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SATLUJ JAL VIDYUT NIGAM LIMITED

CUMMULATIVE AND INDUCED IMPACT ASSESSMENT

RAMPUR HYDRO-ELECTRIC PROJECT (RHEP)

DHI (India) Water & Environment

FINAL REPORT
SEPTEMBER 2006

CUMMULATIVE AND INDUCED IMPACT ASSESSMENT

FINAL REPORT

September 2006

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXURES

CHAPTER –1
INTRODUCTION

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.

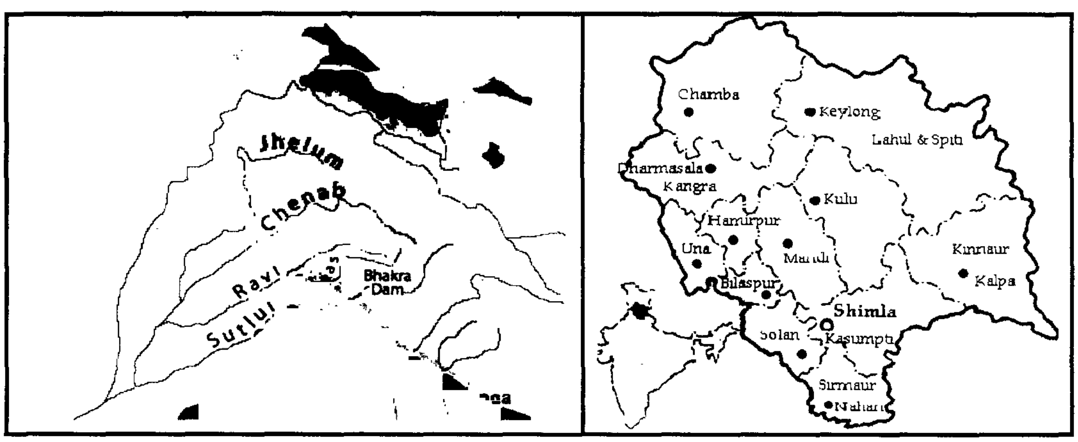


Fig 1.1 Rivers flowing through Northern India ; Location of State of Himachal Pradesh within India

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 are 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 miles^2.

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:

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

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 10^{th} Plan estimated the need based capacity addition of 62,213 MW during 11^{th} 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.

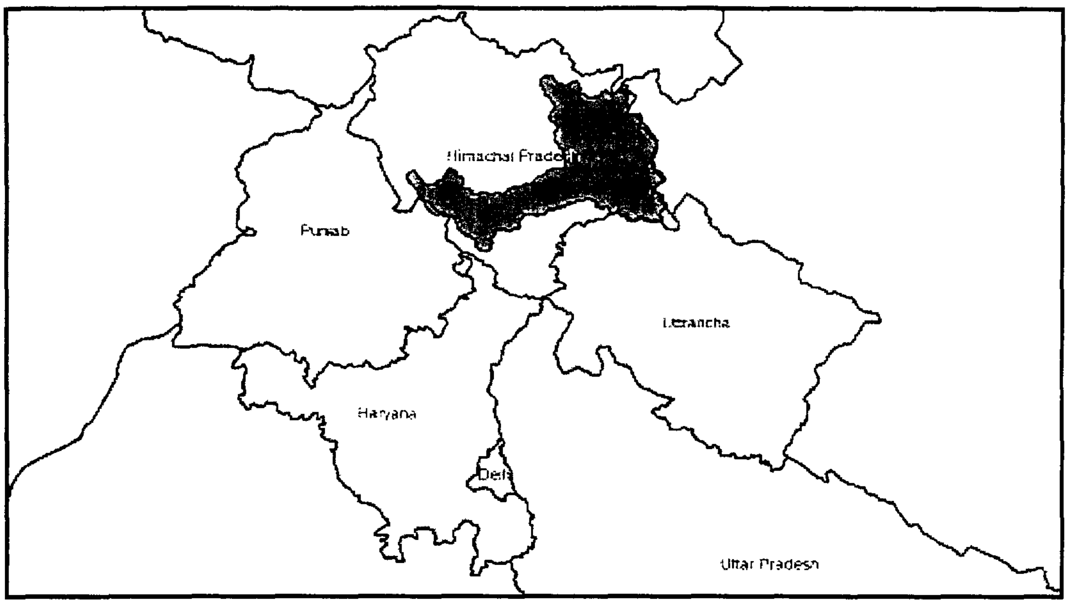


Fig 1.2 Geographical Location of Satluj Basin in State of Himachal Pradesh, Northern India

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 Satlùj 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 Hydroelectric 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 Himacal Pradesh , Economics and Statistical Deaprtment, 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 stake holders, 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 hydropower 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 fur 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.

CHAPTER –2
BASELINE SETUP OF THE AREA

2 BASELINE SETUP OF THE AREA

2.1 River System of Himachal Pradesh

The Himalayan mountain chain has a dominant influence on the climatic conditions prevailing over Indian sub-continent. They lie in the path of rain-bearing monsoon winds and thus bring rain to a large part of India. The Himalaya houses a vast reservoir of moisture both in the form of ice, fresh-water and underground water. The rivers draining the Himalayas sustain life in the Northern part of the Indian sub-continent. The drainage system of Himalaya is very complex. It is composed both of rivers and glaciers. Himalayan River criss-cross the entire mountain chain. In fact a number of rivers are older than the mountain system. They have cut across the various mountain ranges. In Himachal, rivers from two rivers systems- Indus River System (Satluj, the Beas, the Ravi, the Chenab and the Jhelum) and Ganga River System (only river Yamuna) flow through.

Table 2.1 Indus River System

Name of River	Source	Total Stream length (km)	Drainage (km2)	Remarks
Jhelum	Northern of Pripanjal, Kashmir	400	28, 490	Indian Scetor Only
Ravi	Born in Bara Banghal, Kangra district	725	5957	Indian sector only
Chenab	Greater Himalayan Canton of Lahaul	1180	26,755	Indian sector only
Beas	Beas Kund at Southern face of Rohtang pass in Greater Himalayas (4062 m)	470	25, 900	-
Satluj	Mansarvor group of lakes in Tibet Himalayas 4630m	1050	24, 087	Indian sector only
Yamuna	Yamunotri in Gharwal hills and forms the Eastern boundary with Uttar Pradesh	1,300	359,000	Catchment area in Himachal is 2320 km^2

2.1.1 Indus River System

The river Indus rises from the Tibetan plateau and enters the Himalaya in Ladakh. It enters the Kashmir region near its confluence with the river Gurtang, at an elevation of about 4200 metres. The drainage basin of the Indus river system extends from the Naga Parbat mass in the extreme North-Western part of the country to the Western slopes of the Shimla ridge in Himachal Pradesh. It includes the whole of Jammu and Kashmir and most of Himachal Pradesh. The extreme Northern tract of the Indus basin comprises of the cold desert of Ladakh, Lahaul Spiti and Pooh. South of this tract lies the higher Himalayan mountain wall. The lower and middle Himalayas occupy the central part of the Indus basin. The low rolling Shivalik hills occur along its Southern periphery.

Climatic conditions in the Indus river system vary from arctic to sub-tropical. The cold desert area remains devoid of rainfall and experiences heavy snowfall. The important rivers of this system are the Satluj, the Beas, the Ravi, the Chenab and the Jhelum. Out of these five, four flow through Himachal Pradesh and along with their tributaries draining parts of Himachal Pradesh.

2.1.2 Ganga River System

The drainage basin of the Ganga river system covers about one third of the Western Himalaya and the entire Central Himalaya. This basin extends from the Eastern face of the Shimla ridge in Himachal Pradesh to the South-Western slopes of the Kanchanjunga massif on the Nepal-Sikkim border, thereby including parts of Kinnaur, Shimla, Solan and Sirmaur district of Himachal and Garhwal, Kumaun and Nepal. The Ganga is the most sacred river of India.

The Ganga has its source near Gomukh glacier, near Gangotri (Uttar Pradesh). The Ganga is formed by two head streams namely Alaknanda and Bhagirathi. It enters the plains near Haridwar. The Yamuna meets this river at Allahbad known as Sangam. The Ganga is the master stream of the area. South of Farakka, the river divides into a number of channels to form Sunder Ban Delta (Largest in the world). The main tributaries of the Ganga system are the Yamuna, Bhagirathi and Alaknanda, Kali and its tributaries, the Ghagra, the Gandak and the Kosi River. Only river Yamuna flows through the State of Himachal Pradesh.

2.1.3 Satluj River in Himachal Pradesh

Satluj rises from beyond Indian borders in the Southern slopes of the Kailash mountain near Mansarover lake from Rakas lake, as Longcchen Khabab river (in Tibet). It is the largest among the five rivers of Himachal Pradesh. It enters Himachal at Shipkila (altitude is 6,608 meters) and flows in the South-Westerly direction through Kinnaur, Shimla, Kullu, Solan, Mandi and Bilaspur districts. Its coarse in Himachal Pradesh is 320 km. from Rakastal, with famous tributaries viz. the Spiti, the Ropa, the Taiti, the Kashang, the Mulgaon, the Yula, the Wanger, the Throng and the Rupi as right bank tributaries, whereas the Tirung, the Gayathing, the Baspa, the Duling and the Soldang are left bank tributaries. The prominent human settlements that have come on the banks of the Satluj River are Namgia, Kalpa, Rampur, Tattapani, Suni and Bilaspur. Its total length is 1,448 km. It leaves Himachal Pradesh to enter the plains of Punjab at Bhakhra, where the world's highest gravity dam has been constructed on this river. Its total catchment area in Himachal Pradesh is 20,000 sq. km. Its vedic name is Satudri and Sanskrit name Shatadru. The Satluj finally drains into the Indus in Pakistan. The catchment area of about 50,140 km. of Satluj River is located above the permanent snow line at an altitude of 4,500 metres. The upper tracts of the Satluj valley are under a permanent snow cover.

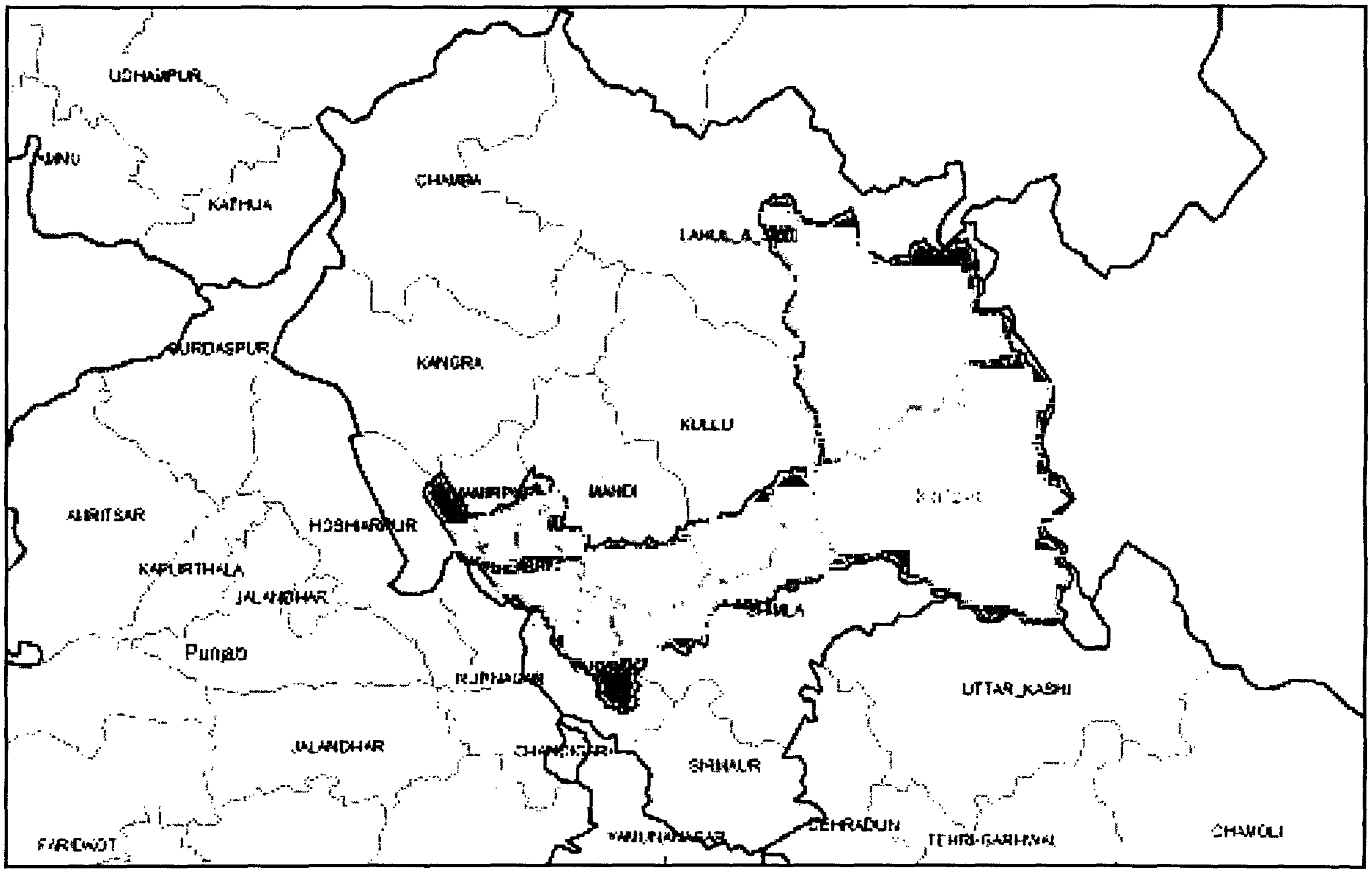


Fig 2.1 Geographical Location of the Satluj Basin in Himachal Pradesh

Important Tributaries of river Satluj

a) Spiti River

The Spiti River originates from Kunzum range and Tegpo and Kabzian streams are its tributaries. Water draining the famous Pin valley area are also a part of the Spiti river system. Its position across the main Himalayan range deprives it from the benefit of the South-West monsoons that causes widespread rain in most parts of India from June to September. The river attains peak discharge in late summers due to glacier melting. After flowing through Spiti valley, the Spiti River meets Satluj at Namgia in Kinnaur district traversing a length of about 150 km. from the North-West beyond that it flows in South-West direction in the Pradesh. Huge mountain rise to very high elevations on either sides of the Spiti River and its numerous tributaries. The mountains are barren and largely devoid of a vegetative cover. The main settlements along the Spiti River and its tributaries are Hansi and Dhankar Gompa.

b) Baspa River

Baspa is an important tributary of the river Satluj in its upper courses. The Baspa is joined by many smaller channels draining snowmelt waters. The Baspa River has cut across the main Himalayan range. Thereafter it empties itself into the river Satluj in district Kinnaur. Baspa originates from the Baspa hills, joins it from the left bank near Karcham. Satluj River leaves Kinnaur district in the West near Chauhra and enters Shimla district.

c) The Nogli Khad

It joins Satluj just below Rampur Bushahar. The river Satluj enters Mandi district near Firnu village in the Chawasigarh and passes through the areas of Mahunm, Bagra, Batwara, Derahat and Dehar. Practically the whole of the ancient Suket state except Jaidevi and Balh circles drains into Satluj. The main tributaries of the Satluj in district Mandi are Siun, Bahlu, Kotlu, Behna, Siman, Bantrehr, Khadel and Bhagmati.

d) Soan River

The Soan River rises from the Southern slopes of the Shivalik range also known as Solasinghi range in the tract to the East of the Beas gap across the Southern periphery of the Kangra valley. It joins the boundary of Himachal Pradesh and Punjab. Its gradient is not very steep and the slopes of the Soan catchment vary from gentle to steep. In the summer the discharge drops drastically, while during monsoon it is in spate.

A detailed map showing various tributaries joining Satluj has been provided in Chapter- 4.

2.2 Hydro Power Potential in Himachal Pradesh

The State has been hallowed by tremendous hydropower potential. A comparative overview with regard to hydropower potential of various river basins in the state has been presented below (refer Table 2.2). The total potential of various river basins in the State in terms of power generation is estimated to be 20463.5 MW approx. As of June, 2003, Himachal Pradesh had 145 Hydro Electric projects worth Rs.47, 479 crore in various stages of planning and implementation. Table 2.3 gives an overview of capacities of different ongoing and proposed projects hydroelectric projects on river Satluj in Himachal Pradesh.

Table 2.2 Hydropower potential in various River Basins of Himachal Pradesh

S.No	River Basin	Identified potential MW
1.	Satluj	9728.25*
2.	Beas	4293
3.	Ravi	2181
4.	Chenab	3301
5.	Yamuna	960
Total		**20463.5 MW**

Source: EIA for Rampur HEP, H.P, Year 2005
**SJVNL , Infra/ Consultancy division, Oct, 2005*

Table 2.3 Hydropower potential of Satluj Basin in Himachal Pradesh

S. No	Name	Installed Capacity (MW)	Status
1.	Bhakra dam	1325.00	Under Operation
2.	Chaba	1.75	
3.	Nigli Stage I	2.50	
4.	Ganwi stage I	22.50	
5.	Sanjay vidyut Pariyogna	120.00	
6.	Rukti HEP	1.50	
7.	Rongtong	2.00	
8.	Baspa II	300.00	
9.	Nathpa Jhakri	1500.00	
	Sub Total	**3275.25**	
10.	Bhaba	4.50	Under Construction
11.	Ganwi II	10.00	
12.	Kashang	66.00	
13.	Kol dam	800.00	
14.	Karcham Wangtoo	1000.00	
	Sub Total	**1880.50**	
15.	Rampur	412.00	DPR prepared
16.	Shongtong karcham	402.00	
	Sub Total	**814.00**	
17.	Kashang II	60.00	Under Investigation
18.	Kashang III	132.00	
19.	Sorang	60.00	
20.	Luhri	700.00	
21.	Khab	636.00	
	Sub Total	**1588.00**	
22.	Yangthang Khab	261.00	PFR's prepared

S. No	Name	Installed Capacity (MW)	Status
23.	Jang Thopan	480.00	
24.	Thopan powari	480.00	
25.	Tidong –I	60.00	
26.	Tidong II	70.00	
	Sub Total	**1351.00**	
27.	Kuling Lara	40.00	Projects yet to be studied
28.	Lara	60.00	
29.	Mane Nadang	70.00	
30.	Lare Sumita	104.00	
31.	Sumta Kathang	130.00	
32.	Chango Yangthang	140.00	
33.	Ropa	60.00	
34.	Baspa-I	210.00	
35.	Bharari	5.50	
	Sub Total	**819.00**	
	Grand Total	**9728.25 MW**	

Source: SJVNL, Infra/ Consultancy Division Oct, 2005

2.3 Project Area

The goal of the present study is to assess the cumulative impacts of all operational and proposed hydroelectric projects on the area. Hence, entire stretch of river Satluj including Spiti at upstream has been considered under project area for the purpose of assessment. Emphasis has been given on RHEP and NJHEP project areas to examine and understand the share of impacts, among aggregate impacts.

The area of influence of Nathpa-Jhakri Hydroelectric project (NJHEP) falls in between longitude 77^0 35' 35'' and 77^0 57' 57'' and latitude 31^0 23' 56'' and 31^0 33' 55''. The Hindustan Tibet Road (NH-22) connects the project site with the country. The nearest broad gauge railhead is at Kalka located at an approximate distance of 280 km from the project site. This road lies on the left bank of the river Satluj, and it is on this side that all the NJHEP project components are situated. The Kalka-Shimla-Narkanda-Rampur-Jhakri-Nathpa road was mainly used for the transportation of various equipment and materials during the construction phase of NJHEP. A road called Rampur Bye-pass road was also constructed as an alternate for transportation of heavy equipment. The site has reasonably good telecommunication and power facilities

The area of influence of Rampur Hydroelectric project (RHEP) falls in between longitude 77°35' to 70°43'N and latitude 31°23' to 31°30'. The catchment area of Rampur HEP includes Rampur range, Bahli range, Machhada catchment of Nankhari Range and parts of Sarahan range viz. (Two blocks of 15/20 of Phancha and Jhagori, Bhagawat Beat of Sarahan Block) in Rampur Forest division and Nirmand range, Nither & Margi of Nither Range in Ani Forest Divison.

2.4 Key features of various Hydro power Schemes on the river Satluj in Himachal Pradesh

The Government of India and State Government of Himachal Pradesh have identified the Satluj River as one of the main sources of hydroelectric projects. The total hydro-power potential of Satluj river basin as estimated is 9728.25 MW out of which 5515.75 MW is being harnessed through projects that are either under operation or in construction stages (refer Table 2.3). In this particular section, key features of main hydro- power projects that are in varying stages of planning, construction, completion and operation have been discussed (refer Fig 2.2). The main hydroelectric power plants and dams are:

Khab, Kinnaur District

The Khab HEP located in the Northern Power region is conceived as a run-of-river development on the river Satluj to tap the hydroelectric potential of the upper reaches of river Satluj as it enters into the Indian Territory. The project envisages the construction of 275 m high concrete gravity dam with 12.6 km long and 9 m dia tailrace tunnel and would generate 1020 MW of electricity with a tentative construction cost of 14000 Crores. It is envisaged that the cost will be shared by downstream benefitting projects due to storage of silt which increases life of downstream reservoirs. For the scheme, diversion works on the river are located at 310 d/s of Khab, the confluence of river Satluj and river Spiti in District Kinnaur of State, about 300km from Shimla.

Karcham Wangtoo Hydroelectric Project (1000MW), Kinnaur District

The Karcham Wangtoo Hydroelectric Project will utilise the head available between the tail waters of Baspa Hydroelectric. Project Stage-II and head waters of Nathpa-Jhakri Hydroelectric Project. The project envisages a concrete gravity dam about 43 m high above the river bed (approx. 98 m high above the deepest foundation level). The dam will have 6 sluice spillway bays of size 9m (W) x 9m(H). The other main component of the Project are: 10.48 m diameter, 17.2 km long head race tunnel, 4.75m dia. 4 nos. pressure shafts, an underground power-house with 4 x 250 MW installed capacity, transformer hall and 909 m long 10.48 m dia tail race tunnel. The diversion of river is envisaged by construction of a Diversion tunnel.

Bhaba Hydel Project, Kinnaur District

The 120 MW Sanjay Vidyut Pariyojna of Bhaba Hydel Project is complete. The project includes a weir across the Bhaba Khad, a right bank tributary of Satluj with a desilting basin, a small reservoir 2.5m (finished), 8.4 km long head race tunnel, 5m dia underground surge shaft, underground pressure shaft, and underground power-house on right bank of Satluj river. The project was commissioned by HPSEB in the year 1989.

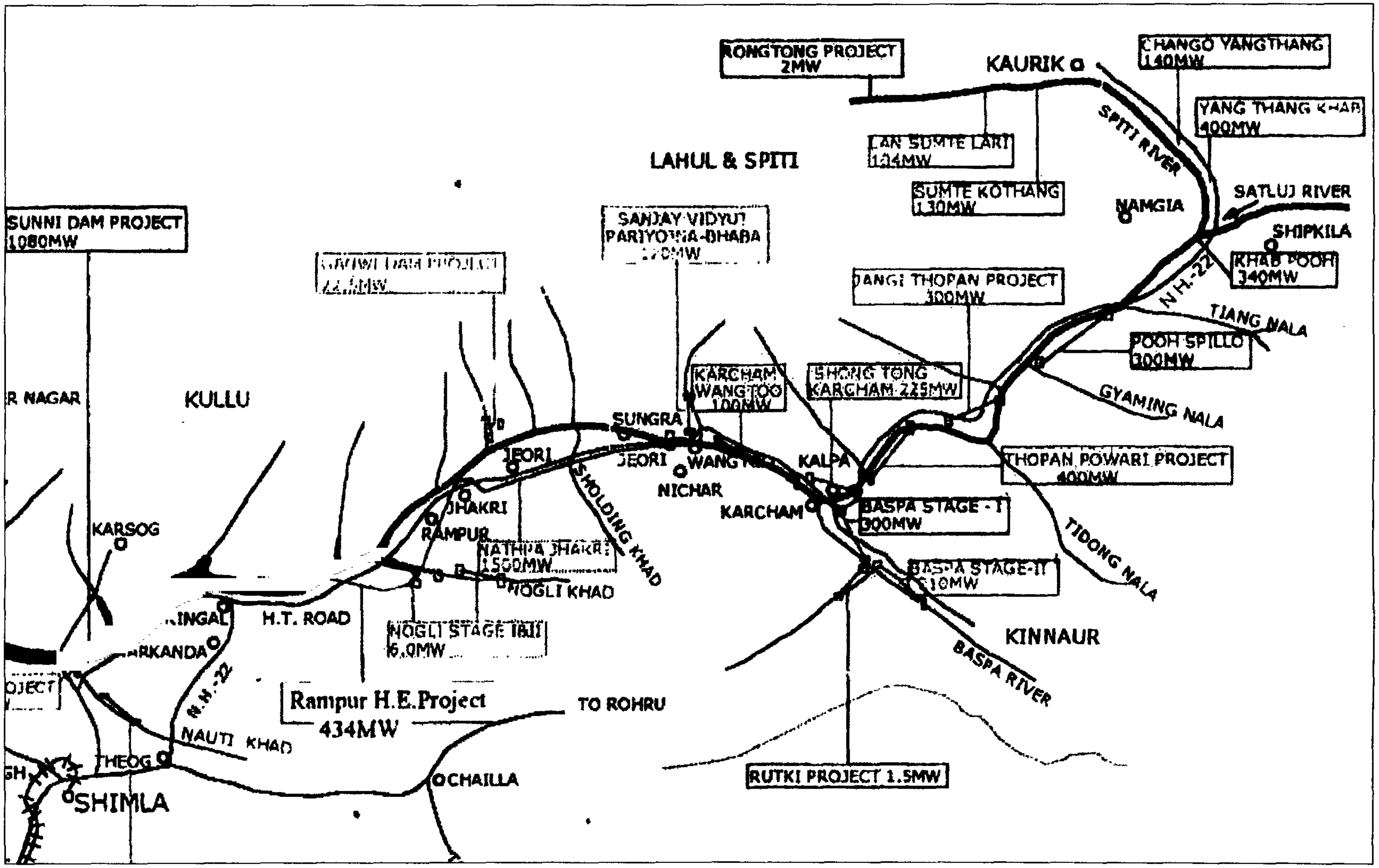


Fig 2.2 *Various Hydro Power projects in the study stretch along Satluj River*

Baspa Hydroelectric Project, Kinnaur District

It is located about 200 km from Shimla on NH-22 and envisages construction of a 10 m. high barrage across river Baspa, 8 km long and 4 m diameter head-race tunnel and underground powerhouse and has installed capacity of 300 MW. Project is complete and is commissioned.

Sorang Hydropower Project, Kinnaur District

The proposed Sorang hydroelectric project is a run-of-the-river type development on Sorang Khad, a tributary of Satluj River, in Kinnaur District. The project consists of construction of trench weir across Sorang Khad at an elevation of + 1943.50 m. The water flow directed shall be fed through + 1.540 km. long HRT and 183 m long pressure shaft and 970 m long buried Penstock to a under ground powerhouse on the left bank of Tikkadda Khad near the confluence with Satluj river. The Project thus utilizes a head rated of 667.15 m. to produce 100 MW of power. The power generated at Sorang HEP is propose to be fed into HPSEB 220/66KW substation at Kotla near Jeori and Kunihar in Distt. Solan. The present power supply position in the Northern Region indicates that there is shortage of peak power as well as energy of varying degree in most of the states. The anticipated power supply position in the year 2006-2007 indicates that the gap between the demand and supply would increase further in the coming years.

Table 2.4 Salient Features of key Hydro-Electric projects

Name of the project	Location		Hydrology		
	District	River	Catchment area (sq. Kms)	Average runoff in 90% dependable year	Average runoff in 50% mean year
Khab	Kinnaur	Satluj	44,000	4413 Mm^3	7138 Mm^3
Karcham Wangtoo	Kinnaur	Satluj	48,755	112558 cumec-day	75697 cumec day
Nathpa-Jhakri	Kinnaur	Satluj	49,820	7689 Mm^3	9596 Mm^3
Rampur	Shimla/ Kullu	Satluj	50,880	-	-
Luhri	Kinnaur	Satluj	52,403	9341 Mm^3	12074 Mm^3

Source: PFR Khab project, Year, 2004; EIA for Updation of NJHEP, Year 2003; Report on Karcham Wangtoo Project, Year 2005; EIA for Rampur HEP, Year 2005; PFR Luhri HEP, Year 2004

Ghanvi-I, Shimla District (22.50 MW)

Ghanvi -I hydroelectric project is a run-of-the-river scheme on Ghanvi khad a tributary of Satluj River in Shimla District of Himachal Pradesh. The project consists of a trench weir across Ghanvi Khad near village Ghanvi, vortex tube type desilting arrangement, power channel, underground forebay, surface/underground surge shaft, surface/underground penstock and a underground power house on the left bank of

Ghanvi khad. The project has been commissioned in the year 2000. The development and operating scheme of Ghanvi-I & II is very similar to that of Sorang Hydroelectric Project.

Ghanvi –II, Shimla District (10 MW)

Ghanvi-II hydroelectric project is being conceived as a run-of-the-river scheme on Ghanvi khad a tributary of Satluj River in Shimla District of Himachal Pradesh. The project consists of a trench weir across Ghanvi khad near village Rungcha, vortex type desilting arrangement, storage reservoir, 1.4 km long head race tunnel, underground surge shaft, surface/underground penstock and an underground power house on the left bank of Ghanvi Khad.

Nathpa-Jhakri Hydel Project, Kinnaur District

This project is the largest run-of-the river scheme on the river Satluj to harness the Satluj River for hydel power jointly undertaken by Haryana & Himachal governments and is. It is located 140 km from Shimla on NH-22 and includes construction of a 60.5 m. high gravity dam built on Satluj at Nathpa, a 27-28 km. long and 10.5 m. diameter head-race tunnel on the left bank and an underground powerhouse at Jhakri, with an installed capacity of 1500 MW (6 x 250). The catchment area at Nathpa Dam site in 49,820 sq. km. The plant will utilize the available 425m gross head between Nathpa & Jhakri. Project is complete and running with full capacity. The salient features are:

- The Nathpa Jhakri Power Project is under operation since 2003 and has a generation capacity of 1500 MW.
- The project is also utilizing the water of an intervening stream, i.e. Sholding khad through a trench weir and a drop shaft.
- The energy generation is of the order of 7425 GWH in a 50% mean year and nearly 6700 GWH in a 90% dependable year. The project has been completed at a cost of Rs.8656 crores.

Rampur Hydroelectric Project, Shimla-Kullu District

SJVNL has envisaged a 412 MW Rampur Hydro Electric project (RHEP), downstream of NHJEP to tap the hydropower potential of the Satluj River between Jhakri and Bael village. The proposed project is conceived as a tailrace development from the 1500 MW Nathpa-Jhakri HE Project (NJHEP). The Rampur project is designed to divert 405 cumec of de-silted water of the Satluj from the tailrace pool of NJHEP through 15 km headrace tunnel to a surface power station near Bael. The water from Rampur Intake structure shall be conveyed to the right bank through a cut & cover Conduit, 10.50 m dia HRT of 15.08 Km length terminating into a 140 m high, 38 m dia Surge Shaft. The length of HRT on left bank is 484 m before it crosses the river Satluj with a 43.2 m long Cut and Cover Conduit. The water will further enter into three underground penstocks 5.4 m dia each bifurcating into six Branch Tunnels each of 3.8 m diameter, to feed six generating units in a surface Power House equipped with Francis turbines driven generating unit each of 68.67 MW capacity. On completion, the project would utilise a gross head of 138 m to generate approximately 1969 GWH of design energy in a 90% dependable year. It will then return the water to the river. The salient features are:

- The project uses water from the Nathpa Jhakri project, and thus the Rampur scheme will not involve the construction of a dam or a reservoir, and no further land will be inundated.
- It envisages diversion of the entire 383.88 cumecs of desilted water from Tail Race Outfall of Nathpa Jhakri Hydro Electric Project (NJHEP) located on the left bank of river Satluj at Jhakri.

Luhri Hydroelectric Project (465 MW), Kinnaur District

The Luhri HEP is foreseen as run-of-the-river developments on Satluj River, in the reach between Luhri and Chaba villages in Shimla district of Himachal Pradesh just downstream of confluence of Behna khad with Satluj River near Luhri. The project site is about 80km from Shimla and is an upstream development to the proposed Kol dam electric project on Satluj River. The project envisages construction of a 60M high (above sea bed) concrete gravity dam on the river near the village Nathan for diversion of a design discharge of 477 cumecs, through 4 intakes and underground desilting arrangement into a 15.50 km long, 10.50m finished diameter head race tunnel on the right bank of the river. A gross head of 127m is available at the power station, which shall be utilised to generate 465 MW (3X 155 MW) of power.

Kol Dam

800 MW Kol Dam hydro electric project in Himachal Pradesh to be set up by National Thermal Power Corporation at an estimated cost of Rs 5300 crore is located in Distt Bilaspur. It envisages to utilize power potential of Satluj. The project involves construction of 163 m high rockfill dam across river Staluj 6 km upstream from existing Dehar power station and installation of four units each of 200 MW. The power generated will be evacuated to power deficient northern region through 400 KV integrated transmission system lines constructed for Nathpa Jhakhri and Kol dam projects.

