pingal	Champal Co. 8/Bh	930	33.06231	75.97933
469)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Chanti	Kellar	Malothi	Gajothi	910	33.03939	75.586
470)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Chanti(Gajoth)	Kellar	Malothi	Gajoth	940	33.0395	75.58703
471)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Chilli	Kellar	Malothi	Chilli	940	33.01153	75.60139
472)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Chilli	Kellar	Malothi	Chilli	970	33.01303	75.60356
473)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Chilly	Kellar	Malothi	Chilli	930	33.01317	75.60303
474)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Chilly	Kellar	Malothi	Chilli	910	33.01364	75.60364
475)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Chururi Chakka	Neeru	Dandi	Co. 56/Neeru	910	33.98039	75.70031
476)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Danda nagru	Kellar	Malothi	Dugli	880	33.04056	75.61233
477)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Dhrr Deri Mata(Waang)	Kellar	Malothi	Gajoth	930	33.04972	75.57503
478)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Diyassa (Chilly)	Kellar	Malothi	Chilli	870	33.00897	75.59853
479)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Diyassa(Chilli)	Kellar	Malothi	Chilli	920	33.01006	75.59969
480)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Drena	Kellar	Ghurakha	Ghurakha -II	880	33.06286	75.62914
481)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Forest Land (5)	Neeru	Puneja II	48/N	910		
482)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Forest Land (6)	Neeru	Dandi II	57/N	960		
483)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Forest Land (8)	Neeru	Puneja II	46/N	960		

484)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Forest Land (9)	Neeru	Puneja II	45/N	890		
485)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Gajoth	Kellar	Malothi	Gajoth	890	33.04094	75.60183
486)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Gajoth Nalah	Kellar	Malothi	Gajoth	940	33.03633	75.59103
487)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Gajoth(Chanti)	kellar	malothi	gajothi	920	33.03931	75.58831
488)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Guwa Naal	Kellar	Malothi	Gajoth	950	33.04556	75.57936
489)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Gyun Nalah	Kellar	Malothi	Dugli	900	33.08917	75.72333
490)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Jara(Gajoth)	Kellar	Malothi	Gajoth	930	33.03958	33.03958
491)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Jara(Gajoth)	Kellar	Malothi	Gajoth	930	33.03589	75.585
492)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Jaxa	Kellar	Malothi	Gajoth	930	33.03144	75.58369
493)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Kainki(Beya)	Kellar	Malothi	Chilli	890	33.02994	75.59336
494)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Kumhari	Kellar	Malothi	Malothi-II	960	33.0725	75.5875
495)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Kumhari	Kellar	Malothi	Malothi-II	890	33.00067	75.58334
496)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Malothi	Kellar	Malothi	Malothi-II	900	33.06539	75.62781
497)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Naik pura Co. 2/bh	Bhalesh	Pingal	Dichhal Co. 2/Bh	920	33.07969	75.93633
498)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Naiylah(Bhatoli)	Kellar	malothi	Dugli	880	33.05172	75.61944
499)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Doda	Bhaderwah	Pat Kut	Kellar	`Malothi	Chilli	1100	33.02253	75.58847

500)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Samaie Co. 95/Bh	Bhalesh	Kiliotra	Jhaloram	910	32.97539	75.90628
501)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Doda	Bhaderwah	Site 1 (Bhaderwah)				1160		
502)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Doda	Bhaderwah	Site 2 (Bhaderwah)				1170		
503)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Doda	Bhaderwah	Site 3 (Bhaderwah)				1120		
504)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Slhari water harvesting ta nk+DRSM	Neeru	Duggi 2nd	Co. no 19 to 22/N Co. No. 20/ neeru	890		
505)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Soti Co. 85/Bh	Bhalesh	Kilhotran	Soti	930	32.97258	75.92475
506)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Talkhan	Khellar	Malothi	Chilli	890	33.04292	75.58939
507)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Talkhan (Beya)	Kellar	Malothi	Chilli	860	33.02728	75.58975
508)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Talkhan(Bey a)	Kellar	Malothi	Chilli	850	33.02539	75.591
509)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Tangoran	Kellar	Ghuraka	Sharora-I	890	33.07894	75.67064
510)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Tangoran top.	Kellar	Ghuraka	Sharora-I	870	33.07894	75.67064
511)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Tansar *Nallah*	Kellar	Paryote	Paryote-II	840	33.09056	75.53139
512)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Tansar *Nallah* -II	Kellar	Paryote	Paryote-II	840	33.09056	75.53306
513)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Tarnoun Trabi+DRSM works in Co. No 121/N, water	Neeru	Duggi 2nd	Tranoun Trabi co. no 5c.n + DRSM 5 and 6/N	840	0	0

					harvesting ta nk						
514)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Tatora	Kellar	Malothi	Gajoth	830	33.04667	75.58334
515)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Bhaderwah	Upper Shaiya	Kellar	Paryote	Paryote-I	870	33.10806	75.54389
516)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Doda	84/5J	Siraj	Gadi	Gadi-II	870	33.34667	75.84981
517)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Doda	86/SJ - Bhalwal (Bhagwah Food)	Siraj	Koti	Bhagwah	960	0	0
518)	CN/JK/CI/01,02,04	Jammu & Kashmir	Doda	Doda	Bagori Co 7/Si	Siraj	Dhandha l	Mundhar	970	33.1636	75.41174
519)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Doda	Doda	Site 1 (Doda)				1140		
520)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Doda	Doda	Site 2 (Doda)				1080		
521)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Doda	Doda	Site 3 (Doda)				1130		
522)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Doda	Doda	Site 4 (Doda)				1130		
523)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Jammu	Bajatta Nalla 59 Compartment	Bahu	Bajalta	Bajalta compart ment 60	1750	32.77742	74.97597
524)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Jammu	Bajatta Nalla 59 Compartment 2	Bahu	Bajalta	Bajalta compart ment 60	1750	32.77742	74.97597
525)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Jammu	Jammu Tawi river 62 compartment	Bahu	Bajalta	Bajalta compart ment 60	1780	32.78289	74.93225

526)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Jammu	Jammu Tawi river 62 compartment 2	Bahu	Bajalta	Bajalta compartment 60	1780	32.78289	74.93225
527)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Jammu	Jammu Tawi river Bank Boaslta Block	Bahu	Bajalta	Bajalta compartment 60	1810	32.77928	74.97144
528)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Jammu	Jammu Tawi river Bank Boaslta Block 2	Bahu	Bajalta	Bajalta compartment 60	1810	32.77928	74.97144
529)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Jammu	Jammu Tawi river Comptt. 62 Sardan Nalla	Bahu	Bajalta	Bajalta compartment 60	1360	32.77542	74.97233
530)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Jammu	Jammu Tawi river Comptt. 62 Sardan Nalla (2)	Bahu	Bajalta	Bajalta compartment 60	1360	32.77542	74.97233
531)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Jammu	Sardan Nalla Private Near 60 Compartment	Bahu	Bajalta	Bajalta compartment 60	1370	32.7745	74.97306
532)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Jammu	Simbal laid (Private land of Pushu)	Jammu	Nagrota II	Jagti	1360	32.83866	74.88061
533)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Jammu	Simbal laid (Private land of Pushu) 2	Jammu	Nagrota II	Jagti	1360	32.83866	74.88061
534)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Gujjar Nagar Bridge	MFP Godown	City Block		1300	32.72744	74.87497

535)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Gujjar Nagar Bridge (2)	MFP Godown	City Block		1320	32.71677	74.86675
536)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Gujjar Nagar Bridge (5)	MFP Godown	City Block		1320	32.71677	74.86675
537)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Gujjar Nagar Bridge 3	MFP Godown	City Block		1300	32.72744	74.87497
538)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Gujjar Nagar Bridge 4	MFP Godown	City Block		1300	32.72744	74.87497
539)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Mahamaya City forest	Sujwan	Mahamaya	Bandi	1350	32.72803	74.88033
540)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Mahamaya City Forest 2	Sunjwan	Mahamaya	Bandi	1420	32.74192	74.88033
541)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Mahamaya City forest 3	Sujwan	Mahamaya	Bandi	1350	32.72803	74.88033
542)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Mahamaya City Forest 4	Sunjwan	Mahamaya	Bandi	1420	32.74192	74.88033
543)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Mahamaya City forest 5	Sujwan	Mahamaya	Bandi	1350	32.72803	74.88033
544)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Ware House Jammu 2	MFP Godown	City Block		830	32.72417	74.87333
545)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Ware House Jammu 3	MFP Godown	City Block		830	32.72417	74.87333
546)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Ware House Jammu 4	MFP Godown	City Block		830	32.72417	74.87333
547)	CN/JK/CI/01,02,04	Jammu & Kashmir	Jammu	Urban Forestry	Ware House-Jammu	MFP Godown	City Block		910	32.71667	74.90111
548)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Kishtwar	Kishtwar	Site 1 (Kishtwar)				1130		
549)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Kishtwar	Kishtwar	Site 2 (Kishtwar)				1120		
550)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Kishtwar	Kishtwar	Site 3 (Kishtwar)				1130		

