

DRAFT
OVERVIEW



DETAILED PROJECT REPORT (DPR) FOR
REJUVENATION OF
SUTLEJ RIVER
THROUGH FORESTRY INTERVENTIONS

OVERVIEW



Preparation of Detailed Project Report (DPR) for Rejuvenation of Sutlej River Through Forestry Interventions

Overview

Introduction to Sutlej River Ecosystem

River ecosystem basically consists of inter-related living and non-living physical environment with varied intricacies, inter-relationships, longitudinal and vertical interactions, lateral exchange processes occur from River to surrounding lands. The understanding of all these processes and patterns in the overall environment of the River and its surrounding land is vital for devising an effective, scientific basis to River management. In India, Rivers are classified mainly of four types based on their geographical locations and origin viz., (a) Himalayan Rivers, (b) Peninsular Rivers, (c) Coastal Rivers, and (d) Inland Rivers. The Himalayan Rivers are glacier fed and perennial, while Peninsular Rivers are altogether monsoon fed. As far as the nature of Himalayan Rivers is concerned, these are antecedent Rivers having deep gorges and chasms, exhibiting practically vertical to convex valley walls; and slope failure have become very common phenomenon particularly in the belts cut active faults in their hilly stretch and also, Himalaya (Fig. 1) is the youngest among the world mountain systems with comparatively more fragile soil. Therefore, Himalayan Rivers provide different gradients of habitat heterogeneity from its headwater to mouth for colonization of diverse aquatic fauna. Further, because of fragility of soil combined with forest degradation and deforestation of riparian watersheds/ catchments, habitat destruction, soil erosion in upper stretch of Himalayan Rivers is very much prevalent causing severe silting to down streams.

Sutlej River Basin

Satudri was the name of Sutlej River during the Vedic period, and called *Shatadru* in Sanskrit - the language of ancient India. Sutlej River originates from beyond Indian borders in the southern slopes of the Kailash Mountain near Mansarovar Lake from Rakshastal in Tibet (China) and known locally as Longcchen Khabab River in the region. It is one of the longest among the five Rivers of Himachal Pradesh. It enters Himachal Pradesh at Shipki La (3,930 m) and flows in the south-westerly direction through Kinnaur, Shimla, Kullu, Mandi, Solan and Bilaspur districts of the State.

The geographical limits of the Sutlej River Basin lie between 30° - 33° N Latitudes, 74° - 83° E Longitudes. The Sutlej River Basin covers Nari Khorsam province in Tibet, China and large area of Himachal Pradesh and Punjab in India. The total catchment area of Sutlej in India is 48,321.62 km². In India, the catchment falls in one Union Territory i.e. UT of Ladakh (1,172.22 km²) and three States of the country viz., Himachal Pradesh (20,181.94 km²), Punjab (26,887.45 km²) and Haryana (80.01 km²) (Table-1.). The total catchment area (Fig-1) of Sutlej River is highest, constituting 36.20% of the total geographical area of the Himachal Pradesh among the five major Rivers.

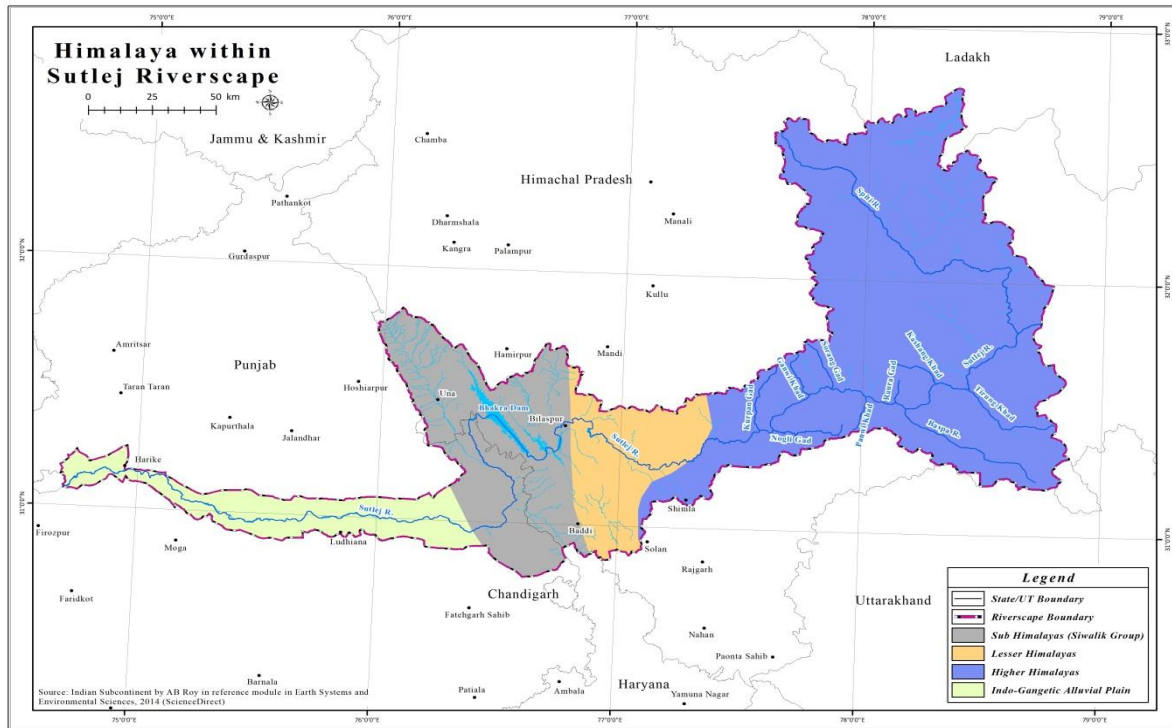


Fig. 1- Map of Himalaya within Sutlej Riverscape

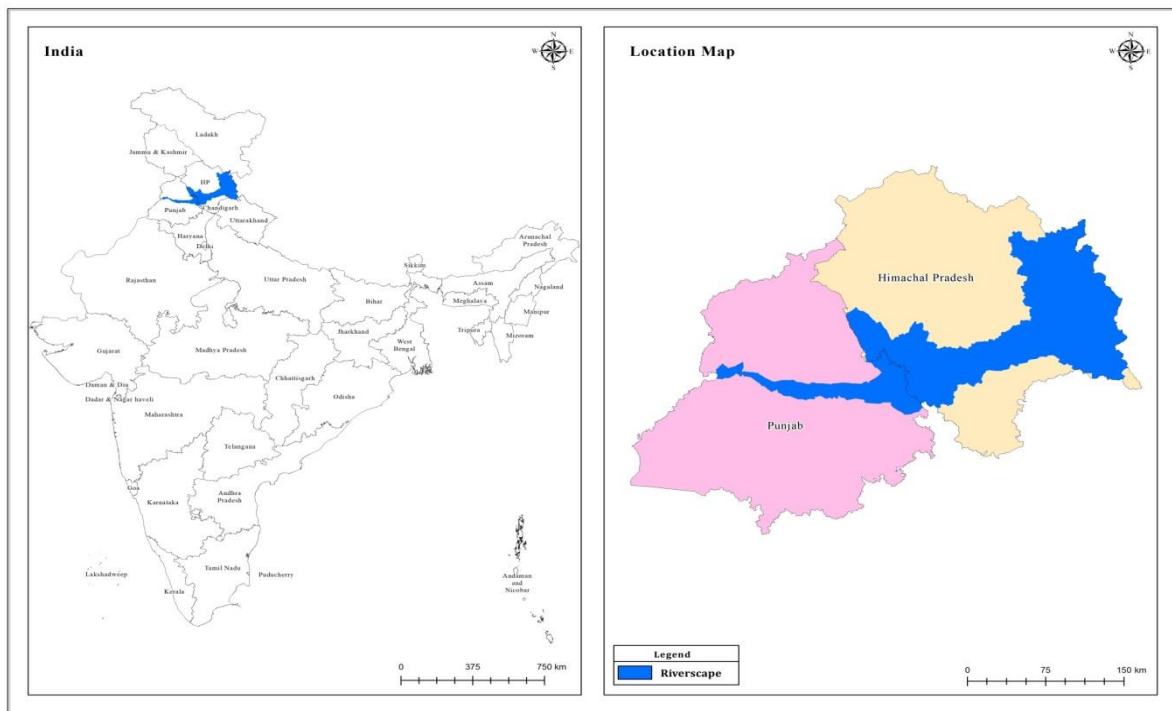


Fig. 2- Location Map of Sutlej Riverscape

Table 1: Catchment Area of Sutlej River in India

State	Boundary	State Area (km ²)	Percentage (%)
Himachal Pradesh	Riverscape	20,154.61	41.71
Himachal Pradesh	Catchment beyond Riverscape	27.33	0.06
Ladakh (UT)	Catchment beyond Riverscape	1,172.22	2.43
Punjab	Riverscape	3,956.22	8.19
Punjab	Catchment beyond Riverscape	22,931.23	47.46
Haryana	Catchment beyond Riverscape	80.01	0.17
Catchment Area of Sutlej River		48,321.62	100

On account of varying geographical features, the Sutlej River Basin is topographically divided into two parts, i.e., the Upper Sutlej River Basin and Lower Sutlej River Basin. Beyond the Nathpa village in Kinnaur district, Sutlej River is considered to be the Upper Sutlej River Basin, while southwestern part of the Nathpa village to Bilaspur is known as the Lower Sutlej River Basin. Since the Upper Sutlej River Basin has favorable slope conditions for the development of hydropower projects, series of large scale hydropower projects have been developed in this part as priority projects for renewable and clean energy and given less weightage to environmental concerns having serious repercussions. About 63% of the State's area is drained by Sutlej and Beas Rivers. It is estimated that about 65% of Sutlej River Basin is covered with snow during winter and 12% of the Basin is covered with permanent snow throughout the year. About 50% of the annual flow to Sutlej River is contributed by the snow and ice melt. Sutlej River is joined by many tributaries, and the main among them are Spiti, Ropa, Taiti, Kashang, Mulgaon, Yula, Wanger, Throng and Ruppi, etc., as right bank tributaries, whereas Tirung, Gayathing, Baspa, Duling, Soldang, Nogli, etc., are as left bank tributaries. The total length of the Sutlej River in India is 635.02 km, and traverses a course of 350.58 km and 284.44 km in Himachal Pradesh and Punjab, respectively. It is considered as a longest River among the six major Rivers (i.e., Yamuna, Sutlej, Beas, Ravi, Chenab and Jhelum) of North-Western India. It leaves the Himachal Pradesh boundary at Bhakhra Dam, which is the second highest dam 225.55 m of the country. Sutlej River finally drains into the Chenab River in Pakistan. The prominent human settlements that have come on the banks of the Sutlej River in India are Reckong-Peo, Rampur, Suni, Tattapani, Bilaspur, Rupnagar, Jalandhar and Ludhiana.