Bhakra Dam

The construction of this project was started in the year 1948 and was completed in 1963. It is 740 ft. high above the deepest foundation as straight concrete dam being more than three times the height of Qutab Minar. Bhakra Dam is the highest Concrete Gravity dam in Asia and Second Highest in the world. There are two power houses namely Left Bank Power Plant and Right Bank Power Plant. It is a Concrete straight gravity with Height above the deepest foundation equal to 225.55 metres (740 feet) Its Height above river bed is 167.64 metres (550 feet). The elevation at top of dam above mean sea level is equal to 518.16 metres (1700 feet). The total installed capacity of left bank power plant is 450 MW - 5 units of 90 MW each and of the right bank power plant is 600 MW - 5 units of 120 MW each. The facility uses the Satluj River to supply drinking and irrigation water for portions of six states.

CHAPTER –3
POLICY AND LEGAL FRAMEWORK

3 POLICY AND LEGAL FRAMEWORK

3.1 Policy, Regulatory and Institutional Structure

The regulatory and institutional decision-making framework for environmental management and protection in India, both at the National and State level, is embodied in nine major acts of the Indian Parliament. Among those, the ones applicable to Water Resource development projects are:

- Water (Prevention and Control of Pollution) Act of 1974
- Air (Prevention and Control of Pollution) Act of 1977
- Environment (Protection) Act of 1986, the Forest (Conservation) Act of 1980, amended in 1988,
- Public Liability Insurance Act of 1991
- Environmental Impact Assessment of Development Projects, of 1994

The Ministry of Environment & Forests (MoEF) is the nodal agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing the implementation of environmental legislation and programmes. Regulatory functions like Environment Clearance, Forest clearance are part of the mandate of this agency. This particular section will discuss the constitutional provisions and key points of policy and regulatory framework of India

3.1.1 Constitutional Provisions

Water Resources

Under the Constitution of India, which came into force in 1950, 'Water' is primarily a State subject and the Union comes in only in the case of interstate river waters.

Entry 17, List II, i.e. State List in 7^{th} Schedule of the Constitution states, "Water, that is to say water supplies, irrigation and canals, drainage and embankments, water storage and water power subject to the provisions of Entry 56 of List I". States are thus free to enact "water" laws and frame policies in accordance with this provision.

Entry 56 of List I (Union list) referred to above states, "Regulation and development of inter-state rivers and river valleys to the extent to which such regulation and development under the control of the Union, is declared by Parliament by law to be expedient in the public interest".

Under Article 262 of the Constitution, Parliament may, by law (1) provide for the adjudication on any dispute or complaint with respect to the use, distribution or control of the waters of, or in, any inter-state river or river valley" and (2) "that neither the Supreme Court nor any other court shall exercise jurisdiction in respect of any such dispute or complaint" as referred to in (1).

Environment

The first constitutional provisions related to environment were made in the Forty-Second Amendment to the Indian Constitution. This amendment was passed in response to India being party to the Stockholm Declaration adopted by the International Conference on Human Environment in 1972. The Forty-Second Amendment inserted Article 48-A into the Directive Principles of State Policy in Chapter IV of the Constitution. This declared the State's responsibility to protect and improve the environment and safeguard the forests and wildlife of the country. Another provision, inserted in Article 51-A (g), stipulated the duty of every citizen to "protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures." These amendments imposed an obligation on the Government and the courts to protect the environment for the people and the nation.

Article 32 and Article 226 of the constitution confer power on the Supreme Court and the High Courts to issue writs in the nature of habeas corpus, mandamus, certiorari and prohibition. These Articles can be used to show that river pollution implicates a public authority that has been vested with the responsibility to prevent pollution but is not executing its powers. These Articles are emancipatory provisions that allow citizens to challenge the structures of domination from within the constitutional framework.

3.1.2 Policy Framework

Water Policy

National Water Policy

The National Water Policy was first adopted in September 1987. It has been recently reviewed and updated in response to a number of new issues recently have emerged of late. The 2002 National Water policy (Ministry of Water Resources, GOI) has emphasized on several facets that are important from an environmental and social viewpoint including the following statements:

- Water is part of a larger ecological system. Realising the importance and scarcity attached to fresh water, it has to be treated as an essential environment for sustaining all life forms.
- Water is a scarce and precious national resource to be planned, developed and conserved and managed as such, and on an integrated and environmentally sound basis, keeping in view the socio-economic aspects and needs of the States

- Water resources development and management will have to be planned for a hydrological unit such as drainage basin as a whole or for a sub-basin, multi-sectored, taking into account surface and ground water for sustainable use incorporating quantity and quality aspects as well as environmental considerations
- Under para 5 it accords ecology a relatively much lower and fourth priority but indirectly recognises water use for fresh water" ecosystems
- In para 6.3 Project Planning, it states "preservation of the quality of environment and the ecological balance should be a PRIMARY consideration" and goes on to add that the adverse impact on the environment, should be minimised and should be offset by adequate compensatory measures
- There should be an integrated and multi-disciplinary approach to the planning, formulation, clearance and implementation of projects, including catchments area treatment and management, environmental and ecological aspects, the rehabilitation of affected people and command area development.
- The drainage system should form an integral part of any irrigation project right from planning stage (Para 6.6)
- The detrimental environmental consequences of over-exploitation of ground water need to be effectively prevented by the Central and State Governments. (Para 7.3)
- There should be a close integration of water-use and land-use policies (para 9.2)
- Water allocation in an irrigation system should be done with due regard to equity and social justice. (Para 9.3)
- Reclamation of water logged/ saline affected land by scientific and cost effective methods should form a part of command area development programme
- On resettlement and rehabilitation it speaks of the need of a "skeletal national policy" and would like States to evolve their own detailed policies.
- Effluents should be treated to acceptable levels and standards before discharging them in to natural streams and that minimum flow should be ensured in the perennial streams for maintaining ecology and social considerations (para 14)
- Special efforts should be made to investigate and formulate projects either in, or for the benefit of, areas inhabited by tribal or other specially disadvantaged groups such as socially weak, scheduled castes and scheduled tribes
- There are several sections covering aspects of Flood Control and Management, Water Conservation, Drought-prone Area Development, etc., besides Institutional Mechanism, Private Sector Participation and Participatory Approach to water resources management

Water Policy of Himachal Pradesh

The State Policy is in consonance with National Water Policy of 1987. It makes a clear statement of objectives. Some of the statements in this policy document relevant from social and environmental viewpoint are:

- Promotes a participatory approach and involves local communities and stakeholders, including women, in the management of water resources, in an effective and decisive manner in various aspects of planning, design, development and management of the water related schemes.
- Ensure ecological and environmental balance while developing water resources
- Promote equity and social justice among individuals and groups of users in water resource allocation and management
- Ensure self-sustainability in water resources development
- Provide a well-developed information system, for water related data for resource planning. A standardized state information system should be established with a network of data banks and data bases, integrating the State and Central level agencies and improving the quality of data collection and analysis
- Effective monitoring of policy implementation

Among the important provisions included in this policy document are:

***Non-Conventional** methods* for augmenting availability of water such as artificial recharge of ground water and traditional water conservation practices like rainwater harvesting, including roof-top rainwater harvesting and use of such water through dual plumbing systems in all buildings need to be promoted. Pilot projects will be supported for demonstration effect. Research and development in these areas shall also be supported.

Water resource development projects should as far as possible be planned and developed as multipurpose projects but provision for drinking water shall be a primary consideration. There should be an integrated and multi-disciplinary approach to the planning, formulation, clearance and implementation of projects, including catchment area treatment and management, environmental and ecological aspects, the rehabilitation of affected people and command area development. Besides, in projects for hydropower generation involving impounding of water, adequate water shall be released round the year to meet the needs of downstream users. The sustainability evaluation of the Project shall determine "Environmental Discharge" to be prescribed for the Project, which shall not be less than 15% of the available discharge at any given time. In forest areas the extraction of water shall be planned keeping in view the needs of the flora and fauna of the area. The involvement and participation of beneficiaries and other stakeholders will be encouraged at the project planning stage itself.

Ecology & Environment: All water resources projects should be examined from ecological and environmental considerations and remedial measures wherever needed should form a part of the project itself and implemented along with it. A minimum flow in the natural streams should be allowed.

Water Harvesting should be given consideration in planning water resources. Viable projects, especially in scarce ground water areas, should be investigated and implemented to increase the surface water availability would also help in recharging the ground water.

Ecological Health Recreational and other needs: All the water resources projects shall give due regard to the "ecological health" and other needs for which adequate provision shall be made on priority basis.

National Environment Policy

The essential components of environmental policy in India are the prevention of pollution at source; the encouragement, development and application of best available feasible technology; the application of the polluter pays principle; the focus on critically polluted areas, and the participation by the people in the environmental aspects of development.

In the Eighth Five-Year Plan, the strategies were set out for prevention and regulation of environmental pollution. For prevention, emphasis was laid on statutory assessment of environmental impacts of projects. For regulation, reliance was placed on the polluter pays principle.

In the Ninth Five-Year Plan, emphasis is being placed on reorienting development policies rather than on direct intervention. It is stated that the measures required to protect the environment will be taken in such a way as to achieve sustainable development.

It is further stated that Agenda 21 of the Earth Summit guides the current environmental policies in India. The policy statements bear out the strong commitment that the government has for environmental protection and improvement.

In August 2004, the draft National Environment Policy was formulated and placed on the web for wide circulation. The main features that appear new in the proposed policy are shown below:

- Definition of environment has been enlarged to include all entities, natural or manmade, external to oneself, which provide value, now or perhaps in the future, to humankind.
- Foundational aspirations have been addressed, which are (i) that human beings should be able to enjoy a decent quality of life; (ii) that humanity should become capable of respecting the finiteness of the biosphere; and (iii) that neither the aspiration for the good life, nor the recognition of biophysical limits should preclude the search for greater justice in the world. The principles of good governance, viz., Transparency, Rationality, Accountability, Reduction in time and costs and Participation with stakeholders, have been incorporated in the action points.
- Mainstreaming environment in all activities has been explicitly emphasized.
- Responsibilities of the State and the citizen have been stated in the light of the amendments introducing fundamental duties in the Constitution of India.

- International commitments on global climate change, stratospheric ozone depletion, and transfer of hazardous wastes and loss of biodiversity have been specifically mentioned.
- Certain new principles for environmental management have been included in the policy, some of them based on judicial interpretations. The new principles include the following:
    - The precautionary approach
    - Polluter pays principle: general and strict liability of the polluter
    - Economic value of services of environmental resources
    - Priority for incomparable entities, e.g., Taj Mahal and the tiger
    - Equity, both intra-generational and inter-generational
    - Civil liability for environmental damage
    - State is trustee (*not the owner*) of all natural resources
    - Standards should be set in the context of society and economy

National Forest Policy

The principal aim of Forest Policy is to ensure environmental stability and maintenance of ecological balance including atmospheric equilibrium, which is vital for sustenance of all life forms, human, animal and plant. The basic objectives that should govern the National Forest Policy are the following:

- Maintenance of environmental stability through preservation and, where necessary, restoration of the ecological balance that has been adversely disturbed by serious depletion of the forests of the country.
- Conserving the natural heritage of the country by preserving the remaining natural forests with the vast variety of flora and fauna, which represent the remarkable biological diversity and genetic resources of the country.
- Checking soil erosion and denudation in the catchment areas of rivers, lakes, reservoirs in the "interest of soil and water conservation, for mitigating floods and droughts and for the retardation of siltation of reservoirs.
- Checking the extension of sand-dunes in the desert areas of Rajasthan and along the coastal tracts.
- Increasing substantially the forest/tree cover in the country through massive afforestation and social forestry programmes, especially on all denuded, degraded and unproductive lands.
- Meeting the requirements of fuel-wood, fodder, minor forest produce and small timber of the rural and tribal populations.
- Increasing the productivity of forests to meet essential national needs.
- Encouraging efficient utilization of forest produce and maximizing substitution of wood.

- Creating a massive people's movement with the involvement of women, for achieving these objectives and to minimize pressure on existing forests.

Essentials of forest management include the following provisions:

- Existing forests and forestlands should be fully protected and -their productivity improved. Forest and vegetal cover should be increased rapidly on hill slopes, in catchment areas of rivers, lakes and reservoirs and ocean shores and, on semi-arid, and desert tracts.
- Diversion of good and productive agricultural lands to forestry should be discouraged in view of the need for increased food production.
- For the conservation of total biological diversity, the network of national parks, sanctuaries, biosphere reserves and other protected areas should be strengthened and extended adequately.
- Provision of sufficient fodder, fuel and pasture, especially in areas adjoining forest, is necessary in order to prevent depletion of forests beyond the sustainable limit. Since fuel wood continues to be the predominant source of energy in rural areas, the programme of afforestation should be intensified with special emphasis on augmenting fuel wood production to meet the requirement of the rural people.
- Minor forest produce provides sustenance to tribal population and to other communities residing in and around the forests. Such produce should be protected, improved and their production enhanced with due regard to generation of employment and income.
- The forest policy provides strategy for area under forests, afforestation, social forestry & farm forestry, management of state forests, rights and concessions, diversion of forest lands for non-forest purposes, wildlife conservation, tribal people and forests, shifting cultivation, damage to forests from encroachments, fires and grazing, forest-based industries, forest extension, forestry education and forestry research.

3.1.3 Regulatory Framework

A regulatory framework related to water sector and environment exists in the form of rules, regulations and guidelines both at the national and state level. The acts, notifications and guidelines related to environment and pollution in the context of project are given below.

Acts:

- Water (Prevention and Control of Pollution) Act, 1974
- Forest (Conservation) Act, 1980 including Rules and Guidelines
- Air (Prevention and Control of Pollution) Act, 1981
- Environment (Protection) Act, 1986
- Forest (Conservation) Act, 1980

Notifications:

- The Hazardous Wastes (Management and Handling) Rules, 1989
- Environmental Impact Assessment Notification, 1994
- The Noise Pollution (Regulation and Control) Rules, 2000

Guidelines:

- Guidelines for Sustainable Water Resources Development and Management, 1992, CWC
- National Guidance Manual on Environmental Impact Assessment, 2003, NEERI on behalf of MoEF

3.1.4 *Staged Environmental Clearance process*

Environmental Protection and Sustainable Development have been the keystones of the policies and procedures governing the industrial and other developmental activities in India. Ministry of Environment & Forests has taken several policy initiatives and enacted environmental and pollution control legislations to prevent indiscriminate exploitation of natural resources and to promote integration of environmental concerns in developmental projects. One such initiative is the Notification on Environmental Impact Assessment (EIA) of developmental projects issued on 27.1.1994 under the provisions of Environment (Protection) Act, 1986 making EIA mandatory for 29 categories of developmental projects. One more item was added to the list in January, 2000. The objective of EIA is to foresee and address potential environmental problems/concerns at an early stage of project planning and design. EIA/EMP should assist planners and government authorities in the decision making process by identifying the key impacts/issues and formulating mitigation measures.

Requirements and Procedure for seeking Environmental Clearance of projects

Any person who desires to undertake any new project in any part of India or the expansion or modernization of any existing industry or project listed in the Schedule-I of this Notification has to submit an application to the Secretary, Ministry of Environment and Forests, New Delhi.

a) The application has to be made in the proforma specified in Schedule-II of this notification and has to accompanied by a project report which should, inter alia, include an Environmental Impact Assessment Report, Environment Management Plan and details of public hearing as specified in Schedule-IV prepared in accordance with the guidelines issued by the Central Government in the Ministry of Environment and Forests from time to time. However, Public Hearing is not required in respect of (i) small scale industrial undertakings located in (a) notified/designated industrial areas/industrial estates or (b) areas earmarked for industries under the jurisdiction of industrial development authorities; (ii) widening and strengthening of highways; (iii) mining projects (major minerals) with lease area up to twenty five hectares, (iv) units located in Export Processing Zones, Special Economic Zones and (v) modernisation of existing irrigation projects.

b) In case of the following site specific projects:

- mining;
- pit-head thermal power stations;
- hydro-power, major irrigation projects and/or their combination including flood control;
- ports and harbours (excluding minor ports);
- prospecting and exploration of major minerals in areas above 500 hectares;

The project authorities have to intimate the location of the project site to the Central Government in the Ministry of Environment and Forests while initiating any investigation and surveys. The Central Government in the Ministry of Environment and Forests then has to convey a decision regarding suitability or otherwise of the proposed site within a maximum period of thirty days. The said site clearance is then granted for a sanctioned capacity and shall be valid for a period of five years for commencing the construction, operation or mining.

c) The reports submitted with the application is evaluated and assessed by the Impact Assessment Agency (IAA), and if deemed necessary it may consult a committee of Experts, having a composition as specified in Schedule-III of the Notification. The Impact Assessment Agency (IAA) is the Union Ministry of Environment and Forests. The Committee of Experts is constituted by the Impact Assessment Agency or such other body under the Central Government authorized by the Impact Assessment Agency in this regard.

The said Committee of Experts has full right of entry and inspection of the site or, as the case may be, factory premises at any time prior to, during or after the commencement of the operations relating to the project.

d) The Impact Assessment Agency then prepares a set of recommendations based on technical assessment of documents and data, furnished by the project authorities supplemented by data collected during visits to sites or factories, if undertaken and details of the public hearing.

The assessment is completed within a period of ninety days from receipt of the requisite documents and data from the project authorities and completion of public hearing and decision conveyed within thirty days thereafter.

The clearance granted is valid for a period of five years for commencement of the construction or operation of the project.

CHAPTER –4
ENVIRONMENTAL AND SOCIO-ECONOMIC SETUP

4 ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SETUP

This section of the report provides an overview of existing environmental and socio-economic profile of the project area. The baseline data has been collected through field surveys, consultation with various Government departments, and related study reports for different hydro projects (refer section 1.3.1). For presenting the macro and micro level issues of river basin, the chapter details out the environmental baseline conditions under the following three sections:

- Entire Satluj basin,
- Indian part of the Satluj basin,
- Influence area of RHEP and NJHEP.

The identified issues would help the stakeholders in establishing the long- term and short-term development guidelines for the sustainable environmental development of the region.

4.1 Entire Satluj Basin

The total length of River Satluj is 1,448 km. It enters Himachal at Shipkila (altitude = 6,608 metres) and flows in the South-Westerly direction through Kinnaur, Shimla, Kullu, Solan, Mandi and Bilaspur districts. Its course in Himachal Pradesh is 320 km from Rakastal. The prominent human settlements that have come on the banks of the Satluj River in Himachal Pradesh are Namgia, Kalpa, Rampur, Tattapani, Suni and Bilaspur.

The following sub-sections broadly discuss about the catchment area in general, along with the existing environmental profile which comprises the following :

- Characteristics of the Catchment Area
- Forest cover
- Wildlife
- Geology and rock structure of the area
- Seisimicity
- Climate changes
- Floods and other Extreme Weather events

4.1.1 Characteristics of the Catchment Area

The geographical limits of the Satluj basin right from start upto Bhakra dam lie between Latitudes 30° N and 33° N and Longitudes 76° E and 83° E. It covers Nari Khorsam province in Tibet, China and in Himachal Pradesh, India. The Catchment area of river Satluj up to Bhakra dam is about 56,876 sq. km out of which about 36,900 sq. km falls in Tibet and 19,975 sq. km in India.

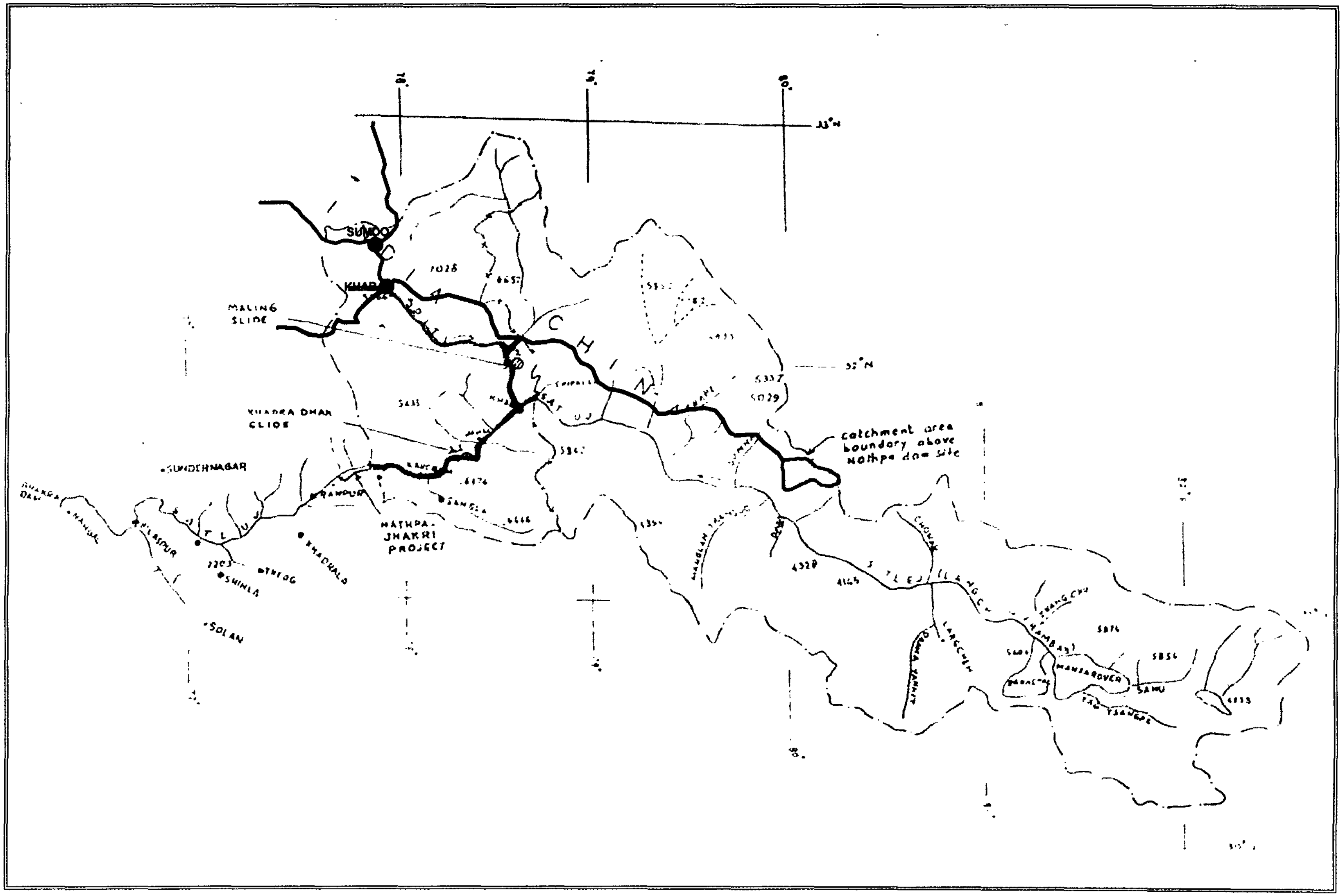
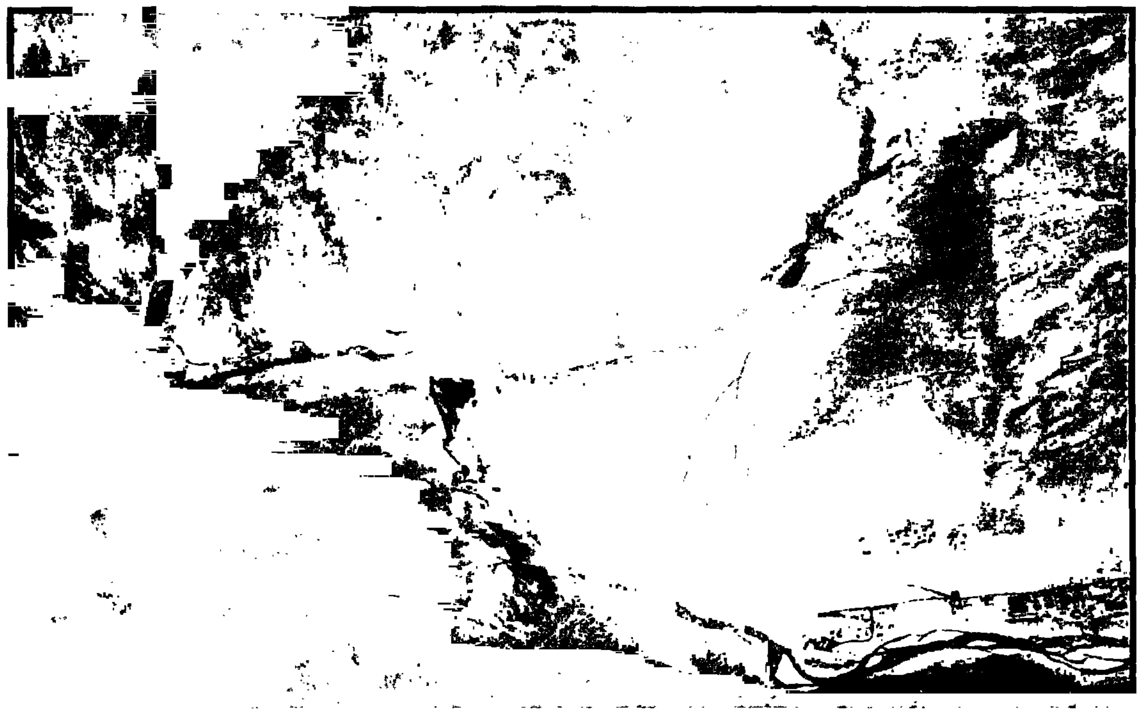
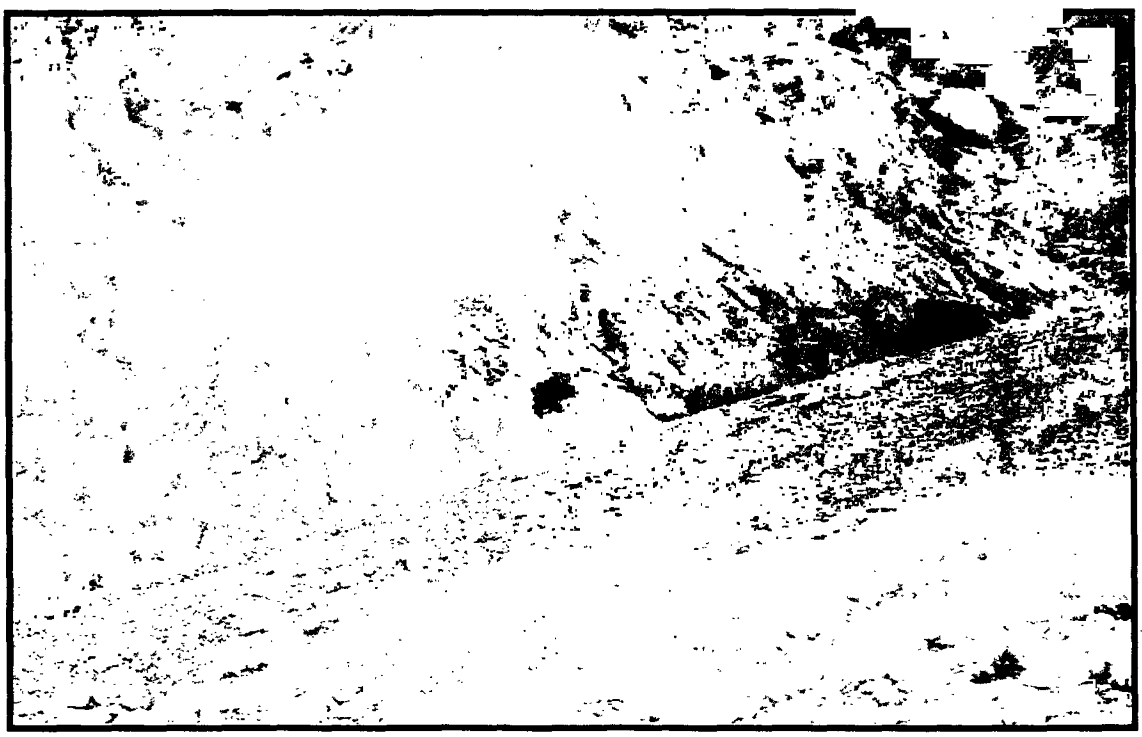


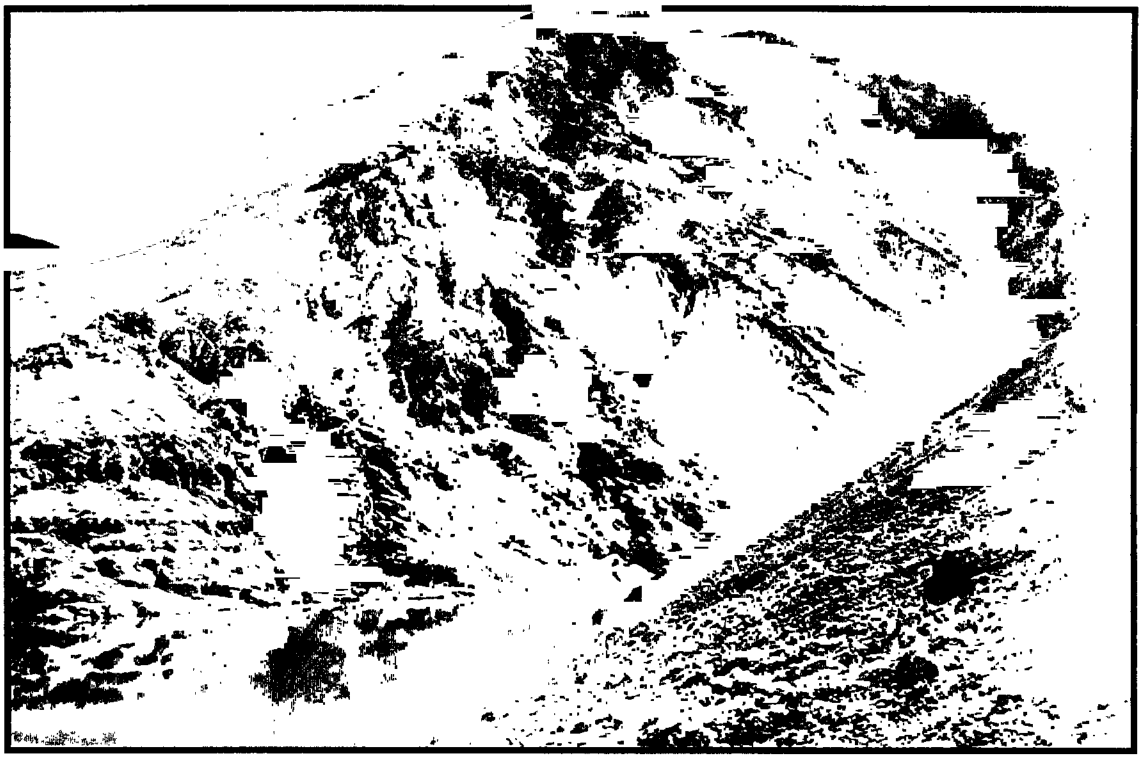
Fig 4.1 A complete view of the catchment area of river Satluj

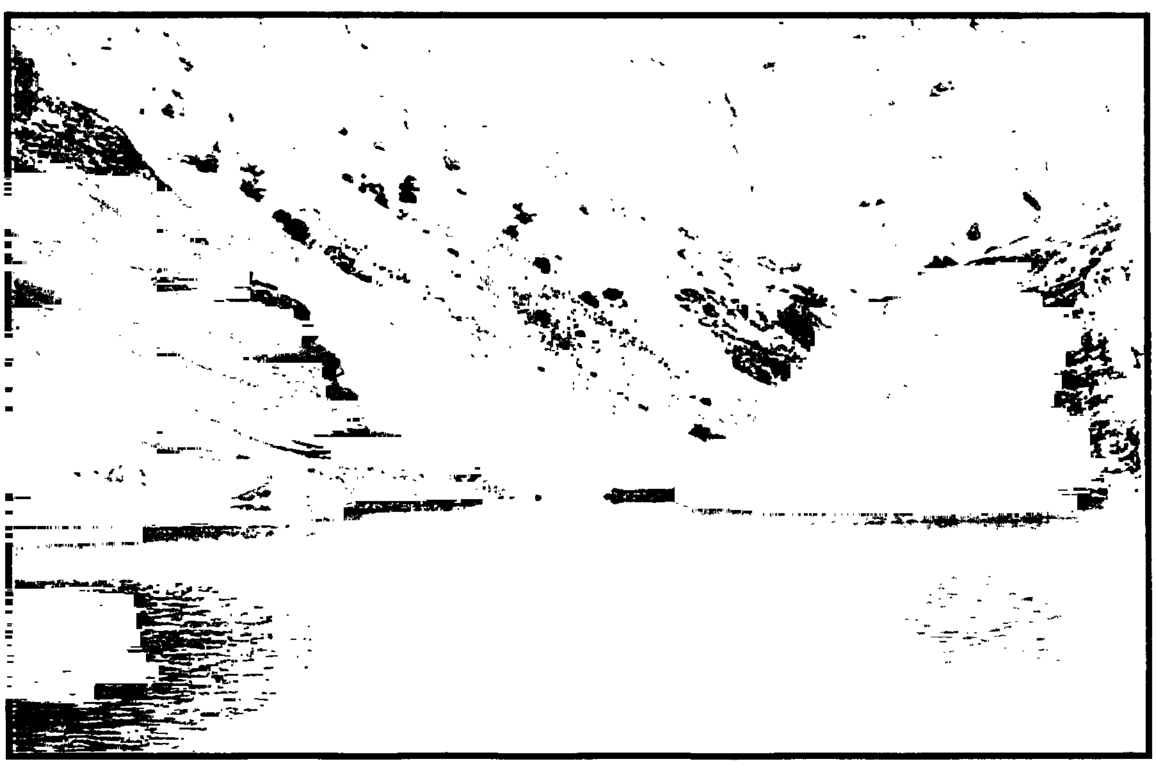
Satluj Catchment Tography in Tibet region





Satluj Catchment Tography in Tibet region





Topographically and climatologically the catchment can be divided into four categories as detailed below:

- Tibetan Plateau
- Spiti Valley
- Khab to Nathpa dam site
- Nathpa dam site

Tibetan Plateau	River Satluj rises in Tibetan plateau in the region of the Mansarover Lake situated at an elevation of about 4570m above mean sea level. The river enters India near Shipkila after traversing a length of about 320 km in the Tibetan province of Nari Khorsam. There is no local rainfall in this region. The snow melt results in deep channel formation on the surface. There is absolutely no vegetation in this region.
Spiti Valley	Spiti River is the largest tributary of the river Satluj and joins river Satluj at Namgia (Khab), about 14 km upstream of Pooh. The characteristics of this catchment area are identical to that of the Tibetan Plateau. Rainfall is scarce in this area. Height of the catchment area drained by river Spiti is between 3048m and 4570m. In this area also there is absolutely no vegetation and the melting of snow forms deep flow channels on the surface.
Khab to Nathpa Dam Site	The catchment area is bounded by moderately high hills with elevation of 1525 m to 3048 m and has little rainfall but heavy snow. The snow line in this region is at $\pm$3048 m. The flows in the river are mainly due to snow melting which follows more or less a regular pattern. The area has steep slopes with little earth covered. Due to the absence of rain, arid conditions prevail and the good forests seen below Reckong Peo are not found at higher altitudes. The pine forests near Karcham-Wangtu give way to chilgoza plantations in the higher altitudes.
Nathpa dam site to Bhakra dam	The catchment has high surrounding hills like Narkanda, Shimla (3050m) etc. but is flanked by foot hills of Shiwaliks near Bhakra Dam (915m). Rainfall in the region is moderate to heavy. The area is forested with scattered to dense patches of trees. There is agricultural development in several locations, mainly along the river and on flatter slopes. In the lower area, Rampur to Bhakra, the average slope of the river is about 1 in 300, with heavier rains and silt loads. The forest cover is sparse with denudation of vegetation because of over-grazing.