551)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Kishtwar	Kishtwar	Site 4 (Kishtwar)				1130		
552)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Kishtwar	Kishtwar	Site 5 (Kishtwar)				1120		
553)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Kishtwar	Kishtwar	Site 6 (Kishtwar)				1130		
554)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Kishtwar	Marwah	Site 1 (Marwa)				1140		
555)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Kishtwar	Marwah	Site 2 (Marwa)				1130		
556)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Kishtwar	Marwah	Site 3 (Marwa)				1120		
557)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Kishtwar	Marwah	Site 4 (Marwah)				1140		
558)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Kishtwar	Marwah	Site 5 (Marwah)				1130		
559)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bhawani	Nowshera	Jhanger	Bhawani	880	33.209244	74.058944
560)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bhawani 'B' Sehar	Nowshera	Jhanger	Bhawani	930	33.217414	74.06261
561)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	(i) Badloon (ii) Bhawani (iii) Kalsian	Nowshera	Jhanger	Jhangar/ Bhawani/ Bhawani	950	33.238023	74.078338
562)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	(i) Lorakha (ii) Kalsian (iii) Bhanwani (iv) Sair	Nowshera	Jhanger	Chowki	950	33.228272	74.11432
563)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	102/k, Narote (Panhar)	Lamberi	Rajal Block	Panhar	930	33.147	74.38807
564)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	102/k, Panhar (Narote)	Lamberi	Rajal Block	Panhar	930	33.1468	74.38855

565)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	103/K Panhar	Lamberi	Rajal	Panhar	1050	33.16405	74.37668
566)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	103/K Panhar (1)	Lamberi	Rajal	Panhar	950	33.16388	74.3759
567)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	142/N Sangpur (Sankar)	Lamberi	Rajal	Sankar	940	33.233846	74.288728
568)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	142/N Sangpur (Sankar)	Lamberi	Rajal	Sankar	960	33.234117	74.28838
569)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kangota (Solki Nala) Co. 25	Lamberi	Rajal Block	Sankar	920	33.12303	74.23277
570)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	149/N, Katrote (papinalla)	Lamberi	Rajal	Papinalla	910	33.20277	74.30697
571)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	149/N, Narian (papinalla)	Lamberi	Rajal	Papinalla	890	33.20547	74.29875
572)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	151/N Kutera Jagir	Lamberi	Rajal Block	Katra Jagir	840	33.19478	74.28363
573)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Allya Comptt: 84/D	Lamberi	Treru	Hari Chuma 'A'	900	33.19478	74.53392
574)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Allya Comptt: 84/D	Lamberi	Kalal	Kangota	960	33.19478	74.53375
575)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Allya Comptt: 84/D (1)	Lamberi	Treru	Hari Chuma 'A'	900	33.18533	74.54674
576)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Allya Comptt: 84/D	Lamberi	Treru	Hari Chuma 'A'	900		

577)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Amlimora (Comptt: 71/D)	Sunder Bani	Devak	Bagla	1470	33.12338	74.52112
578)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Amlimora (Comptt: 71/D) (1)	Sunder Bani	Devak	Bagla	900	33.12985	74.51902
579)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Androth	Nowshera	Androoth	Androoth	900	33.249026	74.168999
580)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bandanoo Co 33/D	Sunder Bani	Dharamsal	Dharamsal	910	33.13828	74.4485
581)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bai Nalla (Keri - Terayth) comptt. No. 81/D	Sunder Bani	Devak	Hathal	890	33.1582	74.53232
582)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bai Nalla (Keri - Terayth) comptt. No. 81/D	Sunder Bani	Devak	Hathal	910	33.1596	74.53232
583)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bai Nalla (Keri - Terayth) comptt. No. 82/D (1)	Sunder Bani	Devak	Hathal	940	33.39583	74.74667
584)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bajabain	Sunder Bani	Kangari	Dhok-Bayed	880	33.0488	74.41593
585)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bakhar	Sunder Bani	Sunder Bani	Thandapani (44/D)	910	33.08838	74.43258
586)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bakhar (2)	Sunder Bani	Sunder Bani	Thandapani (44/D)	850	33.09023	74.4199
587)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bakhar (3)	Sunder Bani	Sunder Bani	Thandapani (44/D)	930	33.07187	74.4348

588)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bakhar (4)	Sunder Bani	Sunder Bani	Thandapani (44/D)	960	33.09462	74.42737
589)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bakhar 43/D	Sunder Bani	Sunder Bani	Thandapani (43/D)	920	33.09332	74.42328
590)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bandhari (Comptt: 110/D)	Sunder Bani	Devak	Makol	880	33.27722	74.8525
591)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bandhari (Comptt: 110/D) (1)	Sunder Bani	Devak	Makol	900	33.21167	74.65167
592)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bandheri (Comptt: 110/D)	Sunder Bani	Devak	Makol	920	33.19972	74.77556
593)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bhajwal	Sunder Bani	Sunder Bani	Sunder Bani	900	33.02818	74.48922
594)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Bhawan 'B' Sehar	Nowshera	Jahnger	Bhawani	870	33.21373	74.065313
595)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Brevi (Thill *Nallah*)	Sunder Bani	Dharamsal	Dharamsal comptt. 29/D	850	33.14798	74.44218
596)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Brevi Comptt. 23/D (Soki Tawi)	Sunder Bani	Dharamsal	Brevi	920	33.16642	74.45088
597)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Brevi Nallah Co 27/D (Solki Nallah)	Sunder Bani	Dharamsal	Brevi	850	33.14575	74.46287
598)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Brevi *Nallah*	Sunder Bani	Dharamsal	Dharamsal comptt. 28/D	850	33.14495	74.4596

599)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Brevi *Nallah* (2)	Sunder Bani	Dharamsal	Dharamsal comptt. 28/D	900	33.14263	74.46032
600)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Brevi *Nallah* (4)	Sunder Bani	Dharamsal	Dharamsal comptt. 28/D	920	33.14255	74.4602
601)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Chabria Khabber Comptt. 70/D	Sunder Bani	Devak	Bagla	880	33.12535	74.51805
602)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Channi (1)	Sunder Bani	Sunder Bani	Channi (41/D)	880	33.11063	74.41132
603)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Channi (2)	Sunder Bani	Sunder Bani	Channi (40/D)	890	33.10848	74.41328
604)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Channi (3)	Sunder Bani	Sunder Bani	Channi (41/D)	900	33.11283	74.40557
605)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Channi Comptt: 40/D	Sunder Bani	Sunder Bani	Channi (40/D)	880	33.10715	74.42473
606)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Channi Comptt: 40/D (1)	Sunder Bani	Sunder Bani	Channi (40/D)	940	33.18103	74.40397
607)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Channi Comptt: 41/D	Sunder Bani	Sunder Bani	Channi (41/D)	880	33.1068	74.41658
608)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Chansergale (Prat) Comptt: 52/D	Sunder Bani	Dharamsal	Salahair 52/D	900	33.12438	74.47588
609)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Charathani	Sunder Bani	Sunder Bani	Sunder Bani	880	33.05115	74.46337
610)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Chavria	Sunder Bani	Devak	Bagla (70/D comptt:)	910	33.28722	74.53528

611)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Chorgalla (Brevi) Comptt. 29/D (2)	Sunder Bani	Dharamsal	Dharamsal	870	33.14218	74.441
612)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Chringle (Kote kabu) Comptt. 61/D	Sunder Bani	Dharamsal	Kallar	880	33.15902	74.48205
613)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Chringle (Kote kabu) Comptt. 62/D	Sunder Bani	Dharamsal	Kallar	910	33.18142	74.48668
614)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Comptt - 121/N Garan	Lamberi	Rajal Block	Craran	900	33.1754	74.33755
615)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Comptt - 18/N, Narota	Lamberi	Rajal Block	Craran	1160	33.1344	74.47992
616)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Rajouri	Nowshera	Comptt 18/N, Danghar	Lamberi	Rajal	Caran	910	33.12103	74.39137
617)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Comptt. - 100N, Bagnote	Lamberi	Rajal	Garan	920	33.15048	74.2954
618)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Comptt. - 12/N, Shanshan Ghat (Garan)	Lamberi	Rajal	Garan	940	33.17372	74.43942
619)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Comptt. - 145/N, Khatrota (Papinalla)	Lamberi	Rajal Block	Papi *Nallah*	960	33.20173	74.30688
620)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Comptt. No-11/N, Tanda Patrari	Lamberi	Rajal	Garan	870	33.18025	74.32918
621)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Comptt: 145/N Khatrota	Lamberi	Rajal	Papi *Nallah*	920	33.20547	74.29875