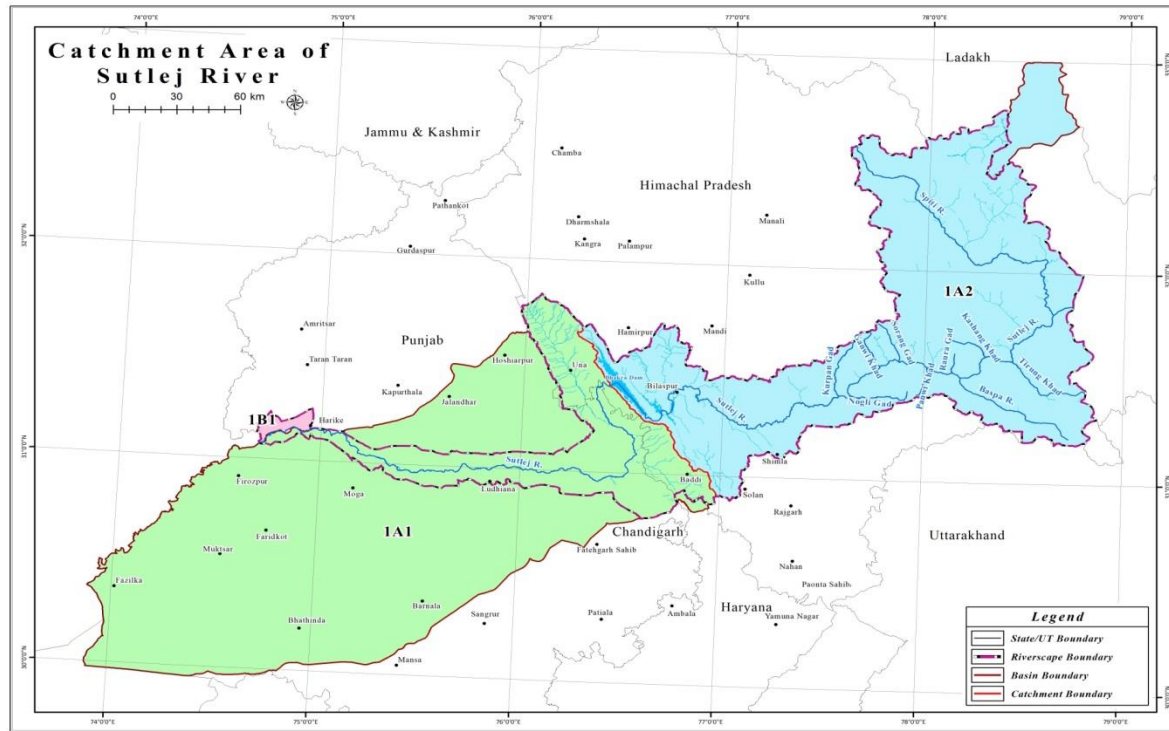


Fig. 3 Catchment Area of Sutlej River in India

River Basin Uniqueness

Sutlej River along with its tributaries is known as the ‘Power House of Himalaya’. The Government of India and State Government of Himachal Pradesh have identified the Sutlej River as one of the main sources of Hydro-electric Projects (HEPs). The total hydropower potential of Sutlej River Basin as estimated is 9,728.25 MW, out of which 5,515.75 MW is being harnessed through projects that are either under operation or in construction stages (SJVNL, 2005). Some of the major HEPs constructed on the River Basin are Bhakra Dam (1,325 MW), Karcham-Wangtoo (1,000 MW), Nathpa-Jhakri (1,500 MW), Rampur (412MW) and Kol Dam (800 MW). The Sutlej River Basin is also known for variations in its biodiversity due to the extreme elevation variation. The upper reaches (i.e., Spiti and upper parts of Kinnaur) of Sutlej River Basin which are cold desert regions have sparse vegetation. The major forest types in this cold desert area are the Dry Alpine Scrubs especially between 3600 - 5500 m amsl, and are famous for the diversity of the high altitude medicinal herbs and shrubs. Major flora in the Sutlej River Basin includes tree species such as *Picea smithiana*, *Juniperus polycarpus*, *Populus ciliata*, *Salix viminalis*, *Alnus nitida*, *Cedrus deodara*, *Pinus roxburghii*, *Lyonia ovalifolia*, *Senegalia catechu*, *Phyllanthus emblica*, *Pinus wallichiana*, *Pinus gerardiana*, *Berberis* spp., *Corydalis* spp., *Geranium* spp., *Astragalus* spp., *Cotoneaster* spp., *Sinopodophyllum hexandrum* (May apple), *Aconitum heterophyllum* (Aconite), *Saussurea obvallata* (Brahma Kamal), *Gentiana algida*, *Artemisia* spp., *Oxytropis microphylla*, *Cremanthodium ellisii*, *Carissa opaca*, *Dodonaea viscosa*, *Indigofera heterantha*, *Rhamnus virgata*, etc. There are also the variations in fauna in the Sutlej River Basin. The fauna of the Upper Sutlej River Basin is of special concern as most of the prominent wild animal species are reported in this part. Some of the prominent faunal species are Snow leopard, Himalayan black bear, Woolly hair wolf, Brown bear, etc. that are reported from this region while the major herbivores in the region are Ibex, Blue sheep, Yaak,

Ghoral, etc. Similarly, in the Lower Sutlej River Basin, Jungle cat, Wild boar, Bengal Fox, and Indian Porcupine are the major fauna. Sutlej River Basin has only one National Park i.e., Pin Valley National Park and six Wildlife Sanctuaries in Himachal Pradesh. Gobind Sagar Reservoir is one of the major reservoirs on Sutlej River which is consistently maintaining highest per hectare fish production level in the country with annual production of over 1,400 MT worth Rs. 8 Crore. The Sutlej River harbours both cold water as well as warm water fishes. The cold water fishes include *Tor* spp., *Schizothorax* spp., *Barilius* spp., *Bangana* spp., *Garra* spp., *Schistura* spp., *Triplophysa* spp., etc. are the indigenous fishes important in terms of food, sport and ornamental value. Important Protected Areas of Punjab includes 11 Wildlife Sanctuaries and 3 Conservation Reserves. Punjab is also having Wetlands of International Importance which includes Ropar and Harike Wetlands which has been declared as Ramsar Sites. Sutlej River Basin also supports livelihood of the local communities in terms of irrigation and drinking water supply as well as the belt is very fertile with production of agricultural and horticultural crops.

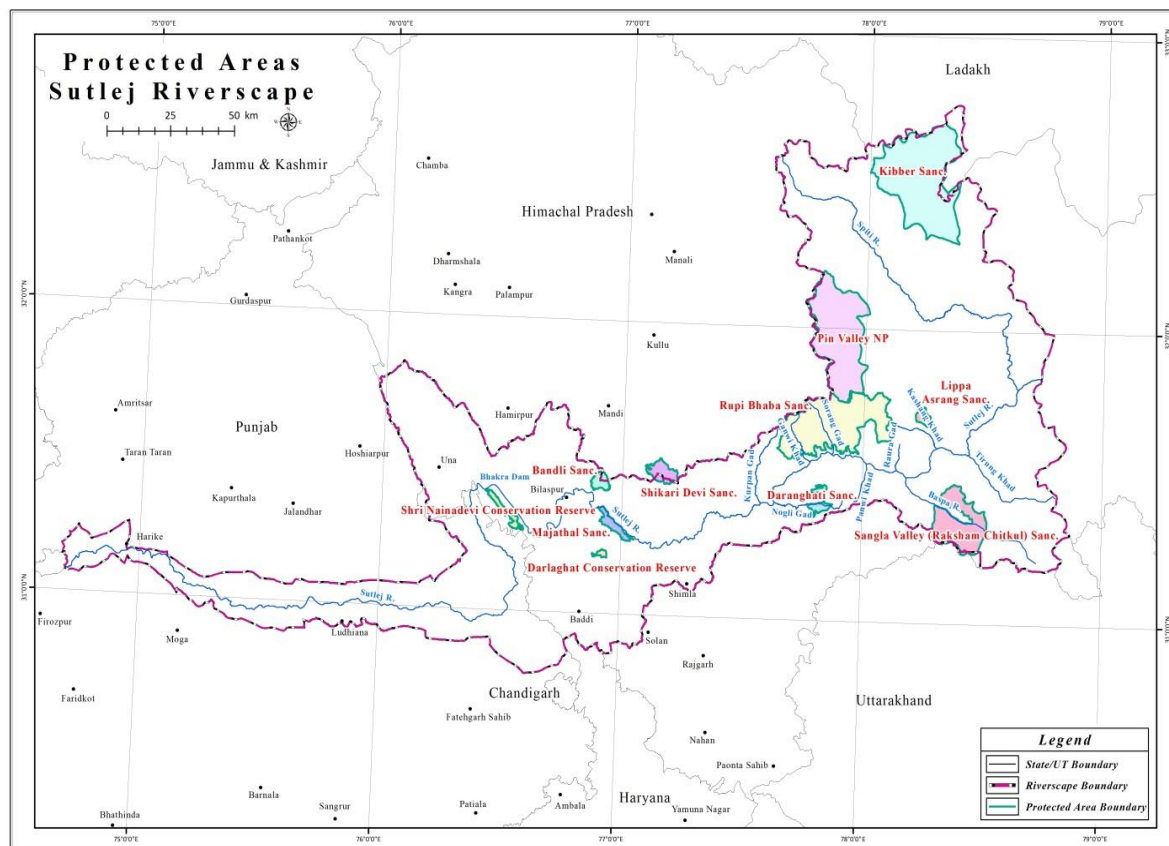


Fig. 4- Map of Protected Areas in Sutlej Riverscape

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 longitudinal, vertical and horizontal linkages. Therefore, it is imperative that the quality as well as quantity of water in the River must be sustained by protecting from all forms of pollution and unscientific exploitation. The main stem of River has been over exploited for sequential HEPs for power generation in the Kinnaur, Shimla, Kullu and Bilaspur districts. Dams constructed on the River are affecting the catchment and the River ecology drastically. In the plain areas, Sutlej River 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. 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 bank of Sutlej River. This is also contributing to the pollution of River. Construction of new buildings and establishments in the recent past has generated lot of wastes and demolition material finds its way into the River and contributes to its degradation. The Sutlej River Basin is quite diverse and complex, which covers the parts of two countries and provides livelihoods and sustenance to the people inhabiting the River Basin. For the better planning and management of Sutlej River Basin, long term national and Regional collaboration framework on scientific lines is urgently required so that quality and quantity of water in Sutlej River is maintained. Therefore, there is an urgent need of scientific management of Sutlej River for ecological regeneration of terrestrial and aquatic biota that ensures improvement in the quality and quantity of the water in the River, which ultimately leads to enhanced ecosystem services and improved livelihoods.

Conservation Initiatives

Various initiatives have been carried out by the forests, other concerned Departments, and NGOs in the past; and continually putting their efforts currently for the conservation of Sutlej River Basin. Some of them have been briefly described below:

a) Catchment Area Treatment (CAT) Plan

Forests play an important role in reducing sediment flux, which is major cause of siltation in the River. Keeping in view of the fact, State Government has mandated that HEPs should include investment in the Catchment Area Treatment (CAT) Plan. The activities envisaged under CAT Plan such as afforestation, pasture management, check dams and trenching were based on thorough field evaluation and consultations. To address various environmental issues arising out of construction of HEPs, Himachal Pradesh Forest Department has formulated Comprehensive Catchment Area Treatment Plans (CCPs) for all the four major River Basins viz., Sutlej, Beas, Ravi and Chenab in the State. These CCPs emphasized on the integrated approach for the treatment upto watershed level and also beneficial for socio-economic and to improve life of the local communities through livelihood support.

b) Plantations under CAMPA

A series of plantation programmes have been launched by the Government of India with the purpose of increasing forest cover and regenerating degraded forests. There is massive funding for these programmes coming directly to the Forest Department and other concerned Departments for carrying out the plantation activities.

c) Other Important Initiatives

Depleting water levels in agrarian States of Punjab and Haryana, resulting in high input costs of crops. With water level going as deep as 200 m in some pockets of Punjab, farmers have to rely on tube wells, raising the input cost substantially. NABARD addresses the problem by engaging community through Self Help Groups, Farmers' Club and Producer Organisations.

Through this initiative, NABARD covered approximately 3,300 villages out of approximately 12,000 villages in Punjab under its water conservation and management initiatives. NABARD created awareness programmes at village and block levels on new innovations in water conservation.

In 2009, Nokia India CSR (Corporate Social Responsibility) team in collaboration with WWF-India and the Department of Forests and Wildlife Preservation of Punjab Government initiated the 'River Watch Project', a programme for the Bio-monitoring of freshwater biodiversity in the Sutlej–Beas–Ravi Rivers in Punjab, which covers the Harike Wetland, a Biodiversity Hotspot. Since its inception in 2010, the 'River Watch Project' has recorded 9 mammals, 200 avian species, 7 turtle species and 26 fish species in this wetland of conservation importance. The wetland is designated as Ramsar Site.

Himalayan Research Group (HRG), Shimla has carried out significant work in 2014-15 for empowering mountain women and other local communities by reducing forest dependency by supplying cost effective solar energy application for domestic water heating in Mool Koti village of Shimla district.

d) Cumulative Environmental Impact Assessment

The Environment Appraisal Committee (EAC) of Ministry of Environment and Forest (MoEF), Government of India (GoI), in its Minutes of 47th EAC Meeting on River Valley Project No. 2011 9J-12011/6/2011-IA.I, has directed the Department of Energy (DoE), Government of Himachal Pradesh (GoHP) to conduct Cumulative Environmental Impact Assessment (CEIA) Study of HEPs in Sutlej River Basin, Himachal Pradesh. Biological Environment (Terrestrial Flora) and Socio-Economic Environment Assessment was carried out by Himalayan Forest Research Institute, Shimla during 2014-15.

e) Himachal Pradesh State Disaster Management Authority and Desert Development Project, Kinnaur and Spiti

Himachal Pradesh State Disaster Management Authority and Desert Development Project (DDP) of Kinnaur and Lahaul–Spiti districts have shown their presence by taking immediate action on impact of disasters such as floods, landslides, earthquake, avalanches and moraine management. Sometimes the roads in the State remain cut-off for months due to the occurrence of landslides, formation of lakes and submergence of roads. There are many instances when the districts of Kinnaur and Lahaul - Spiti remained cut-off from rest of the State for months. At times the connectivity is also broken due to avalanches and snowstorms hindering the transport to the affected border areas. Lack of connectivity would also cause secondary effects such as non-availability of essential supplies, hoarding by the rich and hardship to the poor.

f) Sutlej Action Plan

Keeping in view deterioration in the water quality of Sutlej River, the Government of Punjab (GoP) initiated action in 2008 to identify the sources of its pollution in coordination with Punjab Pollution Control Board (PPCB). Ludhiana City falls within the catchment area of River Sutlej and is contributing significantly to the water pollution of Sutlej River through

Buddha Nallah, which passes through the heart of Ludhiana city. As of now, out of 65 towns, which are discharging their wastewater into Sutlej River, a total of 101 Sewage Treatment Plants (STPs) need to be installed out of which 59 STPs have already been installed, 8 are under installation and remaining 34 are under various stages of planning for establishment.

Vision, Aims and Objectives

Vision

Recognizing the diversity, complexity and intricacies of Forest ecosystems and pivotal multiple functions performed by them and their inter-connectedness with highly dynamic River ecosystems, the Himalayan Forest Research Institute (HFRI), Shimla has embarked on the task to adopt a holistic approach of River Basin management for the restoration of Sutlej River and to prepare a Detailed Project Reports (DPR) on Forestry Interventions.

Aims and Objectives

The proposed project aims to accomplish broader goals of sustainable land and River ecosystem management, enhanced ecosystem services, and improved livelihoods. Besides, the broader objective of ecological regeneration of aquatic and terrestrial biota and ensuring *Aviral Dhara* and *Nirmal Dhara*. The project will also focus on soil and moisture conservation in Riverscape and qualitative and quantitative improvement in the forests.