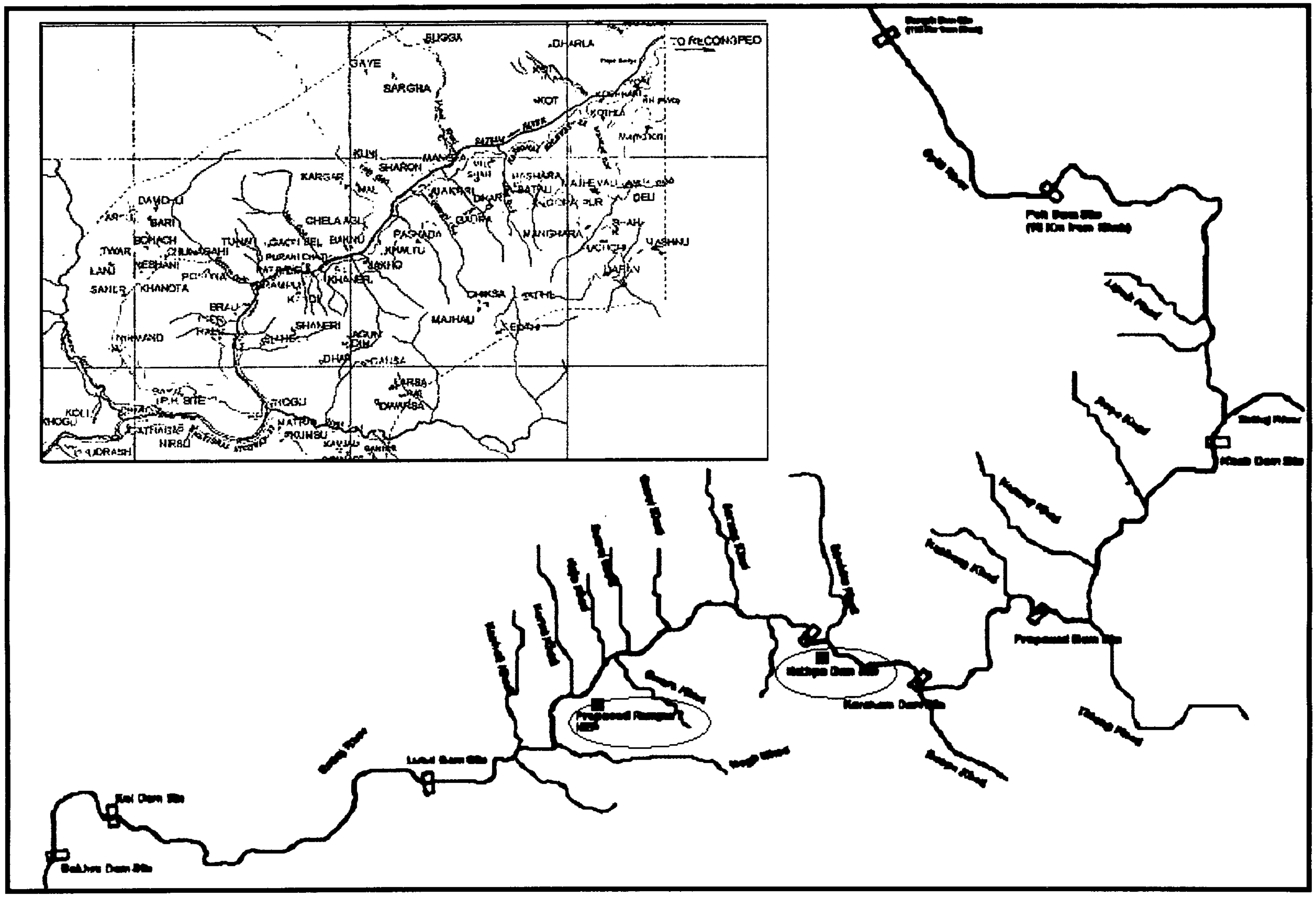


Fig 4.2 Various streams meeting with River Satluj. Also RHEP AND NJHEP sites are indicated

Tributaries joining Satluj River

It was found that along the entire stretch of Satluj, several number of tributaries join the main river (Refer Fig. 4.2). The main tributaries of river Satluj meeting at right bank are:

- Spiti
- Ropa
- Taiti
- Kashang
- Mulgaon
- Yula
- Wanger
- Throng
- Rupi

The main tributaries of river Satluj meeting at left bank are:

- Tirung
- Gayathing
- Baspa
- Duling
- Shoulding

Table 4.1 Tributaries joining Satluj River in the area

Region of confluence	Name of Stream
Joining Satluj in the Tibetan province, Nari Khorsam	Zangchu, Drama, Yankti, Chonak, Manglan, Trunsaco, Sumna, Trape
Joining Satluj Below Shipkila, in India	Spiti, Kashming, Baspa, Bhaba, Shoulding, Seer, Nauti, Nogli, Kurpan, Gambher, Ali, Bharari, Shilaring, Nigulsari/ Chaunda.

Source: EIA for Updation of NJHEP (H.P.), Year 2003

4.1.2 Forest Cover in Entire Satluj Basin

Due to large differences in altitude and precipitation, the vegetation types in this region range from tropical to alpine. In the lower regions, the vegetation type is tropical. The temperature in this part is high and receives a large amount of rainfall, especially during the monsoon. The prevailing forest types in this part are mainly Sal and mixed deciduous. On the southern slopes of the Himalayas, the temperature is low, reaching even zero degrees in winter. Temperate forests consist of temperate mixed deciduous coniferous forests, blue pine forests, deodar forests and oak forests. These areas receive a very large amount of rainfall during the monsoon, because of convection of the monsoon clouds that come from the south. At higher altitudes climate changes into alpine, being very dry and often temperature below zero in winter. Because of these low temperatures and very small amount of precipitation, most of this region is barren

The Forests of Himachal Pradesh, on classification on an ecological basis (as laid down by Champion and Seth), can be broadly categorized into:

- Coniferous Forests, and
- Broad-leaved Forests.

Distribution of various species follows fairly regular altitudinal stratification. The vegetation varies from Dry Scrub Forests at lower altitudes to Alpine Pastures at higher altitudes. In between these two extremes, distinct vegetation zones of Mixed Deciduous Forests, Bamboo, Chil, Oak, Deodar, Kail, Fir and Spruce, are found. The richness and diversity of flora can be gauged from the fact that, out of total 45,000 species found in the country as many as 3,295 species (7.32%) are reported in the Himachal Pradesh. More than 95% of the species are endemic to Himachal Pradesh and characteristic of Western Himalayan flora, while about 5% (150 species) are exotic, introduced over the last 150 years.

Table 4.2 Major Forest Types Recorded in Himachal Pradesh

S.No	Major Forest Type	Classification Code
1	Tropical Moist Deciduozus Forest	3C/ C 2A 3C/C2B
2	Tropical Dry Deciduous	5B/C-1 A 5B/C-2 5B/C2/DS1 5B/E9 5B/1-S2
3	Subtropical Dry Evergreen	10-C1 10-DS1
4	Himalayan Moist Temperature Forest	12/C-1a 12/C-1b 12/C-1c 12/C-1e 12/C2-a 12/C2-b 12/DS1 12/DS-2
5	Himalayan Dry Temperature Forest	13/C1 13/C2a 13/C2b 13/C4 13/C5
6	Sub Alpine Forest	14/C/a 14/C1-b 14/DS1
7	Subtropical Pine Forest	9C1 9DS1 9DS2
8	Most Alpine Scrub	15/C1 15/C2 15/E1 15/C3
9	Dry Alpine Scrub	16/C1

S.No	Major Forest Type	Classification Code
		16/E1

Source: Forest Working Plan Rampur Forest Division

A detailed description on the forest cover exists in the Indian part of the Satluj river basin has been provided in section 4.2.5.

4.1.3 Wildlife in Entire Satluj Basin

Wide altitudinal ranges and varied topography of Satluj basin has resulted in making the state a very rich repository of wild fauna and flora. Wildlife of an area is directly related to the characteristics of the habitat i.e. availability of the food and water, nature and density of flora prevalent in the area along with other factors like slope, climate, prevalent anthropogenic activities, etc. Whereas Snow Leopard, Ibex and Snow Cock have made cold deserts their home, the cold temperate regions of the state form natural habitat of Musk Deer, Himalayan Tahr, Brown Bear, Monal and Western Tragopan. In the lower reaches Sambhar Deer, Barking Deer, Wild Boar, Ghoral and Leopard amongst mammals and pheasants including Cheer and White Crested Kaleej abound. The details of the biodiversity richness, distribution and the protected areas in the Indian part of the Satluj river basin have been laid out in section 4.2.5 under Section II Ecological Resources specific to Influence area of NJHEP and RHEP.

4.1.4 Geology and Rock structure of Satluj Basin

Geologically, Himalaya is one of the youngest oro-genic belts and therefore, represents unstable regions of the earth. Since the Himalayas lies in the sutures of Indian and Chinese plates, regular tectonic movements have taken place including frequent earthquakes, landslides, etc.

Regionally, the Satluj basin area belongs to Jutogh series of formation, which is co-relatable to the archaen group of rocks. These are oldest sedimentary system, which have been metamorphosed and occur more or less as a continuous band between the central axis of higher Himalayas and outer ranges. Jutogh series comprises of gneisses, quartzites, slates, limestones and schists.

In the area, south of Khab in Kinnaur District upto Spillo, around Satluj River, the rocks in general are highly folded granites, phyllites, low grade schist, slates and places gneises grading into Kranite, garnet schists. These metamorphic rocks of Central crystalline zone in the Southern part of the Higher Himachal Himalayas are exposed at Kalpa, Spillo, Pooh and adjoining areas. On the basis of lithology, rock association, and tectonic setting, these rocks are mainly grouped under:

- Wangtoo Gneissic Complex
- Karcham Group and
- Himanta Group

The rocks exposed in upper reaches around Khab project area are grouped under Haimanta Group. This area of the catchment is devoid of any vegetation and is snow fed, the glacial erosion on the slope and summits of the mountains is prominent, the surfacial weathering is very common may be due to the diurnal temperatures and frost action.

The heavy snowfall during winter is followed by the avalanches during the start of the summer so the accessibility to the area is limited to 5-6 months in a year. Geologically the Khab projects are mainly belong to Haimantas, which includes Rakcham Granites on its eastern side, and adjoins a sequence of gneiss, schists and phyllites along the fault called Sumdoh Fault, which is still active.[1]

4.1.5 Seismicity in the Area

In this particular section, the sensitivity of the area in terms of seismic activities has been discussed in context of geology type at various locations of operational or proposed hydroelectric projects in the area.
The various seismo-tectonic features, which can significantly affect the seismicity in the area, are listed below:

Table 4.3 Seismo-Tectonic features

Seismo-tectonic features	Characteristics
Main Central Thrust (MCT)	Regional feature trending parallel to the Himalayan axis and is identifiable along the entire stretch of the Himalayas. In the project area, MCT trends in NW-SE direction with shortest distance from the dam site and powerhouse being 10 km and 26 km respectively.
Kaurik Fault	Trends in the N-S direction in the northern part and NW-SE in the southern part it is one of the bounding features of the Shimla block. The fault has a length of 100-200 km and it runs at a distance of 40 km and 50 km from the dam site and power house respectively.
Rampur Fault	Separates the quartzites of the Rampur from the gneisses and is located about 1 km downstream of the Jhakri underground power house
Main Boundary Fault (MBF)	Lies parallel to MCT at a distance of 60-70 km south of it and runs along the entire stretch of Himalayas.
Foot Hill Thrust (FHT)	Youngest of the regional tectonic lineaments and quaternary/Neogene deformations are observed. The thrust has a strike length of 60 km and trends parallel to MCT and MBF.

Source: EIA Study for Updation of NJHEP, Year 1998

Seismologically, Himachal Pradesh can be classified into the following three sub-domains.

[1] *PFR Khab HEP, Year 2004*

1. **Frontal Foothill Seismic Belt**: Area occupied by the Siwaliks, Tertiary and Quaternary sediments defined on the north by the Main Boundary Fault (MBF). The southern boundary is not well defined. The belt shows evidences of neo-tectonic activity along thrust and transverse faults known as tears in the foothill belt.

2. **Lesser Himalayan Seismic Belt**: is bounded in the north by Main Central Thrust and Main Boundary Thrust in the south. This area demonstrates the highest seismicity level with most of the fault planes solutions being parallel to the Himalayan trend and displaying thrust type of deformations.

3 **Great Himalayan Seismic Belt:** is the area falling north of Main Central Thrust and is characterised with seismic events, majority of which have magnitudes less than 5 on Richter scale.

The state of Himachal Pradesh can be classified into two distinguished seismic zones namely Himachal Upper Seismic Zone (HUSZ) and Himachal Lower Seismic Zone (HLSZ) separated by Basement Thrust Front (BTF). The lateral bounding of surfaces of this seismic belts/zone is through distinct crystal blocks namely Chamba, Kangra and Shimla blocks.

Khab area: The proposed Khab project is lying in active seismic Himalayan belt as per data on earthquake occurrences and geologically and tectonic set up of various parts of the country. This area has experienced minor tremors in the past, probably due to the influence of 1975 Kinnaur earthquake and 1991 Uttarkashi earthquake during which, the estimated intensity was VI (on modified Mercelli scale). During 1905 Kangra earthquake this area experienced an intensity of VII (on Rossi-Forrel Scale). As per seismic zoning of the India, the location of Khab project lies in seismic zone IV and is in close proximity of the Kaurik fault.

Nathpa-Jhakri Area: The NJHEP area lies in lesser Himalayas with general altitude above elevation 1000 mts. The area consists of deep and narrow valleys and gorges having steep cliffs and escarpment faces. The rock types in the area comprise a variety of metamorphic rocks like gneisses, schist, gneissose schist and basic intrusive and granite. These unfossiliferous rocks belong to Rampur block and surrounded by the Jeori-wangtu, Jutog group, Sakala group. The main rock exposed in the Nathpa area is augen gneiss. Schist and amphibiolite bands ranging in thickness from few centimetres to more than a meter occur at places. Figmatile is present as irregular intrusive in the gneiss. Near Emergency Access Tunnel (EAT) portal well foliated schist and gneiss is exposed in an inter-layering form. Gneiss is generally hard and compact moderately jointed and fractured, sheared at some places Foliation and valley side dipping joints are quite common. It can be concluded that in the area shear plains are extremely common. In fact a large shear zone exists near the dam site, which used to cause regular landslides. SJVNL has cable anchored the whole shear zone with substantial expenditure. As per seismic zoning of the India, the location of NJHEP project lies in seismic zone IV.[2]

Rampur Area: The bedding seen in the **Rampur** group and that in the Jeori-wangtu complex is in the form of compositional banding. In the Rampur area the strike direction varies from N 40 E-S40 W to N60 w with southerly dips ranging from 20 to 40. At some places gouge seams are also associated with some of the joints. The foliation trend generally varies from N70W-S70E to N70E-S70W having an average dip of the order of 35 in the northerly direction. The Himalayas lie in the orogenic belt making them prone to earthquakes and project site falls in Seismic Zone IV. The region has a history of occurrences of earthquakes above the scale of 5 and the last major earthquake had occurred in 1991.

The catchment area of Rampur HEP includes Rampur range, Bahli range, Machhada catchment of Nankhari Range and parts of Sarahan range. This tract lies in the western Himalayas. The main rock types are Micaceous, Schist and Chozitite Schist with Gneiss, Granite, Phyllites, Slates, Shales, Shales, Dolomite, Limestones and Quartzite. The rock types of Nogli valley are quartzite. Between Bahli and Surad rock Gneiss with large white rhomboid, Crystals of feldspar. The geology, rock and soil affect the vegetation of a place by influencing the moisture regime, texture and drainage of the soil. The known geological formation in the area is given below:

- Pre-Cambrain system – schists, gneiss, grains and quartzites.
- Late Pre-Cambrain Himanta system – phylities, quartzites, contomerates, shales and states.
- Silurain – Karol, limestone, Quartzite.
- Carboniferous – quartzites, slate, dolomite, limestone.

Table 4.4 Stratigraphic sequence of rocks on the Project area

Age	Formation	Group	Lithology
Pre-cambrian	Manikaran	Rampur	Predominantly white quartzite with minor greenish, grey phyllite and Ortho-amphibolites bodies.
	Banjar	Rampur	Matabasic volcanoic flows with minor white quartzite amd ortho-amphibiolite bodies.
	Garh	Kullu	Augen gneiss with pocket of phyllite, carbphyllite and MEATBASIC intrusive
	Khamrada	Kullu	Phyllite and limestone stone with quartizite interbeds

Source: EIA for Rampur HEP, Year 2005.

[2] *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*

Luhri Area: The proposed Luhri project lies in Mehbar and Maldi gneisses comprised of kyanite and psamatic gneisses with bands of schist and quartzite. These are intruded by basic and acidic rocks. All the rocks are well foliated. The general trend is N-S with moderate dips towards East. The rock formation within the project area going upstream from tailrace consists of Wangtoo, Rampur and Jutogh gneisses and granites. Rocks are covered by glacial deposits, rock debris, and alluvial terraces. The soils of the Satluj valley are relatively poor sandy loam and exposed bedrock, rocks and gravel abound. There is nearly no soil in the valley, but between elevations 1200-3500m, the soils supports some forest cover and is cultivable to a certain extent. As per seismic zoning of the India, the location of proposed Luhri project lies in seismic zone IV. Available data on seismicity within a radius of 150 km of the project shows that earthquakes having a magnitude more than 5 on Richter scale occur at frequent intervals.

Kol Dam: Pink limestone and greyish dolomite are the two types present in the dam site area. The rock weathering is moderate, superficial and extends down to 3 m on the average. The dam site is located in the north-east border of the active frontal folded and thrusted belt of Himalayas, bounded by the main Boundary fault towards the NE and Barsar and its homologous thrusts to the south east. The Barsar and Gambhar thrusts and the main boundary fault can be considered seismic sources capable of generating a major earthquake. The largest earthquake experienced in the region was of magnitude 8.0, was at Kangra in 1905 with epicentre at 32.10N, 76.30E. Other major quakes that hit the region were 1908 Kullu quake (magnitude 6), 1945 and 1947 Chamba quakes (6.5 and 6.6) and 1975 Kinnaur Quake (magnitude 6.8) and f1991 Uttarkashi quake (6.6).

4.1.6 Climate Change

According to WWF, "Himalayan glaciers are among the fastest retreating glaciers globally due to the effects of global warming." A WWF report-*An Overview of Glaciers, Glacier Retreat and Subsequent Impacts in Nepal, India and China*, states that glaciers in the region are now receding at an average rate of 10-15 metres per year. This will eventually result in water shortage for hundreds of millions of people who rely on glacier-dependent rivers in China, India, and Nepal.

As glacier water flows decline, the energy potential of hydroelectric power will decrease, causing problems for industry, while reduced irrigation means lower crop production. Rapid melting of glaciers and snowfields may also lead to disruption of water supplies, fisheries and other wildlife. Himalayan glaciers feed into seven of Asia's greatest rivers, the Ganges, Indus, Brahmaputra, Salween, Mekong, Yangtze and Huange He. In India, the Gangotri glacier, which supports one of India's largest river basins, is receding at an average rate of 23 metres per year. In China, the report shows that Qinhai Plateau's wetlands have seen declining lake water levels, lake shrinkage, the absence of water flow in rivers and streams, and the degradation of swamp wetlands.

A study by the United Nations Environment Program (UNEP) and the International Center for Integrated Mountain Development (ICIMOD) reveals that the temperature in the Himalayan region has risen by almost 1 degree Celsius (1.8 degrees Fahrenheit) since the 1970's. This shift in climate causes meltdown of snowfalls and glaciers - at the fastest rate in the world (50 feet/15 m per year in northern India) - even in winter, causing icy water to accumulate in lakes hedged by unstable dams of sediment and stone. As the lakes swell, the dams often burst, sending muddy streams down the narrow valleys. In addition to life and property – including bridges, hydro-electric plants and tourist facilities – the flood, laden with massive boulders and sediment, also devastates agricultural lands and irrigation systems in the valleys below.

During winter, most of the high-altitude regions experience snowfall, and snow cover plays an important role in the ecology of the region. Therefore, understanding of snow accumulation and ablation is important for utilization of the Himalayan water resource. The heavy snowfall is also fortuitous for the rivers, especially snow-fed ones which will have abundant water during summers when the snow melts, which in turn shall boost hydro-power generation. The snow has also lent some happiness to farmers in the state who are anticipating a good yield with abundant water to enhance their crop quality.

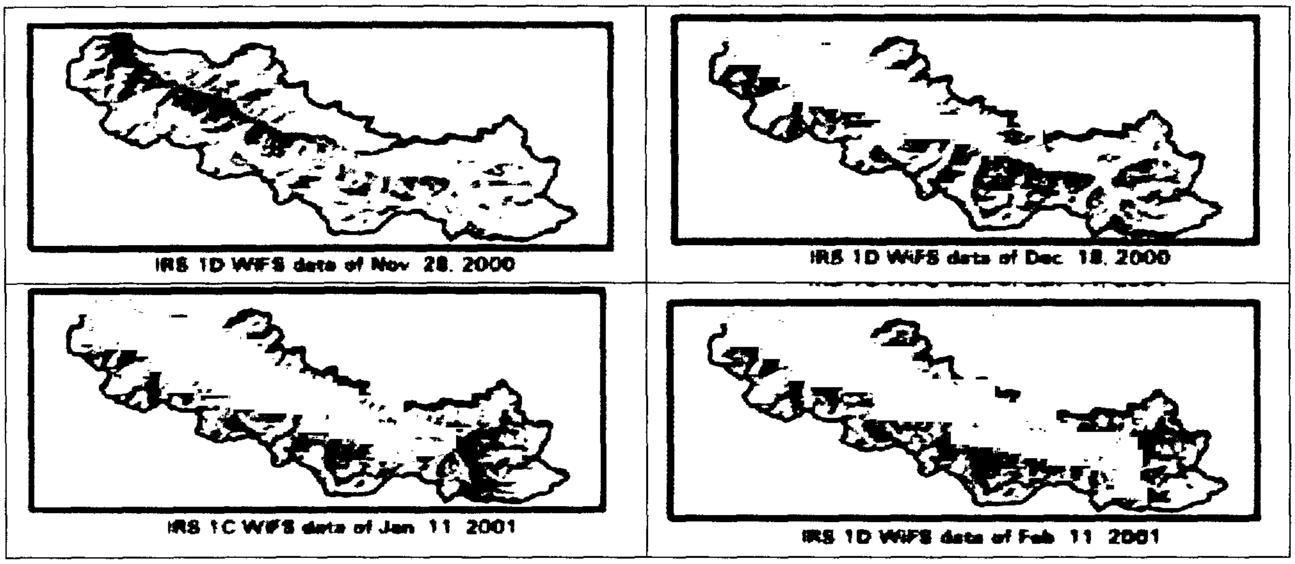
Snowpack ablation is highly sensitive to climatic variations. Increase in atmospheric temperature can enhance energy exchange between the atmosphere and snowpack. This can increase snow-melting. Investigations suggest that climate of the earth has constantly changed in the course of time, during the past ten million years or so. This increase in temperature has continued in the 21st century and average surface temperature of the earth can rise by 1.4 to 5.8°C by the end of the century. This will have a profound impact on snow accumulation and ablation rate in the Himalaya, as snow and glaciers are sensitive to global climate change.

Many research organizations and independent researchers are doing commendable work in systematic analysis of accumulation and ablation of snow cover in the Himalayan region using WiFS data of Indian Remote Sensing Satellite (IRS). A study has also been done for Baspa Basin up to Sangla, in Himachal Pradesh. Baspa is a one of the main tributaries of river Satluj. The study confirms that global warming has started affecting snowmelt and stream run-off in this region of Himalyas. Winter stream flow for the Baspa glacier basin has increased 75% since 1966 and local winter temperatures have warmed, suggesting increased glacier melting in winter. (Refer to figure below)

The problems associated with glacier retreat in the face of climate change are not straightforward. On the one hand current increased melting induces a gradual increase in discharge. In the longer term however as glacial mass decreases there will be a 'tipping point' as runoff begins a decrease trend with massive implications. Perennial rivers could be changed into seasonal streams giving rise to freshwater scarcity in the summer months when melt waters contribute the bulk of the water (around 75%) to the Himalayan rivers.

In addition more melting is expected to increase the frequency of catastrophic events such as glacier lake outburst floods (GLOF) that have devastating consequences for civil works like bridges, dams and powerhouses, and communities living at downstream. Also, the increase in phenomena such as cloudbursts is widely noted. Incidence of landslides, on other hand, was perceived to have slightly declined or remained relatively constant over time. Elderly people recalled major floods in their lifetimes, the first in 1947 and the latest in 1995. The floods were recalled in terms of human life and property. Section 4.1.7 discusses extreme events in detail.

Fig. IRS–WiFS imagery showing distribution of snow cover in Baspa basin for November 2000 to February 2001. Note reduction of snow cover from November to February.



4.1.7 *Other Extreme Events*

The Satluj basin is prone to processes, including floods, landslides, soil erosion, and debris flows. The area also experiences flash floods caused because of lower water retention capacity of the terrain, cloudbursts, creation of an artificial dam because of landslides and its disruption on accumulation of water, etc. The major floods and earthquakes in the basin have been discussed. A detailed analysis of the natural hazards –**Floods/ Cloud Bursts, Earthquakes and Landslides**, as a result of the cumulative impact of the multiple hydropower projects on Satluj has been undertaken in the following section.

Floods/ Cloud burst and flash floods

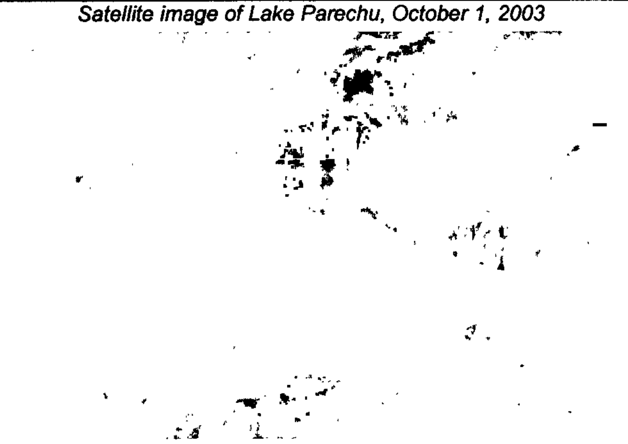
The river Satluj carries the maximum amount of silt among the Indian rivers. The maximum flows in it occur during June-August resulting from combined contribution of rainfall and snowmelt. Three floods that submerged the entire Satluj basin in 1997, 2000 and 2005 have affected the Satluj catchment area immensely. It not only led to damages in the area but the entire topography has also changed with heavy erosion of the riverbanks. During last 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 river Satluj caused extensive damage. The river Satluj was blocked near Wangtoo and a 5 km × 2 km lake was formed in a matter of hours. This nascent water body had submerged an equal length of the National Highway. The peak discharge at Rampur during this flash flood was 2,577 cumecs. In this flood around 223 lives were lost and property worth Rs. 8,146 lakh was damaged.

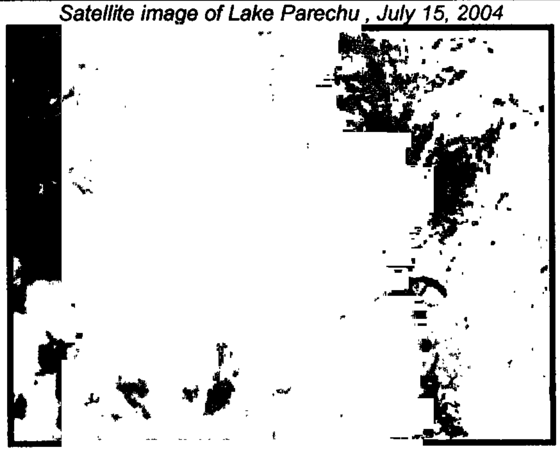
The flash flood of August, 2000, the probability of which was one in 61,000 years, left a trail of destruction in Shimla and Kinnaur districts killed more than 150 persons and washed away 14 bridges. The estimated loss to public and private property in this calamity was around Rs. 1,000 crore. The water level rose suddenly from 12 to 20 metres, damaging a 320 km stretch of the National Highway and the 1500 MW NJHEP.

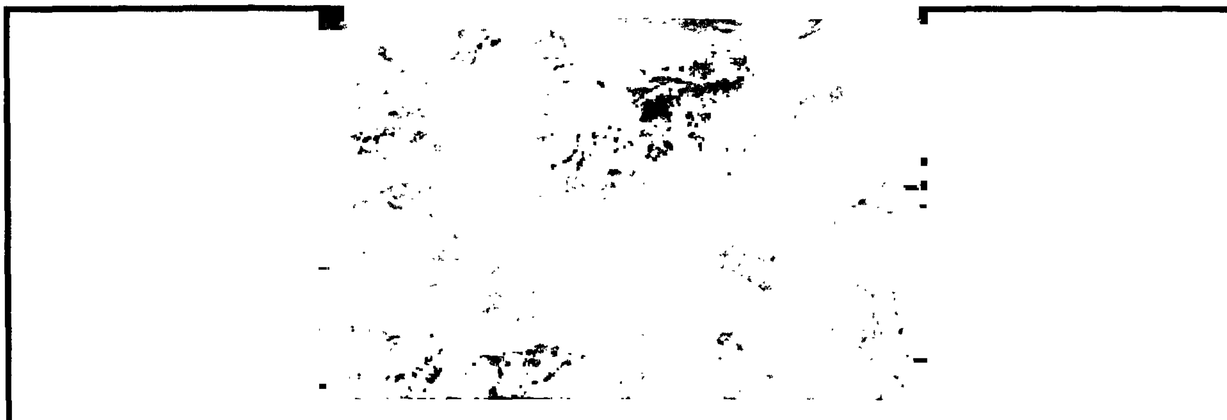
Last year in June 2005, there was a sudden breach in the artificial lake on river Parechu, in Tibet (China), which led to an unprecedented rise in the water level of river Satluj and caused flash floods in five districts of Himachal Pradesh. Parechu is 3500 metre-long 800-metre wide and 15 meter-deep lake in Tibet close to the Indian border which was formed behind a landslide blocking the Parechu river, a tributary of the Satluj river that flows into India from Tibet. The flash floods, however, caused extensive damage to roads, bridges, agricultural crops, Government & private properties and other infrastructure. Also, three hydro-electric power projects in the State viz. Naptha Jakhri, Chamera II and Baspa, had to be temporarily shut down due to heavy siltation caused by the flash floods. The discharge recorded was about 3000 cumecs. It was almost half the maximum discharge of 6,500 cumecs recorded during the August 2000 flood. The impacts of this extreme event have been presented in section 5.1.7 of Chapter 5 Data Analysis and Impact Assessment..

