



1 INTRODUCTION

India, on account of the great river systems and favourable geographical features, has a vast potential for hydropower, estimated over 84000 MW at 60 percent load factor with an anticipated generation of 600 billion units per year. The various hydroelectric schemes presently under operation utilise only about 14-15 % of this total potential. Efforts are on, to increase the present installed capacity. For the purpose of hydroelectric development, the river basins could be divided into six major groups namely Indus, Brahmaputra, Ganga, Central Indian Rivers, West Flowing Rivers and East Flowing Rivers. There is broad consensus in the Government of India to expand power generation by developing the country's hydropower potential. While State and Central Government agencies are largely concentrating on mega-hydel projects, the private sector is being roped in to execute the mini and micro-hydel segment projects. Funding for these projects has come in from the World Bank, private banks like ICICI, nationalized banks like Central Bank of India, various State Banks, and institutions like IFCI and PFC.

Himachal Pradesh has an enormous hydro-potential. The major river systems of the region are the Chandrabhaga or the Chenab, the Ravi, the Beas, the Satluj and the Yamuna (refer fig 1.1). Through preliminary hydrological, topographical and geological investigations, it has been estimated that about 20463.5 MW of hydel power (refer table 2.2 of chapter 2) can be generated in the State by constructing various major, medium, small and mini/micro hydel projects on the five river basins. Out of the total hydel potential only 3275.25 MW has been harnessed so far, out of which only a small portion (of about 326.80 MW) is under the control of the State of Himachal Pradesh, as bulk of the potential has been exploited by the Central Govt. and other agencies.

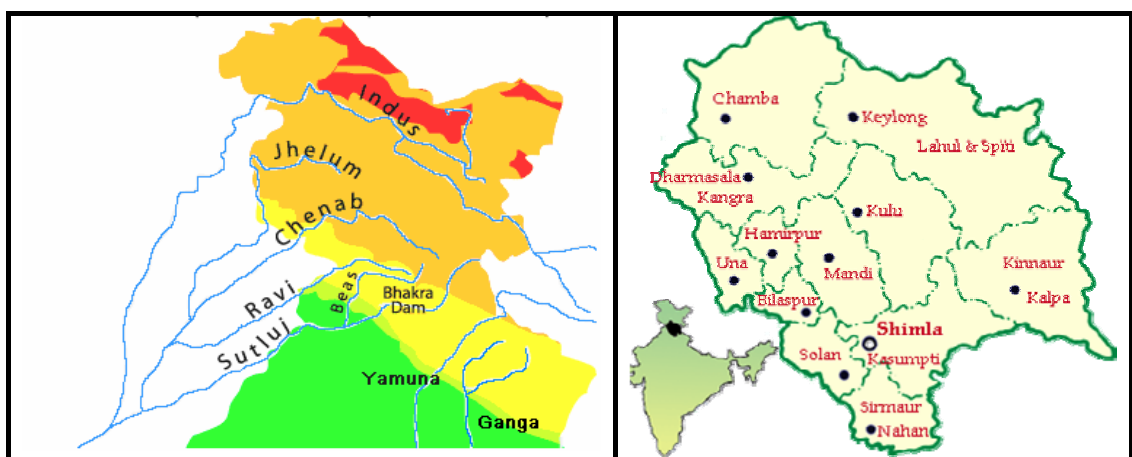


Fig 1.1 Rivers flowing through Northern India ; Location of State of Himachal Pradesh within India

From the Sixth Plan onwards, the hydro-power generation in the state has been accorded top priority as it will bridge the gap in the demand and supply in the northern region of the country. During the Tenth Five Year Plan, a phased programme had



been chalked out to take up various major, medium, small and mini/micro projects in the State besides completing the ongoing projects as early as possible. The State Government had prepared an ambitious plan to accelerate hydro generation by adding 459 MW power under state sector during the 10th Plan i.e 2002-2007 in comparison to earlier achievements of 139.5 MW in 7th Plan, 27.30 MW in 8th Plan and 33.50 MW power in 9th Plan period. Accordingly, the State Government has undertaken several projects. The sites thus identified by the State Government are complying with the guidelines prescribed by the Central Government and the procedure thus followed insists upon the greater public consultation, better monitoring of environmental and social aspects of projects, improvements in resettlement policy and practice, as well as in institutional capacity related to project identification, engineering and design.