Approach

Consultative Process, Situation and Problem Analysis: During the Consultative Meetings, a wide range of themes viz., the concept of Riverscape, delineation of Riverscape boundaries, strategies for project implementation, development of data formats, collection of primary field data, 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. The consultative process and the Sequential Consultative Meetings with varied stakeholders immensely helped in the identification of focal problems, understanding their reasons/ causes, and effects or implications on the River itself and surrounding lands.

Development of Web Portal - Collection and Analysis of Primary Field Data: Prior to the collection of primary field data, the essential requirement was on the development of plantation and treatment models, design of field data formats and software for analysis of field data.

Plantation and Treatment Models: The multi-disciplinary expertise at HFRI developed altogether 21 treatment/ plantation models specific to Natural Landscapes, four of Agriculture Landscapes, eight of Urban Landscapes and ten Models of Conservation Intervention (SMC) and four models of other interventions in consultation with the SFDs of Himachal Pradesh and Punjab.

Design of Field Data Formats: Designed, developed and tested data formats were used in the present exercise for collection of primary field data required for the preparation of DPR. 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: The software was developed in PHP/ Mysql, server Linux based that works on Code Igniter Framework basis. It is a web based and easily accessed via internet. The software is capable of generating reports in the desired formats e.g., 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.

Preparation of Draft DPR: Draft DPR (Vol. I and II) was shared with Himachal Pradesh and Punjab, SFDs, Line Departments and other stakeholders in the States as well as the National Level Consultation Meetings seeking their feedback and valuable inputs. Draft DPR was submitted to the ICFRE, Dehra Dun and MoEF&CC, New Delhi and comments were invited and accordingly modifications done. Necessary presentations will also made at ICFRE and MoEF&CC as per the invitation.

Riverscape and its Environment

A River is not just a channel carrying freshwater, but it is a hydrological, geomorphic, ecological, biodiversity-rich, landscape level system that serves as a key part of the freshwater cycle, balancing dynamic equilibrium between snowfall, rainfall, surface water and groundwater, and provides a large number of social and economic services to the people and ecosystems all through its Basin. It exhibits complex and large-scale directional upstream-downstream linkages. The Sub-Catchments of Sutlej Riverscape have been given in Fig-5.

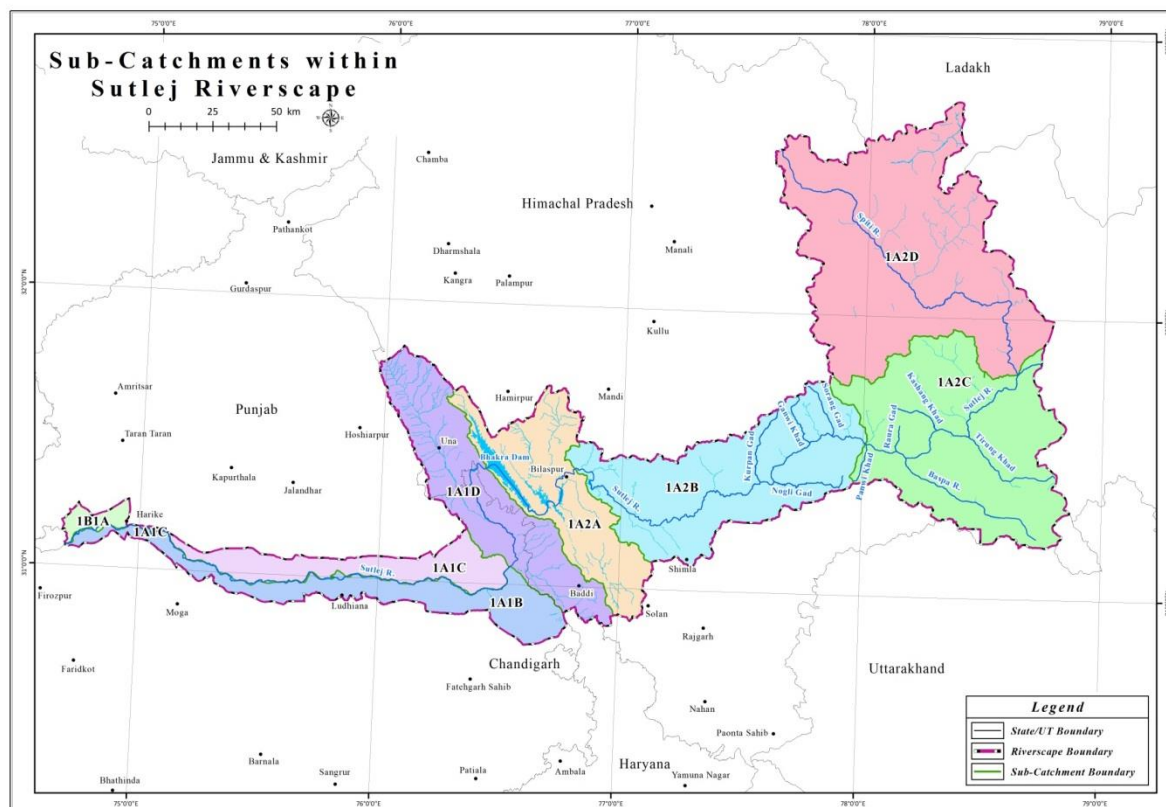


Fig. 5- Sub -Catchments of Sulej Riverscape

The Riverscape perspective recognizes the heterogeneous habitat types within the stream corridor as a single, integrated ecological unit operating across spatial scales. The Sulej Riverscape delineated for the purpose of proposed Forestry Interventions in the present task of preparation of the DPR, is based on the exhaustive consultations with various stakeholders. It constitutes the total catchment of 24, 110.83 km² (Table-2) falling in Himachal Pradesh and Punjab.

Table-2: Riverscape and Total Catchment Area of Sulej River

Boundary	State (H.P. & Punjab) Area (km ²)	Percentage
Riverscape	24,110.83	49.9
Catchment beyond Riverscape	24,210.79	50.1
Total Catchment Area of Sulej	48,321.62	100.00

The physical, biological and socio-economic sub- environments of the Riverscape are based on the collation and synthesis of secondary information which is summarized below.

a) Physical Environment

The physical environment includes physical features of a region, largely influenced by the climate, soils, vegetation, developmental activities and lifestyle of the people. The State of Himachal Pradesh is very sensitive seismic zone and falls in zone V and IV as per the Seismic Zoning Map of India, where 32% of the total geographical area is prone to the severest seismic risks as it falls into the Very High Damage Risk Zone V. Sulej River is among dozens of Basins in the Himalayan region that have thousands of glaciers many of which are receding while some are not. Almost half of the annual flow of the Sulej River

comes from snow and ice melt and it feeds up to 80% of the inflow into the Bhakra Dam in Himachal Pradesh. The Sutlej River Basin has 2,026 glaciers of different sizes. The headwaters of the River consist of a glaciated area of 1,426 km². The Basin has great variation in its climate. The climate of Basin varies from hot and sub-humid tropical in the southern part and while the glacier and alpine are seen in the eastern and northern part of the Basin.

Downstream of upper Kinnaur, the catchment experiences mainly the three seasons (i.e., Summer, rainy, and winter seasons). In the Basin, the summer season range from April to June with an average temperature varies from 20°C to 38°C. The rainy season begin from July to September, followed by relatively warm October. Sutlej River Basin receives winter rains and snow mainly because of western disturbances. During rainy season, the monsoon rains first hits the outer ranges of the Indian Himalaya, that's resulted in heavy rain in the Basin area. The total annual rainfall is observed 766 mm in Kinnaur and 800 mm at Rampur. Later, these disturbances cross the outer Himalaya and enter into the inner Himalaya regions that result in low level clouds along with low precipitation. This precipitation continues to decline in the Spiti Valley and beyond the Tibetan border. At the higher altitudes due to the western disturbances, the valley experiences the snowfall (above 1600 m amsl, but sometimes goes upto 900 m amsl). The winter season begin from November to February with the average temperature varies from 0°C to 15°C. During winter season, upper Sutlej River Basin areas receives snowfall which is common in alpine tracts (above 2200 m i.e., in the higher and Trans Himalayan region). Humidity ranges during winter from 35% to 54.2%, which is very low. Sutlej River Basin has competent rocks which offer a stable foundation for the construction of HEPs. All plutonic rocks or hypabyssal rocks like Granites, Syenites, Diorites, Gabbros, and volcanic rocks are most desirable for the foundation of dam due to their strong, durable, interlocking texture, hard silicate mineral composition, absence of inherent weak planes, resistance to weathering characters. Soil in the Basin area is generally shallow in depth except in the areas that's having vegetation cover they have fairly deep soil. In the regions above 1,500 m amsl, the soil is generally deep. Largely the soil can be classified as podzols, both brown podzols and humus and iron podzols are found. These are acidic in nature with the organic content ranging from medium to high. Nutritional survey of soil and plant analysis suggests that the soils by and large have low levels of Zn, Cu, B and Mo. Watershed within Sutlej Riverscape has been shown in Fig-6.

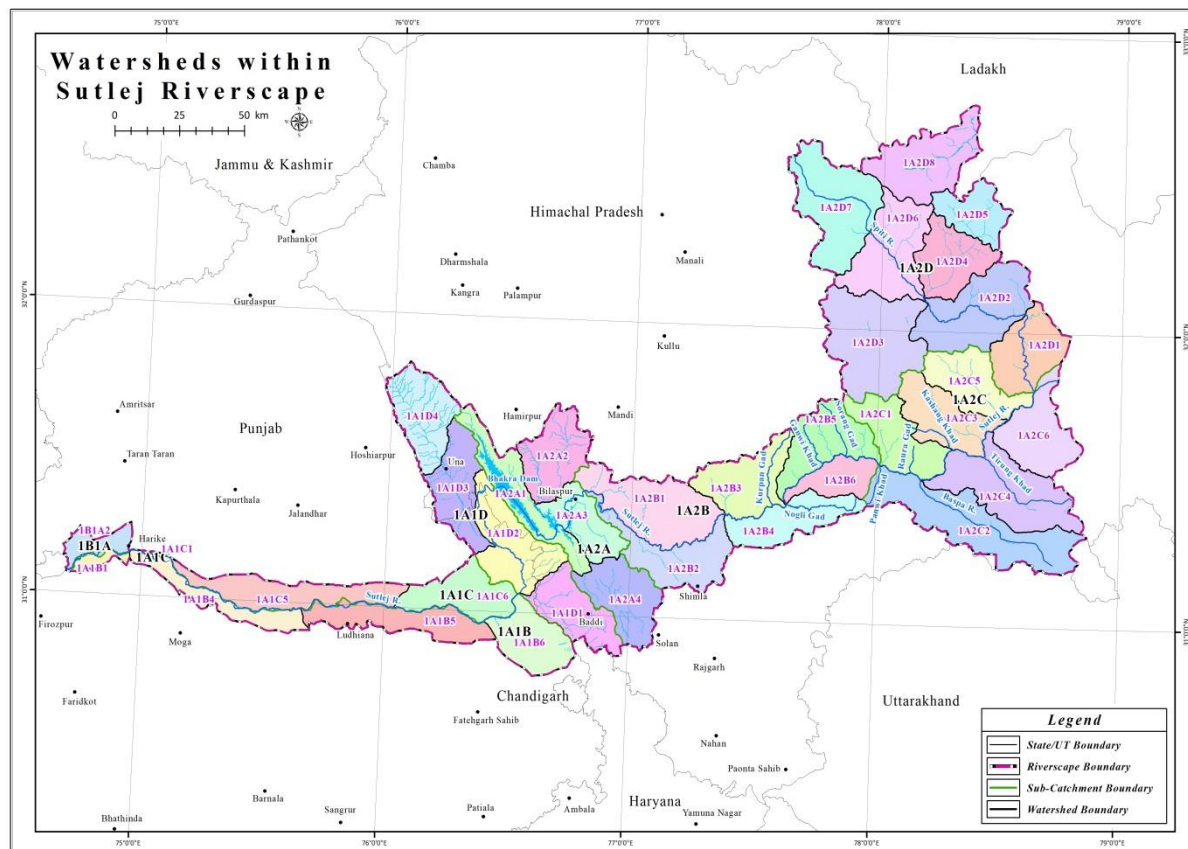


Fig. 6- Watersheds within Sulej Riverscape

b) Biological Environment

Due to varied altitudinal gradients and consequent diversity of micro-climate, Sulej River Basin is richly endowed with diverse forest types. As per forest type mapping undertaken by FSI with reference to Champion and Seth's classification, Himachal Pradesh has 24 forest types which belong to 7 forest type groups. Likewise, Punjab has 5 forest types falling under 2 (Tropical Dry Deciduous Forests and Sub-Tropical Pine Forests) major forest type group (ISFR, 2019). Sulej River Basin comprises of 7 forest type groups having total forest area of 25,363.06 km². The extent of forest types in Sulej River Basin catchments showed a very distinct pattern with Dry Alpine Forests (75.04 km²), Himalayan Dry Temperate Forests (428.29 km²), Himalayan Moist Temperate Forests (1,333.08 km²), Scrubs (771.96 km²), Sub-Alpine Forests (51.59), Sub-tropical Pine Forests (1,633.09 km²), Tropical Dry Deciduous Forests (1,235.4 km²) and Non Forest (19,834.61 km²). While in Punjab, the extent of forest type in Sulej River Basin comprises of Northern Dry Mixed Deciduous Forests (5B/C2) (1,233.57 km²), Dry Deciduous Scrubs (5/DS1) (24.39 km²), Dry Bamboo Brakes (5/E9) (17.81 km²), Khair-Sissoo Forests (5/IS2) (2.67 km²) and Lower or Siwalik Chirpine Forests (9/C1a) (69.51 km²). Besides these forest type groups, Tree Outside Forests (TOFs) with an area of 225.05 km² has also been reported. Sulej River Basin also exhibits great extent of faunal variations, out of which fauna of the upper Basin (Cold Desert) is of special concern; as most of the wildlife is reported in this part of the region. In Sulej River Basin, the major carnivores are mostly endangered species, and are of special concern with the view of conservation purpose. Major carnivores reported from upper Sulej River Basins are Snow Leopard (i.e., State Animal of Himachal Pradesh), Black bear, Wooly hair wolf and Brown