Satellite image of Lake Parechu, October 1, 2003

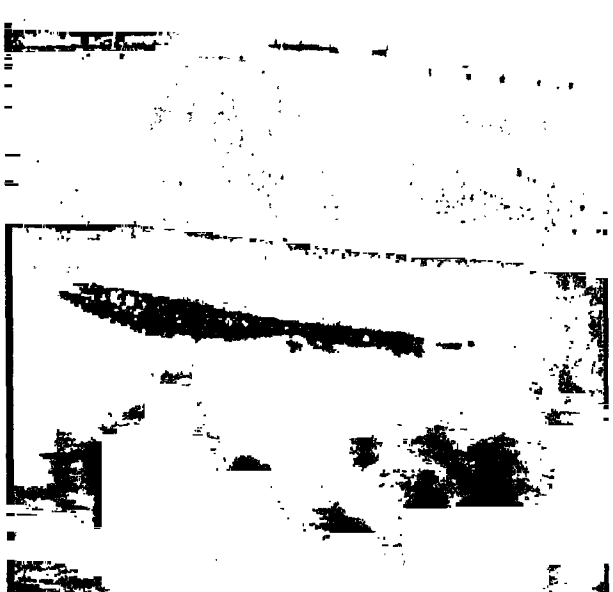


Satellite image of Lake Parechu , July 15, 2004

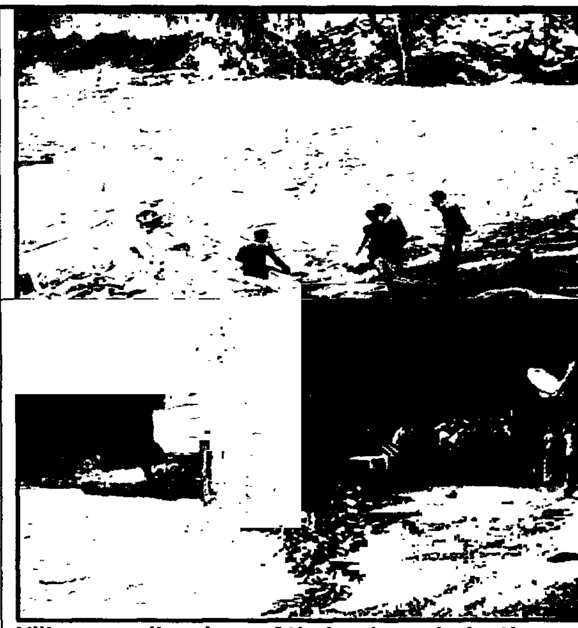




Satellite image of Lake Parechu, September 1, 2004



Flood loss: Broken limb of a bridge in Satluj river near Bael



Villagers collect logs of timber brought by the raging Satluj ;Portion of houses washed away by the torrents at Nogli village, near Rampur

In the last 12 years, over 40 incidents of flashflood, cloudbursts have occurred in Himachal. Most of these were extremely fierce, like the Chirgaon and Wangtoo flashflood, where even the army fell helpless. Over 350 people were killed. Prior to this 1994-95 (August) the Manimahesh cloudburst and flashfloods washed away almost entire length of Chamba-Bharmour road (62 km). Over 50 people feared dead leaving 2000 people injured.(estimated loss over 450 crores). The year 1997 again saw a heavy flashflood in Manglad in Rampur Tehsil of Shimla District. In the year 2000, the Monsoon brought nightmare for people living in Satluj catchment areas. The dead bodies even reached up to Kasol- Chindi (Mandi). Over 150 lost their life, several thousand men lost their livelihood. There was loss of life and property worth Rupees 200 crores.

The following table presents the list of recent major Plash Floods & Cloudbursts that's hit Himachal Pradesh.

List of Recent major Plash Floods & Cloudbursts in Himachal in the year 2003

Sno	Area	Date
1.	Rai Khud (near Sarahan in Rampur Sub division (Shimla) in which loss of crops, cattle's was reported	8th July 2003
2.	Chunahan (Balh valley) Property, crops and real estate, cattle worth crores washed away due to flash flood	13th July, 2003.
3.	Gadsa valley (Pulia Nalla) in Kullu district loss of life over 150 (though reported only 35), Expected loss over 100 crores.	16th July
4.	Balh valley in Mandi district in Gaggal area heavy loss of crops, fields and property reported.	20th July, 2003.
5.	Bahang in Kullu Valley (near Manali) 2 people lost lives, property, houses damaged	24th July 2003
6.	Jhakri area in Rampur Tehsil (Shimla) Indo-Tibetan Border Road, land slid caused huge loss, danger to NJPC, buried dead, a few went missing	26th July 2003
7.	Dansa (Bari Dhar) in Rampur Tehsil (Shimla) cloudburst caused extensive danged to coops, apple orchards, agricultural land	27th July 2003
8.	Lulani village in Baijnath (Kangra) cloudburst revel lent f lash flood damaged houses, 5 killed 18 families marooned	2nd August 2003
9.	Shilara on Rampur - Shimla (NH) road witnessed landslide road blocked	3rd August 2003.
10.	Bhagsunath (Kangra) land slid caused one dead, 2 injured	3rd August, 2003
11.	Balh Valley (Mandi district) witnessed yet another cloudburst extreme damage to crops and ferhla land	6th August, 2003
12.	Kangni Nalla (Solang) in Manali area cloudburst left BRO labours 36 dead 20 stall reported missing	7th August, 2003
13.	Kotkhai Tehsil (Shimla) cloudburst caused, transport bus with passenger washed away 15 had miracle escape	7th August, 2003

Earthquakes

Lying in the sensitive Himalayan belt, the region is prone to seismic activity. Scientific investigations reveal that most of the earthquakes in the region are the result of the movement along thrusts/faults and are located along three major thrust zones i.e.:

1. The Main Boundary Thrust (MBT), delineating the Shivalik foothills from the rest of the Himalayas,
2. The Main Central Thrust (MCT), demarcating the Lesser and Central Himalayas,
3. The Central Counter Thrust (CCT), separating the Central Himalayas from the Tibetan Himalayas.

The existence of major active thrust sheets is the probable cause of the high vulnerability of the area to earthquakes and it being classified as seismic zone IV and V. Earthquakes having a magnitude greater than 5 on the Richter scale occur at frequent intervals.

Table 4.5 Major Earthquakes and intensities, Himachal Pradesh

Date	Place	Intensity
1905	Kangra	8.0+
1908	Kullu	6.0
1945	Chamba	6.5
1947	Chamba	6.6
1975	Kinnaur, Lahaul & Spiti	6.7
1978	Dharamshala	5.0
1986	Dharamshala	5.7

Source: State Development Report, Planning Commission; PFR Luhri HEP, Year 2004.

The table and map below presents the major Earthquakes that hit the region around NJHEP and RHEP sites.

Table 4.6 Major Earthquakes within 200 km from the Project Site with magnitude of 6 and above in Richter scale

Date of occurrence	Epicentre		Magnitude on Richter Scale
	Latitude (°N)	Longitude (°E)	
5.3.1842	30	78	6.5*
16.6.1902	31	79	6.0*
13.6.1906	31	79	6.0
28.2.1908	32	77	7.0*
20.10.1937	31.1	78	6.0
12.5.1939	32.5	78	6.3
22.6.1945	32.8	76.9	6.5
10.6.1947	32.6	75.9	6.0
27.6.1955	32.5	78.5	6.0
12.4.1963	32	78.79	6.0
19.1.1975	32.35	78.76	6.8
20.10.1991	30.75	78.86	6.6

*Note:- * Estimated values based on macro-seismic effects.*
Source: Seismic parameters for Nathpa-Jhakri Hydro-Electric Project site, H.P. Project No. 575 Department of Earthquake Engineering University of Roorkee, Roorkee, 1993

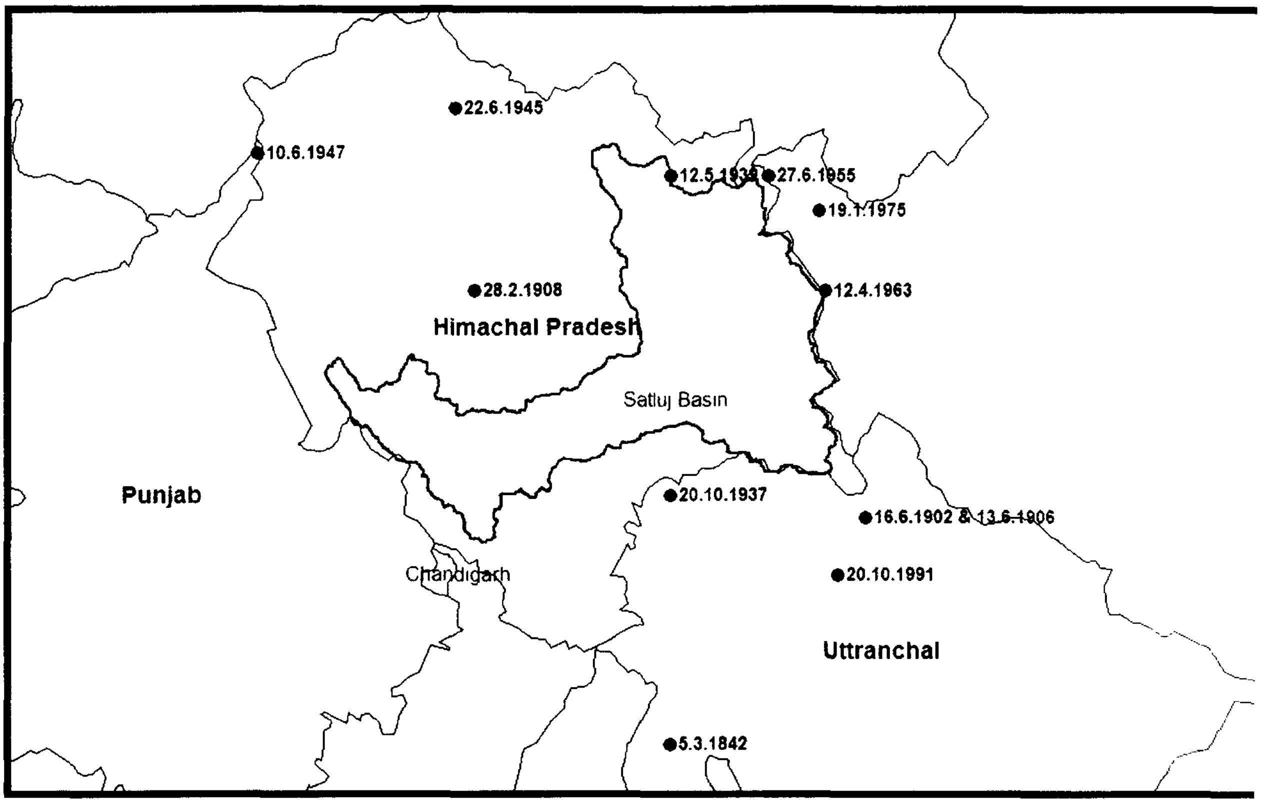


Fig 4.3 Major Earthquakes within 200 km from the Project Site with magnitude of 6 and above in Richter scale

Landslides

Besides earthquakes, landslides are the other natural hazard that plagues the Satluj river basin. Landslides are the downslide movement of soil, debris or rocks, resulting from natural causes, vibrations, overburden of rock material, removal of lateral supports, change in the water content of rock or soil bodies, blocked drainage, etc. In the river basin, the mass movement varies in magnitude from soil creep to landslides. Solifluction (form of creep in which snow or water saturated rocks move down the slope) is another type of movement that is common on the higher snow covered ranges.

The problem of landslides is common and frequent in Himachal Pradesh. Almost every year one or more major landslides affect the state. Loss of life, damage to houses, roads, means of communication, agricultural land, and floods are some of the major consequences of landslides in the region. Flash floods, particularly in the narrow river gorges are one of the leading causes of landslides in Himachal. These in turn jeopardize the stability of the hill as a whole (refer PLATE 4.1). Some of these landslides have often created landslide-dams in various river gorges.

At present, landslides occupy about 1% of the land surface in five central districts of Himachal Pradesh. Some of the major landslides in the state include the following:

- **Thangi Slide** (on the NH 22, 389.2 km on the right bank of Satluj river opposite the confluence with Tirung Khad): It is a recurring landslide with instability caused by toe erosion by Satluj and due to cutting in the road widening. The high discharge of Tirung Khad has forced the Satluj river towards west to undercut the slope.

- **Khadra Dhang Slide Zone** (75 x 1300 x 10m): It is located on the old Hindustan-Tibet road along the right bank of Satluj, opposite to Ribba. The construction of road and steepening of already steep slopes due to toe-cutting by river Satluj make it an active landslide. Though the Hindustan-Tibet road has now been diverted to the left bank of the river, but toe cutting by river Satluj during peak discharge continuously causes active sliding.

- **Pangi Slide** (measuring 65 x 300 x 6m): it is located on the Pangi-Kalpa link roads junction with NH 22. Seasonal seepages along with uncontrolled blasting for the construction of NH-22-Kalpa link road has contributed to the generation of this slide.

- **Powari Slide Zone** (measuring 1000 x 500 x 25m): It is located on the lower slope along the right bank of Satluj river between Powari and Peo. The construction of the approach road from Powari to Kalpa has been one of the lead causes in making this a major landslide area.

- **Barua Slide** (measuring 60 x 100 x 15m): It is located in the left middle slope in the Baspa valley about 5 km southeast of Karcham. Though the slode was triggered in 1987-88 it has been repeatedly activated. The removal of toe to widen the road and already moistened glacial material and seasonal seepage from upslope has contributed to the occurrence of this landslide.

- **Urni Rockfall** (measuring 500 x 250 x 5m): It is located near village Tapri along the lower slope, on the right bank of river Satluj on NH 22. Over steepening of the slopes due to toe cutting by Satluj has been further intensified by rockfall on the opposite bank, forcing the river towards the present slide.

PLATE 4.1 LANDSLIDES IN THE REGION

- **Nichar/ Nathpa Landslide** (measuring 350 x 200 x 35m): It is located in the lower middle slope on left bank of Satluj river is located on NH-22 road. The toe cutting by the Satluj River and widening of the NH-22 road had over steepened the slopes. Thus adverse rock dip and slope relationship and seepage of water from upper slopes have caused this complex rockfall and debris slide.

- **Shoulding Khad Slide** (measuring 200 x 200 x 15m): It is located along the right bank of the Shoulding Khad, a tributary of Satluj River. The toe-cutting by the Soldan Khad have also over-steepened the slope and contributed in sliding. The monsoonal rain of September 1992 have further deteriorated the situation and resulted in debris flow.

- **Jhakri Landslide** (measuring 500 x 500 x 15m): It is located on the left valley slopes of the Satluj valley on NH-22 (288/450 km stone). The upper slope area is covered with agricultural fields of Shah and Ghaso villages are situated. The location of the landslide is in the vicinity of main central thrust and east-west trending Nogli Gad Fault. The greater slide occurred on 24 Feb 1993 following heavy winter rains. The slipped mass (37.5 x 105m) temporarily blocked the river Satluj and within 48 hours a lake was formed which was 1.5 km long, 25-30m deep and 15-20m. The lake induced dimension remains in existence for 7-8 months.

All the landslides have a total volume of more than 2.2 x 106 m3 and a mean age of 6.5 years. This helps to calculate the denudation rate, which is about 12 mm/year (all erosive processes). Landslides have about 2.5 mm /year denudation rate.

4.2 Indian Part of Satluj Basin

The following section presents a broad overview of Indian part of Satluj River Basin under following heads:

- Catchment Characteristics and Drainage Pattern
- Meteorology
- Soil Quality
- Sedimentation aspects
- Ecological Resources of the Area –Forests, Natural Flora, Natural Fauna
- Protected Areas
- Landuse

The representative socio-economic indicators of the area have also been discussed.

4.2.1 Catchment Characteristics and Drainage pattern

Several tributaries join the main Satluj River in the study stretch. Since these tributaries contribute in maintaining the minimum flow requirements in the main river, assessing the average flow discharge levels of various streams form an important part of the study.

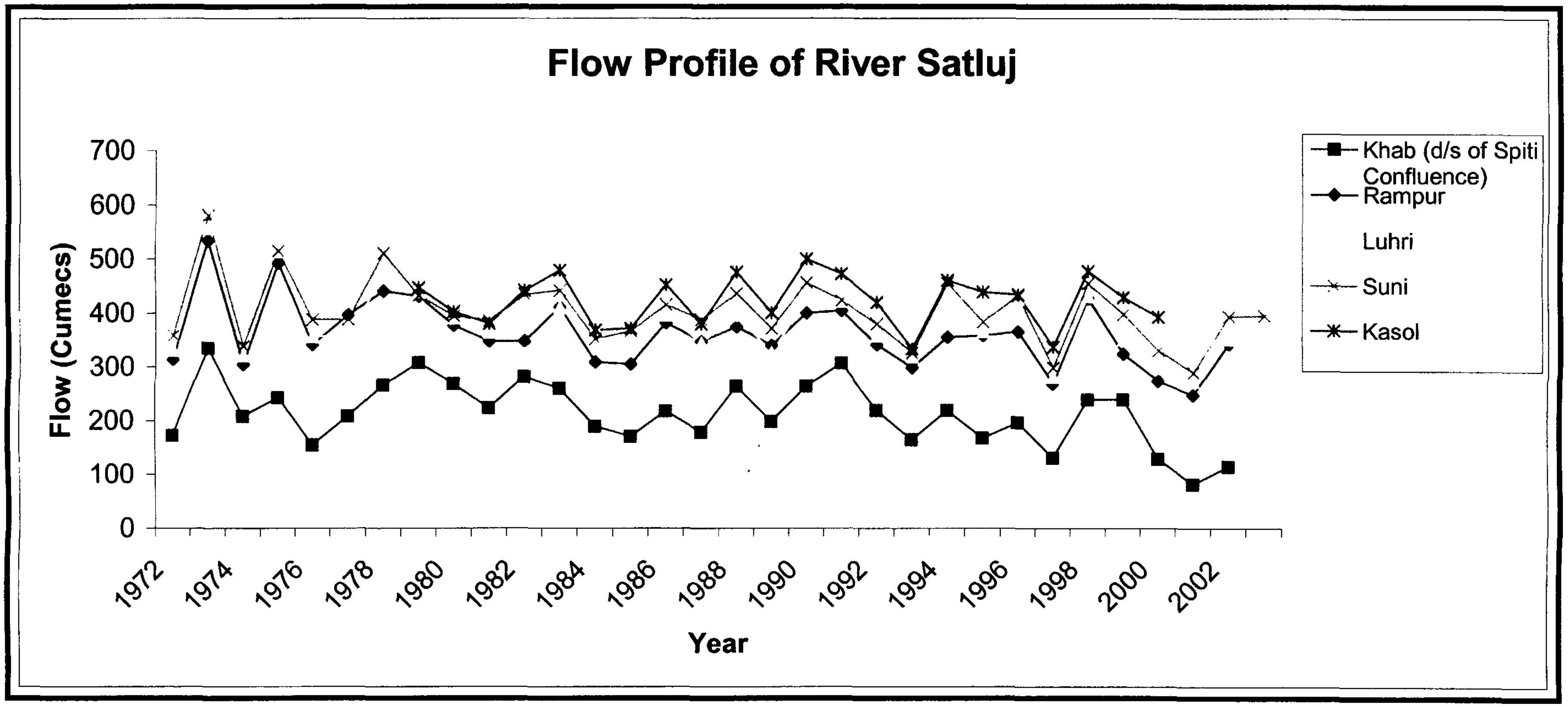


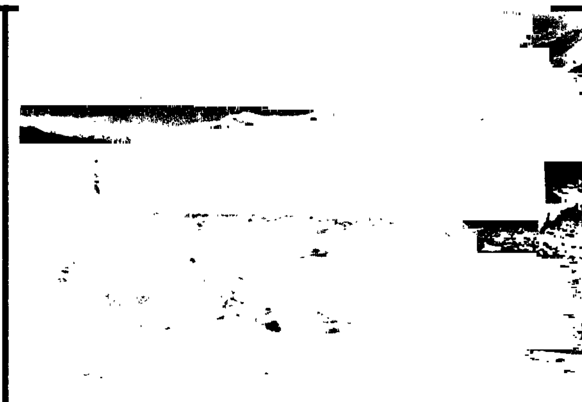
Fig 4.4 Historical River flow profile at different places along the Satluj River Basin.

Referring to various project documents has collected and complied the historical flow data for the river Satluj and its tributaries at various stretches in the basin i.e. Khab, Luhri, Suni, Kasol etc. (refer Annexure III). At Khab, the annual average flow ranges from 81.6 cumecs to about 334 cumecs, with a maximum flow of 334.58 cumecs witnessed in the year 1973. Similarly at Rampur, the minimum flow encountered was of 247.5 cumecs in the year 2001 and a maximum of 534.5 cumecs in year 1973. At Luhri the range of flow is 273.83-557 cumecs. At Suni the maximum flow of the value 580 cumecs was seen in the year 1973. At Kasol, the year 1979 saw the maximum flows of value 446.67, while the leanest flow the region has seen is 336.83 in 1997. Figure 4.4 shows the river flow profile during its course from Khab to Kasol.

The flow data for various tributaries, existing in Nathpa-Jhakri stretch has been compiled from available project reports (refer table 4.7 a). For the determination of the flow levels of the tributaries joining the river in the Jhakri-Bael stretch, a flow measurement campaign was organized for a period of two months (Feb-March, 2006) with each observation taken at an interval of 10 days (refer table 4.7 b). Unlike Nogli khad, the flow in most of the tributaries was very low during the monitoring campaign; hence a current velocity meter was used to measure the flow. Considering, comparatively higher flow in Nogli khad, float method was used. Also refer to PLATE 4.2 showing for river flow at various locations.

Plate 4.2 RIVER FLOW

1. Flow of the river near u/s Jhakri

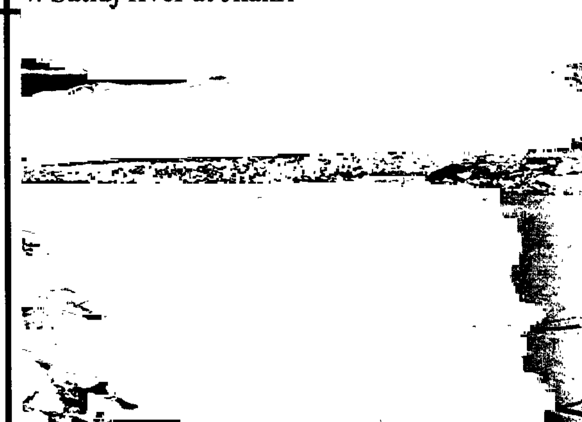


2. Satluj river near u/s Jhakri

3. Satluj river meandering through the region

4. Satluj river at Jhakri

5. Satluj river near d/s Rampur



6. Satluj river at Bayal

Table 4.7a **Measured Flow data for tributaries of River Satluj between Nathpa-Jhakri for the months of Oct 2005t - April, 2006 by IIT Roorkee**

Tributary	Average ten daily discharge (cumec)																				
	October			November			December			January			February			March			April		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Manglad	1.44	1.35	1.32	1.23	1.15	1.12	0.592	0.589	0.563	0.572	0.787	0.619	0.587	0.537	0.505	0.662	0.725	0.934	0.979	1.099	
Chaura Khad	0.62	0.58	0.61	0.60	0.56	0.51	0.485	0.450	0.406	0.464	0.563	0.488	0.470	0.446	0.438	0.686	0.748	0.812	0.867	1.049	
Chaunda Khad	1.01	0.87	0.91	0.79	0.76	0.72	0.437	0.460	0.392	0.407	0.468	0.443	0.419	0.408	0.352	0.589	0.669	0.684	0.744	0.962	
Rupi Khad	1.74	1.46	1.37	1.40	1.15	0.98	0.637	0.535	0.526	0.515	0.706	0.534	0.546	0.516	0.538	0.739	0.771	0.816	0.884	1.106	
Sholding Khad	1.93	1.84	1.56	1.27	1.16	0.98															
Sumej Khad	1.66	1.56	1.32	1.08	1.03	1.00															
Gaanvi Khad	1.92	1.67	1.56	1.53	1.60	1.12															
Sorang Khad	1.58	1.21	0.96	0.75	0.72	0.44															
Silaring Khad	0.91	1.19	1.09	0.69	0.60	0.45															
Unoo Khad							0.134	0.136	0.153	0.162	0.215	0.162	0.149	0.146	0.121	0.155	0.195	0.217	0.246	0.301	
Daaj Khad							0.107	0.094	0.085	0.114	0.152	0.128	0.120	0.114	0.108	0.214	0.221	0.226	0.240	0.308	
Kaowil Khad							0.165	0.118	0.102	0.129	0.170	0.157	0.148	0.144	0.133	0.183	0.195	0.251	0.275	0.350	
Gatti Khad							0.158	0.150	0.136	0.136	0.168	0.149	0.144	0.138	0.135						

b. Jhakri-Bael stretch

S. No.	Name of stream	Date	Discharge (cumecs)
1	Kajo	06.02.2006	0.422
		16.02.2006	0.502
		27.02.2006	0.432
		06.03.2006	0.508
		15.03.2006	0.526
		25.03.2006	0.575
2	Kunni	06.02.2006	0.290
		16.02.2006	0.304
		27.02.2006	0.268
		06.03.2006	0.283
		15.03.2006	0.316
		25.03.2006	0.312
3	Tunnan	09.02.2006	0.113
		16.02.2006	0.147
		28.02.2006	0.131
		06.03.2006	0.166
		15.03.2006	0.179
		25.03.2006	0.184
4	Racholi	09.03.2006	0.103
		17.02.2006	0.141
		01.03.2006	0.102
		07.03.2006	0.131
		16.03.2006	0.121
		26.03.2006	0.114
5	Jhako	17.02.2006	0.107
		01.03.1006	0.097
		07.03.2006	0.114
		16.03.2006	0.111
		26.03.2006	0.112
6	Pashada	08.02.2006	0.101
		17.02.2006	0.117
		01.03.2006	0.118
		07.03.2006	0.131
		16.03.2006	0.120
		26.03.2006	0.114
7	Barauni	18.02.2006	0.133
		02.03.2006	0.095
		09.03.2006	0.092
		18.03.2006	0.083
		27.03.2006	0.082
8	Kasholi	18.02.2006	0.145
		02.03.2006	0.127
		09.03.2006	0.119
		18.03.2006	0.104
		27.03.2006	0.091
9	Badgai	18.02.2006	0.175
		02.03.2006	0.119
		09.03.2006	0.106

S. No.	Name of stream	Date	Discharge (cumecs)
		18.03.2006	0.101
		27.03.2006	0.089
10	Nogli	14.02.2006	3.39
		23.02.2006	4.01
		03.03.2006	3.54
		10.03.2006	3.77
		19.03.2006	4.01
		28.03.2006	4.15

Source: Monitoring Results, Feb-March, 2006 at 10 days interval of time

4.2.2 Meteorology

Climate Data

In general, the climate of this whole region is temperate type but due to large variations in the altitude, there is a wide range of climatic variations, from the sub-tropical climate of sub-mountainous areas at the bottom of the Satluj valley to the alpine in the upper reaches, parts of which are perpetually under snow.

The study area experiences four distinct seasons[3]:

- Severe cold winter during months of December to February,
- Summer during months of April to June,
- Monsoons during months of July to mid-September, and
- Post monsoon/ autumn during months of mid-September to November.

Cloud Cover and Precipitation

The climate of Satluj valley shows a gradual alteration from heavy monsoon of the outer Himalayas to the arid Tibetan type with a winter snowfall practically in summer rains. The monsoon clouds advancing from the plains of India are combed out by the outer ranges of the hill, where most of the monsoon rain falls, so that the inner valley get a good deal of cloud but no steady precipitation during the monsoon months. The Himalayan valleys which open up due to south towards the plain form pathway to which the monsoon clouds are swept, but the Satluj valley lying east and west is badly placed for rainfall and further local aridity is caused by storm clouds being checked in their progress up in the valley by many spurs which jut into the valley. This local aridity is increased by the heating up of the enormous stretches of bare cliffs, making up the deep narrow gorge absolutely stifling under the summer sun. This in turn gives to a hot drying local wind, which beats up and down the main valley with great regularity. Thus, Rampur at 3000 ft elevation in the bottom of the gorge, receives about 800mm rainfall, while Kotgarh at 8000 ft, almost in the same sector of valley receives about 1150 mm of rainfall.

In the NJHEP and RHEP region, during the months of July and August, the sky exhibits heavily clouded to overcast conditions for about 25 days in each month. In the month of November, least cloud cover is observed and the skies are clear to lightly cloud for less

[3] *Catchment Area Treatment Plan for July, 2005, amended in November 2005*

than 25 days in a month. During the period from December to March, in heavy cloud cover is always expected for a period of 10 days in a month due to western disturbances.

The catchment area receives rainfall due to western disturbances that pass over the north-western part of the country during the winter months. Significant precipitation in form of snow is received at higher altitudes. In the valleys the rainfall is received during winter months. About 60 to 70 % of the annual rainfall occurs in the monsoon months. At Shimla, the number of rainy days in a year is about 84.8 days. The area also receives winter rains and snow due to the western disturbances in the months of January to March. Snowfalls occur above 1600 m but sometime goes down to 900 m also, however the snow seldom lies for long periods below 2200 m.

Table 4.8 Historical monthly Rainfall (in mm) Data for Rampur

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1999	78.9	19.9	5.4	0	31.4	19.6	185	60.9	18.5	0	0	5.2	424.8
2000	0	0	0	0	0	244.9	337.9	21.3	12.1	0	0	0	616.2
2001	20	40	105	34	103	113.9	60	123.1	60	0	16	41	716
2002	61.5	142	93	104	13	45	10	152	104	0	0	1	725.5
2003	55	110	60	61	11	41.5	264	132	107	0	4	41	886.5
2004	67	4	0	69	57	114	93	244.5	24	81	2	6	761.5

Source: IMD

Temperature

In the region, the temperature generally starts rising from the beginning of the month of March till June, which is the hottest month of the year. The mean minimum and maximum temperatures observed are around 15.6°C and 24°C respectively. With the onset of monsoons by the end of June, temperature begins to fall. The rate of drop in day temperature is considerable than the rate of drop in night temperature. After the withdrawal of monsoons by mid-September, the night temperature falls rapidly. The month of January is coolest month with the mean maximum and minimum temperatures of around 8.9°C and 1.7°C respectively. During winters, under the influence of western disturbances, the temperature falls appreciably and it may go even below 0°C.

Table 4.9 Temperature Data at Rampur Station

Year	Temp. (°C)	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1989	Max.	16.84	19.32	23.56	30.01	33.18	33.31	32.19	31.39	31.97	29.48	23.48	17.75
	Min.	3.58	6.2	8.99	12.47	17.38	20.16	22.59	20.98	18.96	13.85	8.53	5.5
1990	Max.	20	17.46	30.08	28.24	31.97	34.66	30.53	31.72	30.68	28.56	25.51	19.58
	Min.	6.21	6.52	7.52	12.38	18.13	21.33	-	21.72	19.81	12.84	8.81	5.75
1991	Max.	19.26	10.04	23.4	27.07	33.1	34.18	35.34	31.39	31.68	29.73	23.74	19.26
	Min.	2.47	6.42	9.28	11.87	16.73	20.62	23.67	22.02	20.48	13.9	8.42	5.44
1992	Max.	17.25	18.96	21.39	28.94	32.11	35.11	31.61	30.98	30.75	28.24	23.77	0.66
	Min.	5.66	5.42	9.87	14.18	16.05	20.31	21.45	21.98	19.59	13.65	9.68	5.39
1993	Max.	15.82	20.77	21.39	29.4	34.46	33.85	34.64	28.01	31.63	24.03	22.68	18.45
	Min.	4.64	7.36	8.13	13.01	17.77	22.88	22.5	17.31	14.62	7.49	8.11	5.5
1994	Max.	18.27	18.86	27.74	26.35	32.65	35.96	32.29	31.16	30.88	28.96	25.2	18.96

Year	Temp. (°C)	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
	Min.	5.5	5.21	9.36	11.87	16.81	21.7	22.24	21.89	18.27	13.18	8.46	5.86

Source: IMD

Recording of temperature at Luhri has been initiated by DFO Ani from May 2003. The recorded data has been presented below:

Table 4.10 Temperature data at Luhri

Month (Year 2003)	Maximum	Minimum
May	40.2	17.1
June	44.5	19.0
July	38.6	22.7
August	36.6	22.9
September	40.7	20.5

Source: Luhri PFR, Year 2004

Humidity

Humidity levels recorded in the region are generally low throughout the year except during monsoon months. During summer season, humidity is lowest (36%) while in monsoon season; it goes as high as 80-90%. The highest levels of humidity (91%) are observed in the month of August. The average humidity during synoptic hours is 53% and 62% respectively.

4.2.3 Soil Quality in the basin

Soil quality data of an area plays a significant role while formulating mitigating measures for reservoir siltation, prevention of soil erosion and suggesting remedial measures for catchment area. It also helps in reclamation and conservation purposes.

In Shimla district, the soil is generally shallow in depth except in the areas having vegetation cover where it is fairly deep. In the regions above 1,500 m, the soil is generally deep. Largely the soil can be classified as podzols, both brown podzols and humus and iron podzols are found in the study stretch. 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.