It has been envisaged to exploit the hydro-potential of the complete Basin, with projects like Khab in the upper reaches, then Karcham Wangtoo HEP, 300 MW Baspa HEP on Baspa river, 120 MW Sanjay Vidyut Pariyojana on Bhaba river, a right bank tributary of Satluj, Ghanvi HEP, Sorang HEP. The 1500 MW Nathpa Jhakri HEP is in stage of operation. Most celebrated dam on the river is the Bhakra dam which was completed in 1963. Downstream of Bhakra too there are structures on the river, including the Nangal diversion dam and Ropar barrage. Given a large number of operating and proposed projects in the Satluj Basin, over the time, it is anticipated that in their immediate vicinity of influence and beyond, there would be direct and indirect environmental and social impacts. Though dams have been constructed to harness energy for industry and commerce, to help secure a reliable source of water for domestic, industrial and/or agricultural use, to reduce risks associated with flood hazards, there are certain induced and cumulative ill-effects associated with them too, like impact on ecology, alteration in water temperatures and chemistry, impact on erosion, impact on frequency of disasters etc. The cumulative impact of number of dams on a river is not simple addition of impacts of individual dams. A wider perspective has to be adopted to study it. The present study endeavours to bring out the positive and negative impacts induced by the overall development of the Satluj Basin and its significance. Environmental and social mitigation plans are being prepared and will be implemented to mitigate, offset, reduce negative impacts and strengthen positive impacts on the environment and communities in the individual project area.

INDUS WATER TREATY

The waters of the Indus Basin Rivers had been used for irrigation purposes even before the development of the present canal system in the early 19th century. There were numerous inundation canals in the Indus Valley, which diverted supplies directly from the rivers during the high flow periods, without any diversion works across the riverbed. The local community, tribes, or states managed these inundation canals.

From the middle of the 19th century onwards, irrigation was gradually extended through the introduction of improved methods and the construction of diversion works across the rivers. A number of agreements for the sharing of river waters took place. The most significant of these have been the Indus Basin Treaty (1960) between India and Pakistan. In August 1947, when South Asia was divided into two independent countries, there existed in the area, one of the most highly developed irrigation systems in the world. The system catered to approximately 37 million acres of land, supplying it with the waters of the Indus Rivers. All available water supplies were allocated to various princely States and provinces, in conformity with the principle of equitable apportionment of waters.



The Indus System of Rivers in the Indus Basin comprises of the Indus and its five main tributaries i.e. Jhelum, Chenab, Ravi, Beas and Satluj. They all combine into one river near Mithan Kot in Pakistan and flow into the Arabian Sea, south of Karachi. The total area of the Indus Basin is roughly 365,000 miles².

The Indus Water Treaty was signed at Karachi on September 19, 1960. It consists of 12 articles and 8 appendices, which are titled as given below:

<i>Article I</i>	<i>Definitions</i>
<i>Article II</i>	<i>Provisions regarding Eastern Rivers</i>
<i>Article III</i>	<i>Provisions regarding Western Rivers</i>
<i>Article IV</i>	<i>Provisions regarding Eastern Rivers and Western Rivers</i>
<i>Article V</i>	<i>Financial Provisions</i>
<i>Article VI</i>	<i>Exchange of Data</i>
<i>Article VII</i>	<i>Future Cooperation</i>
<i>Article VIII</i>	<i>Permanent Indus Commission</i>
<i>Article IX</i>	<i>Settlement of Differences and Disputes</i>
<i>Article X</i>	<i>Emergency Provisions</i>
<i>Article XI</i>	<i>General Provisions</i>
<i>Article XII</i>	<i>Final Provisions</i>
<i>Annexure A</i>	<i>Exchange of Notes between Government of India and Government of Pakistan</i>
<i>Annexure B</i>	<i>Agricultural Use by Pakistan from certain tributaries of the Ravi</i>
<i>Annexure C</i>	<i>Agricultural Use by India from the Western Rivers</i>
<i>Annexure D</i>	<i>Generation of Hydro-electric Power by India on the Western Rivers</i>
<i>Annexure E</i>	<i>Storage of Waters by India on Western Rivers</i>
<i>Annexure F</i>	<i>Neutral Expert</i>
<i>Annexure G</i>	<i>Court of Arbitration</i>
<i>Annexure H</i>	<i>Transitional Arrangements</i>