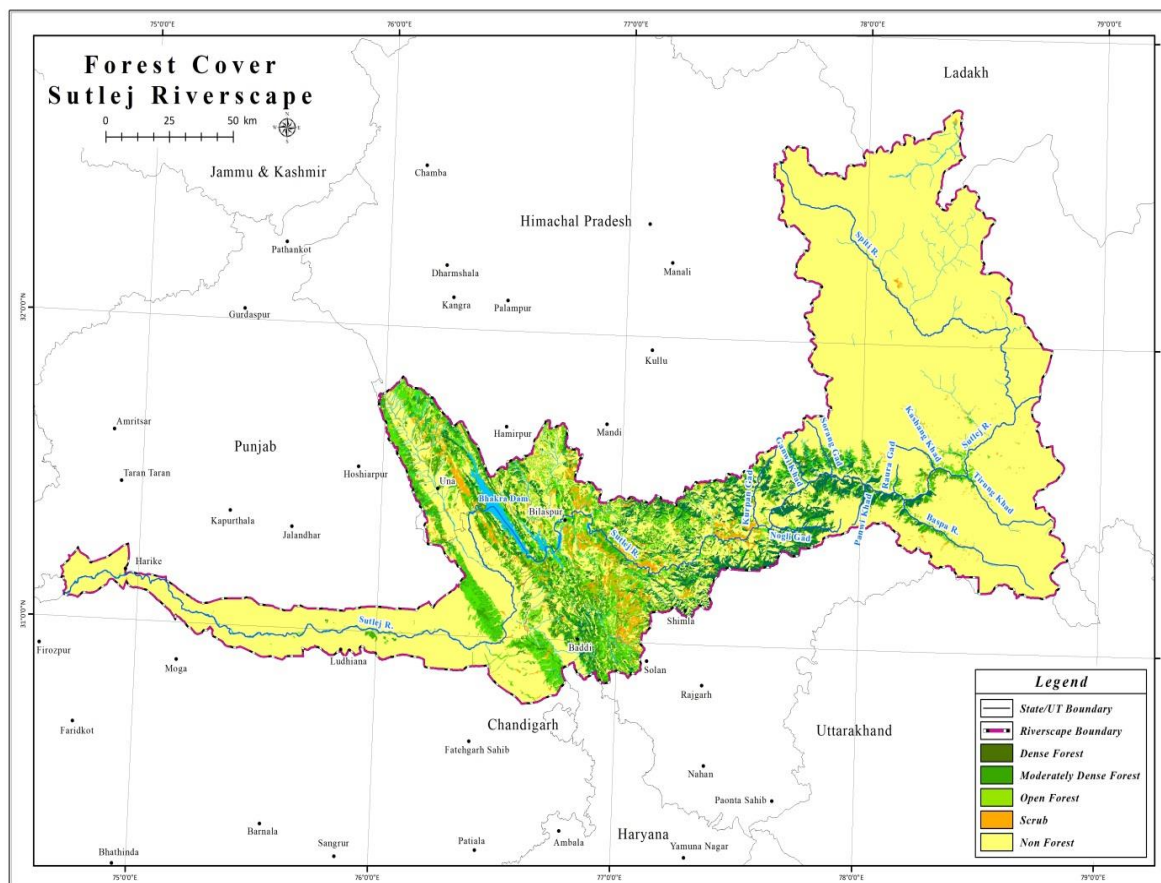


Fig. 8 -Map of Forest Cover of Sutlej Riverscape

c) Socio-Economic Environment

Sutlej Riverscape area falls in Himachal Pradesh and Punjab covering administrative districts viz; Lahaul and Spiti, Kinnaur, Shimla, Kullu, Mandi, Bilaspur, Hamirpur, Solan and Una, with tribal area spread over the district of Lahaul-Spiti and Kinnaur in Himachal Pradesh; and Rupnagar, Mohali, Jalandhar, Ludhiana, Hoshiarpur, Kapurthala, Moga, Amritsar, Taran-Taran and Ferozpur districts in Punjab. Sutlej River is source of fishing, navigation, sand mining, irrigation, drinking water and has also immense hydro-electric potential. People in Sutlej River Basin are mainly engaged in agriculture and horticulture sector. The agricultural crops which are sown and harvested mainly include wheat, paddy, maize, barley, pulses, vegetables, etc. The main horticulture fruits those found in the Riverscape region are apple, pear, almond, apricot, and dry fruits. The Kinnaur district is known for the production of nuts and dry fruits. The potato production is very high in Spiti. Kalpa, Ribba, Peo, Akpa and Rampur are known for the horticulture producing areas. The Solan district is famous for mushroom and tomato production. Bilaspur area under Sutlej catchment is related to the production in the agriculture and fish sectors. As per the Government of India Hydropower Policy, 2008, a revenue equivalent of 1% of electricity generated is available every year till the life time of the HEPs for Local Area Development Assistance (LADA). The Indira Gandhi Canal (Originally: Rajasthan Canal) is the longest canal of India. It starts from the Harike Barrage at Harike, a few km below the confluence of the Sutlej and Beas Rivers in the Punjab and terminates in irrigation facilities in the Thar Desert in the North- West of Rajasthan State. Sutlej River Basin also supports the livelihood of the local communities in term of providing fuel wood, fodder, medicinal herbs and other minor forest products including Chilgoza. Scenic

beauty of Sutlej River and other water bodies in Sutlej River Basin offers immense tourism potential.

The preprocessed geometrically, radio-metrically corrected, and resolution merged Landsat-8 satellite datasets were displayed on screen for attempting visual interpretation of various land use classes. Standard image interpretation keys, viz., shape, size, color, tone, texture, pattern, shadow, site, association and phenology have been used to generate Image Interpretation scheme. Onscreen 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. Land Use and Land Cover of Sutlej Riverscape has been given in Fig-9.

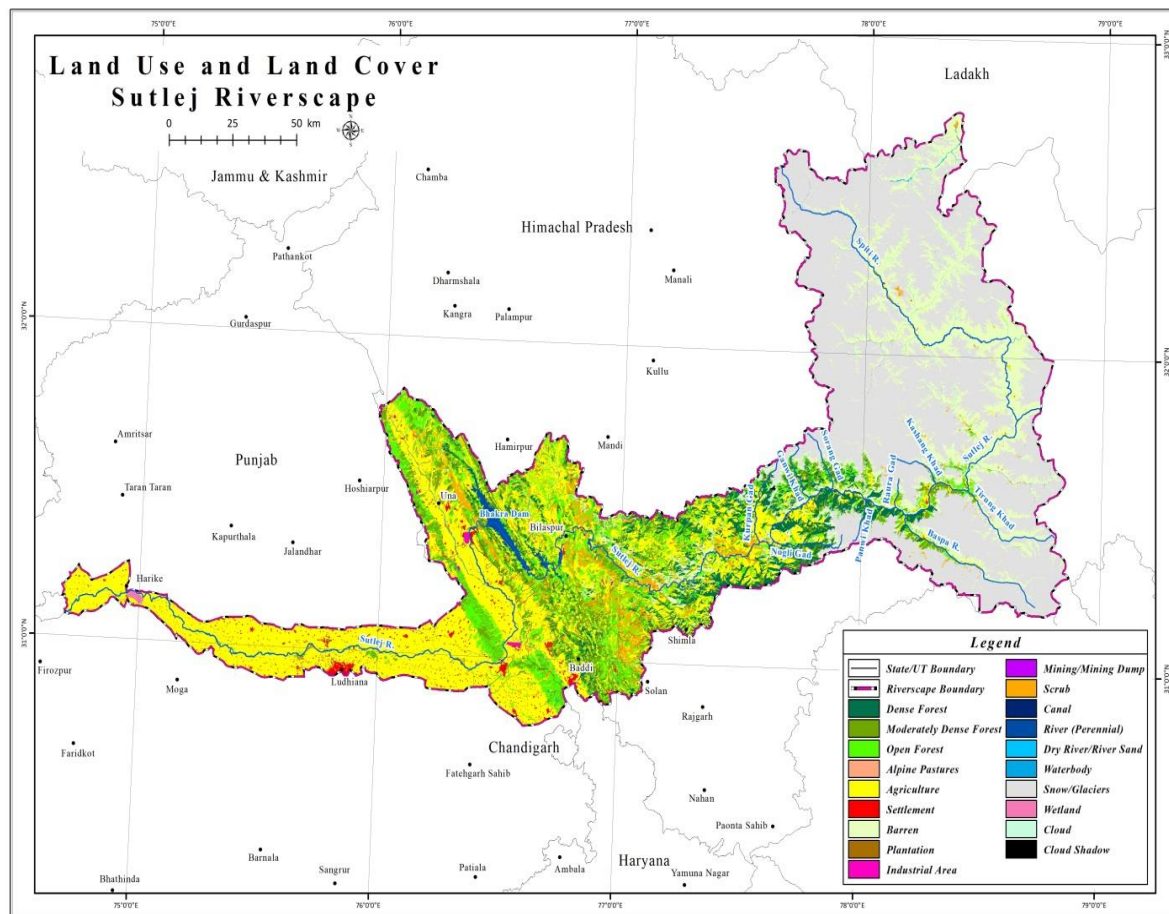


Fig. 9- Land Use and Land Cover of Sutlej Riverscape

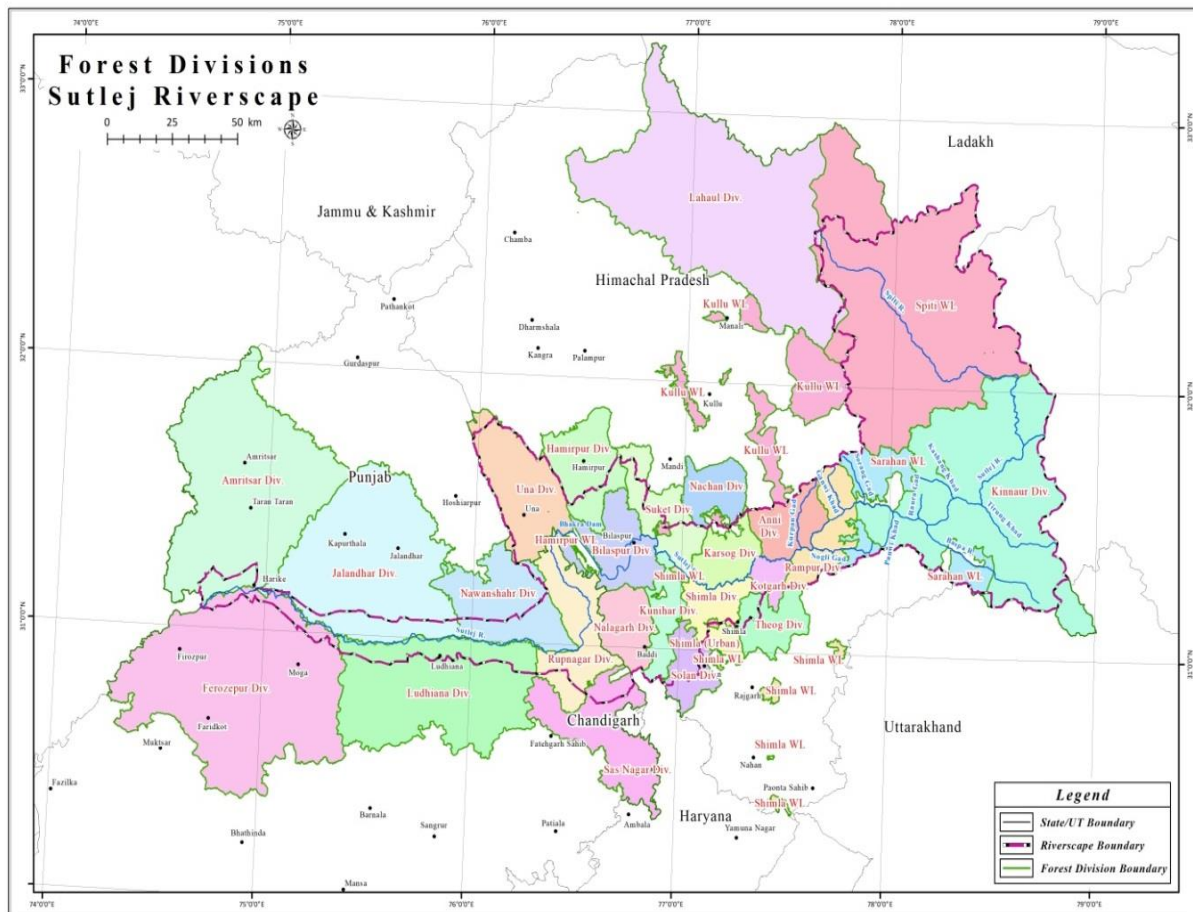


Fig. 10- Map of Forest Divisions of Sulej Riverscape

Priority Treatment Area: The purpose of present DPR on Forestry Interventions for rejuvenation of Sulej River, the approach to delineate the Sulej Riverscape, its geospatial analysis and criteria for modeling to prioritize sites for proposed forestry interventions within the delineated Riverscape. Further, the preceding section has described the physical and biological sub-environments of the Sulej Riverscape so as to comprehend the existing situation of the physical conditions and biological diversity within the Riverscape and at the same time to appreciate the factors responsible for the current state of the environment and degradation of natural resources, particularly the River ecosystem, the analysis of River environment also helped in understanding the past trends and in recognizing the major challenges, issues, threats and constraints relevant to conservation of Sulej River ecosystem. The following Priority treatment areas map and subsequent Table represents the major findings based on geospatial analysis of the Sulej Riverscape and priority sites identified for Forestry Interventions on the basis of multi-criteria modeling performed for the purpose.