Comparative account of soil properties for various locations upstream and downstream of NJHEP area, viz. Upstream of dam near Wangtoo bridge, Upstream of NJHEP dam, Downstream of NJHEP dam, Near power house, Downstream of tailrace discharge from power house, has been presented in the Table 4.11.

In the Luhri region, soil texture is clayey loam rich in organic matter with varying depth. The soil is acidic on higher elevation because of lower rate of decomposition of organic matter. Soil drainage is generally satisfactory except in few isolated patches where it is poor.

Table 4.11 Analysis of soil samples at various locations near of Nathpa-Jhakri area

Parameters	U/s dam near Wangtoo bridge	U/s NJHEP dam	D/s NJHEP dam	Near Jhakri P.H	D/s NJHEP tailrace
pH	6.02	7.22	7.47	7.21	7.4
Electrical conductivity (μs/cm)	174	310	211	575	164
Sodium as Na (meq/100 gm)	0.004	0.004	0.01	0.007	0.01
Nitrogen as TKN (%)	Nil	Nil	Nil	Nil	Nil
Phosphates as PO4 (meq/100 gm)	0.200	BDL	BDL	1.40	0.200
Potassium as K (meq/100 gm)	0.003	0.005	0.002	0.005	0.002

Source: EIA Study for Updation of NJHEP, Year 2004;
EIA study for Rampur HEP, Year 2005

BDL – Below Detectable Limit

4.2.4 Sedimentation Aspects

The Himachal Pradesh State Pollution Control Board had initiated a sediment-sampling programme at several gauging stations in the actual river system. The long time series and frequent sampling intervals have helped various studies in assessing future impacts on the actual projects.

The total suspended load for the Spiti River has been reported to be 7.66 million tones/ year and for Satluj River of 7.30 million tones. The sediment transport is estimated by multiplying the discharge by the sediment concentration. The discharge estimates are based on known cross sections and velocity measurement carried out with a help of a wooden float, floating for 30m along the river. In the context, it should be noted that the annual discharge of Spiti River is at average twice the annual discharge of Satluj River upstream of Khab. The annual sediment transport for the Spiti has been reported to be equal to 7.84 million tones and 7 million tones for Satluj.

Snowmelt and the related erosion processes (rapid mass wasting in combination with glacier runoff are the major sediment sources, but the local influences (i.e. process activities closer to the sampling point) are of great importance. These processes vary in magnitude and frequency between individual years and therefore the concentration figures cannot fit into a standard sediment-rating curve.

The estimated suspended transport at Wangtoo is 26.2 million tones per year according to Sharma et al. This implies the Luhri project area, which is relatively dry, yield about 11 million tones per year. Most of the sediment contribution is likely to originate from area along the main river and can be seen as a contribution from the rapid mass wasting processes and by erosion of ancient glacio-fluvial sediments.

The grain size distribution of suspended sediments at different location at upstream area estimated by Sharma et al. (1991) has been presented in form of a bar chart and the table below:

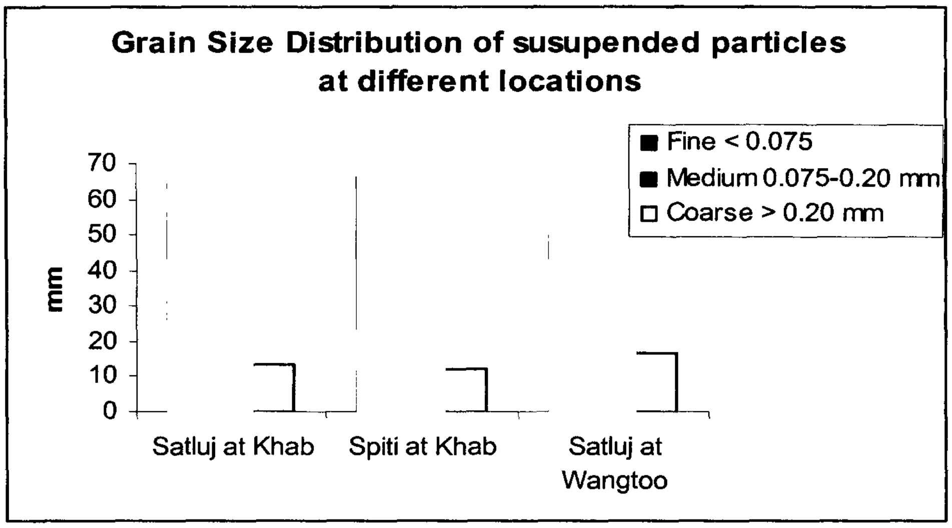


Table 4.12 Grain size of suspended sediments at different upstream locations

River location	Fine < 0.075	Medium 0.075-0.20 mm	Coarse > 0.20 mm
Satluj at Khab	64.1	22.3	13.6
Spiti at Khab	66.4	21.2	12.4
Satluj at Wangtoo	59.9	23.2	16.9

Source: Sharma et al, Year (1991)

At the upper Satluj regions, the bed material is heterogeneous as a result of heavy floods (breaking up the 'erosion pavement" of coarse bed material exposing a finer substratum) or the catastrophic input from rapid mass wasting process. Both factors result in a rapid increase in bed-load transport that is reduced when the riverbed has been adapted to the new situation. It is therefore also pronounce difference between the rising limb and the falling limb of a flood event. (Refer plate 4.3)

The latest data of average silt concentration at a few locations like Khab, Powari, Nathpa, Jhakri, Bael, Nirath and Sunni has been plotted from January to August 2006. The raw data has been annexed as Annexure III.

Silt data for the regions Khab, Powari, Nathpa, Jhakri, Bael, Nirath and Sunni (year 2006)

	Khab (1)	Powari (2)	Nathpa (3)	Jhakri (4)	Bael (5)	Nirath (6)	Sunni (7)
January		126.41	11.97	89.21	98.59	101.61	41.13
February	48.79	95.18	108.09	106.04	118.3	126.78	31.95
March	92.52	98.55	108.8	88.24	127.12	133.85	
April	1181.54	816.95	478.3	1324.63	1211.86	1229.78	
May	2553.11	2863.4	2007.89	3604.77	3246.58	3637.96	
June	686	818.52	583.22	1261.36	1208.75	1248.42	
July	7985.45	4086.79	4296.41	4342.68	4004.92		
August	13155.74	8368.56	8846.56	5979.19	6310.56		

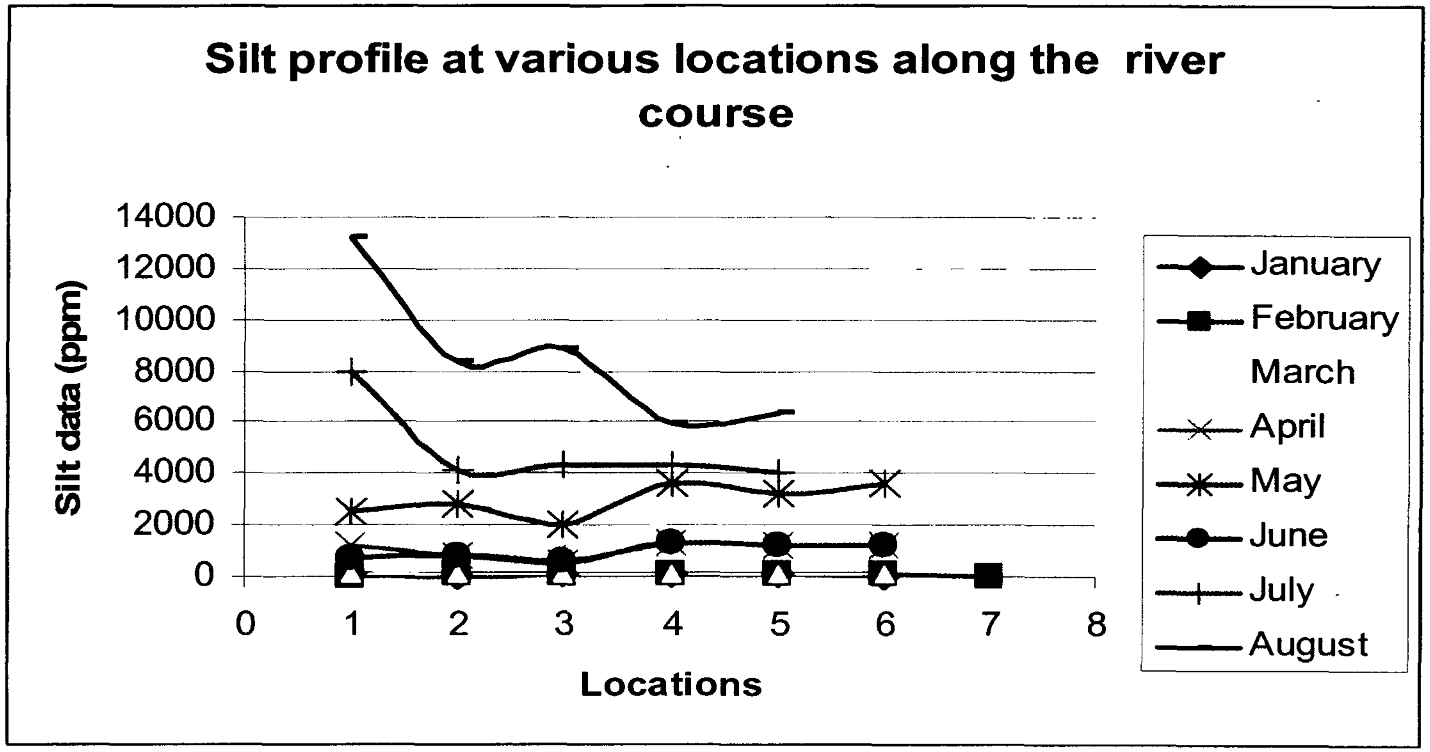
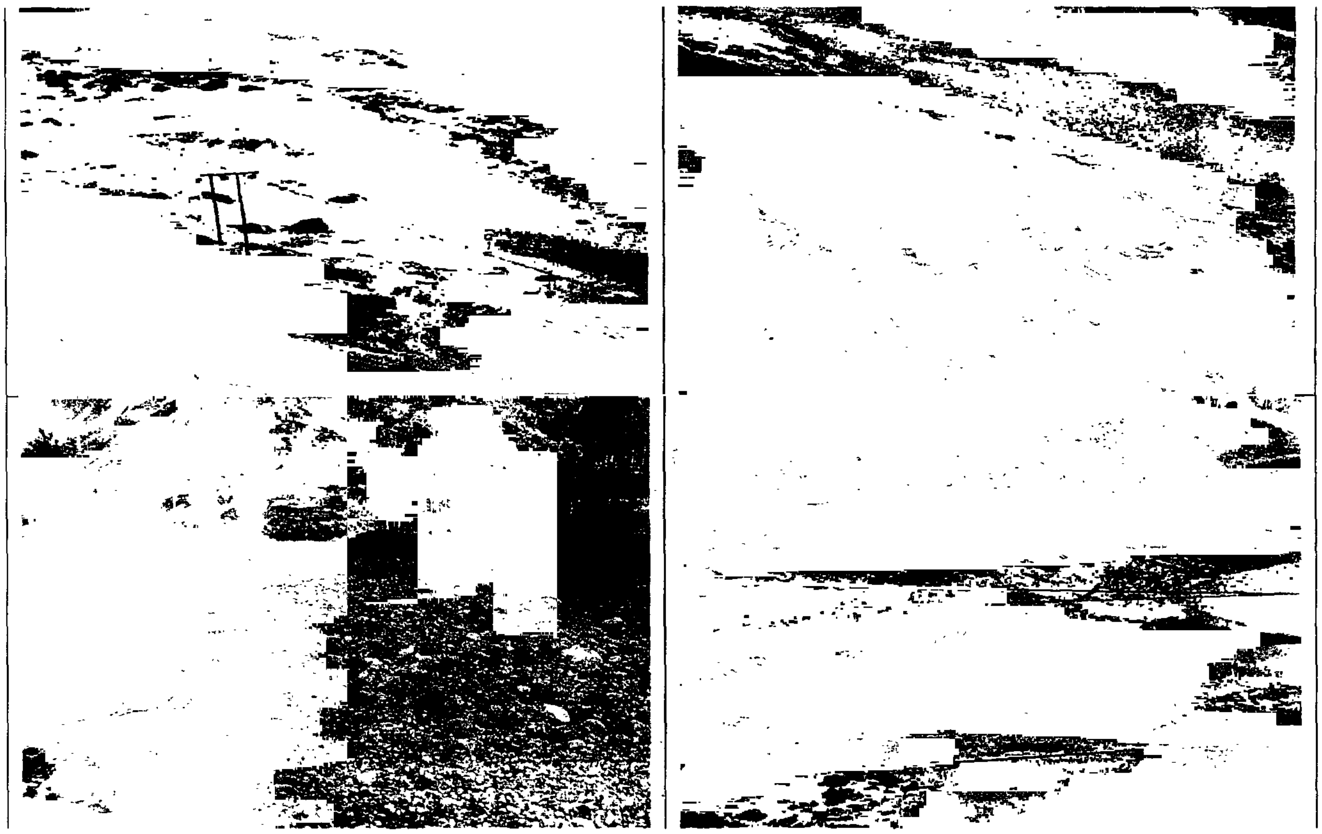
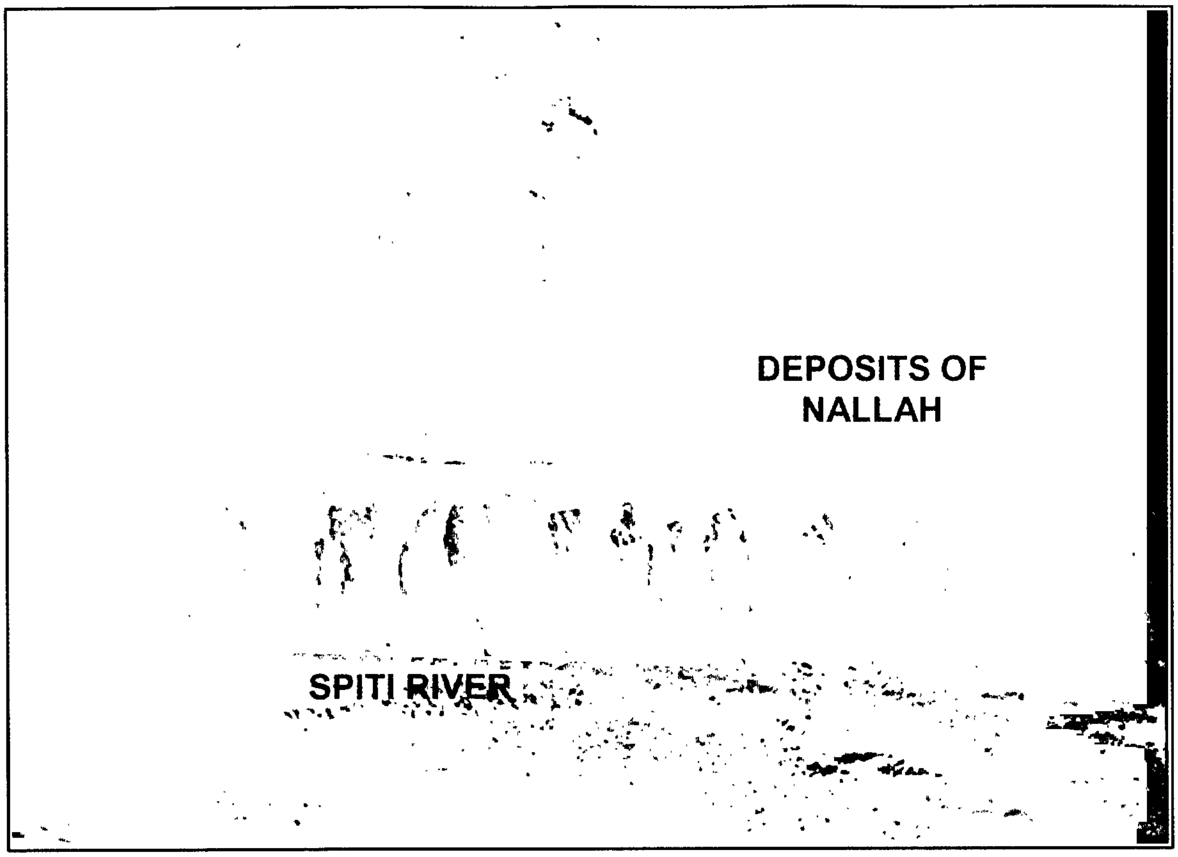
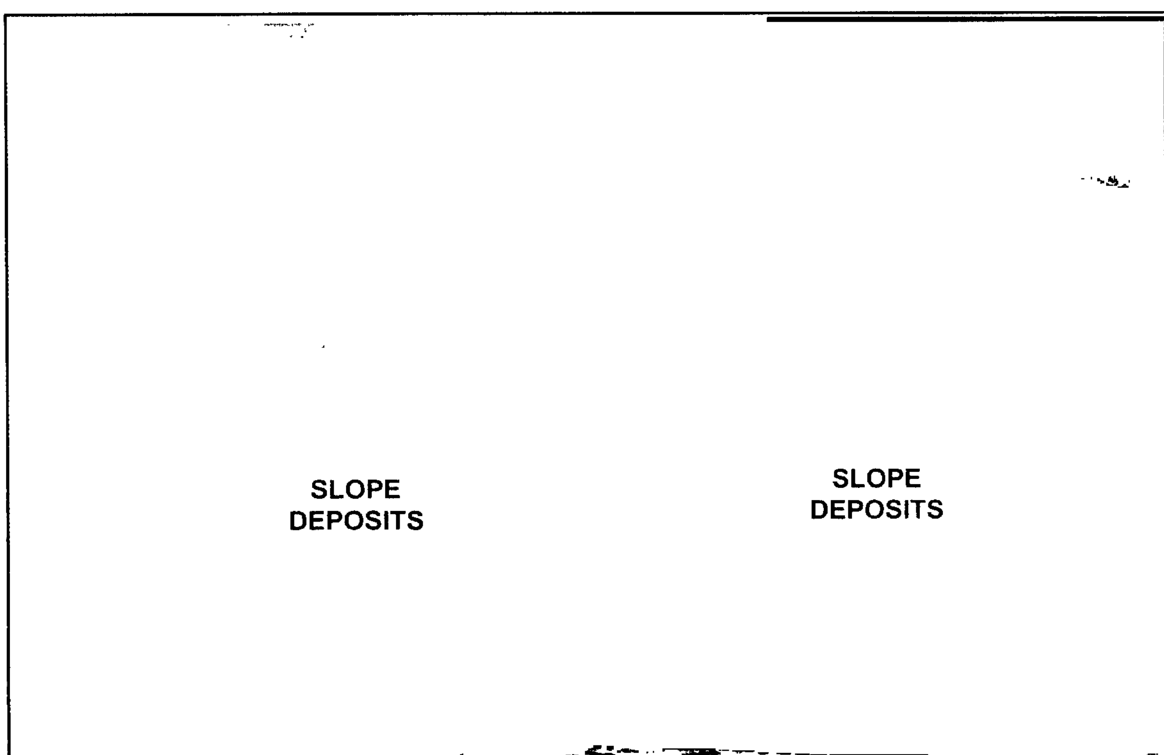


Plate 4.3 SILTATION IN THE REGION




DEPOSITS OF
NALLAH
SPITI RIVER


SLOPE
DEPOSITS
SLOPE
DEPOSITS

4.2.5 *Ecological Resources of the region*

The section has been divided into two sections

I. Ecological Resources of Satluj basin in Himachal and

II. Ecological Resources specific to Influence area of NJHEP and RHEP,

Both these sections include the following sub-section-

- Forests,
- Natural Vegetation and
- Natural Fauna.

Information on Aquatic Ecology (Aquatic Flora and Fauna) has been included in the section for Influence area of NJHEP and RHEP, with special emphasis on Fish type and its availability.

I. Ecological Resources of Satluj Basin in Himachal

i. Forests

The altitudinal variation in Satluj basin leads to variation on forest types. The various forest types reported in Satluj basin is as below.

Table 4.13 Major Forest Types of Satluj Basin

S. No.	Major Forest Type	Classification Code
1	Northern Dry Mixed Deciduous Forests	5B/C-2
2	Himalayan Subtropical Pine Forests	9 C-1
3	Dry Bamboo Breks	5 B/E9
4	Himalayan Sub Alpine Fir Forests	14/ C1b
5	Himalayan Kharsoo – Oak Forests	12/C2 a
6	Himalayan Dry Temperate Forests	13/ C1
7	Himalayan Kharsoo – Oak Forests	12/C1a
8	Mixed Broad leaved Coniferous Forests	12/C1b
9	Coniferous Pine Forests	13/C2a
10	Western Mixed Coniferous Forests	12/C1d

Source: Forest Department, Rampur Division

ii. Natural Vegetation between Spiti Valley to Nathpa

The Satluj River enters into Indian Territory near Shipki. This river has cut across the Dhauladhar, Pir Panjal, main Himalayas and Zanskar ranges. The upper reaches of Satluj basin fall in Lahaul & Spiti and Kinnaur district. Major forest types found are Dry Alpine Scrub predominantly in Cold Desert area form 3600 to 5500m. The vegetation is sparse, discontinuous and scattered represented by shrubs having high medicinal values. The dominant shrubs are *Juniperus sp, Ephedra sp, Myricaria sp, with supported herbs such as, Rosa macrophylla, Ribes orientale, R.alpestrie, Lonicera spinosa, Clematis veratie, Capparis spinosa*, etc.

Based on topography and climate, the catchment area in the Indian part, intercepted at Nathpa dam site can be categorized as below[4]:

- Spiti valley
- Namgia to Nathpa dam site.

The distribution of species is generally governed by microclimate, edaphic and biotic factors. The vegetation of Spiti is broadly classified into dry alpine steppe according to the Champion and Seth classification of 1968. Apparently the area is very poor in vegetation. B.S. Aswal and B.N. Mehrotra in 1994 recorded a total of 985 vascular plant species from Lahaul-Spiti district, of which many are of medicinal value. The lower dry area (Sham) is chiefly dominated by *Causinia thomsonii, Seseli trilobum* and *Crepis flexuosa* community type, whereas the higher dry area (Bhar) is dominated by *Caragana brevifolia* and *Krascheninikovia ceratoides* community type. The moist areas above 4200 m have a variety of plants in patches, of which most of the species are rare and endangered medicinal plants.

At an elevation of 4200m from Namgia to Nathpa dam site, a sparse vegetation of *Juniperus, Betula, Andromeda* and *Rhododendron* sp. is found. The zone from Namgia to Nathpa village is bounded by high hills with elevation ranging from 1500 m to 3050 m. Due to the steep slopes and low precipitation terrain is inhospitable for good forest cover. In Nathpa area, there is a marked altitudinal zonation of vegetation along the entire stretch of the valley. The first 100 m from the river bed is predominantly rocky gorge and does not support any vegetation apart from grass and few bushes. The steep valley extending up from the valley floor upto an elevation of 2800 m is predominantly grassland and settlements with some forest stands and shrub cover. From elevation ranging from 2800 to 3700 m, the forest growth is dense due to lesser human interferences. Above the treeline, alpine meadows extend to the exposed rock of the mountain peaks. A variety of Pines (*Pinus longifolia, Pinus wallichiana, Pinus gerardina*), Deodar (*Cedrus deodara),* Spruce *(Picea smithiana)* and Fir (*Abies pindrow)*, form a broad belt of vegetation along both sides of the Satluj valley and the side streams between the cliffs of the gorge. The *Pinus gerardians* (Chilgoza Pine) abound the area and its edible nuts fetch good prices to the locals and it is their main source of income. On the left side of the valley with northern exposure, forests are observed at a much lower elevation towards the river than they do on the right bank, as reduction in exposure to sunlight restricts the spread of vegetation. On the left side, the forests are particularly continuous.

Based on the satellite data of the project area (from National Remote Sensing Agency (NRSA), Hyderabad) it has been reported in the earlier reports that on lower slopes i.e. upto an altitude of 1500 m, Chir pine occurs in pure forms, on sheltered ravine banks upto an elevation of 2500 m Deodar (*Cedrus deodara)* and Kail (*Pinus wallichiana*) are found at altitudes between 1500 m to 3000 m. At higher elevations, i.e. more than 3000 m

[4] *EIA study for Updation of NJHEP, Year 2003*

Quercus incana and Rhodendron arboreum are observed. Upper Forests consist of *Picea smithiana* and *Abies pindrow* and these merge with top belt of Oak (*Quercus semicarpifolia)*. In areas, upstream of the submergence area of the Nathpa dam, forests of moderate density are observed.

The area also forms the natural habitat for two species *Podophyllum hexandrum* (Bankakri), which is found at an elevation of 2000 - 3500 metres and the broad-leaved *Dioscorea deltoidea* (Kins/Yams), which occur in the list of endangered category by Botanical Survey of India.

iii. Natural Fauna

The altitudinal variation, also the climatic and forest types the variation in fauna of the Satluj basin is observed. The fauna of the upper basin i.e. Cold desert is of special concern; as most of the endangered, endemic and rare species of wildlife is reported, form this region. A large variety of carnivore of endangered/ rare status such as, Snow Leopard, Himalayan Brown Bear, Black Bear, Himalayan weasel, Yellow throated martin, Wooly hair Wolf, and Common Leopard. The herbivores are of various types of which, Ibex, Serow, Blue Sheep, Thar, Musk deer, Ghoral and Barking deer.

The small mammals include the Himalayan and long tailed marmots, Himalayan squirrels and Voles. The lower basin of the Satluj represents the different fauna such as Jungle cat, Bengal Fox, Indian Porcupine, Wild Boar, Common Palm Civet etc. The wildlife reported from various forests types are given in details below.

Table 4.14 The List of Fauna Reported from Satluj Basin

Scientific Name	Common Name	Family
Mammals		
Canis lupus	Indian Wolf	Canidae
Canis aureus	Jackal	Canidae
Capra ibex	Himalayan Ibex	Bovidae
Capricornis sumatraensis	Serow	Sciuridae
Cervus unicolor	Sambar	Canidae
Felis bengalensis	Leopard cat	Felidae
Felis caracal	Caracal	Felidae
Hemitragus jemlahicus	Himalayan thar	Bovidae
Hylopetes, Petaurista	Flying Squirrels	Hylobatidae
Hystrix indica	Indian Porcupine	
Macaca mutata	Rhus Macaque	Cercopithecidae
Martes flavigula	Yellow Throated Martens	
Martes fonia intermedia, ,	Martens	
Moschus moschiferus	Musk deer	Cervidae
Muntiacus muntjak	Barking deer or Muntjac	
Nemorhaedus gora,	Gorals	
Ovis nahura	Bharal	Bovidae
Paguma larvata	Himalayan Palm Civet	

Scientific Name	Common Name	Family
Panthera paradus	Leopard or Panther	Felidae
Panthera uncia	Snow leopard	Platanistidae
Presbytis entellus	Common langur	Cerocopithecidae
Petaurista pataurista	Common Giants squirrels	Sciuridae
Selenarctos thibetanus	Himalayan black bear	
Sus scrofa	Wild pig	Suidae
Tragulus meminna	Mouse deer	Tragulidoe
Ursus arctos	Himalayan Brown bear	Ursidae
Vulpes bengalensis	Indian fox	Canidae
Vulpes ferrilatus	Tibetan fox	Canidae
Reptiles		
Bungarur cacraleus	Common Indian Crait	
Hemiductilus fuviviridis	Common House Geico	
Naja naja	Indian Cobra	
Varanus bengalensis	Monitor Lizard	Varanidae
Pyyas mocosus	Common rat Snake	Bovidae
Varanus bengalensis	Bengal Monitor Lizard	

Source: Forest Department Rampur

II. Ecological Resources specific to Influence area of NJHEP and RHEP

Nathpa Jhakri Hydro-Electric Project (NJHEP) is one of the most eco-friendly projects in the country. Being a run-of-the-river project, it has minimum impact on ecology of the area and least disturbance to flora and fauna.

i. Forests

The Project area of Rampur HEP lie in two districts Simla (Rampur Forest Division) and Kullu (Ani-forest Division). Altitude, precipitation and humidity play a significant role in governing the distribution of various forest species. In Shimla district, various important species of trees namely Deodar, Kail, Chil, Oak, Mohru, and Kharu etc ate found in the forests and the major forest produce are resins and medicinal herbs The available resin in the district is being processed by two resins and turpentine factories at Bilaspur and Nahan. The categories defined below are as per Champion and Seth (1962) classification. The different forest types that occur in the project area are:

- 5 B/ C-2 Northern mixed deciduous forest
- 5/1-5-2 Khair-Sissoo forest
- 9/C-1 Himalayan Subtropical pine forest
- 12/C-1 Ban Oak forest

B/ C-2 Northern mixed deciduous forest5

This type spreads above Rampur upto 40km upstream of river Satluj and its tributaries as scattered patches o in strips, below the *Chil* pine (1200m) on the banks of the streams as well as river Satluj. Such forests are largely scrub type, but quality of vegetation improves slightly in shades and depressions and gorges formed by the river. On alluvial flood banks, *Sissoo* forms a few good patches. This type may be seen near Jeori in Sarahan range. The important tree species observed in this forest category are *Lamna grandis* (Jhingan), *Malllotus phillipinenesis* (Roghi), *Cedrela toona* (Toon), *Bauhinia variegata* (Kachnaar) and *Albizzia lebbeck* (Siris) etc. Poor quality of grasses and bushes along with scatter trees of *Dalbergia sissoo, Cedrela toona, Sapindus mukorsii* and *Bombax ceiba* are seen.

The undergrowth consists of *Desmodium tiliafolium, Rhus colinus, Malllotus phillipinenesis, Plectranthus rugosus* and herbs like *Cannabis sativa, Girardiana heterophylla* and *Euphorbia royleana.* Important species of commercial values are *Dalbergia sissoo, Cedrela toona, Sapindus mukorossi (*Ritha*) and Bombax civa* (Semal)

5/1-5-2 Khair –Sissoo forest

This type of forest is confines to the banks of the river from Pandoa right upto Rampur town. *Dalbergia sissoo* is present and forms the upper storey of the vegetation. Arundo donax is also very common. *Saccharum spontaneum* (Kash) occurs only on the exposed sandy soils. Acacia catechu is conspicuous by its absence throughout the tract. Fairly dense shrubby undergrowth of *Adhatoda vasica, Zizyphus nummularia, Meriandra strobilifera, and Mallotus phillipenensis* is also visible in the area.

9/C-1 Himalayan sub-tropical pine forest

Such forests occur at an elevation of 1000-2000m. The vegetation is overlapping between the tropical dry mixed deciduous forest at lower elevations and temperate forest at higher elevation. The main species is *Pinus roxburghii*, which occurs, in gregarious and robust form. Distribution is irregular and patchy and widely scatted. Improved crops are present near Rampur and upstream of Rampur in a few places on left bank of the river like Pashada, Brauni and Bhandhal. The common associates are *Quercus incana, rhododendron arporeum, Lyonia ovalifolia. Pinus wallichiana* (Kail) makes its appearance in the upper reaches, sometimes extending into Chil as may be noticed in Brawni forest. A peculaira association is rarely noticeable in Gaura forests, Sarahan range, wher owing to the heavy rain fall on a cool Northern aspects, Spruce *(Picea)* comes fairly low upto 1800 m and may be found growing along Chil and Kail. This phenomenon, however, is not widespread.

[5] Revised Working plan for Kotgarh Forest division , HP (78-79-92-93, Part I & II), by CL Sudhera, IFS, DG of Forests

12/C-1 Ban-Oak forest

These types of forests are found in a considerable area at an elevation of 1500-2100m. Pure ban Oak forest occur upstream of Rampur o the left bank of the river satluj. The main trees are *Rhododendron arboreuni, Lyonia ovalifolia* and *Litsea umborsa*. The shrubby undergrowth mainly comprises of *Berberis lycium, Indigofera gerardiana, Sarcacocia salgana* and *Daphine papyracea, Desmodium tiliaefolium, Myrsine africac, Lonicera quinquelocularia.* Most of the area in the impact zone is covered with an open plantation of Eucalyptus tress. The shrubs include *Zizyphus nummularia*

Administration of Forest Resources

The forest in the NJHEP and RHEP area falls under the jurisdiction of the Rampur, Nichar and Outer Seraj forest division of districts Shimla, Kinnaur and Kullu respectively. There are no `Reserve Forests' in the area and all the forests are in the category `Protected Forests.'

Table 4.15 List of Protected Forests under the Study Area

S.No	Rampur Forest Division (Area in ha.)	Distance (KM)	Anni Forest Division	Distance (KM)
1	Bahli Protected Forest (176.17)	2.5	Marha Kod Protected Forest	5.25
2	Banavali Protected Forest	3.0	Khaira Kod Protected Forest	4.0
3	Baruni Protected Forest (32.4)	0.75	Ramgarh Kondi Protected Forest	3.5
4	Daran Protected Forest (5.5)	5.5	Sanpatu Protected Forest	4.5
5	Gaura Protected Forest (113.8)	3.5	Shikarwah Protected Forest	3.75
6	Sanathali Protected Forest (299.70)	2.5	Tandi Thera Protected Forest	3.0

Source: Rampur Forest Division, Terrestrial biodiversity study, CES

The Protected Forest in the directly draining catchment area.Government owned lands including forest, otherwise vegetated land and waste lands have also been designated as Protected Forest in Himachal Pradesh.