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622)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Dehalla - comptt No. 5/N	Lamberi	Rajal Block	Lamberi	930	33.14167	74.35518
623)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Devak (Comptt. No. 107)	Sunder Bani	Devak	Devak	920	33.15028	74.61833
624)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Devak (Comptt. No. 107) (1)	Sunder Bani	Devak	Devak	960	33.18139	74.66833
625)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Devak (Comptt. No. 107) (2)	Sunder Bani	Devak	Devak	920	33.15222	74.80639
626)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Dhok - Baniyarh	Sunder Bani	Kangri	Dhok-Bayed 133/D	940	33.02807	74.40243
627)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Dhok - Baniyarh (Palval)	Sunder Bani	Kangri	Dhok-Bayed 131/D	920	33.03003	74.3977
628)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Dhok - Banyar (1)	Sunder Bani	Kangri	Dhok-Bayed 146/D	900	33.02243	74.40305
629)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Dhok - Bauyaed	Sunder Bani	Kangra	Dhok-Bayed 133/D	870	33.0339	74.38582
630)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Dhokori Comptt. 28/D (Brevi)	Sunder Bani	Dharamsal	Dharamsal Co, 28/D	910	33.13615	74.45355
631)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Dhokori Comptt. 28/D (Brevi)	Sunder Bani	Sunder Bani	Sunder Bani	930	33.13687	74.46108
632)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Dhokori Nalla (Brevi)	Sunder Bani	Dharamsal	Dharamsal Co,	920		

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633)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nadani	Sunder Bani	Sunder Bani	Sunder Bani	900	33.02898	74.48992
634)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Dhroori (prat) comptt: 52/D	Sunder Bani	Dharamsal	Salahair 52/D	910	33.12685	74.47118
635)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Brevi *Nallah*	Sunder Bani	Dharamsal	Dharamsal	920	33.14575	74.45745
636)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Brevi *Nallah*	Sunder Bani	Dharamsal	Dharamsal comptt. 28/D	950	33.1459	74.4571
637)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Dova (Bhajwal)	Sunder Bani	Sunder Bani	Sunder Bani	960	33.03922	74.48333
638)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Firing Line (Bhajwal)	Sunder Bani	Sunder Bani	Sunder Bani	910	33.03752	74.47702
639)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Gabad (Keri-Teryath) (1)	Sunder Bani	Devak	Hathal	960	33.32917	74.62306
640)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Gagrote (Near co. 43/)	Lamberi	Kalal	Gagrote	920	33.09547	74.25657
641)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Ganya	Nowshera	Jhanger	Manpur	950	33.1604	74.160361
642)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Ganya/ Ganya/ Maupur	Nowshera	Jhanger	Maupur	930	33.160195	74.156872
643)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Genera (Prat) Comptt. 51/D	Sunder Bani	Dharamsal	Salaheri (51/D)	900	33.1181	74.38298
644)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Genera (Prat) Comptt. 52/D	Sunder Bani	Dharamsal	Salheri 52/D	900	33.12935	74.45862
645)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Ghai (Hathal) (Comptt. 77/D)	Sunder Bani	Devak	Hathal	940	33.11747	74.5588

646)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Ghai Hathal (Comptt. 77/D)	Sunder Bani	Devak	Hathal	890	33.11795	74.55635
647)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Ghai Hathal (Comptt. 77/D) (1)	Sunder Bani	Devak	Hathal	850	33.12287	74.22482
648)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Ghai. Co. 25/N (Private Land)	Lamberi	Kalal	Kangote	900		
649)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Guem (Hathal) (Comptt. 77/D)	Sunder Bani	Dwak	Hathal	930	33.11842	74.53015
650)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Guem (Hathal) (Comptt. 77/D) (1)	Sunder Bani	Dwak	Hathal	890	33.11765	74.5489
651)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Guem (Hathal) (Comptt. 77/D) (1)	Sunder Bani	Dwak	Hathal	930	33.11952	74.54897
652)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Gura Charlla	Sunder Bani	Sunder Bani	Langer	880	33.0639	74.5596
653)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Gura Charlla (1)	Sunder Bani	Sunder Bani	Langer	880	33.06468	74.5596
654)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Gura Charlla Co. 118/9/D	Sunder Bani	Sunder Bani	Langer	930	33.06478	74.55958
655)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Hardu-Malara	Sunder Bani	Sunder Bani	Rah-Salyote	1010	33.0397	74.56208
656)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Hardu-Malara (1)	Sunder Bani	Sunder Bani	Rah-Salyote	930	33.03972	74.56208
657)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Hardu-Malara (2)	Sunder Bani	Sunder Bani	Rah-Salyote	1000	33.03687	74.55578

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658)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Hardu-Malara (3)	Sunder Bani	Sunder Bani	Rah-Salyote	930	33.0494	74.55347
659)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Hardu-Malara (Ballayian Mohala)	Sunder Bani	Sunder Bani	Rah-Salyote	950	33.0397	74.56208
660)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Hardu-Malara (Charki gain)	Sunder Bani	Sunder Bani	Rah-Salyote	920	33.03847	74.55958
661)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Hathal-B Campa clousure (73/D)	Sunder Bani	Devak	Bagla	890	33.0977	74.52188
662)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Jhariety Mohre	Nowshera	Chaengus	Chattaeyi	910	33.22621	74.269355
663)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kallar Comptt. 58/D (Ranthal Nalla)	Sunder Bani	Dharamsal	Kallar	880		
664)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kallar Comptt. 58/D	Sunder Bani	Dharamsal	Kallar	910	33.13363	74.48488
665)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kallar) Comptt. 56/D (Solki Tawi)	Sunder Bani	Dharamsal	Kallar	940	33.13275	74.47352
666)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kangote, 24/N	Lamberi	Ralel	Kangota	950	33.12093	74.24957
667)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kanra	Sunder Bani	Kangra	Dhok-Bayed 133/D	880	33.04622	74.35078
668)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Katera 151/N	Lamberi	Rajal Block	Katera	880	33.1948	74.2833

669)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Khawan Comptt. - 9/N	Lamberi	Rajal Block	Garan	900	33.17115	74.31178
670)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Konara - (Meenka)	Sunder Bani	Kangri	Meenka 134/D	930	33.04148	74.35268
671)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Konera	Sunder Bani	Kangri	Meenka 134/D	940	33.04148	74.35268
672)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Konera (Meenka)	Sunder Bani	Kangri	Meenka 134/D	940	33.04653	74.35652
673)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Konera (Meenka) (1)	Sunder Bani	Kangri	Meenka 134/D	940	33.04892	74.36343
674)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Konera (Meenka) (2)	Sunder Bani	Kangri	Meenka 134/D	890	33.04712	74.35688
675)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Konera (Meenka) (3)	Sunder Bani	Kangri	Meenka 134/D	880	33.04343	74.36795
676)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kote kabu Comptt. 58/D	Sunder Bani	Dharamsal	Kallar	910	33.1412	74.47955
677)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kote kabu (Mlah) Comptt. 22/D (Sollu Tawi)	Sunder Bani	Dharamsal	Brevi Comptt: 22/D	880	33.17632	74.4742
678)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kote kabu (Mlah) Comptt. 22/D (Sollu Tawi)	Sunder Bani	Dharamsal	Kellar	890	33.17588	74.47908
679)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kote Kabu *Nallah* comptt: 23/D (Sloki *Nallah*)	Sunder Bani	Dharamsal	Brevi	960	33.16645	74.4515
680)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kuldabi	Sunder Bani	Kangri	Bhajwal 128/D	970	33.02787	74.42173
681)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kuldabi (1)	Sunder Bani	Kangri	Bhajwal 128/D	950	33.02335	74.41957