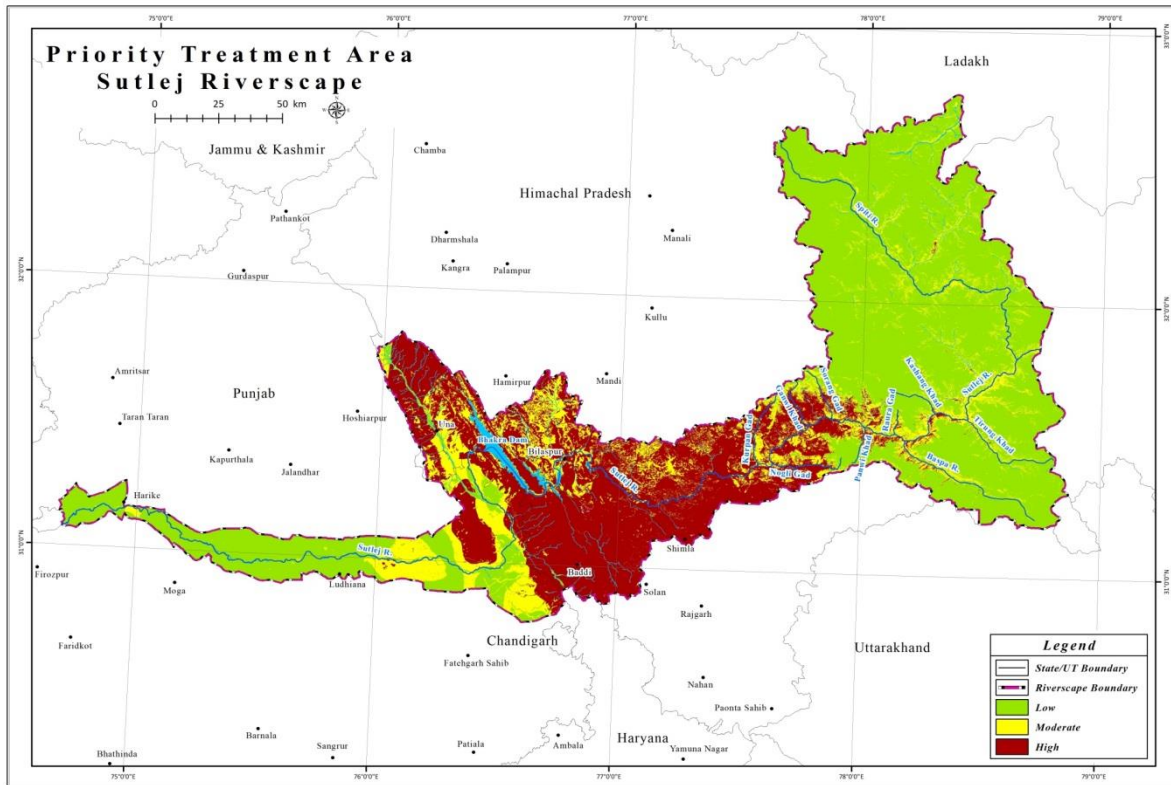


Fig. 11- Priority Treatment Area of Sutlej Riverscape

Table-3 Priority Class in Himachal Pradesh

Priority Class	Area (in km ²)
Eliminate	23.65
High	6,295.41
Moderate	2,961.49
Low	10,874.06
Total	20,154.61

Table-4 Priority Class in Punjab

Priority Class	Area (in km ²)
Eliminate	1.49
High	610.41
Moderate	966.39
Low	2,377.93
Total	3,956.22

Historical and Strategic Perspective

Sutlej River is an eastern River that originates from China and drains into Indus River in Pakistan. As per the Indus Water Treaty 1960, all the waters of the eastern tributaries of the Indus River originating in India i.e., the Sutlej, Beas and Ravi Rivers taken together, were made available for the unrestricted use of India. The main River and the several tributaries contributing to it have their origin in glaciated areas, are therefore, perennial in nature and flow with ample discharge of water around the year.

Legislative, Policy and Institutional Context

The sound policy framework is essentially needed for the purpose of better management of River ecosystems to ensure the equitable, sustainable and resolution of water conflicts amicably. Some of the key elements for this would contain National River Policy, National Water Policy, River zone regulation, floodplain protection, catchment management, protection of local water system, wetland and forests, confirming freshwater flow in perennial Rivers even from existing dams and hydropower projects. Numerous legislative acts, guidelines, regulations have been enacted from time to time in the context of the conservation of diversified components of the environment e.g., forests, grasslands, wetlands, agriculture lands, pasture lands and coastal, and marine habitats and the overall urban/rural surroundings. The conservation of River ecosystems is complex in nature and it comes under the ambit of several laws, guidelines and government authorities. Some of the important International, National and Regional legal guidelines, rules, policies are listed as below:

- (i) Indus Water Treaty, 1960
- (ii) Inter- State Water Disputes Bill, 2019
- (iii) The Water (Prevention and Control of Pollution) Act, 1974
- (iv) Inter-state River Water Disputes Act, 1956
- (v) Rivers Boards Act, 1956
- (vi) The Forest Conservation Act, 1980
- (vii) The Environment (Protection) Act, 1986
- (viii) The Wildlife (Protection) Act, 1972
- (ix) Biodiversity Act, 2002
- (x) National Water Policy, 2012
- (xi) Himachal Pradesh Forestry Sector Medicinal Plants Policy, 2006
- (xii) Himachal Pradesh Grazing Policy, 1990
- (xiii) Himachal Pradesh Hydro-Power Policy, 2006
- (xiv) Policy for Managing Lantana in Himachal Pradesh, 2017
- (xv) Policy on Payment for Ecosystem Services (PES) in Himachal Pradesh, 2013
- (xvi) Prevention of Illegal Mining, Transportation and Storage) Rules, 2015.
- (xvii) Municipal Solid Waste Management Rules, 2016
- (xviii) Wetlands (Conservation and Management) Rules, 2017
- (xix) The EIA Notification, September, 2006
- (xx) Punjab Fisheries Act, 1914
- (xxi) The Punjab State Board for the Prevention and Control of Water Pollution Rules, 1977
- (xxii) The Punjab State Board for the Prevention and Control of Air Pollution Rules 1983
- (xxiii) The Punjab Land Preservation Act, 1900
- (xxiv) Punjab Preservation of Sub-Soil Water Act, 2009

Sutlej River Basin Problems

Sutlej River is a major source of irrigation and hydro-electric power in Northern India and it is the longest of the five tributaries of the Indus River. But, currently due to anthropogenic and natural hazards, the Basin is under threat. Various problems which the Basin faces have been briefly described below:

a) Natural Hazards

Mountain areas are especially vulnerable to natural disasters where development activities over the years have further accentuated the problems by upsetting the natural balance of various

physical, biological and ecological processes operating in the mountain eco-systems. The increasing anthropogenic pressures on the mountain environment have contributed in some measure to natural hazards such as landslides, land subsidence, removal of vegetation and soil erosion, etc.

b) Flash Floods

Floods are another form of natural hazards which the States experience every year. Due to the diverse topography of the area, the flood problem in the State is largely isolated in nature. High monsoon rains in the area of the Shivalik and Lower and Mid Himalayan ranges causes extensive floods during the rainy season. In the upper reaches of the Sutlej valley, the main problems are flash floods and bank erosion because of steep slopes of Rivers and High River flows due to heavy rains. Often the flash floods caused due to cloudbursts, glacial lake outbursts and temporary blockage of the River channels have been also observed. As a result of breaches in embankments and damage to various utilities like irrigation/flood control schemes, roads, bridges and houses are also observed. Three floods that submerged the entire Sutlej River Basin in 1997, 2000 and 2005 have affected the Sutlej River catchment area immensely. It not only led to damages in the area, but the entire topography has also changed with heavy erosion of the Riverbanks. During the period between 1991-2003 nearly 36 major cloudbursts and flash floods have been observed.

A Study conducted by Sharma *et al.* (1996) suggested that the part of Punjab comprising districts of Mansa and Sangrur get flooded locally due to congested drainage in 1988 and 1993. The comparative study of extent of flooding in 1988 and 1993 suggests that during the 1988 floods a large area along the Sutlej River in Ludhiana and Firozpur districts was flooded. However, during the 1993 floods, this area in the Ludhiana and Firozpur districts remained unaffected as most of the water got diverted, flooding large tracts in Rupnagar, Fatehgarh Sahib, Patiala and Mansa districts. This was mainly due to breaches in embankments of the Sutlej River, Sirhind canal, Bhakhra Main Line and Sutlej Yamuna Link Canal.

c) Climate Change

Sutlej River is significantly fed by glaciers, and those are likely to be altered considerably in the future due to climate change, as glaciers are highly sensitive to variations in temperature and precipitation. This phenomenon has negatively influenced the mass and area of glaciers in the region in last few decades, which are now at risk of shrinking, thus affecting water availability in the region. The Higher Hills comprising the districts of Kinnaur and Lahaul & Spiti are particularly vulnerable to the hazards of avalanches. The destruction caused as a result of avalanche in the past in Himachal Pradesh though not widespread is confined to higher reaches only resulting in drastic increase in the silt load of the River.

d) Anthropogenic Activities

Due to fragile ecosystem of the Himalayan region, River Basin is very prone to landslides either through anthropogenic activities (i.e., HEPs constructions, encroachments, road diversion, construction and over dependency of local communities on forests) or through natural disturbances. In the recent past too, the Basin has witnessed various landslides in different locations in the upper reaches of the Basin, which ultimately resulted in soil erosion.

There has been reduction in apple production which is attributed to dust pollution caused by various hydro-power project-related activities (e.g., blasting and construction of underground tunnels for channelizing the waters of River) in Sutlej River Basin.

e) Muck and Silt Problem

Dumping of muck along Sutlej River is another big threat as it has not only narrowed the original River course, but it has forced the River to change its course at some places. The Sutlej River carries the maximum amount of silt among the Indian Rivers. The total suspended load for the Spiti River has been reported to be 7.66 MT/ year and for Sutlej River of 7.30 MT/year. The annual sediment transport for the Spiti River has been reported to be equal to 7.84 MT and 7 MT for Sutlej River. The maximum flows in it occur during June-August resulting from combined contribution of rainfall and snowmelt floods have been recorded.

f) Depletion of Natural Water Resources

Construction of HEPs and other developmental activities in Himachal region has resulted into depletion of natural water resources. A study by the Water and Power Department of Punjab in 2009 included South Punjab among the regions where the ground water, due to heavy pumping and little recharging prospects, had become unfit for human consumption and irrigation purposes. Punjab region also faces a problem of decline in ground water table due to over exploitation of these precious resources in last 4-5 decades.

g) Pollution

Although River has self-cleansing capacity through water tabulations but to a certain extent as due to heavy metal, other toxic effluents influx from factories and waste water from the households that drain to the Sutlej River as it is or through tributaries like Sarsa *nallah*, Buddha *nallah* and Chitti Bein which has further degraded the water quality of the Sutlej. Since the water of the River has been used for the purpose of drinking in Himachal Pradesh, Punjab, Haryana and Rajasthan there has been cases of severe diseases like cancer in those areas. Therefore, it is right time to clean this River through Forestry Interventions, bio-remediation, etc.

h) Sand Mining

Illegal sand mining not only harming the ecology of the region in the Sutlej River Basin, but is also resulting in environmental hazards to fragile mountains of Himalaya and also results into frequent changes in River coarse, floods and eroding the fertile River banks.

National Importance

The Sutlej River is among the three eastern Rivers that were divided between India and Pakistan according to the Indus Water Treaty (IWT) in 1960. Under the IWT, all the waters of the eastern tributaries of the Indus River originating in India, i.e., the Sutlej, Beas and Ravi Rivers taken together, are made available for the unrestricted use of India. Other importance of Sutlej River is the Bhakra Dam, which is the major point of water supply and electricity generation in northern India. It is worth mentioning that the International law about the utilization of the Rivers says the upper Riparian cannot use the waters of a River to the extent

that it affects its flow pattern. People had cultivated cash crops like pulses, gram and wheat and reared livestock on the Riverside for centuries, but a drying Sutlej pushed them into the realm of extreme poverty.

Details of specific Stakeholders

A broad-based list of stakeholders in five identified groups, highlighting the prominent Central/ State Governments Ministries, Departments, Agencies, Organisations besides Civil Agencies and NGOs that were consulted or their representatives participated in National Level Project Launch and Brainstorming Workshop and subsequent sequential Consultative Meetings organized for the purpose at the Forest Circle/ Division level in Himachal Pradesh and Punjab lying along the main River course is given in Table-5.