Provisions regarding the Eastern Rivers:

- (i) All the waters of the Eastern Rivers (including Satluj) shall be available for the unrestricted use of India.*
- (ii) Except for domestic and non-consumptive uses, Pakistan shall be under an obligation to let flow, and shall not permit any interference with, the waters of Satluj Main and the Ravi Main in the reaches where these rivers flow in Pakistan and have not yet finally crossed into Pakistan.*
- (iii) All the waters, while flowing in Pakistan, of any tributary which, in its natural course joins the Satluj Main or the Ravi Main after these rivers have finally crossed into Pakistan shall be available for the unrestricted use of Pakistan.*

Provisions regarding the Western Rivers:

- (i) Pakistan shall receive for unrestricted use all those waters of the western rivers.*
- (ii) India shall be under an obligation to let flow all the waters of the Western rivers, and shall not permit any interference with these waters.*

Provisions regarding the Eastern and western Rivers:

- (i) Pakistan shall use its best endeavors to construct and bring into operation a system of works that will accomplish the replacement from the Western rivers (and other sources of) the water supplies for irrigation canals in Pakistan, which on 15th August, 1947 were dependent on water supplies from the Eastern rivers.*
- (ii) The use of the natural channels of the rivers for the discharge of flood or other access waters shall be free and not subject to limitation by either party, or neither party shall have any claim against the other in respect of any damage caused by such use.*



- (iii) *Each party declares its intention to prevent, as far as practicable, undue pollution of the waters and agrees to ensure that, before any sewage or industrial waste is allowed to flow into the rivers, it will be treated where necessary, in such manners as not materially to affect those uses.*

Under the provisions of Article VIII (1) of the Indus Waters Treaty 1960, both India and Pakistan have appointed a Commissioner for Indus Waters. Unless either Government decides to take up any particular question directly with the other Government, each Commissioner is the representative of his Government for all matters arising out of the Treaty and serves as the regular channel of communication on all matters relating to the implementation of the Treaty. The two Commissioners together form the PERMANENT INDUS COMMISSION whose purpose and functions are

- (i) *to establish and maintain cooperative arrangements for the implementation of the Treaty,*
- (ii) *to promote cooperation between the Parties in the development of the waters of the 'Rivers',*
- (iii) *to make every effort to settle promptly any question arising between the Parties and*
- (iv) *to undertake tours of inspection of the Rivers to ascertain facts.*

1.1 Power Scenario and Need for the Study

India has achieved remarkable progress in the field of power development since independence in 1947. The rate of growth of installed capacity, though impressive, has not been able to keep pace with the increase in power demand and the country is presently facing peak power shortages of varying degree in various regions of the country.

The power availability in 2005-06, in the northern region, comprising Chandigarh, Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab, Rajasthan, UP and Uttaranchal, was 168, 511 million units (MU) against the requirement of 188,418 MU. This region suffered a shortfall of 19,907 MU in 2005-06 which works out to be 10.6 per cent.

In a projection made by Assocham on Power Sector Performance, since only about one-third of 10th Plan capacity target addition had been accomplished by March, the impact would be much higher in the northern and western regions, which suffered power shortage to the extent of 11 and 14 per cent during 2005-06. In the year 2006-07, total energy and peak energy demands in the northern region shall be 220,820 MU and 355,540 MU against availability of 181,468 MU and 29,667 MU respectively. Thus, there shall be deficit of 17.8% and 16.5% for total energy and peak energy respectively, in the northern region. These deficit figures for all India are 12.9% and 12.3% respectively. Further, the Report of the Group on Power for 10th Plan estimated the need based capacity addition of 62,213 MW during 11th Plan.

Thus, it is necessary to commission projects to generate power to bridge the ever-increasing gap in demand and supply scenario. Satluj Jal Vidyut Nigam Limited (SJVNL) has proposed for complete Basin development by constructing several hydropower projects along the Satluj basin (refer Fig 1.2) to exploit such an enormous source of energy which lies untapped in the State.