682)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kuldabi (2)	Sunder Bani	Kangri	Bhajwal 128/D	960	33.02293	74.4246
683)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Kuldabi (3)	Sunder Bani	Kangri	Bhajwal 128/D	890	33.02432	74.42307
684)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Lamberi Pati - comptt No - 5/N	Lamberi	Rajal	Lamberi	910	33.1404	74.35252
685)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Langer	Sunder Bani	Sunder Bani	Langer	960	33.08785	74.53133
686)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Langer (Tahgala)	Sunder Bani	Sunder Bani	Langer Comptt: 115/B	920	33.07762	74.51898
687)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Lower Hathal	Sunder Bani	Dharamsal	Salehari	890	33.08313	74.51905
688)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Lower Hathal Comptt: 54/D	Sunder Bani	Dharamsal	Salehari 54/D	890	33.1103	74.49207
689)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Makol	Sunder Bani	Sunder Bani	Langer Comptt: 114/D	930	33.069	74.58335
690)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Makol (II)	Sunder Bani	Devak	Makal	910	33.08572	74.58572
691)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Makol (1)	Sunder Bani	Sunder Bani	Langer Comptt: 114/D	870	33.06948	74.58297
692)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Makol (3)	Sunder Bani	Sunder Bani	Langer Comptt: 114/D	950	33.07958	74.5774
693)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Rajouri	Nowshera	Makol (4)	Sunder Bani	Sunder Bani	Makol	1140	33.07955	74.58358
694)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Makol (comptt: 113/D) (1)	Sunder Bani	Devak	Makol	890	33.0842	74.58693

695)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Makol (comptt: 113/D) (2)	Sunder Bani	Devak	Makol	950	33.05273	74.5874
696)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Makol (comptt: 113/D) (3)	Sunder Bani	Devak	Makol	940	33.0924	74.5955
697)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Makol (comptt: 113/D) (4)	Sunder Bani	Devak	Makol	880	33.08498	74.5865
698)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Makol 60	Sunder Bani	Devak	Makol	920	33.0744	74.58858
699)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Makol comptt: 113/D	Sunder Bani	Devak	Makol	940	33.07638	74.59323
700)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Marchala	Sunder Bani	Dharamsal	Salahair 49/D	950	33.08732	74.48152
701)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Marchala	Sunder Bani	Dharamsal	Salheri	900	33.0873	74.48173
702)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Marchala (1)	Sunder Bani	Dharamsal	Salahair 49/D	950	33.08537	74.47835
703)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Marchala (3)	Sunder Bani	Dharamsal	Salahair 49/D	870	33.09375	74.46088
704)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Marchala (3)	Sunder Bani	Dharamsal	Salahair 49/D	950	33.08142	74.4767
705)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Marchala (4)	Sunder Bani	Dharamsal	Salahair 49/D	550	33.0839	74.3974
706)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Marchala (5)	Sunder Bani	Dharamsal	Salahair 49/D	910		
707)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Margala (Langer)	Sunder Bani	Sunder Bani	Langer Comptt: 114/D	910	33.07697	74.5456
708)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Margala (Langer) (1)	Sunder Bani	Sunder Bani	Langer Comptt:	950	33.08003	74.54392

								115/D			
709)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Margala (Langer) Comptt: 114/D	Sunder Bani	Sunder Bani	Langer Comptt: 114/D	940	33.07723	74.54565
710)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Mathani Comptt 13/D	Lamberi	Treru	Gunda	880	33.23855	74.55313
711)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Mathani Comptt: 13/D (1)	Lamberi	Tereni	Gunda	880	33.23473	74.5543
712)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Mawa	Sunder Bani	Sunder Bani	Langer	920	33.05458	74.52837
713)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Mawa (1)	Sunder Bani	Sunder Bani	Langer	1010	33.05672	74.5245
714)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Meenka (Chita Rat)	Sunder Bani	Kangri	Meenka 135/D	940	33.05477	74.33258
715)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Morha Patiyan	Sunder Bani	Devak	Bagla	910	33.12893	74.50717
716)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Morha-Patiyan	Sunder Bani	Devak	Bagla	880	33.12817	74.50795
717)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Morha-Patiyan (2)	Sunder Bani	Devak	Bagla	930	33.12742	74.50713
718)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nadani	Sunder Bani	Sunder Bani	Sunder Bani	940	33.02372	74.49293
719)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nadani Co. 124/D	Sunder Bani	Sunder Bani	Sunder Bani	880	33.02097	74.49332
720)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nadani Co. 124/D (1)	Sunder Bani	Sunder Bani	Sunder Bani	920	33.03087	74.49012
721)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nadani Bhajwal Co. 123/D	Sunder Bani	Sunder Bani	Sunder Bani	900	33.02457	74.49868
722)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nadani Bhajwal Co.	Sunder Bani	Sunder Bani	Sunder Bani	890	33.02615	74.4872

					124/D						
723)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nadani Co. 124/D	Sunder Bani	Sunder Bani	Sunder Bani	950	33.02407	74.49213
724)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nandani	Sunder Bani	Sunder Bani	Sunder Bani	900	33.0246	74.4973
725)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nandani (1)	Sunder Bani	Sunder Bani	Sunder Bani	930	33.02528	74.48872
726)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nandani (3)	Sunder Bani	Sunder Bani	Sunder Bani	900	33.0269	74.4939
727)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nandani (4)	Sunder Bani	Sunder Bani	Sunder Bani	890	33.02545	74.48757
728)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nandani (5)	Sunder Bani	Sunder Bani	Sunder Bani	940	33.05112	74.49012
729)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nandani (6)	Sunder Bani	Sunder Bani	Sunder Bani	940	33.05112	74.49012
730)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nandani Co. 124/D	Sunder Bani	Sunder Bani	Sunder Bani	910	33.02497	74.48813
731)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nella dub-Bhajwal	Sunder Bani	Kangri	Bhajwal 127/D	930	33.02982	74.45152
732)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nelladub-Bhajwal	Sunder Bani	Kangri	Bhajwal 127/D	930	33.02447	74.4509
733)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nohotti (Comptt: 75/D)	Sunder Bani	Devak	Hathal	920	33.085	74.5637
734)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nohotti (near campa closure) Compttt. 75/D	Sunder Bani	Devak	Hathal	930	33.08782	74.55938
735)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nohotti (near campa closure) Compttt.	Sunder Bani	Devak	Hathal	890	33.09055	74.55672

					75/D (1)						
736)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nohotti (near campa closure) Compttt. 75/D (2)	Sunder Bani	Devak	Hathal	970	33.08782	74.55938
737)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Nohotti (Near encroachment closure) Comptt: 75/D (3)	Sunder Bani	Devak	Hathal	920		
738)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Noorkot	Nowshera	Chingus	Chattaryri	890	33.264561	74.263853
739)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Pali	Sunder Bani	Devak	Kangri 147/D	930	33.0186	74.4159
740)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Panais Compt No.28/N	Lamberi	Kalal	Manglalo devi	960	33.08108	74.34442
741)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Panghlar Comptt 88/D	Lamberi	Treru	Hari Chuma 'B'	890	33.233742	74.570383
742)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Panglar Comptt No 88/D	Lamberi	Treru	Harichuma 'B'	930	33.231341	74.596633
743)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Pathi (Chani) comptt. 38/D	Sunder Bani	Dharamsal	Dharamsal	870	33.11995	74.44342
744)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Pathi (Chani) comptt. 39/D	Sunder Bani	Dharamsal	Dharamsal	920	33.12422	74.45675
745)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Patrara	Sunder Bani	Sunder Bani	Langer	900	33.06295	74.53058
746)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Patrara (1)	Sunder Bani	Sunder Bani	Langer 117/D	900	33.06248	74.53078
747)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Patrara (2)	Sunder Bani	Sunder Bani	Langer	940	33.05675	74.53135

748)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Peli	Sunder Bani	Devak	Kangri 147/D	970	33.01922	74.4338
749)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Pir Khana	Sunder Bani	Devak	Bagla	920	33.10105	74.51703
750)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Pir Khana (2)	Sunder Bani	Devak	Bagla	900	33.10242	74.52193
751)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Pir Khana Comptt: 73/D	Sunder Bani	Devak	Bagla	980	33.09108	74.52468
752)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Plassi Hill - comptt. 6/N	Lamberi	Rajal Block	Lamberi	960	33.15003	74.35952
753)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Playkar (Dhar)	Sunder Bani	Devak	Kangri 147/D	900	33.01927	74.4166
754)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Pothagala (Kote Kabu) Comptt: 59/D	Sunder Bani	Dharamsal	Kallar	900	33.14947	74.47292
755)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Pothagale Kasi Comptt. 27/D (Solki)	Sunder Bani	Dharamsal	Brevi	920	33.1459	74.46913
756)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Prat Comptt. 49/D (1)	Sunder Bani	Dharamsal	Saleri	930	33.09048	74.47992
757)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Prat Comptt: 49/D Private Land	Sunder Bani	Dharamsal	Salaheria 49/D	940	33.10815	74.46392
758)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Prat Moiden	Sunder Bani	Dharamsal	Saleri 49/D	900	33.09055	74.39705
759)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Proot	Sunder Bani	Dharamsal	Salahair 49/D	890	33.09873	74.46635
760)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rah	Sunder Bani	Sunder Bani	Rah-Salyote Comptt: 120/D	920	33.04392	74.53298
761)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rah (1)	Sunder Bani	Sunder Bani	Rah-Salyote	920	33.04395	74.53347