Table-5: Broad-based list of stakeholders in five identified groups

A. Target Groups (Primary and Secondary Target Groups and Beneficiaries)
Civil Society – Villagers, Farmers, Fishermen and Urban Population
State Forest Department (SFD) – Himachal Pradesh and Punjab
Department of Agriculture
Department of Animal Husbandry
Department of Horticulture
Department of Soil and Water Conservation
Department of Fisheries
Department of Highways and Public Works Departments (PWDs)
Department of Irrigation
Hydro-electric Projects
Department of Tourism
Para Military Forces
Panchayats
Municipal Corporations/ Municipal Boards
B. Project Owners and Partner Organizations
Ministry of Environment, Forest and Climate Change (MoEF&CC), New Delhi
Indian Council of Forestry Research and Education (ICFRE), Dehra Dun, Uttarakhand
State Forest Departments (SFDs) – Himachal Pradesh and Punjab
Himalayan Forest Research Institute (HFRI), Shimla, Himachal Pradesh
C. Decision Makers
The Central Government Ministries/ Departments/ Agencies/ Organizations
NITI Aayog, New Delhi
Ministry of Environment, Forest and Climate Change (MoEF&CC), New Delhi
Ministry of Jal Shakti (MoJS), 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 Defense (MoD), New Delhi
Bhakra Beas Management Board (BBMB), Chandigarh
Central Water Commission (CWC), New Delhi
National River Conservation Directorate (NRCD), New Delhi
Central Pollution Control Board (CPCB), New Delhi
National Medicinal Plants Board (NMPB), New Delhi
National Biodiversity Authority (NBA), Chennai
<i>Nehru Yuva Kendra Sangathan (NYKS), New Delhi</i>
State Government Ministries/ Departments/ Agencies/ Organizations in States – Himachal Pradesh and Punjab
State Governments and Concerned Ministries - Himachal Pradesh and Punjab
State and District Administration
State Forest Department
State Forest Development Corporation
State Biodiversity Board
State Agriculture Department
Irrigation and Public Health Department
Horticulture Department
Department of Animal Husbandry
State Disaster Management Authority
State Pollution Control Board
D. Experts and Specialized Scientific Organizations
Indian Council of Forestry Research and Education (ICFRE)
Forest Research Institute (FRI)
Forest Survey of India (FSI)
Himalayan Forest Research Institute (HFRI)
Indian Institute of Soil and Water Conservation (IISWC)
National Institute of Hydrology (NIH) and its Regional Centers
Central Water Commission (CWC)
Central Groundwater Board (CGWB)
Wildlife Institute of India (WII)
Indian Institute of Remote Sensing (IIRS)
Zoological Survey of India (ZSI)
Botanical Survey of India (BSI)

Survey of India (SOI)
Indo-Tibetan Border Police (ITBP)
Eco-Task Force (ETF)
National Horticulture Board (NHB)
National Bureau of Fish Genetic Resources (NBFGR)
Indian Agriculture Research Institute (IARI)
Centre of Inland Waters in South Asia (CIWSA)
Central Inland Fisheries Research Institute (CIFRI)
National Medicinal Plants Board (NMPB)
Bombay Natural History Society, Mumbai
WWF – India, New Delhi
Dr. Y. S. Parmar University of Horticulture and Forestry (UHF), Nauni, Solan, Himachal Pradesh
Himachal Pradesh University (HPU), Shimla, Himachal Pradesh
CSK Himachal Pradesh Krishi Vishva Vidyalaya, Palampur, Himachal Pradesh
Punjab Agriculture University (PAU), Ludhiana, Punjab
Punjab University (PU), Chandigarh
Guru Nanak Dev University (GNDU), Amritsar
Bhakhra Beas Management Board (BBMB)
Himalayan Organization for Organic Agri-product Research and Development (HIMOARD)
Himalayan Research Group (HRG), Shimla
E. Funding Agencies
Central Government – Ministry of Finance, MoEF&CC, MoJS, MoA, MoRD, Ministry of AYUSH, MoPR
State Government - Ministry of Finance/ Environment and Forest/ Rural Development/ Agriculture/ Tribal Affairs/ Panchayati Raj, etc.

Details of Consultative Meetings held with Stakeholders

For the preparation of Detailed Project Report (DPR), extensive consultative and subject matter expert meetings were held. Trainings to the field staff of State Forest Department(s) of Himachal Pradesh and Punjab were also provided at different places. Details are provided in Table-6:

Table- 6 Consultative Meetings at the National and State Levels for the Preparation of DPR

Sr.No.	Consultation Event	Date, Venue	No. of Participants
1	National Level Inception Workshop on Preparation of DPRs of Indian Major Rivers	24-25 April 2019 ICFRE, Dehradun	61
2	State Level Project Launch and Brainstorming Workshop – for all the three States viz. HP, Punjab and	28-29 June 2019 Hotel Holiday Home, Shimla	178

	Erstwhile J&K		
3	Consultative Meeting for Rampur Forest Circle, Himachal Pradesh	2 August 2019 Office of the Rampur Forest Division, Rampur	55
4	Consultative Meeting for Kinnaur Forest Division, Himachal Pradesh	9 August 2019 Reckong Peo, Kinnaur	50
5	Consultative Meeting for Bilaspur Forest Circle, Himachal Pradesh	17 August 2019 Bilaspur,	47
5	State Level Consultative Meeting for the state of Punjab	21 August 2019 Forest Complex, Mohali, Punjab	65
6	Consultative Meeting for Lahaul & Spiti Forest Division, Himachal Pradesh	17 September 2019 Lahaul & Spiti	38
7	Consultative Meeting for Solan Forest Circle, Himachal Pradesh	1 October 2019 Solan	55
7	Subject Matter Specialists Meeting for Ludhiana, Punjab	16 October 2019 Punjab Agriculture University, Ludhiana	53
8	Consultation Meeting for Una Forest Division, Himachal Pradesh	14 November 2019 Office of the Una Forest Division, Una, Himachal Pradesh	43
9	Training to Punjab Forest Department	3-11 December 2019 at Ferozpur, Amritsar, Jalandhar, Phillaur, Ludhiana, Roop Nagar and Mohali etc.	102
10	Subject Matter Specialists meeting with Soil Conservation and Drainage Department of Punjab	9-10 December 2019 at Ludhiana	15
11	Final Consultative Meeting for Finalization of Detailed Project Reports (DPRs) for Rejuvenation of Beas, Ravi and Sutlej River Basins through Forestry Interventions'	12 March 2020 Forest Complex Mohali, Punjab	75
12	Final Consultative Meeting for Finalization of Detailed Project Reports (DPRs) for Rejuvenation of Indus River Basin through Forestry Interventions'	26 June 2020 (through Video Conferencing)	55

Current and Important Issues

The Sutlej River Basin has witnessed several flash floods in the recent decades along the tributaries of the Sutlej River. It was 1993, 1995, 1997, 2000, 2005, 2007 and 2013 when most of the disastrous floods were experienced in the Sutlej River. During flash floods, unusual high discharge was observed. Water level in a River could rise up to 15 to 20m from normal River level and its discharge may go up to 10-12 times more than a normal discharge. During the period of 12 years (1991-2003), nearly 36 major cloudbursts and flash floods have been recorded. An unprecedented cloudburst and flash flood of August 11, 1997 in the catchment area of Sutlej River caused extensive damage. The Sutlej River was blocked near Wangtoo and a 5 km long and 2 km wide lake was formed in a matter of hours.

Activeness of floods in Sutlej River floodplain area can be noticed from the frequent flood incidences occurred during 1988, 1993, 2010 and 2013. During September, 1988, Sutlej River breached its banks near Machhiwara and in Budha Nallah stream, which affected agricultural

fields in Rupnagar and Ludhiana Districts. In July–September, 1993, Dhussi Bandh in Phillaur tehsil of Jalandhar District was breached and caused loss to the crops and lives of adjoining villages. Population distribution pattern on land portrays the relationship between land and its users. Agriculture fields are very close to Riverscape. Agriculture runoff from fields is also contributing to water pollution. It also receives waste water from the villages and other sources situated along the River. The fertilizer / pesticide run off from agricultural fields on both sides of the River also contribute to its pollution load of the Riverscape. Influx of toxic effluents from Buddha *Nallah* and Sarsa *Nallah* is major challenge for keeping River water safe for use in drinking and irrigation purpose. The whole process of landscape transformation in Punjab Sutlej floodplain accentuates the problem of resource depletion. Loss of biodiversity was an important adverse implication of land use and land cover change. The qualitative and quantitative loss of surface and sub-surface water is also the major concern of the Basin area. Soil degradation through soil erosion, waterlogging and soil loss is also one of the major concerns. Despite Sutlej Action Plan, it remains a non-starter for the last few years at Ludhiana, Jalandhar, Phagwara, Kapurthala and Phillaur, which yet have to see any major progress on the project. There also has been blatant violation of e-Flow regulation by the HEPs especially in winter months.

Suggestions and Recommendations Received During Consultative Meeting

During the various consultative meetings with various Stakeholders and Subject Matter Specialists, following recommendations/suggestions were provided by the Experts/ participants for inclusion in the DPR:

1. Silt problem in the River should be addressed by the Forestry Interventions.
2. Proper policy for muck disposal off should be framed and implemented as developmental activities have caused ecological imbalance in the Himalayan region.
3. Avalanche/Moraine management should be addressed in the DPR
4. Bio-filtration of the waste water should be on priority in DPR
5. Pollution (Toxic effluents) by Budhha *Nallah* and Sarsa *Nallah* should be monitored through policy frame work
6. Pasture development must be addressed in DPR
7. Enrichment plantations need to be recommended for improving quality of forests.
8. New landslide prone areas should be identified and treatment measures should be suggested in the DPR.
9. Representatives of the HEPs were of the view that over mining of the River bed has caused sinking of the River bed and cutting of the River bed through mechanical means should be addressed.
10. Officials of Himachal Pradesh Forest Department were of the view that over dependency of the local communities to the forest resources should be minimized by making provision of alternative livelihood opportunities.
11. There has been increase in number of cases of human-wild animal conflict; therefore measures should be suggested for keeping wildlife in the forest through Forestry Interventions.
12. Removal of *Lantana*/weed (IAS) should be addressed in DPR.
13. Water quality issues needs to be addressed.

14. Low ground water table in case of Punjab is major concern which needs to be addressed.
15. Some incentive schemes need to be added in the DPR for motivating farmers of the Punjab towards agroforestry.
16. Flooding in Punjab is a major concern which needs attention.
17. There has been an issue of livelihood support to the local communities residing within the Basin area, needs to be addressed.
18. Drying of natural water resources is also one of the major concerns.
19. Soil erosion check through check dams /brushwood structures is also recommended in the Meetings.
20. Participants were of the views that forest fire is also major concern to prevent biodiversity loss, which needs attention in the current task of DPR.
21. The issue of minimum e-flow in the River also raised in the Meetings which need to be addressed.
22. Issue of diversion of water through tunnelling has resulted into drying of natural water resources and ultimately River, which needs to be looked into through policy interventions.
23. Issue of over exploitation of Sutlej River by construction of enormous HEPs was also raised by the participants.

Proposed Forestry Interventions

- (a) **Himachal Pradesh:** Following the Consultative Meetings/Trainings, field functionaries of the Forest Division(s) of Himachal Pradesh Forest Department carried out extensive field exercise and submitted duly filled in formats to HFRI for designing of the plantations/treatment models.
- (b) **Punjab:** Following the Consultative Meetings/Trainings, field functionaries of the Forest Division(s) of Punjab Forest Department carried out extensive field exercise with regard to various Forestry Interventions and returned duly filled in formats to HFRI for designing of the plantations/treatment models.

Treatment Models Proposed by HFRI

A multidisciplinary team of Scientists, Forest Officers, Technical Officers and staff worked out the modalities with respect to various Forestry Interventions and proposed plantation and treatment models for Sutlej River Basin in Himachal Pradesh and Punjab which is summarised in Table-7.

In general, following guidelines would be applicable to all proposed Plantation Models meant for three different Landscapes 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 3 and Annexure 4, respectively
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 barbed 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 Landscape, the Seechewal Model (Punjab) for bio-remediation and bio-filtration 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 micro plan 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.
24. The suggested interventions is to be considered flexible and not rigid, in terms of changing the site location, area, species and minor changes in the models and the applicable schedule rates if the circumstances demand so while implementation the DPR Sutelj and the concerned Conservator of Forest shall exercise the power to approve such changes as and when required.
25. The project costs have been worked out on the basis of rate prevalent during year 2019-20 in the respective State/UTs and 7% escalation in the project cost during the subsequent years has been incorporated in anticipation of the cost escalation in future. However, actual project cost at the time of implementation on yearly basis shall need revision as per the change in Wholesale Price Index (WPI) on year to year basis. The Conservator of Forest may be empowered to revise the project cost accordingly for the quality desired output of the project.