Villagers have the traditional rights of the forest resources. The declaration of these forests as protected curtails their rights. In a Protected Forest tree burning, cutting of trees to make new agricultural fields without prior permission from the Forest Department is not allowed. Villagers have right only to collect dead wood from the protected forests. Fuel and timber harvesting is limited to two trees per year, and only on prior payment of Rs.2 per tree. Special permits could be issued by Forest Department for commercial logging.

ii. Natural Vegetation

The climatic and altitudinal variations markedly influence the type of species distribution in various zones. Physiognomically flora of the study area can be categorized as trees, shrubs, herbs and grasses. The list of Flora reported by forest department is given in table below. The climax and dominant species of forests are species of the forests are Chir

(*Pinus roxburghii*) Kail (*Pinus wallichiana*), Deodar (*Cedrus deodara*) and Ban Oak (*Quercus incana*) along with their major associated species. The dominant associate of (*Cedrus deodara*) Deodar is Ban Oak (*Quercus incana*) Kharsu Oak (*Quercus semicarpifolia*).

Table 4.16 Flora Recorded Under The Rampur Project Influence Area (7km)

S. NO	SCIENTIFIC NAME	LOCAL NAME	FAMILY
			TREES
1	*Acacia leucophloea*	Subabul	Mimosaceae
2	*Albizzia lebbek*	Seris	Leguminosae
3	*Bauhinia variegata*	Kachnar	Leguminosae
4	*Bombax ceiba*	Semal	Bombaceae
5	*Callistemon citrinus*	Bottle brush	Myrtaceae
6	*Cedrala serrata*	Darloi	Miliaceae
7	*Cedrela toona*	Toon	Miliaceae
8	*Cedrus deodara*	Devdaar	Coniferae
9	*Celtis australis*	Kharak	Urticaceae
10	*Cupressus torulosa*	Leuri	Coniferae
11	*Dalbergia sissoo*	Shisham	Fabaceae
12	*Emblica officinalis*	Amla	Euphorbiaceae
13	*Eucalyptus globulus*	Safeda	Myrtaceae
14	*Ficus bengalensis*	Bargad	Urticaceae
15	*Ficus elastica*	Rubber tree	Urticaceae
16	*Ficus palmata*	Fedu, Phegru	Urticaceae
17	*Ficus religiosa*	Pipal	Urticaceae
18	*Ficus roxburghii*	Timal	Urticaceae
19	*Grevillea robusta*	Silver oak	Proteaceae
20	*Grewia oppositifolia*	Biul	Tiliaceae
21	*Juglans regia*	Akhrot	Juglandaceae
22	*Lannea grandis*	Jinghini	Anacardiaceae
23	*Litlsea umbrosa*	Shuru	Lauraceae
24	*Mallotus philippinenisis*	Ruin	Euphorbiaceae
25	*Mangifera indica*	Aam	Anacardiaceae
26	*Melia azaderach*	Dhenk	Meliaceae
27	*Morus alba*	Tut	Urticaceae
28	*Morus serrala*	Himu, Tut	Urticaceae
29	*Morus sps*	Paper Mulberry	Urticaceae
30	*Pinus roxburghii*	Chil	Coniferae
31	*Populus ciliala*	Poplar	Salicaceae
32	*Prunus amygradus*	Badam	Rosaceae
33	*Prunus armeniaca*	Chuli	Rosaceae
34	*Prunus cerasoides*	Paja	Rosaceae
35	*Prunus communis*	Aloocha	Rosaceae
36	*Prunus persica*	Aroo	Rosaceae
37	*Punica granatum*	Aanar	Lythraceae
38	*Pyrus malus*	Seb	Rosaceae
39	*Quercus incana*	Ban	Cupuliferae
40	*Quercus dilatata*	Moru	Cupuliferae

S. NO	SCIENTIFIC NAME	LOCAL NAME	FAMILY
41	*Robinia pseudoacacia*	Pahari kikar	Papilionoidaea
42	*Rhodondendron arboreum*	Burans	Ericaceae
43	*Sapindus mukorossi*	Ritha	Sapindaceae
44	*Syzium cumini*	Jamun	Myrtaceae
45	*Tamarindus indica*	Imli	Caesalpiniaceae
SHRUBS			
1	*Adhatoda vasica*	Basuti, Vasika	Acanthaceae
2	*Agave americana*	Rambans	Cactaceae
3	*Aloe vera*	Aloe	Liliaceae
4	*Artemesia vulgaris*	Kubash	Compositae
5	*Berberies aristata*	Karmshal, Kashmoi	Berberidaceae
6	*Berberis lyceum*	Kashmanl	Berberidaceae
7	*Calotropis gigantea*	Aak	Asclepiadaceae
8	*Cannabis sativa*	Bhang	Cannabinaceae
9	*Carissa spinarum*	Karonada	Apocynaceae
10	*Colebrookia oppositifolia*	Bambher, Sidhar	Labiatae
11	*Cotoneaster acuminata*	Ruinish	Rosaceae
12	*Cotoneaster bacillaris*	Ruinish	Rosaceae
13	*Daphne papyracea*	Chamua, Satpura	Thymelaeaceae
14	*Debregeasia hypoleuca*	Sihanru	Artocarpeae
15	*Desmodium tiliaefolium*	Martoi	Leguminosae
16	*Dodonaea viscosa*	Mehandi	Sapindaceae
17	*Euphorbia royleana*	Shuru	Euphorbiaceae
18	*Girardinia heterophylla*	Bichhu, Kushki	Urticaceae
19	*Hypericum oblongifolum*	Phiunli	Hypericaceae
20	*Indigofera gerradiana*	Kathi	Leguminosae
21	*Indigofera pulchella*	Sakina	Leguminosae
22	*Lantana camara*	Lantana	Verbinaceae
23	*Lonicera anguslifolia*	Banchulu	Caprifoliaceae
24	*Mohonia nepalensis*	Khoru	Berberidaceae
25	*Moriandra strobilifera*	Pothi	Labiatae
26	*Murraya koengii*	Kath Neem	Rutaceae
27	*Musa paradisiaca*	Kela	Scitaminaeae
28	*Opuntia monocantha*	Nagphani	Cactaceae
29	*Plectranthus coesta*	Chichiri	Labiatae
30	*Princepia utilis*	Bhekal	Rosaceae
31	*Ricinus communis*	Arandi	Euphorbiaceae
32	*Rubus ellipticus*	Hinsar	Rosaceae
33	*Rumex hastatus*	Bhilmora	Polgonaceae
34	*Sarcococca saligna*	Tiliari	Euphorbiaceae
35	*Solanum surattense*	Kateli	Solanaceae
36	*Stribilianthus sp.*	---------------	Acanthaceae
37	*Woodfordia fruticosa*	Dhaula	Lythraceae
38	*Zizyphus jujuba*	Beri	Rhamnaceae
39	*Zizyphus nummularia*	Beri	Rhamnaceae
HERBS			
1	*Achyranthes aspera*	Aghada, Puthkanda	Amaranthaceae
2	*Argemone mexicana*	Prickly poppy	Papaveraceae
3	*Asparagus racemosa*	Sahansarpali	Liliaceae

S. NO	SCIENTIFIC NAME	LOCAL NAME	FAMILY
4	*Bauhinia vahlii*	Malo	Leguminosae
5	*Chenopodium album*	Bathwa	Chenopodiaceae
6	*Chromolaena odorata*	Triva gandha	Chromolaenae
7	*Clemapis montana*	Kauniabali	Ranunculaceae
8	*Datura suaveolens*	Datura	Solanaceae
9	*Dioscorea deltoidea*	------	Scitamineae
10	*Echinops echinatus*	Gokhru	Compositae
11	*Erigeron bellidioides*	Horse weed	Compositae
13	*Fragaria indica*	Bhumla	Rosoideae
14	*Frageria vesica*	Bhumla	Rosoideae
15	*Heliotropium strigosum*	Hatta-juri	Boraginaceae
16	*Jasminium officinalis*	Chameli	Oleaceae
17	*Ocimum basilicum*	Vantulsi	Labiatae
18	*Oxalis corniculata*	Amrit sak	Oxilidaceae
19	*Polygonatum chinensis*	Jangli palak	Polgonaceae
20	*Pteris sps*	Fern	Pteridaceae
21	*Sonchus oleraceus*	Dudhi, Pathari	Convolvulanceae
22	*Thymus serphyllum*	Hasha	Lebiatae
23	*Tridex procumbens*	Ground weed	Amaranthaceae
24	*Trifolium pratense*	Purple clover	Papilionoidae
25	*Verbascum thapsus*	Gidar tamakus	Scrophulariaceae
GRASSES			
1	*Arundo donax*	Phiral, Naru	Gramineae
2	*Cynodon dactylon*	Dhub	Gramineae
3	*Saccharum spontaneum*	Kans	Gramineae
4	*Parthenium hysterophorus*	Congress grass	Compositae
5	*Phragimites communis*	Naal	Gramineae
6	*Erianthus munja*	Munj	Gramineae

Source : Field Survey CES (I) Pvt. Ltd, Feb- April 2006

Floristic Composition

For the purpose of EIA study for the Rampur and Nathpa Jhakri HE projects, ecological studies were conducted in September 2004 for the catchment area. It was found that there is no vegetation in the submergence area of the NJHEP.

Two species diversity indices viz., Shannon index of general diversity (H) and Evenness index (e) were computed using the following formula

Shannon index of general diversity (H):- $\sum P_i \log P_i$ where,

n_i = importance value for each speceis
N = total importance values
P_i = importance probability for each speceis = n_i/N

Evenness index (e): H/log S where,

H = Shannon index of general diversity, and,
S = number of species

IVI values were used for computation of both the diversity indices.

Shannon Index and Evenness Index as estimated for trees and herbs observed in the study area have been given in tables in Annexure III

Floral Diversity
A total of 69 floral species have been reported in the sample sites during the survey carried out in September 2004 in which 23 tree species, 23 shrubs and 23 herbs were observed[7]. No rare/endangered floral species have been reported in the project area. It has been stated that the left bank of the river inhabits healthy and bountiful vegetation as compared to the right bank. *Cedrus deodara* and *Pecia sinithian* were observed as dominant tree with co-dominant of *Pinus sp., Berberis aristata* was noticed as dominant shrubs which *Mentha sylvestris* as dominant herbs.

Medicinal Plants

Some important medicinal plants that grow in the area are *Berberis aristata, Aesculus indica, Prunus persica, Juniperus recurva,* These species are observed at higher elevations in the catchment area. Villagers collect these species for local therapy and usage. There are 25 medicinal plants reported in the NHJEP project area (Refer Annexure III). None of these species come under submergence due to proposed increase in Nathpa Jhakri dam height.

Threatened species
No rare and endangered species reported in the NJHEP project area. The diversity and density of various floral species in the study area was found to be very less. The tree density at various sampling station ranges between 5 to 27 per ha on right bank which on left bank, it is slightly higher (i.e. between 5-30 tree/ha). The Shannon diversity index is around 1.0, which indicates the low species diversity. The evenness index of trees is 0.94. This indicates that species are distributed evenly.

Frequency, Density and Importance Value index of different tree species at village Bael (RHEP powerhouse site), Duttnagar and Nogli regions are annexed. (Refer Annexure III).

iii. Natural Fauna

The fauna of the study area is represented by reptiles, birds and animals. The variation in altitude, climate, topography, forests type and forest cover leads to variation in animals. The fauna can be characterized as domestic animals and wild life.

The details of the former have been discussed under section 4.3.5 "Economic activities" and the wildlife of the region is described below.

Wildlife

Wide altitudinal ranges and varied topography of Himachal Pradesh has resulted in making the state a very rich repository of wild fauna and flora. The state has an inventory of more than 3,500 higher plants, many of which are endemic to the region and many form the basis of local health traditions.

Spiti region: Higher up in Spiti valley, most majestic and stately animals of Ibex and tangrol exist. Other animals include brown bear, panther and leopard cats. However, the habitats of these wild animals are quite away from the proposed Khab HE project.

Khab to Spillo: The lower part of the valley from Khab to Spillo supports floral diversity, which also provides suitable habitation for wild animals, birds and reptiles. The main species of mammals include Jackal and hill fox, porcupine etc which are also present in the area. The common reptile species are the Indian Chameleon, common Krait, monitor lizard, common house gecko, garden lizards etc. Among bird snow cocks, partridge sparrow, pheasant monals, hawks, eagles, dove and pigeons are also very common. As stated in the PFR for Khab HE project, no national parks or wildlife sanctuaries lie in the Khab project area. There are three wild life sanctuaries namely Lippa asrang, Rupi Bhaba and Rakcham chitgul under Sarahan wild life division, which are away from the proposed project.

Shimla district: The Shimla District used to be home of wild life in the distant past. However, the advancing civilization, liberal grant of firearms and shooting licences fast development of means of communication led to the virtual disappearance of precious animals and birds. Animals like *Suscristatus (Indian wild bear), Antilope cervicapra (Antilope), Canis aureus (Jackal), Felis bengalensis (Leopard Cat), Felis pardus (Panther), Ursus torquartus* (Black Bear) are very common in the district. The birds found in the district are Common Quail, Indian spotted dove, Pea-fowli, Black Partridge, Blue hill pigeon, Jangli murghi besides many others.

Kullu district: Parts of the Satluj basin which fall in Kullu district provide inhabitation to brown and black bear, the spotted and white leopard, musk deer, wild cat, flying squirrel, hyaena, wild pig, jackal, fox, marton. The white crested pheasant, koklas, and the cheer, wood partridge, chukor are very common. In winters, the snow pheasants and snow partridge are also found along with the wild duck and geese. In Luhri area, the common animals found are *Lepus indicus (common Indian Hare), Sciurus palmarus (Common Squirell), Macac malatta (Monkey), Presbytis entellus (Common Langoor), Canis aureus (jackal), Hepestes edwardsil.*

iv. Aquatic Ecology (Flora and Fuana)

Ecology comprises of the inter-relationship between the biotic and the abiotic environments. The river also serves ecological functions and thus a study of the ecology of the area is an essential component of a managed river flow study to determine the impacts on the ecology in the river stretch because of a less than normal flow and to determine the minimum requirements to maintain certain ecological functions. The aquatic ecology is one of the key aspects that are directly dependent on the river flow, hence study of aquatic ecology of the area has been considered as an indicator to assess the minimum flow requirement of the river.

The plankton population that are often used as indicators of environmental and aquatic health because of their high sensitivity to environmental change and short span of life and serve as a base for the food chain that supports the fisheries, has been primarily considered for study. Both the flora and fauna in the study stretch have been described in the following paragraphs. The information is based on secondary data and has been supplemented with primary studies. The analysis has been done in a sequential manner using information collected from different sources and that are available studies, findings of village level survey and results of primary level monitoring.

The following section describes both the aquatic flora as well as aquatic fauna in the study stretch. A special attention has been given to fish population of the area. Following documents/ references have been used to establish a useful database/ account on aquatic species:

1. Interaction with Dr. KL Sehgal and reference to Report on "Ecology and Fisheries of Mountain Streams of the North-Western Himalayas", KL Sehgal, ICAR, Nainital, 1988
2. Information collected from Himachal Pradesh Fisheries department/reservoir, Shimla
3. Report on 'Environmental Impact Assessment for Updation of EIA for Nathpa-Jhakri Hydroelectric Project', Year, 1998
4. Report on 'Environmental Impact Assessment for Rampur Hydroelectric Project', Year 2005
5. Aquatic survey/ Monitoring carried out during February, March 2006
6. Market Survey (for fish availability), at Tapri, Bhabanagar, Rampur and Bael. Interaction with local fisherman, in Nogli region near Rampur town.

Sequentially, the findings have been put together to analyse the results and to carry out the impact assessment. The parameters mainly considered for assessing the minimum requirements for survival of aquatic species in the river are altitude, current flow velocity and water temperature. Some of the other principal variables are type of sub-stratum and dissolved salts that may affect the density and quality of benthic biota.

a. Aquatic Flora

Studies conducted in the past for various stretches of the river indicate that the planktonic community in river Satluj and its tributaries is inherently poor. The growth of planktonic community subjected to constant changes and has little role to play in ecological niche in the Satluj river system. The plankton growth, which depends on local conditions like temperature and incidence of high water discharge on heavy precipitation, was found to be very poor where the flow is turbulent.

A comparative analysis that has been done at various river stretches from available reports for the area. The findings are:

Karcham-Wangtoo: Plankton growth is lesser due to turbulent flow conditions and lesser temperature

Nathpa-Jhakri: Micro-flora consists of attached algae which grow as a thin film on all kinds of solid objects in the streams and even on sand and mud patches. Diatoms (*Bacillariophyceae*) is one of the dominant groups especially the epiphytic and epilithic general represented by *Navicula, Gyrosigma, Nitzschia* and *Suriella*. During the months of February and March stones at the bottom remain covered with dark green to blackish green patches of blue-green algae (*Myxophyceae*). The density of these algae at the bottom ranges 85,800-96,900 units/cm^2. The predominant genera which occurs during the above season includes *Rivularia, Phormidium* and *Oscillatoria*. The other genera of importance recorded were *Tetraspora*, *Ulothrix* and Oedogonium *amongst* green algae (Chlorophyceae). The benthic micro-fauna, which occurred in association with algal film, include *Arcella*, *Difflugia* and *Monostyla*. Mainly as stray specimens. The macrophytes, which remain attached to the rocks, boulders, stones etc., belong to various genera of Bryophyta (mosses). These macrophytes are essentially inhabitants of fast flowing and turbulent streams receiving snow melt and spring waters.

Jhakri-Rampur-Bael: A **monitoring survey** was conducted for this stretch in the month of March 2006. The following floral species have been found in the river stretch:

Table 4.17 Floral Species in Satluj along Jhakri-Rampur-Bael stretch

Type	*Species*	*Characteristics*
Green Algae	Tetraspora, Ulothrix *and* Oedogonium	*Contains chloropyll, hence use captured light energy to fuel the manufacture of sugars.*
Blue green algae	Microcystis, Chrococcus, Gloecapsa, Arthrospora, Oscillatoria, Lyngbya, Phormidium, Schizothrix, Richella, Anabaenopsis, Cylinderospermum, Wollea, Nostoc, Anabaena, Gloetricha, Fisherella.	*The blue green algae do not possess flagellated motile cells and hence found attached except a few forms like oscillatoria which shows slow creeping movement* *A large number of blue green algae are able to fix atmospheric nitrogen e.g. Nostoc, Anabaena, Cylinderospermum etc.*
Diatoms	Navicula, Gyrosigma, Nitzschia *and* Suriella.	*unicellular algae* *cell walls of these organisms are made of silica, and are of varied shapes*
Bryophyta	Riccia fluitans, Marchantia simlana Pellia endiviaefolia, Madotheca	*"amphibious" in nature* *grow in moist and shady places on the sides on river water*
Pteridophytes	Equisetum ervense, E. debile, E.	*containing all the vascular plants that*

Type	Species	Characteristics
	ramosissimum and E.diffusum	*do not bear seeds: ferns, horsetails, club mosses, and whisk ferns*

Source: *Monitoring carried out during March, 2006*
EIA for Updation of Nathpa-Jhakri Hydroelectric Project, Year 1998;

b. Aquatic Fauna

Micro fauna

The faunal communities have to adapt to the various hydrological parameters of fast flowing riverine conditions. Great hazards are caused due to variable velocities of water, ice formation during winter, occurrence of periodic floods due to cloud burst and continuous rolling of bottom material consisting of boulders, stones, gravels etc. High flood causes dislodging of benthic animals, but still turbulent river Satluj has provided microhabitats for various animals to get suitably adapted to the environment.

Between Nathpa-Jhakri river stretch: The following faunal species had been monitored in the river stretch in past:

Table 4.18 *Faunal Species in Satluj between Nathpa-Jhakri River Stretch*

Phyllum	*Order/ Class*	*Name of Species*
Invertebrates	*Naids of Ephemeroptera*	Epeorus, Caenis, Ecdyonurus. Heptagenia, Arthroplea Ironoedis, Psuedocloeon, Procloeon, Heterocloeon Baetis, Ephemerella, Rhithrogena, Iron
	Naids of Odonata	Ophiogomphus, Octogomphus, Agrion
	Naids of Plecoptera	Peltoperla, Atoperla, Aeronuria, Isoperla, Nemoura, Pereinella, Allocapnia
	Larvae of Trichoptera	Hydropsyche Rhyacophila Glossoma Polycentropus Brachycentrus Leptocella Philopotamus Phrygena
	Larvae of Diptera	Simulium, Chironomus, Antocha Atherix, Tabanus, Dixa, Deuterophlebea, Hexatoma, Tipula, Tendipes Blepherocera, Probezzia, Sarcophaga, Psychoda
	Larvae and adults of Coleoptera	Psephenus Gyrinus Elmis Hydrophilus Haliplus Troposternum
	Turbellaria	Planaria
Vertebrates	*Amphibia*	*Tadpoles of Rana*
	Fishes	Salmo trutta fario *(Fry and fingerlings),* Schizothorax richardsonii *(Young stages),* Nemacheilus gracilis, N. stolizkae, N. botia, Glyptothorax stoliczkae, G. conirostre

Source: *EIA for Updation of EIA for NJHEP, Year 2003*

Jhakri-Rampur-Bael: The following faunal communities had been found in the river stretch:

Table 4.19 Faunal Species in Satluj along Jhakri-Rampur-Bael stretch

Phyllum	***Species***	***Characteristics***
Invertebrates	Arcella.	*stagnate water containing much vegetation* *was found growing at-least 20 meter away from the riverbank.* *secretes yellow to brown thick hard transparent and hemispherical shell*
	Diffusia	*free living* *symmetrical shell* *feeds upon algae, hence it is in plenty where algae are in abundance*
	Planaria Eg. Dogesia	*Found at the bottom where it is found resting on the undersurface of stones and on the aquatic leaves.* *Planarians were collected for laboratory analysis by baiting shallow streams with raw pieces of raw liver*
	Coleoptera,Elm is Psephenus, Hydrophilus.	*forewings are leathery possess antenna* *Mouth parts are chewing type.*
Vertebrates	Amphibia	*Tadpoles of* Rana
	Fishes	Only Trout (*Schizothorax richardsonii* (Asla)) was found during the survey conducted in March 2006. Salmo trutta fario *(Fry and fingerlings),* Schizothorax richardsonii *(Young stages), Nemacheilus gracilis, N. stolizkae, N. botia, Glyptothorax stoliczkae, G. conirostre*

Source: EIA for Updation of EIA for NJHEP, Year 2003;
Monitoring Results, March, 2006.

Fish type and availability

As mentioned above, for this purpose, the references that were used:

1. Interaction and referring to the Report on "Ecology and Fisheries of Mountain Streams of the North-Western Himalayas", KL Sehgal, ICAR, Nainital, 1988
2. Information collected from Himachal Pradesh Fisheries department, Shimla
3. Aquatic survey/ Monitoring carried out during February, March 2006
4. Market Survey (for fish availablility), at 4 local markets-two upstream of Nathpa dam-Tapri, Bhabanagar, and two downstream of the dam-Rampur and Bael.
5. Interaction with local fisherman, in Nogli region near Rampur town.

   i. Name of the fisherman : Mr. Arjun
   ii. Contact No. : +91-9816199347

Mr. Jaguram is another fisherman who has been issued a fishing licence. He is a local resident of the region.

A small survey was carried out in the markets of above said locations to confirm the source, availability, quantity and type of fish found in this particular stretch. It was found that main Satluj river has very less fish population in the stretch between Nathpa and Bael and there too it comes from khads meeting Satluj.. The fish species found is mainly Trout.
The fish found in main Satluj river generally comes from the khads. That is the reason, the fish catching is mainly practiced at confluence of Nogli tributary with Satluj. At other above mentioned places, no fish catching is done for selling purpose. There are four licenses issued to the local people at the Nogli confluence area, for carrying out fishing. In this region, about 2-2.5 kg can be caught from Nogli khad. However, it was found during the market survey that for selling purpose, fish is mainly brought from Bilaspur. The questionnaire used for market survey is appended as Annexure IV.

Interaction with the Deputy Director, Mr. Tapesh, Fisheries Department, Himachal Pradesh confirmed the same. According to him, the study stretch has very less fish population. They are mainly confined to the side streams like Nogli, Samej and Kurpan. For commercial selling, fishing is only done at Nogli khad by local fishermen. However, major portions are brought from Bilaspur.

As per the historical information collected from the Fisheries department, the streams of river Satluj at high reaches i.e. upstream of Bilaspur, harbored 51 species of cold water fishes (ref. Table No 4.20) including exotic trout, snow trout and several species of hill stream fishes.

Table 4.20 Fish Species reported historically by the Fisheries Department in the upper reaches of Satluj River

Family	Species
Cyprinidae	*Barilius bendelisis, B. vagra, B. barila, B. modestus, Oxygaster bacaila, Rasbora daniconius, Carassius auratus, Cirrhinus reba, C. mrigala, Crossocheilus latius, Catla catla, Labeo dero, L. dyocheilus, L. bata, L. calbasu, L. rohita, Cyprinus carpio var. communis, C. carpio var nudus, C. carpio var specularis, Schizothorax richardsonii*, S.plagiostomius, Ctenopharyngodon idella, Hypophthalmicthys molitrix, Tor putitora*, Garra gotyla gotyla, G. lanita , Puntius sarana, P. ticto, P. chola and P. sophore.*
Cobitidae	*Biota dario, B. birdi, B. lohachata, Noemacheilus botia, N. rupicola, N. monatanus, N. kangrae and N. horai*
Bagridae	*Mystus seenghala and M. aor*
Schilbeidae	*Clupisoma garua*
Sisoridae	*Glyptothorax pectinopterus and G. cavia*
Belonidae	*Xenentondon cancila*
Ophiocephalidae	*Channa gachua and C. punctatus*
Mastocembelidae	*Mastocembelus armatus armatus*
Salmonidae	*Salmo trutta fario**

Source: Himachal Pradesh Fisheries Department

**Migratory fish*

The same was confirmed by referring to the thesis on "Ecology and Fisheries of Mountain Streams of the North-Western Himalayas", KL Sehgal, ICAR, Nainital, and Year1988), which reported a large number of fish species mainly belonging to 13 taxonomical families (51 species) inhabited the Satluj River in Himachal region in the past. As per discussions with Dr. K. L. Sehgal, these species have been reported in the entire Satluj basin up to downstream before coming up of Govind Sagar project. Refer table below.

Fish Species reported in River Satluj in the past, Himachal Pradesh

Family	***Species***	***Local Name***	***Fish Type***
Notopteridae	Notopterus chitala (Hamilton)	*Pari*	
	N. notopterus (Pallas)	*Moh*	
Cyprinidae	Barilius barila (Hamilton)	--	
	B.bendelisis chedra. (Hamilton)	*Patha*	
	B.vagra(Hamilton)	*Lohari*	
	B.shacra (Hamilton)	*Chilwa*	
	Danio (danio)devario (Hamilton)	*Parrandah*	
	D.(Brachydanio) rerio (Hamilton)	*Kangi*	
	Esomus danricus (Hamilton)	*Makni*	
	Rasbora daniconius (Hamilton)	*Chindolachal*	
	Tor chilinoides		
	Tor putitora (Hamilton)	*Mahseer chiniaru*	*Migratory Sharp decline in catch*
	Catla catla (Hamilton)	*Theila*	
	Cirrhina mrigala (Hamilton)	*Mori*	
	C.reba (Hamilton)	*Sunni*	
	Crossocheilus latius punjabensis (Hamilton)	*Tiller*	
	Garra gotyla (Gray)	*Kurka*	
	Puntius chola (Hamilton)	*Chidu*	
	P.chonchonius (Hamilton)	*Chidu*	
	P.ticto (Hamilton)		
	P.sophore (Hamilton)		
	Labeo boga (Hamilton)	*Morah*	
	L.calbasu(Hamilton)	*Kalbaus*	
	L.dero (Hamilton)	*Gid*	
	L.dyocheilus(MeClelland)	*Kunni*	*Sharp decline in catch over the years*
	L.gonius (Hamilton)	--	
	L.pangusia(Hamilton)	--	
	L.rohita (Hamilton)	*Rohi*	
	Schizothorax richardsonii	*Trout*	*(Migratory)*

Family	Species	Local Name	Fish Type
Cobitidae	Botia birdi	*Chipar*	
	Noemacheilus botia(Hamilton)	*Sundal*	
	N.botia aeurus (Hamilton)	*Sunda*	
	N.corica (Hamilton)	*Talana*	
	N.kangrae(Menon)	--	
Siluridae	Ompak bimaculatus(Bloch)	*Pallu*	
	Wallago attu (Hamilton)	*Mullae*	
Bagridae	Mystus (Mystus) bleekri (Day)	--	
	M.(Mystus) vittatus (Bloch)	*Kingra*	
,	M.(Osteobagrus) seenghala (Sykes)	*Singhara*	
	Rita rita (Hamilton)	*Khagga*	
Amblycipitidae	Amblyceps mangois (Hamilton)	*Sundal*	
Sisoridae	Glyptothorax conirostris (Steind)	*Nao*	
	G.pectinopterus(Hamilton)	*Mochi nao.*	
	G.stoliczkae(Steind)	*Naiya*	
Schilbeidae	Clupisoma garua (Hamilton)	*Bachwa*	
Belonidae	Belone cancila (Hamilton)	*Takla*	
Muglidae	Mugil cascasia (Hamilton)	*Buah*	
Channidae	Channa gachau (Hamilton)	*Dauli*	
	C.marulius (Hamilton)	*Saul*	
Mastocembelidae	Mastacembalus armatus (Lacepede)	*Bami*	
Salmonidae	Salmo trutta fario	*Trout*	*Exotic fish*

Source: 'Ecology and Fisheries of Mountain streams of the North-Western Himalayas', K.L Sehgal, ICAR, Nainital, 1998

The above-mentioned thesis also mentions that as compared to other mountain streams of N-W Himalayas, the fish population in river Satluj (like Chenab, another Indus River) is scanty. The river flows through deep gorges alternating with oblong and wide valleys. Advance debris and/or glacial moraines and landslides continuously cause modifications in the morphology of Satluj. In the river course such places are clearly marked by a sudden widening of the valley indicating a damming of the river and the creation of a natural reservoir. These changes have resulted in different stream ecology.

In contrast to our traditional way of considering a self-contained system in a water body, the mountain stream is not governed by principle where everything released into the medium tends to be carried away downstream and possibility of being recycled on the spot is a very rare phenomenon. If at all any recycling takes place it is continually dislodged in downstream direction.

Based on stream velocity alone, streams have been classified in Europe, North America and Canada. The Satluj can be considered Category A or high mountain stream ranging 0.92 – 2.68 m/s in velocity. The other abiotic parameters which affect the biotic communities are source of water, size, elevation, slope, substratum, water temperature, dissolved oxygen, water hardness etc. Many of these parameters control the biological productivity either singly or in combination.

The data available on quantitative qualitative analysis of micro and macro-benthic communities in the river stretch reveal that river Satluj and its tributaries are represented by major benthic invertebrates and vertebrates. The micro-biotic communities are represented by diatoms, blue-green and green algae on which the invertebrate and benthic fish subsist. The invertebrates are represented by young stages of insects which contribute up to 80% of total invertebrates' density. The vertebrates are represented by benthic (live on the bottom) fish species belonging to garrids, nemacheilids and glyptothoracids groups. Nektonic fish (swim and migrate freely) are represented by *Schizothorax richardsonii and Salmo trutta fario.*

Although no data are available in the literature on utilization of micro and macro biotic life by the fish in river Satluj but considerable literature is available in closely related rivers of the Indus system. In river Beas, Sehgal (1988) and Sehgal et al. (1984) worked out a coefficient of accessibility or availability factor or forage ratio (Pf/Pb where Pf is percentage of animal/plants foraged and Pb is percentage of benthic biota in the stream) in S . richardsonii and S. trutta fario. It was observed that forage ratio ranged 2.8- 4.2, 0.3 -1.0 and 0.3 – 3.7 for larvae of Diptera, nymphs of Ephemeroptera and larvae of Trichoptera in young of S. richardsonii (15-65 mm in total length). In the grown up specimens 140-480 mm in total length, the fish subsisted on benthic algae. The food quotient ranged 0.9 -1.2, 0.3 -1.6 and 0.5 -2.8 for diatoms, blue green and green algae respectively. The brown trout S. trutta fario which is sight feeder has been studied in Beas and Jhelum. Fish ranging 101-200 mm in total length consumed 74.2 % of Ephemeroptera in total animal foraged although other groups were fairly abundant. Specimen ranging 201- 400 mm in total length consumed larvae of Trichoptera to the extent of 54.6 % in total invertebrates and on aerial insects and other small land animals to the extent of 20.9%. The forage ratio for Ephemeroptera ranged 0.6 -1.1 against 1.0-4.3 for Trichoptera. Based on the results obtained for other rivers of North West Himalayas it is presumed that ecology of river Satluj is conducive for propagation of two commercially important species. Due to high velocity, low temperature, lack of spawning beds (pebbles, gravel etc) in the project area, fish is induced to enter the tributaries, which maintains comparatively higher temperature where they mature and spawn. The newly hatched young fish remain in the tributaries till they are able to take care of themselves.