762)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rah (2)	Sunder Bani	Sunder Bani	Rah-Salyote	890	33.04457	74.53093
763)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rah (3)	Sunder Bani	Sunder Bani	Rah-Salyote	970	33.04257	74.54852
764)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rah (4)	Sunder Bani	Sunder Bani	Rah-Salyote	910	33.04743	74.5433
765)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rah (5)	Sunder Bani	Sunder Bani	Rah-Salyote Comptt: 120/D	890	33.03975	74.54235
766)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rah Comptt: 120/D	Sunder Bani	Sunder Bani	Rah-Salyote	830	33.04257	74.54852
767)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rah. Salyote	Sunder Bani	Sunder Bani	Sunder Bani	900	33.05208	74.51042
768)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rah. Salyote (1)	Sunder Bani	Sunder Bani	Sunder Bani	950	33.04853	74.52608
769)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rah. Salyote (2)	Sunder Bani	Sunder Bani	Sunder Bani	960	33.04973	74.52672
770)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rugha (Prat) comptt: 49/D	Sunder Bani	Dharamsal	Salaheri 49/D	940	33.09047	74.5214
771)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rajgarh (Hathal) Comptt. 74/D	Sunder Bani	Devak	Hathal	840	33.1125	74.54267
772)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rajgarh (Sayda)	Sunder Bani	Devak	Hathal	920	33.10408	74.54097
773)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rajgarh (Sayeda) (Comptt. No. 74/D)	Sunder Bani	Devak	Hathal	1000	33.11148	74.54227
774)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rajgarh Sayeda Hathal (Comptt:	Sunder Bani	Devak	Hathal	900	33.10452	74.53353

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775)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Ranthal Comptt: 59/D (Salori *Nallah*)	Sunder Bani	Dharamsal	Kallar	930	33.14285	74.48123
776)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Rugha (Prat)	Sunder Bani	Dharamsal	Salahair 49/D	900	33.10568	74.47832
777)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salaheri (2)	Sunder Bani	Dharamsal	Salehari 53/D	930	33.0979	74.50927
778)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Saleheri Comptt: 49/D (1)	Sunder Bani	Dharamsal	Salheri comptt. 49/D	970	33.09788	74.50498
779)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Saleri (Lower Hathcl) Co.l 49/D	Sunder Bani	Dharamsal	Salahair 49/D	930	33.10762	74.50055
780)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salheri	Sunder Bani	Dharamsal	Salehari 53/D	940	33.09802	74.50888
781)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salheri (10)	Sunder Bani	Devak	Bagla	880	33.10313	74.51722
782)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salheri (11)	Sunder Bani	Devak	Bagla	950	33.10273	74.51785
783)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salheri (12)	Sunder Bani	Devak	Bagla	960	33.10367	74.52103
784)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salheri (12)	Sunder Bani	Devak	Bagla	950	33.10842	74.51458
785)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salheri (5)	Sunder Bani	Dharamsal	Salehari 53/D	950	33.09652	74.50518
786)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salheri (6)	Sunder Bani	Devak	Bagla	910	33.10358	74.52135
787)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salheri (7)	Sunder Bani	Devak	Bagla	890	33.1014	74.51512
788)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salheri (8)	Sunder Bani	Devak	Bagla	940	33.1008	74.50445

789)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salheri (Lower Hathal)	Sunder Bani	Dharamsal	Salehari 54/D	900	33.09753	74.50508
790)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salheri Comptt. 53/D (2)	Sunder Bani	Dharamsal	Salehari 54/D	920	33.08885	74.49798
791)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salheri Comptt. 73/D	Sunder Bani	Devak	Bagla	970	33.10168	74.51365
792)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Salheri Comptt. 73/D (2)	Sunder Bani	Devak	Bagla	920	33.10048	74.51662
793)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Sanchal Galli Co. 147/k	Kalakote	Kalakote	Sadda 'B'	960		
794)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Sangar - 97/D	Lamberi	Treru	Rausoo - comptt. 97/D	920	33.16818	74.64752
795)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Sangar - 97/D (2)	Lamberi	Treru	Rausoo - comptt. 97/D	950	33.16882	74.64667
796)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Rajouri	Nowshera	Sangar Bambliya Comptt 98/D	Lamberi	Treru	Lanso comptt 98/D	1130	33.16725	74.64328
797)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Sangar Comptt: 97/D	Lamberi	Treru	Rausoo - comptt. 97/D	950	33.1591	74.6307
798)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Sangpur Comptt No. 142/N	Lamberi	Rajal Block	Samkar	910	33.235059	74.289783
799)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Sarohti (Khabber) (Comptt. No. 78/D)	Sunder Bani	Devak	Hathal	910	33.12833	74.54263

800)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Sarohti (Khabber) (Comptt. No. 78/D) (2)	Sunder Bani	Devak	Hathal	850	33.13052	74.54253
801)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Sarohtti (Khabber) (Comptt. No. 78/D)	Sunder Bani	Devak	Hathal	480	33.11765	74.55428
802)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Saya (Compartment 111/D) (1)	Sunder Bani	Devak	Makol	860	33.10452	74.6036
803)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Saya (Compartment 113/D)	Sunder Bani	Devak	Makol	860	33.09527	74.62288
804)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Saya (Comptt: 113/D) (1)	Sunder Bani	Devak	Makol	910	33.09227	74.59638
805)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Serya (Comptt: 112/D)	Sunder Bani	Devak	Makol	880	33.09488	74.6259
806)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Seyia (Comptt. - 107/D)	Sunder Bani	Devak	Devak	910	33.09838	74.59133
807)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Simble ghai (Brevi) Comptt. 30/D (2)	Sunder Bani	Dharamsal	Dharamsal	860	33.1435	74.43055
808)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Siot	Sunder Bani	Sunder Bani	Thandapani - 43/D	880	33.09952	74.38478
809)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Siot (43/D) (1)	Sunder Bani	Sunder Bani	Thandapani - 43/D	910	33.10912	74.39335
810)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Siot 43/D	Sunder Bani	Sunder Bani	Thandapani - 43/D	910	33.10023	74.38312

811)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Sulla (Bandhari) (1)	Sunder Bani	Devak	Makol	870	33.11913	74.60785
812)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Sulla (Bandhari) (Comptt:/09/ D)	Sunder Bani	Devak	Makol	890	33.11917	74.60842
813)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Sulla (Comptt: 112/D)	Sunder Bani	Devak	Makol	920		
814)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Sulla Bandhari	Sunder Bani	Devak	Makol	990	33.11777	74.60855
815)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Tanda-Thichka	Sunder Bani	Kangri	Meenka 134/D	850		
816)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Tanha Hathal (Compartmen t No. 76/ D)	Sunder Bani	Devak	Hathal	850	33.10548	74.5567
817)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Tanua (Hathal) (Comptt. 76/D) (1)	Sunder Bani	Dwak	Hathal	830	33.10688	74.55182
818)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Tanua (Hathal) (Comptt. 77/D)	Sunder Bani	Dwak	Hathal	880	33.10568	74.55877
819)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Tanua Hathal (Comptt: No. 76/D)	Sunder Bani	Dwak	Hathal	830	33.10688	74.55182
820)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Tanua Hathal (Comptt: No. 76/D) (1)	Sunder Bani	Devak	Hathal	830	33.10287	74.5565
821)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Thanda Pani (47/D)	Sunder Bani	Sunder Bani	Thandapa ni (47/D)	930	33.105	74.34583