Table-7: List of models proposed in Sutlej River Basin Rejuvenation

Landscape	Himachal Pradesh	Punjab
Natural Landscape	1. Cold Desert Greening SL/HP/NL/01 2. Cold Desert Conservation SL/HP/NL/02 3. Alpine Conservation SL/HP/NL/03 4. Sub-Alpine Enrichment SL/HP/NL/04 5. Dry Temperate Conifer Forest Enrichment SL/HP/NL/05 6. Temperate Conifer Forest SL/HP/NL/06 7. Temperate Mixed Forest SL/HP/NL/07 8. Pasture and Grazing land Development SL/HP/NL/08 9. Himalayan Chir Pine Forest SL/HP/NL/09 10. Himalayan Mixed Forest SL/HP/NL/10 11. Sub-Tropical Dry Deciduous Forest SL/HP/NL/11 12. Eradication of <i>Lantana</i> SL/HP/NL/12 13. Control/ Removal of Invasive species < 50% <i>Lantana</i> SL/HP/NL/13 14. Protection Model for Natural Re-generation SL/HP/NL/14 15. Fire Protection Model SL/HP/NL/15 16. Plantation by Eco -Task Force in temperate Forests SL/HP/NL/16	1. Shivalik Hills Forest Enrichment SL/PB/NL/01 2. Degraded Model with Staggered Trench and Pits SL/PB/NL/02 3. Control / removal of Invasive species and <i>Lantana</i> SL/PB/NL/03 4. Block Plantation Model SL/PB/ NL /04 5. Road Side Plantation SL/PB/ NL /05
Agriculture Landscape	1. Boundary Plantation Model SL/HP/AL/01 2. Block Plantation Model SL/HP/AL/02	1. Boundary Plantation Model SL/PB/AL/01 2. Block Plantation Model SL/PB/AL/02
Urban Landscape	1. Bio-remediation and Bio-filtration SL/HP/UL/01 2. Riverfront Development SL/HP/UL/02 3. Institution Plantation SL/HP/UL/03 4. Eco-Park Development	1. Bio-remediation and Bio-filtration SL/PB/UL/01 2. Riverfront Development SL/PB/UL/02 3. Institution Plantation SL/PB/UL/03 4. Eco-Park Development

	SL/HP/UL/04	SL/PB/UL/04
Conservation Interventions	1. SL/HP/CI/01 Brushwood Check Dam 2. SL/HP/CI/02 Dry Stone Check Dams 3. SL/HP/CI/03 Crate Wire Structures 4. SL/HP/CI/04 Ponds 5. SL/HP/CI/05 Silt Detention Structures/ WHS	1. SL/PB/CI/01 Brushwood Check Dam 2. SL/PB/CI/02 Dry Stone Check Dams 3. SL/PB/CI/03 Crate Wire Structures 4. SL/PB/CI/04 Ponds 5. SL/PB/CI/05 Silt Detention Structures/ WHS
Other Interventions	1. SL/HP/CI/06 Riverine and Riparian Wildlife Management 2. SL/HP/CI/07 Wetland Management	1. SL/PB/CI/06 Riverine and Riparian Wildlife Management 2. SL/PB/CI/07 Wetland Management

Implementing Agencies and Institutional Context

Although the subject of water and water resources in India comes under the ambit of Union Ministry of Jal Shakti, but the subject of Forestry and Forestry Interventions in River Basin and catchments come under the purview of MoEF&CC. Accordingly, the MoEF&CC assigned the current task of the preparation of DPR to HFRI, Shimla, through its HQ, ICFRE, Dehradun. The DPR recognizes that the State Forest Departments of the Himachal Pradesh and Punjab would function as the primary Implementing Agency (IA) at the State level. Thus, existing JFMCs, Gram Panchayats and other related CBOs would appropriately be involved in programme implementation. Central Armed Police Forces (ITBP), Eco- Task Force, *Nehru Yuva Kendra*, *Mahila Mandals*, and other CSOs in programme implementation as envisaged in the DPR would also be involved by participating SFDs.

Suggested Implementation and Fund Flow Mechanism

The mechanism of implementation at the State and field levels and constitution of State Level Project Steering Committee (PSC) in Himachal Pradesh and Punjab are diagrammatically shown below in the Fig. 12



Fig. 12- Implementation and Fund Flow Mechanism

Potential Source of Funding

Ministry of Jal Shakti (MoJS)

Ministry of Environment Forests and Climate Change (MoEF&CC)

National Afforestation and Eco-Development Board (NAEB)

Compensatory Afforestation Fund Management and Planning Authority (CAMPA)

KFW Development Bank

Japan International Cooperation Agency (JICA)

Asian Development Bank (ADB)

World Bank

NABARD

Project Budget

The total financial outlay for phase I and phase II for the DPR of Sutlej River through Forestry Intervention is **Rs. 996 Crore**. The projected financial outlay of the Phase 1 on Project Implementation of five-years duration is **Rs. 824.64 Crore**. The projected budget outlay of Phase II (Maintenance Phase) of five-year duration is **Rs. 42.20 Crore**. As mentioned above, the project includes four broad based components. Accordingly, financial cost of each of these four components is given below (Table-8):

Table-8: Component/ Activity Wise Budget Allocation for Sutlej Riverscape

Sr. No.	Component/ Activity	Amount	Allocation Total	Allocation Phase I
		(Rs. in Crore)	(%)	(%)
A.	Implementation of Forestry Interventions in Sutlej Riverscape, in two States (A1+A2)+(C1+C3)	851.84	85.53	87.64
A.1	Plantations and Treatment Models in Three Categories of Landscape	525.17	52.73	63.68
A.1.1	Natural Landscapes	324.03		
A.1.2	Eco Task Force	44.86		
A.1.3	Agriculture Landscapes	47.68		
A.1.4	Urban Landscapes	108.60		
A.2	Conservation Interventions	197.51	19.83	23.95
A.2.1	Soil and Moisture Conservation	144.38		
A.2.2	Riverine and Riparian Wildlife Management	45.93		
A.2.3	Wetland Management (Natural and Artificial)	7.2		
A.3	Supporting Activities	46.62	4.68	5.65
A.3.1	Policy Level Interventions	0.36		
A.3.2	Research Activities	3.31		
A.3.3	Capacity Development	12.95		
A.3.4	Awareness	10.17		
A.3.5	Participatory Monitoring	1.63		
A.3.6	Cost of PMUs of UT Level Implementing Agencies	17.09		
A.3.7	Evaluation	1.02		
A.3.8	Contingency and Miscellaneous Activities	0.09		
B.	Strengthening Knowledge Management and National Capacity for Forestry Interventions and Conservation of Riverscapes	29.52	2.96	3.58
C.	DPR – Phase II (Maintenance phase) Including Scaling Up and Replication of Successful Models of Forestry Interventions	42.20	4.24	
C.1	Maintenance Cost of A.1 and A.2 (Cost of Phase II)	93.03		
C.2	Maintenance Cost of A.3, B and D	42.20		
C.3	Scaling Up and Replication of Successful Models of Forestry Interventions (5% of A.1 & A.2)	36.13		
D.	National Coordination for Forestry Interventions and Riverscape Conservation	25.82	2.59	3.13
	Total Phase I (A+B+D)	824.64		
	Total Project Cost (Phase I+II) (A+B+C+D)	996.00	100.00	100.00

Project Outlay: Component and Activity Wise

The Principal Component-A: Implementation of Forestry Interventions in Sutlej Riverscape

An amount of Rs 851.84 Crore, which is 85.53 % of the overall project budget, is provisioned for principal component A. which include Rs. 525.17 Crores for component A.1, Rs. 197.51 Crores for component A.2 and whereas, Rs. 93.03 & 36.13 crore is provisioned for Sub-component C.1 & C.3 respectively.

Component –A {(A1+A2)+(C1+C3)}: 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. 525.17 crore is provisioned for Forestry Interventions in three Landscapes, which is 52.73% of total budget outlay of the project. Amongst three Landscapes, the more emphasis is on Natural Landscapes, thus a sum of Rs. 324.03 Crores has been provisioned for proposed Afforestation/Reforestation activities in Natural Landscapes in Sutlej Riverscape. The projected budget outlay for proposed plantations in Natural Landscapes accounts for 38.04% of the principal component A. The projected budget outlays for Eco-Task Force, Agriculture and Urban Landscapes are of the tune of Rs. 44.86 Crores, Rs. 47.68 Crore and Rs. 108.60 Crore or 5.83%, 6.20% and 14.12%, respectively of the envisaged cost of the Principal component- A. The projected budget outlays for Sub Component-C.1(Maintenance Cost of A.1 and A.2 -Cost of Phase II) is 93.03 and the projected budget outlays for Sub Component-C.3 (Scaling Up and Replication of Successful Models of Forestry Interventions -5% of A.1 & A.2) is 36.13 Crore respectively.

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 197.51 Crores are provisioned for this sub component, which is 19.83 % of total budget outlay. Of this, the budget outlay for SMC is Rs. 144.38 Crore, which is 16.95 % allocation of the funds provisioned for Component -A. Budget outlay provisioned for Riverine and Riparian Wildlife Management and Wetland Management is 53.13 Crore, which is 6.24 % of total budget of component -A.

The third Sub-component (A.3) pertaining to ‘Supporting Activities’ is to be executed by State/Level IAs. This Sub-component includes eight broad based activities viz., (a) Policy level interventions, (b) Participatory monitoring, (c) Adaptive research, (d) Capacity development, (e) Awareness, (f) Project management, (g) Evaluation, and (h) Contingency and other expenses. A budget of 46.61 Crore or 5.47 % of the component -A or 4.68% of total budget proposed to Himachal Pradesh and Punjab has been provisioned for carrying out various supporting activities for five-year period.

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. 29.52 Crore or 2.96% of the overall project outlay. The highest budget amounting Rs. 10.24 Crore has been provisioned for cost of PFU, while budget of Rs.10.07 Crore has been provisioned for Research and Development, while Rs. 2.68 Crores, Rs. 4.32 Crore, Rs. 5.76 Crore, Rs. 1.54 Crore, Rs. 1.06 Crore and Rs. 2.26 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 years 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. 42.20 Crore or 4.24 % of the total project financial outlay has been envisaged specifically for the Sub-Component – C.2 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. 25.82 Crore, representing 2.59 % 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 Himachal Pradesh and Punjab.

A total of 24 Territorial Forest Divisions and 8 Wildlife Divisions in Sutlej Riverscape will carry out proposed activities relevant to Forestry Interventions within the Riverscape. A total of 27,016 ha area of three Landscapes, 2,000 ha of ETF, 542 ha area of Riverine and Riparian Wildlife Management and Wetland Management and 7,50,828 m³ extent of Soil and Moisture Conservation in Sutlej 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 5-years duration in each case. Thus, the total duration for project implementation including the maintenance phase is of 10-years. At this juncture, it is not clear when the project would commence and which will be the first year of project implementation during Phase I. Since the DPR is prepared by MoEF&CC through ICFRE-HFRI, therefore, it is expected that the Government of India will give responsibility 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. 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 the months 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 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 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.

Potential Benefits

Carbon Sequestration

The HFRI, Shimla has carried out a study on the assessment of carbon stock in biomass and soils in prominent forest types of Shimla Forest Circle. The values of carbon stock in biomass and soils showed high variability on account of the varied forest composition, tree density, growth class, and site characteristics. The values of carbon stock in total biomass various forest types at different field sites ranged from 1.65 t/ ha (Alpine pastures) to 522.2 t/ ha (Kharsu Oak – *Quercus semecarpifolia* forest). Likewise, carbon stock in soils in different forests varied from 39.2 t/ ha (Alder – *Alnus nitida* forest) to 163.2 t/ ha (Alpine pastures). Moreover, there is no precise insight available on the carbon stock in biomass and soils of varied aged forest plantations that too in different agro-climatic and edaphic conditions. Thus, it is difficult to estimate exact information on carbon stock in proposed forest plantations under different treatment models prescribed in various agro-climatic zones and site conditions.

Estimated CO₂ Reduction from Forestry Interventions in Three Landscapes of Natural, Agriculture and Urban (29,016 ha) after 20 years will be 70.22 (metric tonnes CO₂ eq/ha/year)

Water Conservation

The Forestry Interventions activities will conserve 48.53MCM water annually (Table-9)

Table-9: Potential Benefit of water Quantity

Benefits of CAT activities	Component 1: Water Quantity	Plantations	47.93 MCM Water Savings
		SMC works	0.6 MCM Groundwater Recharge
		Total	48.53 MCM

Silt Load reduction

River training works like spurs, Check dams, etc. are various methods which have been adopted universally, falls in the category of Other Interventions. Proposed activities like Brushwood Check Dam, Dry Stone Check Dams, Crate Wire Structures, Creation of Ponds and Water Hydral Structures (WHS) in Conservation Interventions are intended to reduce the silt load in the River. Besides all these mechanical measures, there are certain tree/shrub/grass species proposed in the Plantation models which possesses the qualities of good soil binder also intended to reduce the silt load of the Sutlej River and its tributaries. The Forestry Interventions will reduce 1,35,244 m³ of sedimentation annually (Table-10).

Table-10: Sedimentation Estimation

State	Sedimentation factor (000' m ³ / km ² /yr)	Trap Efficiency	Total CAT Intervention Area km ²	Sedimentation ('000 m ³ /yr)
Himachal Pradesh	0.682	0.9	192.61	118.24
Punjab	0.682	0.9	27.73	17.02
Total	0.682	0.9	220.34	135.24

Increase in Green cover

The proposed forest plantations in Natural Landscapes would fall in the category of 'Protective Plantations', particularly 'Environmental Plantations'. 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, canals and in educational and industrial estates would also fall in the category of environmental plantations. Agro-forestry plantations would also immensely help in increasing the tree cover in TOFs. Proposed Forestry Interventions in the Riverscapes of Sutlej, Jhelum, Beas, Chenab and Ravi Rivers will further contribute to achieving National Goal of 33% forest and tree cover which will increase green cover besides adding carbon sink.

Biomass production

Biomass Production in Natural, Agriculture and Urban Landscapes in Himachal Pradesh and Punjab after 20 years will be 84871.80 tonnes.