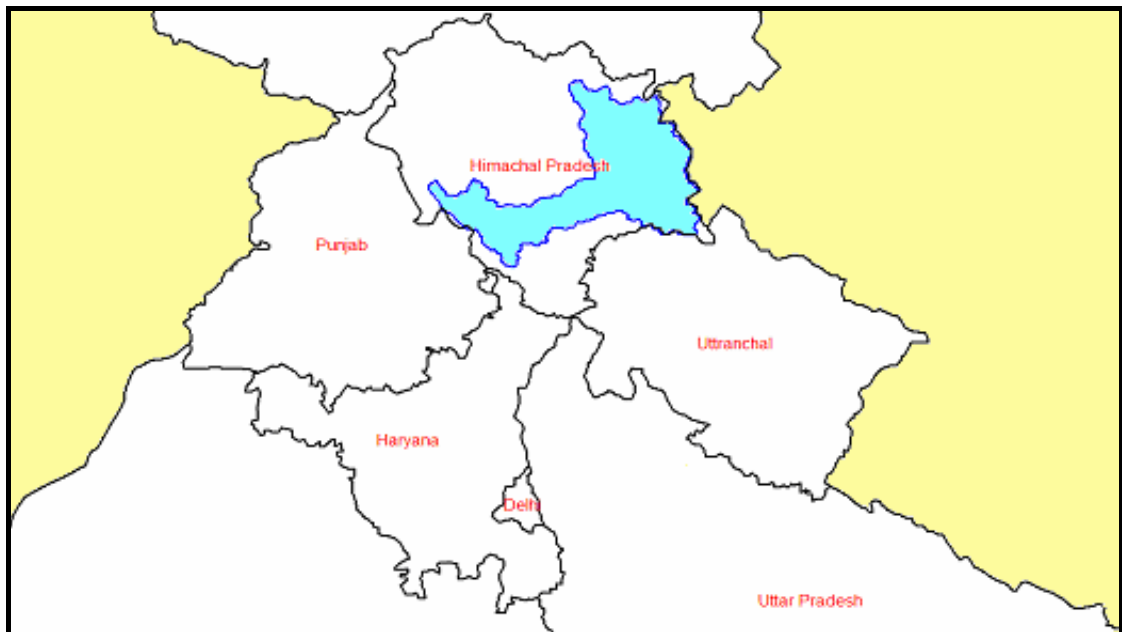


Fig 1.2 Geographical Location of Satluj Basin in State of Himachal Pradesh, Northern India

A description of these projects and related issues has been discussed in section 2.4 of Chapter 2, under the head “Interlinking of the project with similar initiatives in the area”.

Considering the massive hydropower development that is taking place in the region and the impacts on socio-economy and environment that are foreseen because of the development, the client has proposed this study named ‘Cumulative Impact Assessment’ to understand and to assess the incremental, induced and cumulative impacts of all the projects on the river basin.

However, as per TOR, emphasis has been given to examine and understand the share of impacts, among the aggregate impacts of basin-wide hydropower development, directly attributable to RHEP. Particularly important will be to understand the nature and magnitude of impacts from RHEP over and above the impacts of the project already in place.

1.2 Objectives of the study

The overall goal of the study is to help the SJVNL with an Advisory tool for medium- and long-term environmentally sustainable development planning projects in the RHEP project area as well as in Satluj river basin.

The specific objectives of the study are:

- To examine and understand the aggregate impacts from: (i) the construction and operation of all the current and proposed projects in Satluj Basin and (ii) potential scenarios for development that could affect the environmental and social dimensions impacted by the proposed projects.



- To examine and understand the share of impacts, among the aggregate impacts of basin-wide hydropower development, directly attributable to RHEP. Particularly important will be to understand the nature and magnitude of impacts from RHEP over and above the impacts of the project already in place.
- Carry out initial public consultations on the outcomes of the CIA, and to record the views of the local communities and other stakeholders.
- To recommend specific measures, to be implemented by RHEP, as well for other future projects, for addressing the cumulative impacts issues over and above the mitigation and/or management measures for project-specific impacts.