The probable reasons fish being scanty in river Satluj are as follows:

a) The flow regime in river Satluj is very unstable. This makes the upper reaches, difficult habitats for fish. Frequent occurrence of spates makes conditions worse for breeding and propagation of cold-water fish. Sometimes entire species type from the river body disappears due to devastating floods, as happened in case of river Ravi. The flood in 1947 caused complete removal of brown trout population in Ravi.

b) The above mentioned thesis also states that cold-water streams are inherently poor in biological productivity due to low temperature and scanty food. Most of the energy of cold-water fishes is utilised in maintaining their position in fast–flowing waters and hence they live under continuous physiological stress.

c) The current velocity and natural biota are also the factors inhibiting fisheries in the area. Average stream velocity of 2.00 m/s is high and hence fish enter the side streams for feeding and breeding.

d) The hydrological factors also change the structure and consistency of the substratum of the river channel thus making less favorable for well-being and propagation of cold water fish.

e) According to the thesis, most of the energy of cold-water fishes is utilised in maintaining their position in fast–flowing waters and hence they live under continuous physiological stress and exhibit poor biological productivity.

Fish population specific to study stretches

Karcham-Nogli: As per WAPCOS EIA report, low fish population in the Karcham-Nogli stretch of river, may be accounted by the prevailing low water temperatures of 7.5-8.2°C during March to April. This temperature is comparatively less favourable for growth of fish type that is identified for the river stretch. The stenothermal (tolerating a narrow range of temperature species) like fry and fingerlings of S. *trutta fario, S. richardsonii, Namacheilus* sp. and *Glyptothorax sp.* have been observed in such climatic conditions.

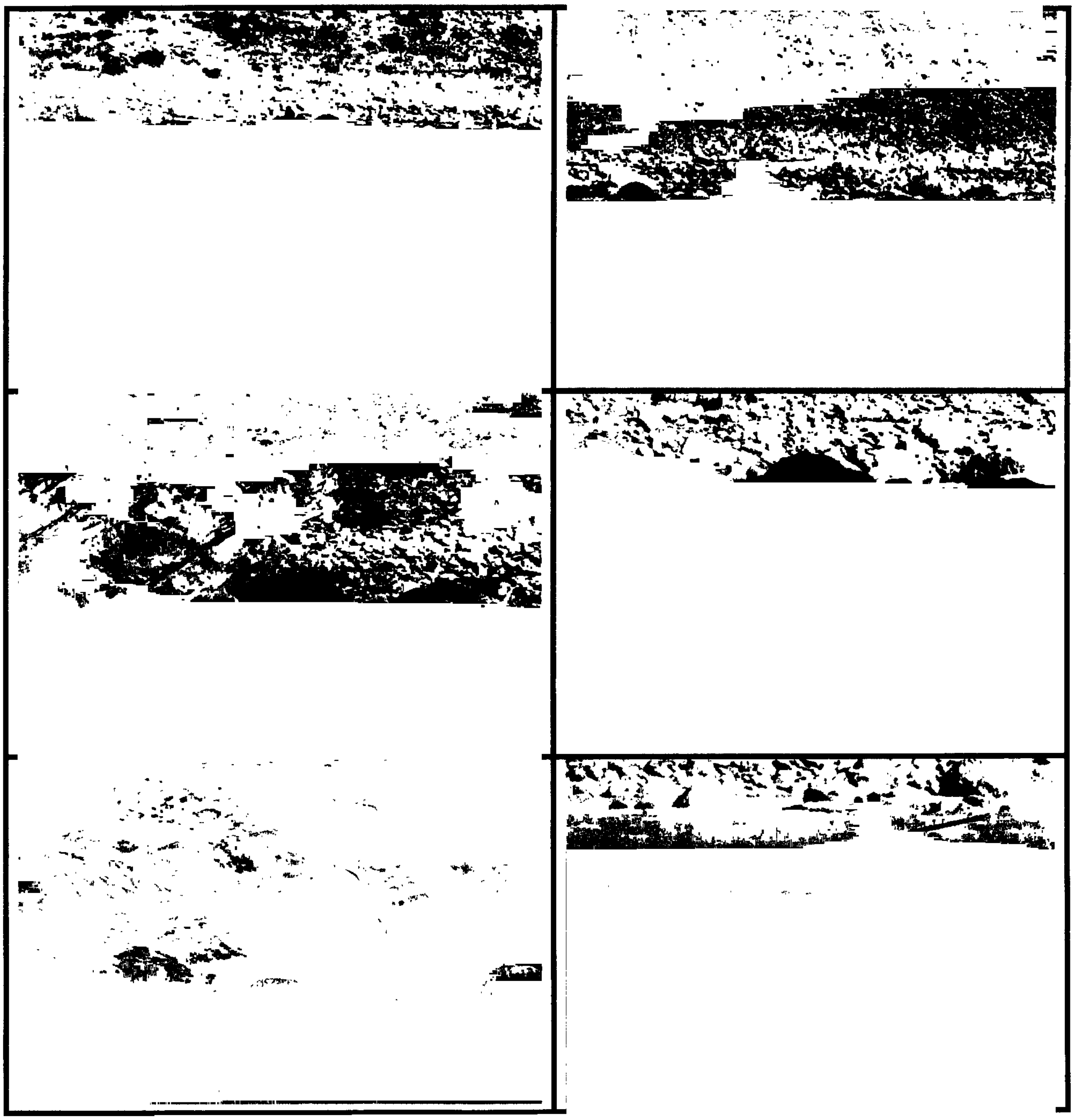
Nogli-Luhri However, literature reviews have shown that the downstream river stretches, even during this period from March to April, show presence of relatively more fish species like trouts. The river stretch from Nogli-Luhri during same time has a temperature of 13.4 to 15.8°C, which is favourable for propagation of species such as *N. botia, Glyptothorax stoliczkae* and *G. conirostre* in addition to *S. richardsonii.*

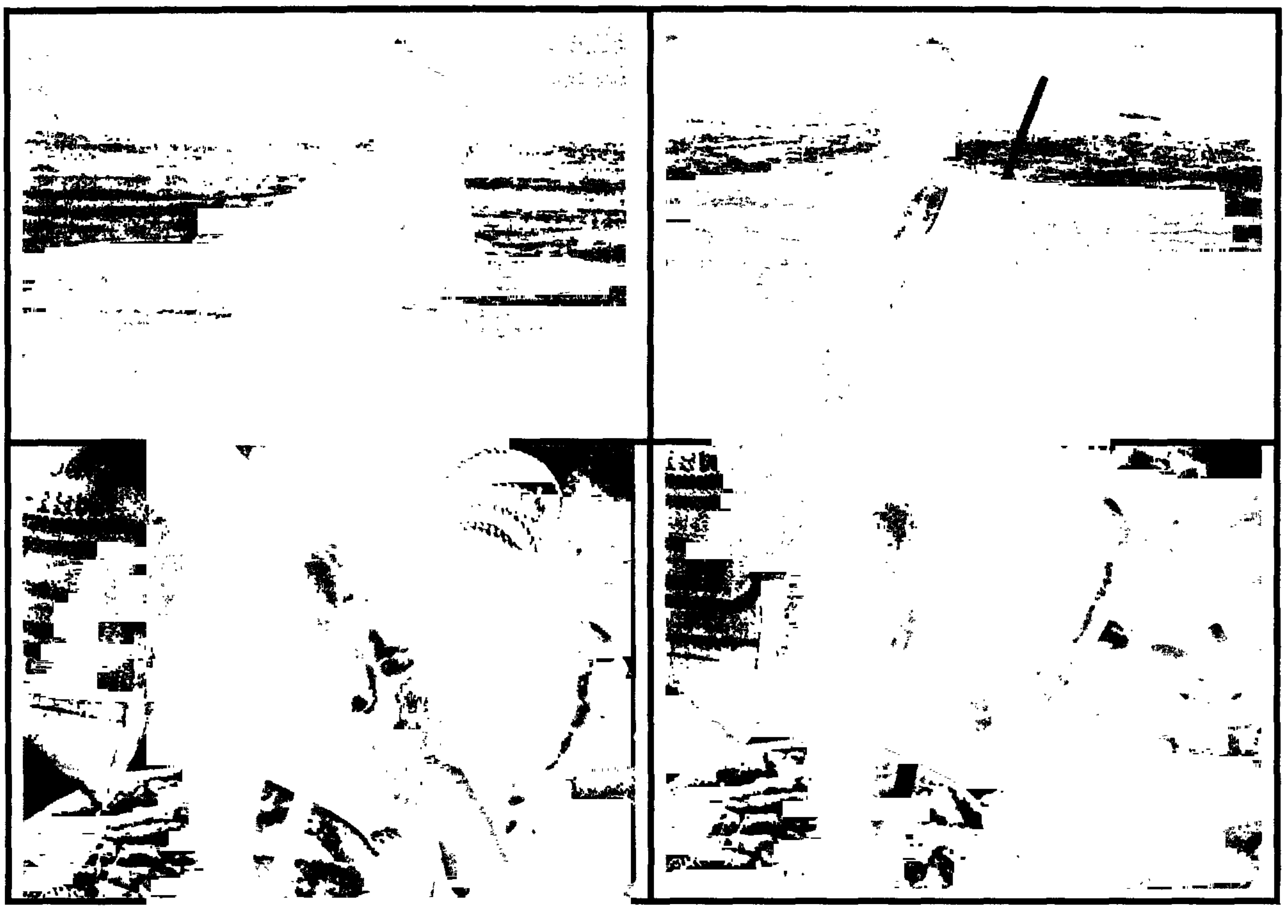
Aquatic Monitoring

To assess the existing scenario of fish type available in the river body, 20 days monitoring campaign was carried out in month of March as already mentioned in earlier part of the section. Small-narrow thread system, which is quite prevalent in the area, was used in the tributaries for fish catch. In the study area no fish has been encountered in Satluj River during 20 days monitoring campaign probably due to high turbulence in the river water and lesser temperature, which creates unfavourable conditions for the fishes to adapt. However, fishes were monitored in the Nogli Khad, Sumej Khad and Kajo Khad, near its confluences with Satluj River. The only fish type found in Nogli was Snow trouts (*Schizothorax spp, Schizothoraichthys spp.*), which belong to taxonomical family Cyprinidae and sub-family Schizothoracinae . It is a small variety of fish and is locally known as "asla". (Refer Plate 4.4). Asla is a cold water riverine and migratory fish.

Poor catches in the main Satluj are contributed by many factors especially the high velocity, lack of suitable shelter for the fish to escape fury of high floods and absence of suitable gear which can be operated in torrential waters. Cast net of 1.5 – 2.0 mm dia, when spread, is a universal gear used by persons engaged in fishing. Due to torrential nature of the river, the cast net is operated near the shore area. The catches are small and hence it is a subsistence fishery.

Plate 4.4 LOCAL FISHERMAN ENGAGED IN CATCHING FISH IN MAIN SATLUJ RIVER, DOWNSTREAM OF NOGLI





Migratory fish species

When the temperatures start rising above 22 °C to 25 °C, sometimes during Feb-March, *S. richardsonni* species in Satluj starts migrating upstream to colder reaches of the river from downstream. But there again they experience an unfavourable low temperature of 8-9.5 ° C, due of the influx of snow-melt water, which is not conducive for the ripe fish to spawn. Hence, these trouts enter the side streams of the river, which receive warm ground waters (17.5-21.5°C) and spawn profusely (density of fertilized eggs 20-23 per sq. m and hatchlings 37-40 sqm) (Ref D Sc dissertation Dr. K. L. Sehgal).

ASLA (Schizothorax and Schizothoraichthys)

Genus *Schizothorax and Schizothoraichthys*, (Cyprinidae, Schizothoracinae) are cold water river fish locally, and are known as Asla and more generally as snow trout. They are widely distributed in the Himalayan and sub-Himalayan region of the Indian-Chinese sub-continent. It needs a high dissolved oxygen concentration. Asla has a conical head with slender, elongated and strong body to resist the strong water current of the hill streams and rivers. The body is covered with minute silvery scales and the abdomen with lighter brown scales. Snout bears nuptial tubercles and the size and number are well developed in males. They are grayish black on the dorsal side and silvery on belly and sides. A distinct suctorial disc in addition to 4 barbels is present on the chin for attachment to stones. Maximum weight and size are 1.5 kg (48 cm).*Schizothorax* has a blunt snout and suctorial lip whereas *Schizothoraichthys* has a pointed snout and no suctorial lip.

Feeding habits

The feeding habits of asla have been reported by many authors (Shrestha, 1979; Masuda and Karki, 1980; Terashima, 1984; Sharma, 1989). Asla is a phytophagous fish, with its mouth adapted to scraping attached algae from the surfaces of stones. It feeds on attached algae including *Spirogyra, Ulothrix, Oedogonium,* as well as on the benthic insect larvae of mayflies, caddis flies, ephemeropterans, etc. *S. plagiostomus* is herbivorous and feeds on aquatic plants and algae attached to stones and rocks (Shrestha, 1979). Asla food was found to contain predominantly green and blue-green algae, folllowed by detritus and aquatic insects. Diatoms attached to rocks, stones and boulders as aufwuchs form the primary source of food in torrential streams whereas aquatic macrophytes, decayed organic matter and green algae are minor diets.

Spawning

Asla spawns when two years old, depending on food supply. Sexual dimorphism is developed in *S. plagiostomus* (Rajbanshi, 1971) and in *S. macrophthalmichthys, S. nepalensis and S. raraensis* (Terashima, 1984) in anal fin, presence of nuptial organs and size of the basal sheath scale. Mature asla has a change in colour during the breeding time. Mature males develop tubercles on either side of the snout, faint yellow colour of the body, and reddish colour of fins. Females spawn in natural as well as in artificial environments. Asla can spawn naturally or by stripping the wild/cultured mature female during the spawning season. It spawns in September/October and March/April.

Sport fisheries

Sport fisheries are not fully developed in these areas. Low water temperatures along with difficult terrain, high turbulence compel the fishermen to operate their net only for a very short period of time and at selected locations only. The sport fishery in the area is constituted by brown trout, *Salmo trutta fario* and Rainbow trout (*Salmon gairdneri*). The sport fishery is confined mainly in river Baspa and its tributary. The first transplantation in the Baspa was made in 1930. Subsequently, to meet the ever-increasing demand of such transplants, a medium sized farm was established at Sangla in 1962. The details of production of Fry at Sangla and their transplantation in Baspa river system are given in Table-2.21. The details on number of anglers, licensing fees and the revenue earned have been collected from Fisheries Department, Shimla, H.P are given in Table-4.22

Table 4.21 Production of trout seed at Sangla farm and their transplanting in Satluj river system

Year	No. of green eggs	No. of Fry	No. of fry transplants	
			Rainbow trout	**Brown trout**
1992-93	1,15,900	93,262	68,907	24,355
1993-94	1,02,270	54,570	31,096	11,737
1994-95	60,985	23,332	21,340	1,992
1995-96	69,180	35,509	35,509	-
1996-97	1,24,250	68,949	42,213	13,568
1997-98	75,700	23,631	-	-
1998-99	80,800	3,000	827	57,612
1999-2000	55,000	48,659	-	25,437
2000-2001	88,000	57,200	-	-
2001-2002	102,000	72,267	44,082	-
2002-2003	6000	55,287	-	-
2003-2004	-	23,000	-	-

Source: Himachal Pradesh, Fisheries Department, Shimla

Table 4.22 Angling pressure, licensing fee and amount of revenue earned

Year	Number of anglers	Daily licencing fee (Rs.)	Revenue earned (Rs.)
1992-93	21	10	210
1993-94	23	10	230
1994-95	95	100	9,500
1995-96	87	100	8,700
1996-97	31	100	3,100
1997-98	53	100	5,300
1998-99	29	100	2,900
1999-2000	39	100	3,900
2001-2002	7	100	700
2002-2003	7	100	700
2003-2004	15	100	1500

Source : Himachal Pradesh Fisheries Department, Sangla, H.P.

Outcomes of the study on fish availability

It seems essential to quantify the current scenario of existence of the fish type in the river stretch but the limited time schedule of the study did not permit for an upstream river stretch study. However, after assessing the available historical data and the results of the monitoring campaign that was conducted, and interaction with concerned departments, fisheries expert and fisherman, it may be concluded:

1. The main Satluj river has very less fish population in stretch between Jhakri to Bael. The fish found in Satluj river in this stretch comes from the khads. Fish species mainly found are Trouts viz, Snow trouts and Brown trouts. *S . richardsonii* (Snow trout) is most common fish in river Satluj. The species is neither a rare nor endangered fish but is categorized as vulnerable one. (Sehgal 1988 and 1994)

2. All species available in River Satluj (stretch from Jhakri to Rampur to Bael) are endemic excepting the brown trout which is exotic.

3. The side streams like Nogli khad, Samej khad have fish populations. The probable reasons might be less flow instability, favorable temperature and less turbidity. Also fishes have also been sighted at the confluence points of khads (Nogli, Sumej and Kajo).

4. Fish catching is not very prevalent in the area. Only a few fishermen do fishing at Nogli for selling purpose. Four fishing licence have been issued in this region. For commercial purpose, the fish is mainly brought from downstream areas like Bilaspur. At upstream, few sites have been identified for sport fishing i.e. Sangla.

5. Construction of a dam across a river usually has a profound effect on free passage of migratory fishes like the snow trout etc., to and fro from their spawning grounds located upstream, owing to changes in water velocity, volume of discharge, water chemistry, temperature and turbidity. But this impact is not foreseen here as the stretch has very less fish population and that too has been found to mainly exist in tributaries and their confluences with river Satluj.

6. Mahseer is migratory fish and its migration is affected by construction of Bhakra dam on the Satluj. Its availability in project area is a remote possibility due to low water temperature.

A detailed study would be required for the entire stretch to understand the exact route that is being followed by the fishes in the river especially after construction of hydroelectric projects and to understand the microclimate needed for the fish growth in the area.

4.2.6 Protected Areas

The catchment area includes eleven protected areas that are declared as National Parks or Wild Life Sanctuaries (refer Table 4. 23 and Fig 4.5).

Table 4.23 National Parks/ Wild Life Sanctuaries in the Catchment Area

S. No.	Name of Wild Life Sanctuary/National Park	Region	Area (sq. kms.)
1.	Bandli Wild Life Sanctuary	Mandi	41
2.	Gobindsagar Wild Life Sanctuary	Bilaspur	100
3.	Majathal Wild Life Sanctuary	Solan	40
4.	Darlaghat Wild Life Sanctuary	Solan	6
5.	Shilli Wild Life Sanctuary	Solan	2
6.	Rupi Bhabha Wild Life Sanctuary	Kinnaur	503
7.	Daranghati (Part I & II)	Shimla	167
8.	Lippa Asrang	Kinnaur	31
9.	Sangla Valley	Kinnaur	-
10.	Great Himalayan National Park	Kullu	765
11.	PIN Valley National Park	Lahaul & Spiti	675

Source: Environmental Information Centre, Ministry of Environment & Forests

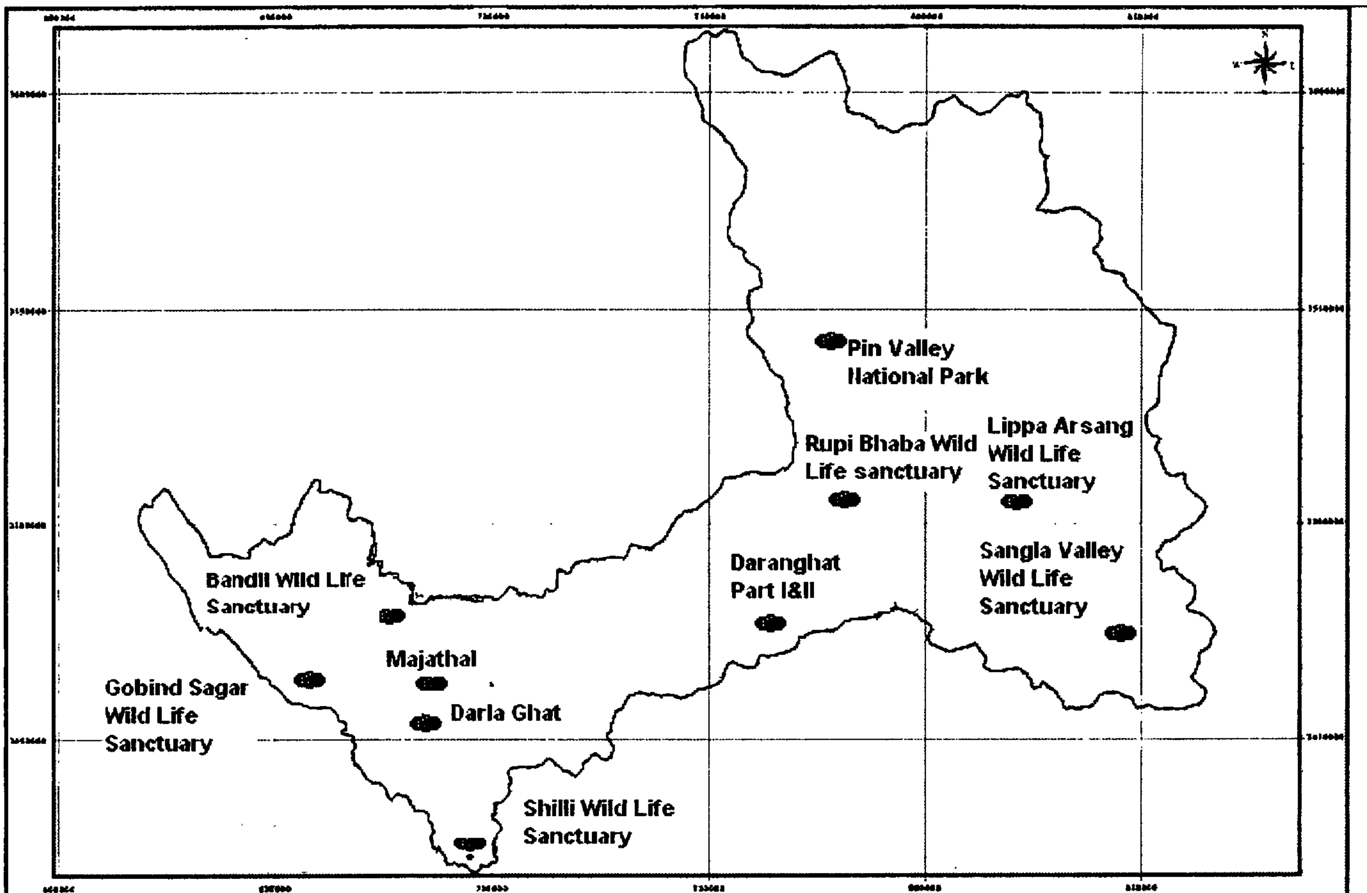
The two big National Parks that exist in the region are Great Himalayan National Park in Kullu and Pin Valley national park in Lahul & Spiti. A brief description on these two with regard to flora and fauna has been provided below.

The Pin Valley National Park: It spreads over an area of 675 Km^2 in the trans-Himalayan cold desert region of Spiti valley and falls in the catchment of the Pin River, which is one of the main tributaries of Satluj in Spiti area, and its major tributary, Parahio. Altitude of the National Park ranges from about 3,500 meters near Ka dogri to more than 6,000 meters at its highest point.

The apparently scanty vegetation in the Park contains many plant species of high conservation value. Prominent amongst these species are provides a striking contrast to the otherwise dry surrounds.

Great Himalayan National Park: Bounded to the East by the Himalayan Mountains, the Great Himalayan National Park (GHNP) forms part of the boundary between four ecological zones:

- the dry deserts of interior Asia and the well-watered lowlands of the Indian plains,
- the Oriental and Palearctic faunal realms,
- the high plateau of Tibet and the jumbled Himalayan peaks, and
- the catchments of the Beas and Satluj Rivers, both mighty tributaries of the Indus.



PROTECTED AREAS IN SATLUJ BASIN HIMACHAL PORTION

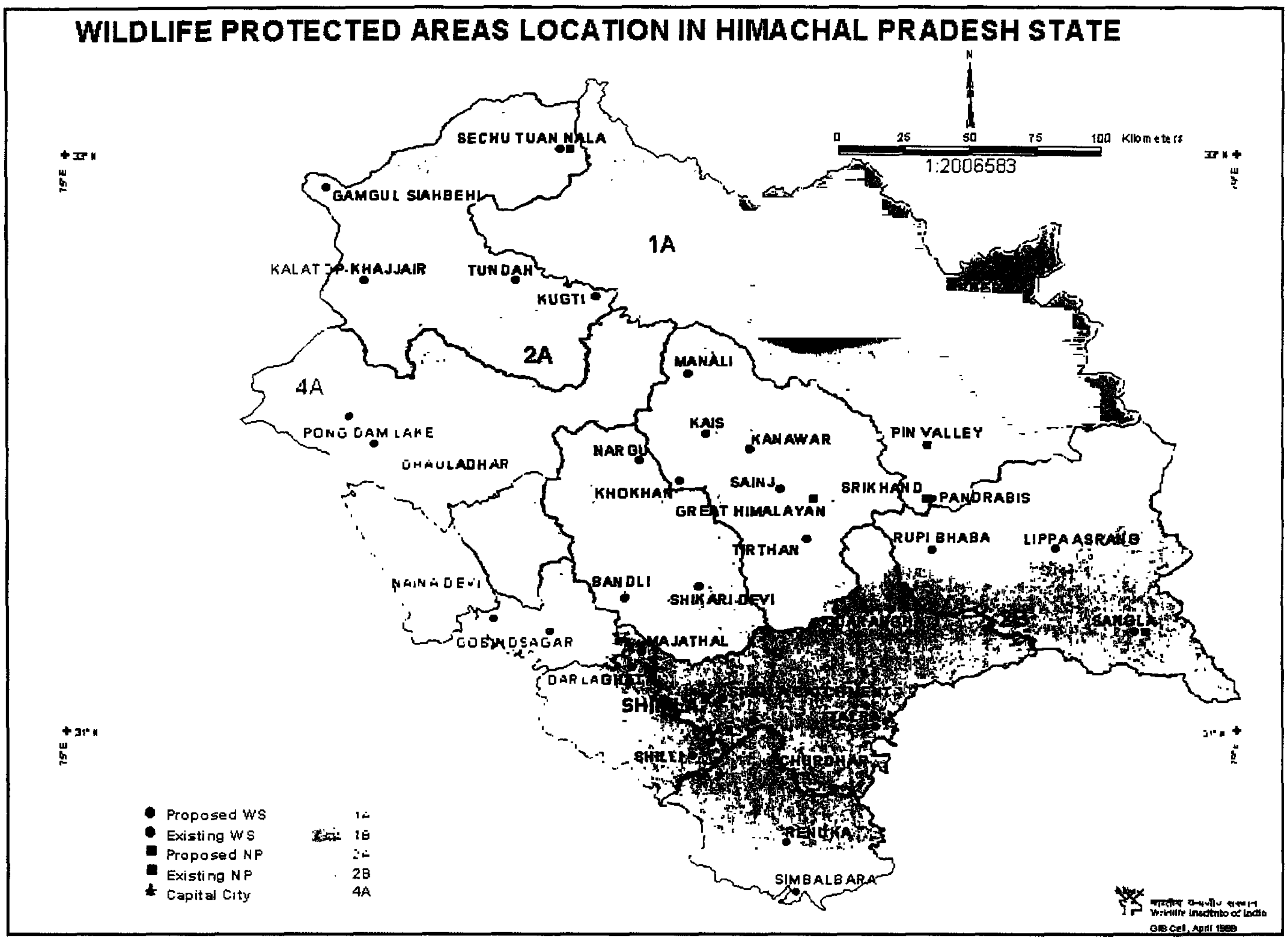


Fig 4.5 Protected areas (National Parks & Wild Life Sanctuaries) in Satluj Basin of Himachal Pradesh

Table 4.24 Flora and Fauna in Pin Valley National Park

Flora	**Fauna**
Snowcovered, scanty tufted vegetation including: *Ratanjot (*Arnebia euchroma & A. benthamii*), Salampanja (*Dactylorhhiza hatageria*), Somlata* (Ephedra gerardiana), *Seabuckthorn* (Hippophae rhamnoides*) Ateesh* (Aconitum heterophyllum*).* *Wild rose (*Rosa webbiana) *-gorgeous pink flowers and bright red fruit*	*A number of endangered animals found:* *Himalayan Ibex, Snow Leopard, Bharal, Wooly Hare, Tibetan Wolf, Snow Cock, Snow Leopard, Snow Cock, the Himalayan Ibex*

The boundaries of GHNP are contiguous with the Pin Valley National Park in Trans-Himalaya, the Rupi-Bhawa Wildlife Sanctuary in Satluj watershed, and the Kanawar Wildlife Sanctuary. Together the varied wildlife habitats of these protected areas support the full range of Western Himalayan biodiversity, from tropical to alpine and Tibetan.

Table 4.25 Flora and Fauna in Great Himalayan National Park

Flora	***Fauna***
Several species of balsams (Impatiens), species of Androsace, Hedysarum, Draba (Whitlow grass), etc. *Species of taxa. - Valerians, Dactylorhiza, Yew, and Leycesteria are found.* *Buckthorn (Hippophae), Cedar trees, herbaceous Violets, and grasses such as Poa and spurge (Euphorbia) shrubs.*	*Goral* (Naemorhedus goral), *the Himalayan Tahr* (Hemitragus jemlahicus), *Bharal, or Blue Sheep* (Pseudois nayaur). *Leopards, Snow Leopards, Himalayan Black Bears.* *Endangered Western Tragopan.* *Four other species of Pheasant Himalayan including Monal.* *Raptors, Lammergeiers, Himalayan Griffon Vultures, and Golden Eagles.*

4.2.7 Landuse

Land use pattern has been studied using latest satellite data (IRS P6, LISS III sensor) for the entire Satluj basin. Raw digital satellite data was procured from National Remote Sensing Agency and processed in house using the hardware and software facilities available with the consultant. The land use classification has been presented in the table below:

Table 4.26 Landuse type in study area

S.No.	Landuse Category	Percentage of total Satluj basin area
1.	Agricultural land	10.95
2.	Fallow land	0.08
3.	Plantations	0.25

4.	Land without scrubs	1.68
5.	Forest areas	24.96
6.	Water bodies	0.69
7.	Snow covered area	37.87
8.	Settlement	0.21
9.	Barren areas	20.16
10.	Grassland	3.16
	Total	100

Source: *Satellite Imagery, Year 2005*

The study area falls in valleys and high elevations and in general, the Catchment area is characterised by undulating hilly terrain, steep hills and deep valleys. The cultivation is possible in small terraces of holdings in the high hills and the khad basins in most parts. In the valleys, cultivation is spread over vast areas. It is only in the valleys that the land is flat and cultivation is done. A digital elevation model has been generated for the entire Satluj basin. The Digital Elevation Model (DEM) and Land use classification of the entire Satluj basin has been shown in Fig 4.6 & 4.7.

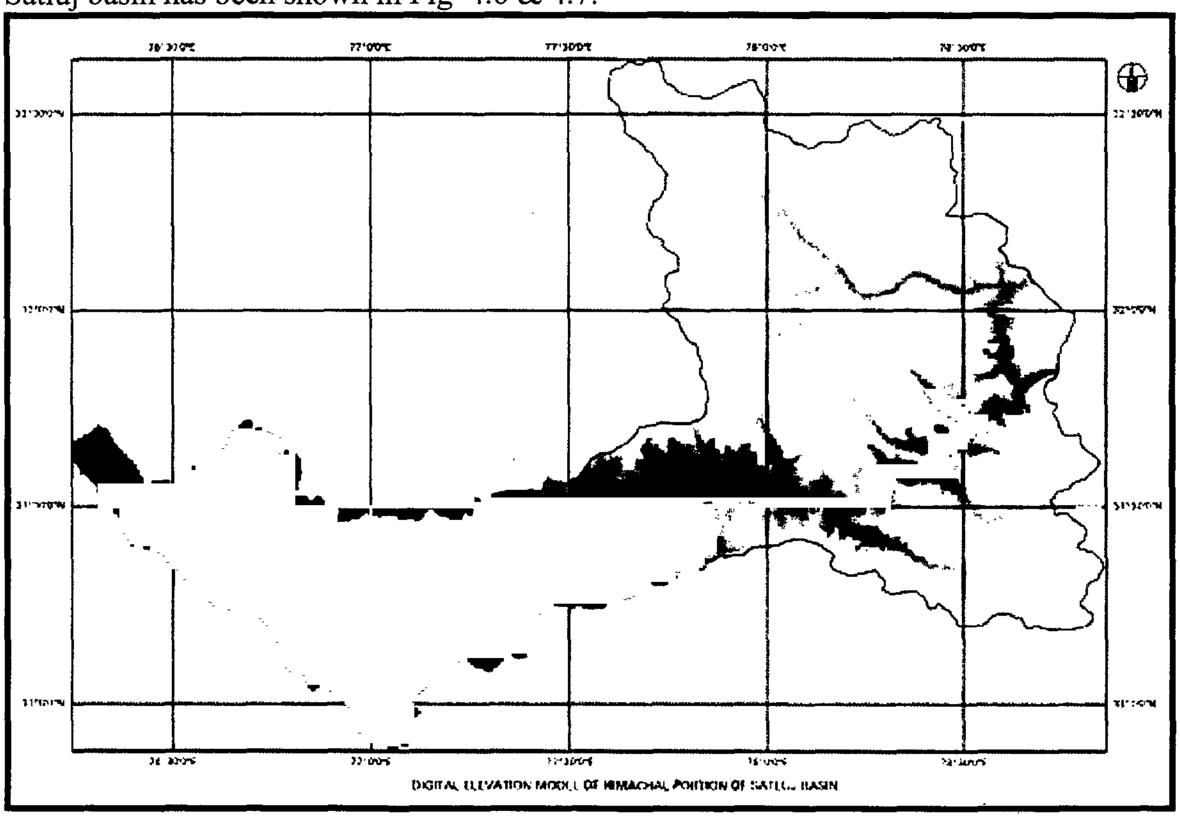


Fig 4.6 *Digital Elevation Model (DEM) of Himachal portion of Satluj basin*

DEM is a raster image depicting continuous changes in elevation values. The lighter shades depict higher values of elevations while the darker ones show the lower values of elevations. DEM has been used to arrive at slope map for the basin which has been used to identify areas vulnerable to soil erosion in the basin using USLE (Universal soil loss equation) modelling techniques .