Generation of Carbon Credits

Potential to generate carbon credit from plantation in three Landscapes (i.e., Natural, Agriculture and Urban Landscapes) over a span of 20 years will be 4.6431 million Carbon Credits.

Income Generation through NTFPs

The estimated income from growing, selling and extracting NTFPs from forests plantations in Sutlej River Basin for Himachal Pradesh after 10 years and for Punjab after 1.5 years will be 172.31 and 27.76 lakh, respectively.

Employment Generation

There will be generation of employment through plantation activities and Other Interventions being proposed in the present task besides improving the local climate for better output of agricultural and horticultural crops. Generation of Employment from Plantation Activities and Other Conservation Interventions in total man days in Phase I and Phase-II will be 3,69,89,136.

Research and Monitoring

A large number of organizations responsible for different aspects of River ecology (i.e., glaciology, hydrology, forestry, wildlife, demography, sociology, development, economics, etc.) are working in isolation and as per the entrusted mandate of each sector. Thus, most of the available research and monitoring information is either isolated, scattered or, in some instances, obsolete/archival in nature, piecemeal, or relevant to specific segments/ stretches of the River or its tributaries only. Under such circumstances, it is difficult to develop a holistic understanding of intricate interrelationships those are vital for addressing the requirements of a complex and dynamic River ecosystem. The foregoing review has revealed that on the one hand enormous varied information through researches undertaken by geologists, meteorologists, climatologists, hydrologists, biologists, ecologists, foresters, social scientists, economists, conservationists, etc. has been made available on essential aspects on the ecology of Sutlej River, on the other hand, it is also evident that there are considerable gaps in the information and developed understanding. Likewise, many agencies are involved in various types of monitoring activities relevant to different dimensions of River ecology. However, there is a felt need to improve, strengthen, augment and institutionalize these efforts in a more meaningful and effective manner. Therefore, need based research will be financed during project implementation phase. Besides this, enough funds will be earmarked for monitoring of project implementation activities and recording of various parameters such as silt load, environmental flow, etc.

Implications and the Way Forward

The issues involved in the management and restoration of the Sutlej River are as vast as they are complicated. The policy and legal interventions proposed should be viewed in the context of the broader framework of governance of Rivers and factors affecting them. It is important to address the regulatory gaps, some of which could potentially be corrected within the existing regulatory frame while others may need a new approach. Some of the regulatory gaps include the planning and construction of projects without adequate assessment of their individual as well as cumulative environmental impacts. The interrelationship between forests and their hydrological function is not adequately understood. Unless such assessments factor in the ecosystem services of Rivers and forests, decision making will continue to remain fragmented and sub-optimal.

The Riverine ecosystem needs to be rejuvenated and protection of this ecosystem is critical for long term sustenance of the River and its associated biodiversity. The approach towards forests must be multiple. It must be a pro-active approach aimed at assessing possible threats and taking pro-active steps to avoid the same, and based on a more restorative approach. The provisions of the Forest (Conservation) Act, 1980, the Environment (Protection) Act, 1986 and the Biological Diversity Act, 2002 must be creatively applied in order to achieve the task of long term protection of the forests adjoining the Rivers. The legal and policy approach could focus on the following:

Declaration of identified stretches as Protected Areas under the Wildlife (Protection) Act, 1972, declaration of areas rich in biodiversity as Biodiversity Heritage Sites under the Biological Diversity Act, 2002, declaration of identified areas as Ecologically Sensitive Sites/Zones under the Environment (Protection) Act, 1986, ensuring cumulative Environmental Impact Assessment as well as comprehensive EIA with respect to any biotic interference such as sand and boulder mining, effective implementation of the Wetland Rules, 2010 specifically in demarcation of the Zone of Influence so far as wetland areas adjoining Rivers are concerned.

There is a need to review the minimum flow requirement prescribed by various States. The minimum flow does not reflect the ecological needs of the River. In addition, there is a need to identify areas adjoining Rivers as ecologically sensitive irrespective of whether there is tree growth or not.

One of the most significant interventions is to subject any proposal for diversion of forest land next to the River to the strictest of scrutiny. Existing proposals for diversion of forest land give justification on the forest density and do not adequately address the ecological significance of forests and vegetation in the Riverine areas. The members of the Forest Advisory Committee, the State Advisory Group under the Regional Offices of the MoEF& CC must be oriented to the significance of these areas. In addition, it must be mandatory to undertake detailed site inspection before approving any project involving forest in Riverine tracts.

There is a strong mandate and available avenues within the legal framework to develop proactive interventions with legal backing. These have been supplemented with insightful judicial interpretations as well as implementation to develop a rich body of environmental jurisprudence. Therefore, the issues, present in equal measures, challenges and opportunities.

Guidelines for Implementation of Detailed Project Report (DPR) for Rejuvenation of Sutlej River Through Forestry Interventions

The name of Sutlej River during the Vedic period was *Satudri*, and called *Shatadru* in Sanskrit - the language of ancient India. The Sutlej River originates from beyond Indian borders in the southern slopes of the Kailash Mountain near Mansarovar Lake from Rakshastal in Tibet (China) and known locally as Longchen Khabab River in the region. It is one of the longest among the five Rivers in Himachal Pradesh. It enters into Himachal Pradesh at Shipki La (3,930 m) and flows in the south-westerly direction through Kinnaur, Shimla, Kullu, Mandi, Solan and Bilaspur districts and in Punjab, it enters near Roopnagar and flows through Nawashahr, Ludhiana, Jalandhar, Amritsar and Ferozepur districts and finally to Pakistan. The geographical limits of the Sutlej River Basin lie between 30° - 33° N Latitudes, 74° - 83° E Longitudes. The Sutlej River Basin covers Nari Khorsam province in Tibet, China and large area of Himachal Pradesh and Punjab in India. The total catchment area of Sutlej in India is 48,321.62 km². In India, the catchment falls in one Union Territory i.e., UT of Ladakh (1,172.22 km²) and three States of the country viz., Himachal Pradesh (20,181.94 km²), Punjab (26,887.45 km²) and Haryana (80.01 km²). The total catchment area of Sutlej River is highest, constituting 36.20% of the total geographical area of the Himachal Pradesh among the five major Rivers. The 'DPR on Rejuvenation of Sutlej River through Forestry Interventions' will be implemented by the State Forest Departments (SFDs) of Himachal Pradesh and Punjab. In all, 32 Forest Divisions (17 territorial, 5 Wildlife in Himachal Pradesh and 7 territorial, 3 Wildlife in Punjab) in two implementing States will participate and carry out proposed activities relevant to forestry interventions including plantations, Conservation Interventions, and supporting activities. The guidelines for implementation of the DPR are as follows:

- The existing framework within the Ministry of Environment Forest and Climate Change (MoEF&CC), Government of India (GoI) shall implement the DPR. National Afforestation and Eco-development Board (NAEB) will be the National Project Management Unit (NPMU).
- The SFDs of Himachal Pradesh and Punjab are the primary Implementing Agencies (IAs). State Project Management Unit (SPMU) shall be at the headquarters of SFD headed by Additional Principal Chief Conservator of Forests (APCCFs) level official and implement through the hierarchical structure of Chief Conservator of Forests (CCF) – Conservator of Forests (CF) – Divisional Forest Officers (DFO) of SFDs.
- Other departments such as agriculture, horticulture, soil conservation, revenue, etc.; groups such as *Gram Panchayat*, *Van Panchayat*, Non-Government Organizations (NGOs), etc.; and public representatives shall be suitably involved in steering, execution and monitoring committees of the project.
- Separate bank account should be maintained to operate the DPR at division level. General Financial Rules (GFRs) and other rules/guidelines of the government are to be followed strictly during implementation.

- A Steering Committee and a Monitoring Committee shall be created at National and State levels.
- The State level Steering Committee shall meet at least twice a year for approving the Annual Plan Operations (APOs) and discussing other related issues.
- The SFDs would dovetail activities with similar ongoing /future schemes of various departments through appropriate Memorandum of Understandings (MoUs) for synergy and avoiding duplication.
- Incentives such as free quality planting material of fruit or forestry plants and maintenance cost are provisioned for farmers in the DPR. Also explore possibilities of providing more incentives from other schemes in the State.
- An Execution Manual would be prepared by the SFDs of Himachal Pradesh and Punjab in local official language at the start of project implementation in line with DPR recommendations with participation of all line departments specifying roles and responsibilities.
- Suitable native species of trees, shrubs, herbs and grasses given for the models will be selected for the proposed treatment models/ plantations. The traditional and prominent horticultural and ornamental species those under cultivation in the region for quite some time, are proposed in the Agriculture and Urban Landscapes. Mixed plantations will be adopted 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.
- 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.
- Appropriate quantity of farmyard or organic manure or mycorrhizae 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
- 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.
- 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.
- The budget will be provided after submission of Annual Plan Operations (APOs) for each year. The prevailing wage rate will be applicable whenever DPR is implemented. There should be provision of regular financial reporting of the project at all levels and compilation of quarterly financial reports and annual financial statements of the project. Also provision of internal and external audit should be ensured.
- The fencing cost has been calculated on average basis of enclosure of area to the extent of 5 hectare and average carriage leed is taken as 1 km (up & down). Adjustments need to be done in case of variable planting areas and carriage leed.

- The nursery time for plants in multitier model is taken on average basis i.e., 1.5 – 4.5 years 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 of Himachal Pradesh and Punjab.
- The cost norms proposed in the treatment models 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 and will not exceed these Departmental Norms. The suggestive cost models are to create multistoried forest cover for improving the biodiversity of the area, which in turn conserve the water and soil in-situ.
- In *Lantana* eradication models or wherever *Lantana* removal is involved, the Cut Root Stock (CRS) method should be adopted.
- The fencing must be ensured before planting activities.
- In Fire Protection Model, the 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.
- In Agriculture models the guidelines of Sub-Mission on Agroforestry (SMAF) of Central Government should be considered as being adopted in the States.
- Under Urban Landscape, the Seechewal Model (Punjab) for bio-remediation and bio-filtration may be taken into consideration.
- Also in Urban Landscape, Eco-Park Development, Institutional Plantations and Riverfront Development models can be converged with *Nagar Van Yojna* as launched by GoI.
- 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.
- 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 micro-plan and estimates.
- The suggested interventions are to be considered flexible and not rigid, in terms of changing the site location, area, species and minor changes in the models and the applicable schedule rates if the circumstances demand so while implementation the Sutlej DPR and the concerned Conservator of Forests shall exercise the power to approve such changes as and when required.
- The project costs have been worked out on the basis of rate prevalent during the year 2019-20 in the respective State and 7% escalation in the project cost during the subsequent years has been incorporated in anticipation of the cost escalation in future. However, actual project cost at the time of implementation on yearly basis shall need revision as per the change in Wholesale Price Index (WPI) on year to year basis. The Conservator of Forests may be empowered to revise the project cost accordingly for the quality desired output of the project.

- Soil and Moisture Conservation (SMC) measures and grasses would be given high priority for the enhancement of ground water recharge and promotion of favorable conditions for rejuvenation of the entire ecosystem.
- Flexibility is allowed to address the changing stakeholder needs, national, regional or local priorities, and learning from local knowledge, concurrent experiences and research.
- Best practices of site selection (such as Decision Support System) and treatment of the site shall be adopted. ‘Ridge to valley’ approach would be followed for the treatment of sites in the Sutlej riverscape and its tributaries.
- Divisional Forest Officers (DFOs) will have flexibility on choice of species, site, model, quantity of work, specifications and timing of activities within the total budget proposed in the DPR for the Division.
- Annual Plan Operation (APO) shall serve as the standard document for Global Positioning System (GPS) location and extent of treatment site for Sutlej DPR.
- The cost estimates in models are for guidance and not serve as actual budget for the treatment of a site. The rates in force at the time and place would be applicable and reflected in the APO.
- Cost of the project would be adjusted for the actual date of start of implementation of the project based on Wholesale Price Index (WPI). The expenditure must be restricted to the actual amount sanctioned to the state. In Himachal Pradesh, further 25% hike in wage rates would be applied for Tribal Areas.
- Services of suitable Experts may be used for bio-remediation, eco- park development, river front development, etc. and also for designing SMC structures.
- Farmers would be allowed to choose species for plantation. Quality planting material (QPM) of superior varieties of fruit species should be supplied in consultation with the Horticulture Department.
- Indigenous species recommended in the DPR/divisions working plan should be used in the natural landscape. The Non-Timber Forest Products (NTFPs) and other species that support livelihood would be given priority.
- Inhospitable and difficult areas would be identified by the SFDs and assigned to the Eco- Task Force for treatment as sufficient budget provision is there in the DPR.
- Invasive species areas are to be planted with economically important species.
- Public awareness and participation should be ensured.
- Capacity building activities should be planned for the staff during first year of implementation and there should be continuous skill up-gradation on later years.
- There should be proper Grievance Redress Mechanism (GRM) in place.
- The regular monitoring of project activities should be ensured. Monitoring shall have two dimensions: (i) monitoring of project activities and (ii) monitoring for ecological and socio-economic indicators.

Don'ts

- No work should be implemented which are not comply with the environmental laws and policies at National and State levels.
- No work should be undertaken unless its Geographic Information System (GIS) tools are not used for planning and not incorporated in the APO.
- *Lantana camara* on fragile slopes and extremely harsh sites should not be removed en masse.
- Species known to consume large amount of water are to be avoided.
- No work should be undertaken which has negative impacts on environment and society.