822)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Thandapani	Sunder Bani	Sunder Bani	Thandapani (47/D)	870	33.0616	74.48182
823)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Thandapani Comptt. 59/D (Ranthal Nalla)	Sunder Bani	Dharamsal	Kallar	870	33.15452	74.4773
824)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Thandapani (3)	Sunder Bani	Sunder Bani	Thandapani (43/D)	910	33.06303	74.5011
825)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Thandapani (47/D)	Sunder Bani	Sunder Bani	Thandapani (47/D)	840	33.0704	74.48235
826)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Thandi Kassi (Comptt: 72/D)	Sunder Bani	Devak	Bagla	870	33.11135	74.51597
827)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Thandi Kassi (Comptt: 72/D) (1)	Sunder Bani	Devak	Bagla	890	33.12027	74.51397
828)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Thangriote	Lamberi	Treru	Rausoo - comptt. 97/D	850	33.14777	74.5702
829)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Thilh (chani) Comptt. 35/D	Sunder Bani	Dharamsal	Dharamsal	840	33.1259	74.47285
830)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Treru (Sangore) comptt: 16/D	Lamberi	Treru	Treru	850	33.23617	74.52445
831)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Treru 15/D	Lamberi	Treru	Treru	870	33.2275	74.5486
832)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Treru Comptt: 16/D	Lamberi	Treru	Treru	870	33.23227	74.53355
833)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Treru (Parriah) comptt. 151D	Lamberi	Treru	Treru	870	33.23483	74.52523
834)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Trimbli (133/D	Sunder Bani	Kangra	Dhok-Bayed	840	33.04323	74.36052

					Comptt)			133/D			
835)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Upper Kangri	Sunder Bani	Kangra	Dhok-Bayed 133/D	850	33.04153	74.36827
836)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Nowshera	Upper Kangri comptt: 133/D	Sunder Bani	Kangra	Dhok-Bayed 133/D	860	33.04428	74.36263
837)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Aarangh	Kandi	Budhal-A	Kandi-A	890	33.40007	74.51684
838)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Amlimora (Comptt: 71/D)	Sunder Bani	Devak	Bagla	900	33.12353	74.52098
839)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Bathuni	Rajouri	Bathuni	Bathuni - B	950	33.33336	74.32306
840)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Bindi	Kandi	Kalalkass	Lankaban -B	900	33.15019	74.35025
841)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Bindi (2)	Kandi	Kalalkass	Lankaban -B	890	33.40006	74.50021
842)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Dangle Kass (Surota Forest) co. 55/k	Kandi	Bakoal	Kangota	910	33.35001	74.61097
843)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Jamola	Kandi	Kalalkass	Jamola-B	950	33.31683	74.43345
844)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Jamola (1)	Kandi	Kalalkass	Jamola-B	930	33.31684	74.45013
845)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Kalakass	Kandi	Kalalkass	Kalalkass -A	920	33.33351	74.36694
846)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Kalakass (2)	Kandi	Kalalkass	Kalalkass -A	910	33.35014	74.38336
847)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Kalalkass	Kandi	Kalalkass	Kalalkass -B	910	33.33352	74.3834
848)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Khark Comptt. No.	Kalakote	Kalakote	Tatapani	970	33.16687	74.4

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849)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Ladote	Kandi	Kalalkass	Kalalkass-B	930	33.35019	74.41678
850)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Ladote (1)	Kandi	Kalalkass	Kalalkass-B	910	33.35022	74.41674
851)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Ladote (2)	Kandi	Kalalkass	Lankaban-A	940	33.3169	74.40012
852)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Ladote (3)	Kandi	Kalalkass	Lankaban-A	920	33.31684	74.40025
853)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Lamman	Sunder Bani	Sunder Bani	Sunder Bani	900	33.0309	74.47965
854)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Leyal (Comptt: 73/D) (1)	Sunder Bani	Devak	Bagla	900	33.08357	74.5168
855)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Noorkot	Rajouri	Bathuni	Sowani 'A'	910	33.26674	74.26693
856)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Mangrote Comptt. 132/k	Kalakote	Kalakote	Kanthol	890		
857)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Morcha Pahyan	Sunder Bani	Devak	Bagla	920	33.11689	74.50014
858)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Rah Salyote, Co. 122/D	Sunder Bani	Sunder Bani	Sunder Bani	890	33.05238	74.51043
859)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Sail Sui (Kukad-deh) Comptt. 99/K	Kalakote	Sial sui	Khadadian-B	960	33.43083	74.49
860)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Sail Sui-99/K	Kalakote	Sial sui	Khadadian-B	940	33.43083	74.49
861)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Saliote	Kandi	Dhangari	Dhangari	940	33.2334	74.43337
862)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Sawari (3)	Kandi	Kalalkass	Nagoon	890	33.35004	74.46681

863)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Sawari-A	Kandi	Kalalkass	Sawari-A	980	33.35015	74.41686
864)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Sawari-A (1)	Kandi	Kalalkass	Sawari-A	890	33.35016	74.41688
865)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Sawari-A (2)	Kandi	Kalalkass	Nagoon	920	33.35007	74.46678
866)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Solki (2)	Kalakote	Dhaleri	Solki	950	33.15013	74.41681
867)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Solki Comptt.	Kalakote	Dhaleri	Solki	910	33.15013	74.41684
868)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Solki comptt. 160/k (1)	Kalakote	Dhaleri	Solki	930	33.15013	74.41685
869)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Thangrote (Comptt. No. : 104/ D)	Sunder Bani	Devak	Devak	840	33.13933	74.56763
870)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Thangrote (Comptt. No. : 104/ D) (2)	Sunder Bani	Devak	Devak	850	33.13933	74.56763
871)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Thangrote (Comptt. No. : 104/ D) (3)	Sunder Bani	Devak	Devak	840	33.14555	74.57425
872)	CN/JK/CI/01,02,04	Jammu & Kashmir	Rajouri	Rajouri	Thangrote (Comptt. No. : 104/ D)(1)	Sunder Bani	Devak	Devak	870	33.14685	74.57047
873)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Ramban	Batote	Site 1 (Batote)				1250		
874)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Ramban	Batote	Site 2 (Batote)				1220		
875)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Ramban	Batote	Site 3 (Batote)				1290		
876)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Ramban	Batote	Site 4 (Batote)				1290		

877)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Ramban	Batote	Site 5 (Batote)				1220		
878)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Ahama Com. 35/R	Ramban	Bhingara	Bhingara 'B'	950	33.32029	75.22145
879)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Arjun Kote Co. 23/ Rbn	Ramban	Bhingara 'A'	Paristan 'A'	940	33.32082	75.36986
880)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Bagroo (Dal) Co. 27/R	Ramban	Bhingara	Paristan - 'B'	950	33.30606	75.30685
881)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Dadan Naala Co. 20/R	Ramban	Bhingara	Paristan-A	910	33.32029	75.22145
882)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Dardahi Co. 35/R	Ramban	Bhinghara	Bhinghara 'B'	900	33.31481	75.22883
883)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Darpat (Bordhar) Co.11/R	Ramban	Neel	Neel-C	910	33.35709	75.21628
884)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Dnari Galli (Co. 66/R)	Ramban	Rajgarh	Rajgarh 'A'	960	33.22758	75.34575
885)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Drubla - (Co. 67/R)	Ramban	Rajgarh	Rajgarh 'A'	940	33.23314	75.20428
886)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Dugga (Co. 65/R)	Ramban	Rajgarh	Rajgarh 'B'	880	33.17587	75.36869
887)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Nag Mandir Thamhal (Co. 69/ R)	Ramban	Rajgarh	Rajgarh 'B'	940	33.22371	75.39228
888)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Neva Bajkot (Co. 63/R)	Ramban	Rajgarh	Dundrath 'B'	910	33.22837	75.34357
889)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Opposite Chivli Co. 25/R	Ramban	Bhingara 'A'	Paristan 'A'	950	33.30437	75.34983
890)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Paristan Naala Co. 20/R	Ramban	Bhinghara	Paristan-A	960	33.32914	75.33318

891)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Sarbagni	Banihal	Sarbagni	Sarbagni - A	930	33.32519	75.16678
892)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Sarvadhar Co. 25/R	Ramban	Bhingara	Paristan 'B'	890	33.29011	75.35144
893)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Sati Nag Mandir (Zangaldhar/. Co - 65/R)	Ramban	Rajgarh	Rajgarh 'B'	860	33.17312	75.36838
894)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Sherigalli Co. 45R	Ramban	Ramban	Ramban 'A'	950	33.24528	75.2453
895)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Ramban	Ramban	Site 1 (Ramban)				1140		
896)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Ramban	Ramban	Site 2 (Ramban)				1150		
897)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Ramban	Ramban	Site 3 (Ramban)				1140		
898)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Thamal Mandir (Nag Mandir) Co. 69/R	Ramban	Ramban	Rajgarh 'B'	850	33.22371	75.37562
899)	CN/JK/CI/01,02,04	Jammu & Kashmir	Ramban	Ramban	Uthba (Batoo) Co.10/R	Ramban	Neel	Neel-'C'	880	33.36299	75.24176
900)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Reasi	Mahore	Site 1 (Mahore)				1130		
901)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Reasi	Mahore	Site 2 (Mahore)				1130		
902)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Reasi	Mahore	Site 3 (Mahore)				1130		
903)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Reasi	Mahore	Site 4 (Mahore)				1130		
904)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Reasi	Mahore	Site 5 (Mahore)				1130		