1.3 Scope and Methodology adopted for the Study

The study is predominantly based on information available from secondary sources, including the available projects documents (feasibility study, detailed engineering reports, evaluation reports, etc., of the current and proposed hydropower projects), and state level and disaggregated socio-economic, environmental and planning data. Scope of the CIA study has been briefed below:

- Community and Stakeholder consultations have been considered as an integral part at each stage of the study;
- Identification of key issues to assess the impacts of on-going and proposed hydroelectric project in the Satluj river basin including water flow and water quality, water contamination, loss of forest cover, loss of bio-diversity and habitats, climate change, loss of horticulture crops, drying up of small sources of water etc has been done;
- The cumulative impacts of the project have been assessed on following including quantitative long term projection, wherever necessary;
 - Entire Satluj Basin
 - Indian part of Satluj Basin
 - Influence area of RHEP and NJHEP that could be considered as linear development zones associated with the development
- Assessment and Risk assessment for development Scenarios considering 'business as usual' development pattern and development that reflects adoption of 'best available practices' with broad policy support for environmentally and socially sensitive development;
- The study covers spatial and temporal dimensions to cumulative impacts of on-going and proposed development projects on environment and ecology of the basin and takes into account medium- and long term strategic planning in the project area and in the entire Satluj basin.

The methodology adopted for the study has been kept in accordance with the terms of reference (TOR). The study has been completed under the following stages:



1.3.1 Project Initiation

A start up meeting with the key representatives of the clients was held to fully understand the scope of work, approach & methodology to be followed and the perception of the client, their expectations from the consultants for this consultancy and their concerns, so that the work can be suitably organized and oriented. All the available reports/data related to ongoing or completed projects in the Satluj river basin have been referred. Few of the studies are enlisted below:

1. WAPCOS & SJVNL, Environmental Impact Assessment of NJHEP (completed),
2. WAPCOS & SJVNL, Interim Environmental Impact Assessment of NJHEP (ongoing),
3. WAPCOS & SJVNL Environmental Impact Assessment for updation of NJHEP.
4. IIT-Roorkee IIT-and SJVNL, Flow monitoring Study on the Nathpa-Jhakri stretch of Satluj (ongoing),
5. SJVNL, Visual Study of the Flows from tributaries on Nathpa-Jhakri stretch of Satluj (completed),
6. SJVNL & Himachal Pradesh Pollution Control Board,
7. SJVNL- Status of Environment Management and Protection Measures of NJHEP
8. SJVNL- Baseline Demographic Socio-economic Survey of Rampur Hydro-electric Project, Conducted in 2005
9. Quarterly Operation Period Water Quality Monitoring Reports for NJHEP, SJVNL,
10. PFR.s and DPRs of all the proposed projects on the river Satluj like Khab- I and II HEP, Luhri HEP, Karcham Wangtoo HEP, Nathpa Jhakri HEP etc
11. Statistical Outline of Himachal Pradesh , Economics and Statistical Department, HP
12. Final Report, Delineation of zone of Blasting influence and measures to control ground vibration and air overpressure at NJPC, HP, Dec, 1997, National Institute of Rock Mechanics, Ministry of Mines, GOI
13. Report on “Ecology and Fisheries of Mountain Streams of the North-Western Himalayas”, KL Sehgal, ICAR, Nainital, 1988

Other Secondary data from the concerned organizations like Hydrological and Meteorological reports, Topographical maps have been collected from concerned departments.

An assessment of roles and responsibilities vis-à-vis environmental, ecological and social aspects, of different sectoral departments of the government, different stakeholders, community based organizations and others have been made based on the discussions with them and through the available literature. People’s opinion was also



sought for their view on the commitment and sincerity while dealing with these issues.

An institutional review of key policy, legal and regulatory framework for environmental and social management has also been presented in the later part of the Chapter 3 of the report.

1.3.2 Baseline Data Generation through Secondary Sources

The objective of base line data generation was to collect, compile and provide a database for understanding the anticipated environmental impacts that are expected to accrue as a result of the proposed project.

Baseline scenario has been described in 3 levels:

- The entire Satluj basin including parts in China.
- The Indian part of Satluj basin
- Influence area for the RHEP and NJHEP

The first step in data collection was to identify the key issues and related parameters that need to be considered for the study and to outline the activities for collecting data on each parameter.