905)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Aghar Jitto	Katra	Bhaga	Buttan	940	33.00425	74.88625
906)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Aghar Jitto (2)	Katra	Bhaga	Buttan	930	33.007	74.89569
907)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Aghar Jitto (3)	Katra	Bhaga	Buttan	950	33.00878	74.89897
908)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Aghar Nalla Co. 33/R	Reasi	Reasi	Mari	980	33.10549	74.83227
909)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Anji *Nallah* near Sula Peak	Katra	Bhaga	Bhaga-I	970	33.06674	74.83337
910)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Bagdhar, Co.10/R	Reasi	Bhonag	Nagote	950	33.14016	75.00568
911)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Balni	Katra	Bhaga	Bultan	920	32.99597	74.92567
912)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Barote Kote, Co. 15/R	Reasi	Reasi	Mari	910	33.14774	74.96801
913)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Bhabber Raaryala	Katra	Bhaga	Bhaga-I	940	33.05009	74.80001
914)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Bhabber Raaryala 77/k Co.	Katra	Bhaga	Bhaga-I	960	33.05013	74.80002
915)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Bhaga	Katra	Bhaga	Bhaga-II	950	33.04122	74.86372
916)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Bhaga Saldi	Katra	Bhaga	Bhaga-II	910	33.04186	74.86203
917)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Bhangal	Katra	Bhaga	Buttan	900	33.01742	74.89375
918)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Bhum (Surjandhar) Co.17/R	Reasi	Bhomag h	Nagote	880	33.12676	74.95318
919)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Bidda Galli, co.32/R	Reasi	Reasi	Mari	860	33.10519	74.82789

920)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Chatiya	Katra	Bhaga	Buttan	940	33.00956	74.86614
921)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Chatiya (Aghar Jitto)	Katra	Bhaga	Buttan	890	33.00364	74.87475
922)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Chumbia	Katra	Bhaga	Babber-I	890	33.01872	74.81247
923)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Dabbad, Near Narib Chand House	Katra	Bhaga	Bhabber-B	940	33.02314	74.86808
924)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Dhanwa	Thakrakote	Talwara	Talwara I	960	33.06767	74.77998
925)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Dogalla, Aghar Ballian Co. 33/R	Reasi	Reasi	Mari	950	33.10896	74.82832
926)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Drawna Nalla, Mari, Co. 34/R	Reasi	Reasi	Mari	940	33.10933	74.87281
927)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Gwswan Bonekhad Nalla Co. 36/R	Reasi	Reasi	Mari	920	33.09742	74.88219
928)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Jerri	Thakrakote	Talwara	Talwara I	890	33.03658	74.79456
929)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Jerri (3)	Thakrakote	Talwara	Talwara I	910	33.039	74.78892
930)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Julla	Katra	Bhaga	Bhabber-B	920	33.01869	74.85583
931)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Julla (2)	Katra	Bhaga	Bhabber-B	930	33.02314	74.8575
932)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Julla, Mana ka Drad	Katra	Bhaga	Bhabber-B	910	33.02392	74.85828

933)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Julla, Near Chuni Lal Lamberdars House	Katra	Bhaga	Bhabber-B	920	33.01769	74.85742
934)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Julla, Near Ramesh Chander Hou se	Katra	Bhaga	Bhabber-B	930	33.02022	74.85731
935)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Jyotipuran-Aghar nalla (Below Bidda Jyotipuram R oad Co. 33/R)	Reasi	Reasi	Mari	910	33.10442	74.83976
936)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Kai Khad (Forest) Chatiya	Katra	Bhaga	Buttan	940	33.01192	74.85016
937)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Kalara	Katra	Bhaga	Bhaga-II	920	33.04422	74.88714
938)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Kalara, Near Satsung Ghar Kalara	Katra	Bhaga	Bhaga-II	950	33.04422	74.88714
939)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Kanka, Near M.S Kanka	Katra	Bhaga	Bhabber-B	950	33.02106	74.87233
940)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Kanka, Near Puran Chand House	Katra	Bhaga	Bhabber-B	940	33.01856	74.87406
941)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Kanka, Roadside and Alongside Pai river	Katra	Bhaga	Bhabber-B	920	33.01592	74.87797
942)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Kans Brahmna	Thakrakot e	Talwara	Talwara I	950	33.06278	74.78258

943)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Karla Khad (Chatiya)	Katra	Bhaga	Buttan	910	33.00961	74.86533
944)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Karun Kote, Co. 14/R	Reasi	Bhonag	Nagote	980	33.14774	74.96801
945)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Karwa	Katra	Bhaga	Bhabber - B	960	33.03069	74.88142
946)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Karwa Dansar Baba	Katra	Bhaga	Bhabber-B	930	33.02758	74.87056
947)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Karwa Pai	Katra	Bhaga	Bhaga-II	940	33.02761	74.86897
948)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Karwa, Near Raj Kumar House	Katra	Bhaga	Bhabber-B	900	33.02494	74.87953
949)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Karwa, Near Shiv Mandir	Katra	Bhaga	Bhabber-B	920	33.02528	74.87675
950)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Kheral	Thakrakote	Talwara	Talwara I	950	33.07108	74.77164
951)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Kund (Bultan)	Katra	Bhaga	Buttan	940	32.98497	74.88894
952)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Kundra Pai	Katra	Bhaga	Bhabber-B	900	33.02908	74.84061
953)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Mand *Nallah*, Near Police Chowki	Katra	Bhaga	Babber-I	960	33.01936	74.8474
954)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Mansoo	Katra	Bhaga	Babber-I	980	33.01314	74.84244
955)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Nai Devi, NH Reasi-Katra road	Katra	Bhaga	Bhabber-B	910	33.02242	74.88842
956)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Pai	Katra	Bhaga	Bhaga-II	950	33.02642	74.84844
957)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Pai (2)	Katra	Bhaga	Bhaga-II	900	33.02828	74.84696

958)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Reasi	Reasi	Pathi	Katra	Bhaga	Kanjoli	1110	32.99039	74.84636
959)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Pathi (2)	Katra	Bhaga	Kanjoli	940	32.98647	74.83353
960)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Patta	Thakrakot e	Talwara	Talwara I	900	33.03658	74.79456
961)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Saldi	Katra	Bhaga	Bhaga-II	950	33.03769	74.86297
962)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Saldi (1)	Katra	Bhaga	Bhaga-II	910	33.04181	74.86364
963)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Saldi (2)	Katra	Bhaga	Bhaga-II	960	33.02106	74.86788
964)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Saldi Pai	Katra	Bhaga	Bhaga-II	930	33.02947	74.86581
965)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Sarad Co. 11/R	Reasi	Bhonag	Nagote	940	33.14159	74.98906
966)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Sarad Co. 11/R	Reasi	Bhonag	Nagote	940	33.14159	74.98906
967)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Sarli Talab-Jyotipuran Nalha, Co. 32/R	Reasi	Reasi	Mari	950	33.11529	74.84754
968)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Sarma Nalla (Mari) Co. 34/R	Reasi	Reasi	Mari	900	33.11659	74.86009
969)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Saroon	Katra	Bhaga	Buttan	900	32.98467	74.89897
970)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Saroon (1)	Katra	Bhaga	Buttan	860	32.98339	74.89586
971)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Satoi-Galli, co. 120/R and co. 12b/R	Reasi	Bhonag	Nagote	900	33.13205	74.99424

972)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Seela Panasa	Katra	Bhaga	Bhaga-I	900	33.05014	74.78359
973)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Seela Panasa (Paili)	Katra	Bhaga	Bhaga-I	940	33.05022	74.78355
974)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Seela Panasa War	Katra	Bhaga	Bhaga-I	900	33.0502	74.78355
975)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Simbal Choa	Katra	Bhaga	Bhaga-II	920	33.03358	74.85075
976)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Talwara	Thakrakote	Talwara	Talwara I	940	33.06792	74.77106
977)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Talwara (1)	Thakrakote	Talwara	Talwara I	870	33.08653	74.79028
978)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Tand, Sia *Nallah*	Katra	Bhaga	Bhabber-B	870	33.00003	74.85575
979)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Tanda	Katra	Bhaga	Bhabber-B	870	33.00133	74.84836
980)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Tanda	Katra	Bhaga	Bhabber-B	910	33.01172	74.84783
981)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Tanda Mansoo	Katra	Bhaga	Babber-I	910	33.01397	74.84325
982)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Tanda Near M.S Tanda	Katra	Bhaga	Bhabber-B	890	33.00603	74.8485
983)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Tanda Sari	Katra	Bhaga	Babber-1	830	33.00033	74.91722
984)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Tanda, Near M.S Tanda	Katra	Bhaga	Babber-I	830	33.00633	74.84775
985)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Tanda, Near Pritam Singh House	Katra	Bhaga	Bhabber-B	840	32.99878	74.84867
986)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Tanda, Sia *Nallah*	Katra	Bhaga	Bhabber-B	920	32.99522	74.85275
987)	CN/JK/CI/01,02,04	Jammu & Kashmir	Reasi	Reasi	Thata-Basti Nalha Co.	Reasi	Reasi	Mari	930	33.10094	74.86994

					34/R						
988)	CN/JK/CI/01,02,04	Jammu & Kashmir	Udhampur	Ramnagar	North Range				1420		
989)	CN/JK/CI/01,02,04	Jammu & Kashmir	Udhampur	Ramnagar	North Range 2				890		
990)	CN/JK/CI/01,02,04	Jammu & Kashmir	Udhampur	Ramnagar	North Range 3				870		
991)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Udhampur	Ramnagar	North Range 4				1140		
992)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Udhampur	Ramnagar	North Range 5				1130		
993)	CN/JK/CI/01,02,04	Jammu & Kashmir	Udhampur	Ramnagar	South Range				940		
994)	CN/JK/CI/01,02,04	Jammu & Kashmir	Udhampur	Ramnagar	South Range 2				920		
995)	CN/JK/CI/01,02,04	Jammu & Kashmir	Udhampur	Ramnagar	South Range 3				930		
996)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Udhampur	Ramnagar	South Range 4				1110		
997)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Udhampur	Ramnagar	South Range 5				1140		
998)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Udhampur	Udhampur	Site 1 (Udhampur)				1120		
999)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Udhampur	Udhampur	Site 2 (Udhampur)				1120		
1000)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Udhampur	Udhampur	Site 3 (Udhampur)				1080		
1001)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Udhampur	Udhampur	Site 4 (Udhampur)				1120		
1002)	CN/JK/CI/01,02,03,05	Jammu & Kashmir	Udhampur	Udhampur	Site 5 (Udhampur)				1120		

v) Other Intervention											
S.No.	**Model**	**State/ UT**	**District**	**Division**	**Sitename**	**Range**	**Block**	**Beat**	**Area (Ha)**	**Latitude**	**Longitude**
1003)	CN/JK /CI/06	Jammu & Kashmir	Jammu	Jammu WD	Bahu(2)				32	32.7266	74.857
1004)	CN/JK /CI/06	Jammu & Kashmir	Jammu	Jammu WD	Gharana				5		
1005)	CN/JK /CI/06	Jammu & Kashmir	Jammu	Jammu WD	Kukarian 3				10	32.7266	74.857
1006)	CN/JK /CI/06	Jammu & Kashmir	Jammu	Jammu WD	Nandini Wildlife Sanctuary(2)				10	32.7266	74.857
1007)	CN/JK /CI/06	Jammu & Kashmir	Jammu	Jammu WD	Pargwal(2)				10	32.7266	74.857
1008)	CN/JK /CI/06	Jammu & Kashmir	Jammu	Jammu WD	Sangral- Asa Chak				10	32.7266	74.857
1009)	CN/JK /CI/06	Jammu & Kashmir	Jammu	Jammu WD	Sheshara CR				5		
1010)	CN/JK /CI/06	Jammu & Kashmir	Kishtwar	Chenab WD	Kishtwar National Park				30	33.3116	75.7662
1011)	CN/JK /CI/06	Jammu & Kashmir	Kishtwar	Chenab WD	Kishtwar National Park (2)				20	33.3116	75.7662
1012)	CN/JK /CI/06	Jammu & Kashmir	Ramban	Chenab WD	Jawahar Tunnel(3)				10	33.2427	75.2392
1013)	CN/JK /CI/06	Jammu & Kashmir	Samba	Jammu WD	Nanga				10	32.553	75.1108
1014)	CN/JK /CI/07	Jammu & Kashmir	Udhampur	Jammu WD	Mansar (Ramsar Site)				10	32.916	75.1416
1015)	CN/JK /CI/06	Jammu & Kashmir	Udhampur	Jammu WD	Mansar Surinsar Wildlife Sanctuary(3)				10	32.916	75.1416

1016)	CN/JK /CI/06	Jammu & Kashmir	Udhampur	Jammu WD	Ramnagar Wildlife Sanctuary				10	32.916	75.1416
1017)	CN/JK /CI/06	Jammu & Kashmir	Udhampur	Jammu WD	Sudhmahadev				10	32.916	75.1416
1018)	CN/JK /CI/07	Jammu & Kashmir	Udhampur	Jammu WD	Surinsar (Ramsar Site)(2)				8	32.916	75.1416

Annexure: 14- Letter from PCCF and HoFF Himachal Pradesh Forest Department Regarding Availabilty of Land for Carrying out Forestry interventions Himachal in Chenab Riverscape

Office of
Principal Chief Conservator of Forests
(Head of Forest Force)
Himachal Pradesh Forest Department Headquarters, Talland, Shimla-171 001

स्वच्छ भारत
एक कदम स्वच्छता की ओर

No. Ft.15-642/2019(D)DPR/IRB
Himachal Pradesh Forest Department

To

The Director,
Himalayan Forestry Research Institute,
Conifer Campus, Panthaghati, Shimla-1710013.

Dated Shimla-1, the - 3 NOV 2020

Subject Request to provide information on availability of land for forestry interventions and certificate of verification of plantation and cost.

Sir,

Kindly refer to your office letter No.4 (Vistar-28) Hi.v.a.s./2020/ 1288 dated 25.09.2020 on the subject cited above.

2. In this regard it is certified that land is available in the concerned Forest Divisions for proposed forestry inventions as mentioned in the Draft Detailed Project Reports (DPRs) for rejuvenation of five major rivers i.e. Beas, Chenab, Jhelum, Ravi & Satluj prepared/finalized by the Himalayan Forest Research Institute, Shimla in consultation with the field officers of this department as per geo-coordinates given in the DPRs.

Yours faithfully,

Chief Conservator of Forests (Fin.)
Himachal Pradesh.

3.11.2020

Tel.No. 0177-2624207, 2623147, 2624186, Fax: 0177-2624192, E-mail: pccf-hp@nic.in

Annexure: 15- Letter from PCCF and HoFF Jammu and Kashmir UT Forest Department Regarding Availability of Land for Carrying out Forestry Interventions in Chenab Riverscape

Office Address

May to October: Forest Complex, Shiekh Bagh, Lal Chowk, Sgr-190001 | Phone: 0194-2483937, Fax: 0194-2455027

Nov. to April: Van Bhawan, Below Gumat, Jammu-180001 | Phone: 0191-2560585, Fax: 0191-2547276

URL Address: www.jkforest.gov.in

E-mail: pccfjkforest@gmail.com

सत्यमेव जयते

Government of Jammu & Kashmir
Office of the Pr. Chief Conservator of Forests & HoFF
Jammu & Kashmir Forest Department

Director General of Forest
& Special Secretary, Government of India,
MoEFCC, New Delhi.

No: PCCF/Plg/208/1405-07 **Dated:** 26 **-11-2020**

Reference No.: D.O. No. 12-4/2017-B-III (P) dated 17.11.2020

Subject: DPR on Forestry Interventions for Chenab, Jhelum & Ravi for Jammu & Kashmir.

Sir,

The J&K Forest Department is providing all necessary assistance to Himalayan Forest Research Institute for the preparation of DPR on Forestry Interventions for rejuvenation of Jhelum, Chenab & Ravi rivers in Jammu & Kashmir. The Director, Himalayan Forest Research Institute has shared certain information and has sought inputs with regard to the availability of land in various forest divisions in the riverscapes of aforementioned rivers for the proposed forestry interventions. After getting the inputs from the concerned DFOs, the necessary information have also been sent to DG ICFRE vide this office No. PCCF/Plg/Himalaya/208/1320-23 dated 12.11.2020.

It is once again reiterated that J&K Forest Department will continue to provide the necessary assistance for implementation of the projects as per the approved DPRs.

Yours faithfully,

(Dr. Mohit Gera) IFS
Pr. Chief Conservator of Forests (HoFF), J&K

Copy for information to:

1) DG ICFRE, P.O. New Forest, Dehradun-248006
2) Director HFRI, Panthaghati, Shimla.