The data/information was collected from existing literature/reports and from the various concerned departments like, All India Soil & Landuse Survey, IMD, Agriculture Department, Forest Department, Ground Water Department, Census records and Gazetteers, Fisheries Department etc. The existing and ongoing studies for the Satluj river basin as listed above have also been referred to. An extensive use of Remote Sensing Satellite Imagery data has been made. The processing of satellite data has been carried out in-house by our GIS experts and analysts with the existing facilities available at DHI.

1.3.3 Impact Analysis and Assessment

The basic aim of the impact assessment is to understand the environmental impact, and mitigative measures for sustainability based on the impacts likely to accrue as a result of different projects.

An assessment of the potential economic, environmental or ecological and social trends including those potentially induced by all hydro development projects was undertaken. An evaluation of overall income generation opportunities, growth in infrastructure, direct employment opportunities, loss of forest resources etc has also been made for the basin area.



1.3.4 Summary Recommendations

Based on the outcome of the tasks accomplished, the CIA outlines the following as part of the recommendations in the report:

- A description of the different trade-offs involved in the development hydro-power projects in the Basin. Decision making process also describes vis-à-vis these trade-offs.
- Recommendations for water management strategy and plans in Satluj River for managing use for irrigation, human consumption and environment including need if any for creating storage or water bodies.
- A holistic view of overall development of the basin has been taken and recommendations for overall development of the Satluj basin, including all hydropower projects in the Satluj Basin, with respect to manage the social and environmental issues in a sustainable manner have been highlighted.
- Specific recommendations for management and mitigation of the cumulative and induced environmental and social issues during the implementation and operation of the RHEP.
- A strategy/plan would be mooted to involve all stakeholders in environmental management of entire basin. Business solutions for effective Environment Management in the Satluj Basin, with a description of roles and responsibilities among the different stakeholders, and a plan to build synergies among all the stakeholders, the government and the community based organizations.
- Recommendations to relevant government agencies including sectoral agencies, hydro power regulators and local governments for their future planning and programs; including improving the institutional convergence and linkages
- Suggest such interventions that may induce impact of flood.
- In addition, based on the environmental baseline studies and impact evaluation, mitigative measures would be suggested to ameliorate negative environmental impacts on physical, chemical and biological environment of the basin. An environmental management strategy will be developed to minimize or ameliorate adverse environmental impacts on critical areas. Alternative methods would also be evaluated to reduce or eliminate adverse environmental impacts. A broad cost estimates for undertaking/implementing environmental management plan would be prepared.
- While preparing the Environmental Management Plan the listing of Disasters happened in the area will be done including earthquakes, floods etc. The consultant will suggest specific mitigation plans.



1.4 Structure of the Report

Chapter 1: The Chapter gives an overview of the present power scenario in the region and hydropower potential of Himachal Pradesh. It also describes about the development of various hydropower projects mainly emphasising on NJHEP and RHEP. The objectives, scope of the study, and the methodology adopted has also been described.

Chapter 2: The Chapter presents the description of Satluj basin including river system of the State and its hydropower potential. It also talks on interlinking of the proposed project with other hydroelectric projects that are proposed or under operation in the region.

Chapter 3: The Chapter gives and overview of the Policy, Regulatory and Institutional Structure in environmental field.

Chapter 4: The Chapter gives an overview of the environmental status under three sections- a) Entire river basin, b) Indian part of Satluj basin, and c) influence area of RHEP and NJHEP. Various aspects related to Drainage pattern, Geology and Hydrology of the area, Climate and Soil conditions, Ecology, Land use, and Agricultural pattern will be discussed with emphasis on Nathpa, Jhakri and Rampur areas for analysing the micro level issues such as Socio-Economic pattern, Infrastructure, Health and Employment generation etc.

Chapter 5: The Chapter presents the impact analysis and assessment for various parameters related to the environment and the socio-economic aspects. The impacts that are foreseen due to proposed hydroelectric projects and that are in operation in the vicinity are also summarised.

Chapter 6: Based on impact assessment analysis, this section of the report provides broad recommendations for the river basin considering overall environmental and socio-economic development of the region.