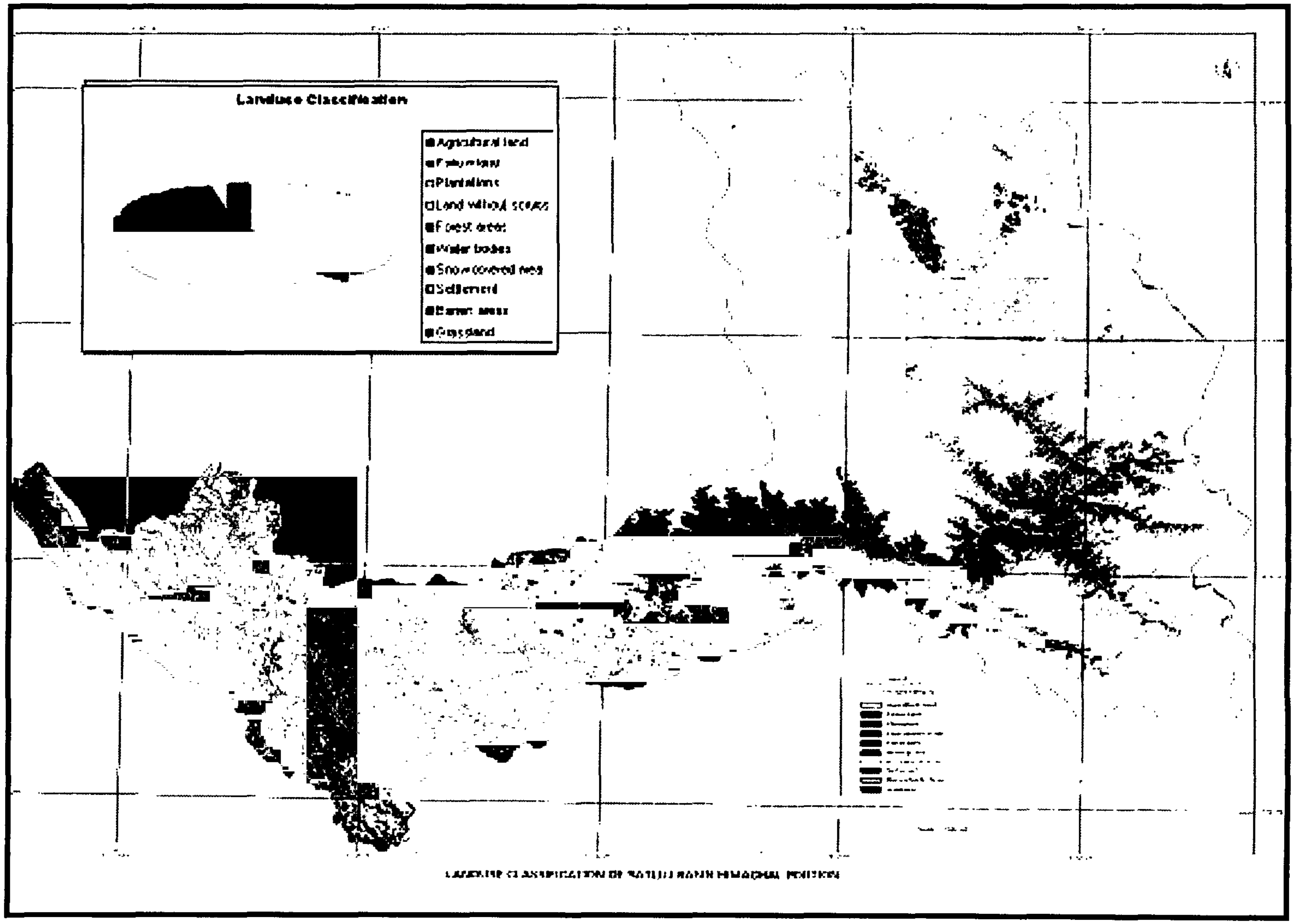


Fig 4.7 Landuse Classification of Satluj basin in the State of Himachal

4.2.8 *Socio-Economic Indicators*

General socio-economic conditions of the area have been described based on the following indicators:

- Demography
- Ethnicity and Language
- Livelihood Practices i.e. Agricultural, Industries etc.
- Basic Infrastructure
- Health Profile

A general socio-economic profile of the Satluj River basin that includes six prominent human settlements along the banks of the Satluj River Namgia, Kalpa, Rampur, Tattapani, Suni and Bilaspur has been presented below (refer Table 4.27):

The massive hydroelectric development in the region has somewhere influencing socio - economic growth of the area. The related issues will be overviewed in later part of the chapter and will be further discussed in Chapter 4 with special emphasis on NJHEP and RHEP areas.

Table 4.27 General Socio-Economic Profile of the Entire River Basin

Characteristic	Profile in the study area			
Demography	Settlement	Total Population	Rural	Urban
	Namgia	437	437	-
	Kalpa	17,630	17,630	-
	Rampur	72,026	66,373	5,653
	Tattapani	483	483	-
	Suni	31,425	29,896	1,529
	Bilaspur	97,622	84,564	13,058

Characteristic	Profile in the study area
Ethnicity and Language	The population in the area is primarily Hindu which speaks both Hindi and various dialects of Western Pahari.
Livelihoods	Agriculture: ➢ People are primarily involved in farming activities including both agriculture and dairy farming. ➢ Apart from this people are also employed as labour for farming and construction activities in the area. ➢ Salaried employment is also prevalent in areas near urban localities. ➢ Small land holdings scattered over the region are used for cultivation of all kinds of crops depending on the altitude. ➢ Cereals such as wheat and maize are grown at the lower altitudes while temperate fruits such as plums; apples, walnuts, chilgozas etc. are found in the upper reaches. ➢ The percentage of irrigated cultivable area is relatively low with people mostly relying on natural sources Fishing: ➢ Fishing is not a source of livelihood in the surveyed sub-area. Industries: ➢ As such no key industries are located in the area along rive Satluj. Only fewer packaging set-ups at smaller level could be located in upper reaches, where in apple production is in abundance.
Basic Infrastructure	➢ Water is primarily available from taps (in the lower regions), wells, tanks and canals (some areas). Other sources include bowlis, springs, nallahs, etc. ➢ Most villages have more than one source of water for drinking and other purposes. Apart from drinking people mostly rely on the natural sources of water. ➢ Other basic amenities and infrastructure in the form of health care facilities (dispensaries, health care centres, etc.), postal facilities, electrification and roads (kuccha and pukka) are present in most villages but not all. Though communication facilities are fairly well established the access to pukka road is a concern in some areas. ➢ Almost all the villages have pits for sewage disposal with open defecation being practiced in some places. Rampur town has a sewerage system in place with plans underway for its extension.

Characteristic	Profile in the study area
Health Profile	As such no prevalent diseases especially water borne has been reported in the region other than the incidence of malaria in the summer months.

4.3 Influence Area of NJHEP and RHEP

Referring to the earlier sections of the Chapter, wherein a detailed description on existing environmental and socio-economic status of the region has been provided, in this particular section, influence area of Nathpa-Jhakri and proposed Rampur Hydro Electric Project has been detailed out under the following heads:

- Demographic profile
- Water Source, use and quality
- Land use
- Employment Pattern
- Economic Activities
- Infrastructure Accessibility
- Health Profile
- Archaeological Structures

4.3.1 Demographic Profile

The influence area of NJHEP falls under three districts that are Shimla, Kinnur and Kullu. The total population in the influence area is about 50,010 with an average density of 47 persons/sq.km. The total no. of villages in the influence area of Nathpa-Jhakri Hydro Electric Project is 66. The demographic profile of the area has been given below:

Table 4. 28 Demographic Profile of the NJHEP Influence area

Description	Total Population	Male Population	Female Population	Other Information
Population	50,010	26,253	23,757	No. of females per 1000 males is 957
SC Population	16,440	8,464	7,976	% of total population is 32.87
ST Population	6,210	3,118	3,092	% of SC population to total population is 12.42

Description	Total Population	Male Population	Female Population	Other Information
Literacy Rate (%)	60.0	33.1	47.2	

Source: EIA Study for Updation of NJHEP, Year 2003

The influence area of proposed Rampur Hydro Electric project falls under Rampur Tehsil of Shimla District and Nermand Tehsil of Kullu Districts. The population densities in the tehsils are very low due to difficult hilly terrain and climatic conditions. The villages are sparsely located in the area though those in Shimla district have higher population density (141 persons per sq. km) than in Kullu (41 persons per sq. km). The total no. of villages is in the influence area of Rampur Hydro Electric Project. The current literacy rates in Shimla and Kullu districts are 79.1% and 72.9%, respectively.

The population of RHEP influence area consists of about 53% SC and 20% ST and the approximate sex ratio (number of females per 1000 males) for the study area is higher than the sex ratio for the state as a whole of 968 (ref. Table no.4.29).

Table 4.29 Demographic Profile of the RHEP Influence area

Name of Tehsil	Area (hectares)	Total Population*	ST Population		SC Population	
			Male	Female	Male	Female
Nermand Tehsil, Kullu District	2222	15926	3708	76	3933	3708
Rampur Tehsil, Shimla District	6927	9505	2759	386	2771	2759
Total	9149	33313	6467	462	6704	6467

Source: District Census for Shimla & Kullu Districts, Year 2001

* Population of Rampur town and Jhakri Township have not been included

Table 4.30 Population Sex Ratio in RHEP area

Tehsil (District)	Area (hectares)	Total Population*	Male Population	Female Population	Sex Ratio
Nermand (Kullu)	2222	15926	8128	7798	959
Rampur (Shimla)	6772	17100	9359	7741	827
Total	8994	33026	17487	15539	

Source: District Census for Shimla & Kullu Districts, Year 2001

* Population of Rampur town and Jhakri Township have not been included

4.3.2 Land Use

To understand the changes in land use pattern of the NJHEP influence area during past few years after operation of power project, a baseline setup for land use pattern has been established for various land use types considering different categories of households who had been given compensation by the concerned authority under the NJHEP project.

Table 4.31 Land use pattern for those households who had been given land for land (area in hectares)

Land use	Year 1996	Year 2002	Change in area(-)
Total Land	1.380	0.58	0.80
Grass land	0.117	-	0.117
Orchard	0.205	-	0.205
Cultivated Land	1.058	0.58	0.478
Net Sown area	1.058	0.58	0.478
Cropped area	1.416	0.894	0.522
Maize	0.560	0.458	0.102
Rice	0.115	0.0	0.115
Wheat	0.502	0.374	0.128
Barley	0.089	0.00	0.089
Pulses	0.150	0.062	0.088

Source Impact assessment of resettlement implementation under NJHEP, Year 2002

Table 4.32 Land use pattern for those households who had been given alternative house or cash compensation (area in hectares)

Land use	**Year 1996**	**Year 2002**	**Change in area(-)**
Total Land	1.013	0.190	0.823
Grass land	0.085	0.00	0.085
Orchard	0.224	0.021	0.203
Cultivated Land	0.704	0.169	0.535
Net Sown area	0.928	0.190	0.819
Cropped area	1.132	0.244	0.888
Maize	0.160	0.064	0.328
Rice	0.414	0.054	0.106
Wheat	0.080	0.072	0.342
Barley	0.080	0.048	0.032
Pulses	0.086	0.006	0.080

Source Impact assessment of resettlement implementation under NJHEP, Year 2002

Table 4.33 Land use pattern for those households who had been given alternative shop plots (area in hectares)

Land use	Year 1996	Year 2002	Change in area(-)
Total Land	0.042	0.042	0.0002
Grass land	-	-	-
Orchard	-	-	-
Cultivated Land	0.042	0.042	0
Net Sown area	0.042	0.042	0
Cropped area	0.080	0.054	0.026
Maize	0.026	0.022	0.004
Rice	0.006	-	0.006
Wheat	0.032	0.026	0.006
Barley	0.006	-	0.006

Pulses	0.010	0.006	0.004

Source *Impact assessment of resettlement implementation under NJHEP, Year 2002*

Table 4.34 *Land use pattern for those households who had been given alternate employment in the project (area in hectares)*

Land use	Year 1996	Year 2002	Change in area(-)
Total Land	0.710	0.422	0.289
Grass land	0.030	0.00	0.030
Orchard	0.090	0.037	0.053
Cultivated Land	0.590	0.385	0.205
Net Sown area	0.590	0.385	0.205
Cropped area	0.931	0.456	0.475
Maize	0.363	0.295	0.068
Rice	0.570	0.012	0.558
Wheat	0.348	0.106	0.242
Barley	0.185	0.00	0.185
Pulses	0.043	0.006	0.037

Source *Impact assessment of resettlement implementation under NJHEP, Year 2002*

GRAZING LANDS IN THE REGION

Table 4.35 *Land use pattern for those households who had been given cash component only (area in hectares)*

Land use	Year 1996	Year 2002	Change in area(-)
Total Land	0.712	0.454	0.258
Grass land	0.010	0.006	0.004
Orchard	0.162	0.148	0.014

Land use	Year 1996	Year 2002	Change in area(-)
Cultivated Land	0.540	0.30	0.240
Net Sown area	0.702	0.448	0.254
Cropped area	0.804	0.494	0.310
Maize	0.320	0.194	0.126
Rice	0.076	0.038	0.038
Wheat	0.310	0.202	0.108
Barley	0.026	0.010	0.016
Pulses	0.072	0.050	0.022

Source: Impact assessment of resettlement implementation under NJHEP, Year 2002

The influence area of RHEP includes village Nirmand, which is having largest geographical area of 1102 hectares. Other main villages falling in RHEP influence area are Bael, Duttnagar, Poshna and Koyal. Village Bael has smallest geographical area of 76 hectares. Bael and Poshna villages do not have any land under category of 'non-agriculture' use. Details on land use pattern of the RHEP influence has been presented below in Table 4.36:

Table 4.36 Land use pattern (in hectares) of RHEP influence area

Landuse Type	**Koyal**	**Bael**	**Dutt Nagar**	**Tunan**	**Poshna**	**Nirmand**
Area under Forests	-	-	-	-	-	-
Area not available for Cultivation (non-agri/uncultivable)	29	15	83	107	49	246
Other uncultivable land excluding fallow land (permanent pastures/other grazing land, miscellaneous tree crop/groove included in net area sown, culturable waste	114	547	-	-	-	-
Fallow Land (current/others)	1	4	-	23	22	71
Total cropped area (net sown area/area sown more than once)	316	114	230	731	391	1553
Total Cultivable area (irrigated/un-irrigated)	133	57	-	6	244	856
Village common lands	-	-	-	-	-	-
Land put to other use (industry/community house)	-	-	-	-	-	-
Area under ponds for agriculture	-	-	-	-	-	-

Source Baseline Demographic Socio-Economic Survey of Rampur Hydroelectric Project, Year, 2005

It can be inferred from the above data that there is a decline in landuse under agriculture related activities and irrespective of form of compensation provided to affected people in the project influence area, there has been a shift from agriculture based pursuits to non-agriculture based ones. This could mainly be attributed to the influx of more number of people, greater available opportunities and other related development in the area that is induced by the hydro development.

4.3.3 Water Source, Usage and Quality

The river Satluj is not the main source of water in the area. The natural springs and 'chashme' are the key sources of water for people living in the area for their own consumption, livestock use and irrigation purposes. In most of the villages except those, situated on high hills, IPH Department has laid down the pipelines to connect the natural springs (at upper reaches) to the households through storage tanks for water supply after providing primary treatment. The villages those are located on higher reaches depend directly on natural springs or khads flowing in vicinity. The main khads in the NHEP area are Sholding Khad, Panvi Khad, Bhawa Khad, Baspa River, Kut Khad etc, while in RHEP area, the main khads are Nogli, Kajo, Kunni, Racholi, Kasholi, Barauni etc. For drinking purpose, about 76.6 % of population depend upon piped water supply about 5.8 % and 17.6 % utilize water from perennial/seasonal streams and natural sources respectively. For cleaning and other domestic uses 49.4 % use pipe and tap, 20 % use streams and 30.6 % use natural sources. For cattle, tap water takes care if 43 % of the requirement, 18 % of the water comes from natural sources while streams/river and meet 39 %.

Water requirements for the NJHEP area: 2.0 MLD* (@ 40 lpcd for villages based on findings of primary level village surveys)

Water Requirement for the RHEP area: 1.33 MLD* (@ 40 lpcd for villages based on findings of primary level village surveys)

* *Population of Rampur town and Jhakri Township have not been included. The specific water demand for these areas is 0.68 MLD and 0.60 MLD respectively*

Further, agriculture crops in the area mainly depend on rains, however, irrigation canals also exist in some of the villages especially in the downhill parts of the areas. These canals are basically known as 'Khuls' in the area and having capacity of only 3-4 cusecs. The water in the streams, khads, is also used by people living alongside as on requirement, especially for livestock purposes.

The water quality for river Satluj has been monitored at various stretches between Nathpa-Jhakri and Jhakri-Bael river stretch by different agencies. As a part of study on 'Managed River Flow' taken by the consultant, a separate water quality monitoring campaign was also organised. A water quality data profile has been compiled up for the NJHEP and RHEP influence areas and the same has been presented below in Table 4.37 a and Table 4.37b:

Table 4.37a Water Quality Profile of River Satluj (Year 2003 Monitoring Results) along Nathpa-Jhakri stretch

Parameter	***u/s Nathpa***	***d/s Nathpa***	***u/s N.Sari***	***d/s N.Sari***	***u/s Jhakri***
BOD (mg/L)	0.10	0.20	0.20	0.10	0.30
COD (mg/L)	16	20	14	14.80	48
TSS (mg/L)	214.90	322	29.70	36.10	208.90
TDS (mg/L)	254	258	80	68	207
Turbidity (NTU)	72.80	104	25.00	26.40	68
pH	8.20	8.17	7.40	8.05	7.93
Total hardness (mg/L)	160	152	26	28	134
Total Alkalinity (mg/L)	105	15	35	30	165
Faecal Coliform (MPN/100 ml)	na	na	na	na	na
Total Coliforms (50 standard value)	na	na	na	na	na
Mercury as Hg (ppb)	nd	nd	nd	nd	nd
Iron as Fe (mg/L)	0.03	0.09	nd	0.06	0.12
Nickel as Ni (mg/L)	0.08	nd	0.10	0.46	0.08
Cadmium as Cd (mg/L)	nd	nd	nd	0.01	nd
Chromium as Cr (mg/L)	0.03	nd	0.23	nd	0.01
Zinc as Zn (mg/L)	0.01	0.03	0.10	0.02	0.01

Source: State Environment Protection & Pollution Control Board, 2003

na: data not available; nd: value not detected

Table 4.37b Water Quality Profile of River Satluj below Jhakri ((Year 2006 Monitoring Results) along Jhakri-Rampur-Bael Stretch)

Parameter	***Below NJHEP tailrace outfall***	***Rampur u/s***	***Rampur d/s***	***Bael Town***
BOD (mg/L)	1.00	1.05	12.00	1.00
COD (mg/L)	19.36	19.36	19.36	53.24
TSS (mg/L)	22.0	29.0	39.0	28.0
TDS (mg/L)	290	320	360	380
Turbidity (NTU)	1.4	1.2	1.6	1.4
pH	7.88	7.95	8.10	8.10
Electrical Conductivity (µS/cm)	490	530	600	630
Total hardness as CaCO3 (mg/L)	175	175	170	175
Total Alkalinity (mg/L)	186	186	186	186
Faecal Coliform (MPN/100 ml)	Absent	Absent	4	na
Total Coliforms (50 standard value)	na	na	14	na
Mercury as Hg (ppb)	7.11	-	-	nd
Iron as Fe (mg/L)	< 0.05	-	-	< 0.05
Nickel as Ni (mg/L)	< 0.02	-	-	< 0.02
Cobalt as Co (mg/L)	0.051	-	-	0.077
Cadmium as Cd (mg/L)	< 0.1	-	-	< 0.1

Parameter	*Below NJHEP tailrace outfall*	*Rampur u/s*	*Rampur d/s*	*Bael Town*
Chromium as Cr (mg/L)	< 0.003	-	-	< 0.003
Zinc as Zn (mg/L)	< 0.05	-	-	< 0.05

Source: *Monitoring Results carried out by the consultant in Year, 2006*

na: data not available
nd: value not detected

Water Quality Data of River Satluj, monitored by WAPCOS during July 2004

Parameters	**Sampling Locations**			
	100 m u/s of Nathpa Dam	100 m d/s of Nathpa Dam	Near power house	Downstrea mof tailrace
pH	7.4	7.4	7.3	7.5
Electrical conductivity (μs/cm)	210	290	203	263
Total Dissolved Solids, mg/l	130	179	125	163
Total Suspended Solids, mg/l	466	60	558	880
Total alkalinity ($CaCO_3$), mg/l	98.4	118	118	118
Carbonates, mg/l	Nil	Nil	Nil	Nil
BOD, mg/l	3.2	2.1	2.7	13.2
COD, mg/l	18.4	13.8	18.5	27.6
Nitrate as NO_3, mg/l	BDL	BDL	BDL	BDL
Phosphate as PO_4, mg/l	0.28	BDL	0.16	0.40
Fluoride as F, mg/l	BDL	BDL	0.2	BDL
Chloride as Cl, mg/l	7.9	7.9	7.9	7.9
Sulphate as SO_4, mg/l	45.3	56	49	86
Sodium as Na, mg/l	11	11	8	9
Potassium as K, mg/l	1	2	1	1
Calcium as Ca, mg/l	34.7	44.2	28.4	38.7
Magnesium as Mg, mg/l	1.9	1.9	4.8	3.3
Oil & Grease, mg/l	BDL	BDL	BDL	BDL
Phenolic Compound	BDL	BDL	BDL	BDL
Total Coliforms	21	21	21	12
MPN	21	21	21	12

BDL: Below detectable limit

Specific Findings of River Quality

The level of DO observed during monitoring carried out in Feb, 2006 varies from 8 to 8.5 (mg/l) between Jhakri to Bael. The high DO levels in the river indicate high water quality in the study stretch. It may be because of higher water flow in the river and low environmental temperature.

The pH value as observed is 8.1 and 7.88 at Bael and Jhakri respectively indicates that the river water is slightly alkaline in nature. The level of Biochemical Oxygen Demand (BOD) observed in the river is around 1.0 mg/l at all places except at downstream of Rampur town, where value observed was 1.2 mg/l. Water Quality in terms of pathogenic bacteria appears to be fine except at Rampur downstream, where faecal Coliform was observed as 4 MPN/100ml and the value of Total Coliform was observed as 14. Otherwise none of the samples (Jhakri outfall, Rampur u/s, Bael) has shown the presence of faecal contamination.

Iron and Zinc were found <.05 at Jhakhri outfall and at Bael but value of Mercury was observed on higher side. Mercury was found 7.11 (ppb) at Jhakri outfall that may be due to mecahnical processing taking place in Jhakri Power house.

In **WAPCOS samples** results, the total hardness in various water samples was well below the permissible limit. The low calcium and magnesium levels are responsible for soft nature of water. The carbonate hardness (for water with alkalinity level as observed in the study area) is equal to the alkalinity level. The non-carbonate hardness accounts for the balance hardness. Normally non-carbonate hardness can be removed by boiling. However, hardness levels in the area do not warrant any treatment.

The low EC and TDS values indicate the lower concentration of cations and anions. This is also reflected by the fact that the concentration of most of the cations and anions are well within the permissible limit. The fluorides level was of the order 1 mg/l which just meets the permissible limit for drinking purposes.

The BOD and COD values are very low, which indicates the absence of organic pollution loading. This is mainly due to the low population density low agro-chemical dosing and absence of industries in the area.

In past, no major epidemic has been reported in the area. Thus, it can be said that although, there are no sewage treatment facilities in the area, the pollution loading (organic and bacteriological) is well within the carrying capacity of the water available for dilution in river Satluj and its tributaries.

Variation in the water quality parameters could be attributed to the fact that WAPCOS sampling was carried out in the month of July while DHI's sampling was carried out in the month of February.

A time series profile has been plotted for Rampur u/s and d/s for three parameters namely pH, BOD and DO (Refer. Fig 4.6). It is evident from the data that DO levels in latest data have dropped while BOD is increased significantly. The reason for this could be either low flows or increased pollution load from Rampur town. But since results show same trend at upstream as well as at downstream reaches, the reason could be attributed to low flows in the month of February.

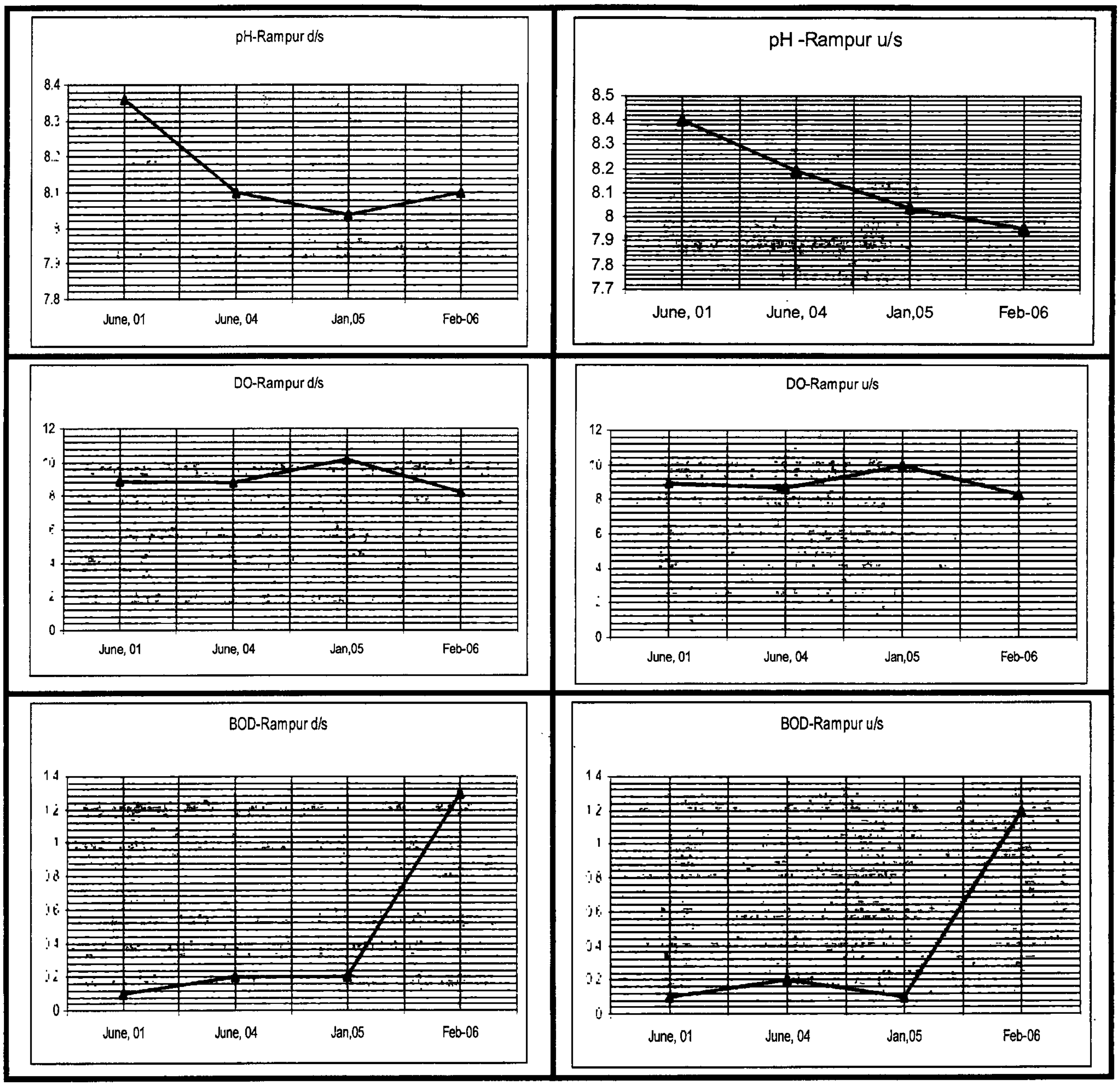


Fig 4.8 *Time Series Plot for indicative Water Quality Parameters at Rampur u/s and d/s*

4.3.4 Occupational Profile

This particular section gives a brief description on occupational profile/employment pattern of RHEP and NJHEP influence areas. The data has been complied from past studies carried out by SJVNL, which is further substantiated by Census data for the respective tehsils coming into study area

The detailed surveys/studies carried out by the concerned agencies indicate that about 52% of the total population in the project-affected area are workers. The population engaged in business activities was about 8%, which further goes up due to induced development taken place after operation of Nathpa-Jhakri power plant. Non-working population is about 75% in the area. To understand the changes in occupational status of the NJHEP influence area during past few years after operation of power project, a baseline setup has been provided considering different categories of households who had been given compensation by the concerned authority under the NJHEP project.

Table:4.38 Average no. of family members in different occupations of those households who have been given land for land (NJHEP) (no. of workers/household)

Occupation	Year 1996	Year 2002
Agriculture		
Male	16	9
Female	42	39
Total	58	48
Wage Labour		
Male	10	9
Female	-	-
Total	10	9
Service		
Male	32	35
Female	-	-
Total	32	35
Petty Business		
Male	-	9
Female	-	-
Total	-	9
Total		
Male	58	61
Female	42	39
Total	100	100

Source: Impact assessment of resettlement implementation under NJHEP, Year 2002

Table 4.39 Average no. of family members in different occupations of those households who have been given alternative house or cash compensation (NJHEP) (no. of workers/household)

Occupation	Year 1996	Year 2002
Agriculture		
Male	38	22
Female	43	41
Total	82	63
Service		
Male	8	22
Female	3	3
Total	11	25
Petty Business		
Male	8	13

Female	-	-
Total	8	13
Total		
Male	54	57
Female	46	43
Total	100	100

Source: *Impact assessment of resettlement implementation under NJHEP, Year 2002*

Table 4.40 Average no. of family members in different occupations of those households who have been given alternative shop plots (NJHEP) (no. of workers/household)

Occupation	**Year 1996**	**Year 2002**
Agriculture		
Male	12	9
Female	42	44
Total	54	53
Service		
Male	3	3
Female	-	-
Total	3	3
Petty Business		
Male	42	44
Female	-	-
Total	42	44
Total		
Male	58	56
Female	42	44
Total	100	100

Source: *Impact assessment of resettlement implementation under NJHEP, Year 2002*

Table 4.41 Average no. of family members in different occupations of those households who have been given employment in the project (NJHEP) (no. of workers/household)

Occupation	**Year 1996**	**Year 2002**
Agriculture		
Male	28	3
Female	41	37
Total	69	40
Wage Labour		
Male	-	9
Female	-	-
Total	-	9
Service		
Male	31	45
Female	-	1
Total	31	46
Petty Business		
Male	-	6
Female	-	-
Total	-	6

Occupation	Year 1996	Year 2002
Total		
Male	60	63
Female	40	37
Total	100	100

Source: Impact assessment of resettlement implementation under NJHEP, Year 2002

Table 4.42 Average no. of family members in different occupations of those households who have been given cash component only (NJHEP) (no. of workers/household)

Occupation	Year 1996	Year 2002
Agriculture		
Male	39	34
Female	38	39
Total	77	73
Wage Labour		
Male	4	6
Female	-	-
Total	4	6
Service		
Male	15	19
Female	1	1
Total	16	20
Petty Business		
Male	1	1
Female	-	-
Total	1	1
Total		
Male	58	60
Female	42	40
Total	100	100

Source: Impact assessment of resettlement implementation under NJHEP, Year 2002

It can be inferred from the above data that irrespective of form of compensation provided to affected people in the project influenc area, there has been a tendency to shift from agriculture based pursuits to service based occupation. This could mainly be attributed to the influx of more number of people, greater available opportunities and other related development in the area that is induced by the hydro development. These potential have been created due to influx of more popluation from different states, cross-cultural mixes with the local polulace, coming up of various kind of support infrastructure for them, more earning opportunities and hence better economic status, enhanced aspiration of locals with the in flux of affluence.

As per the detailed surveys carried out by SJVNL in past, the Project Affected Families (PAFs) for RHEP fall in Bael, Koel, Duttnagar and Nermand phatti. About 60% of the total population in the project affected households are workers. The percentage is envisaged to increase with the increase in quality of life with the upcoming project. The occupational pattern of the area has been presented (refer Table 4.43). For the purpose of analysis, only main occupation adopted by population has been considered but they may engage in more than occupational activity. The number of males who had agriculture as the main occupation is lower than the number of females. The percentage of agricultural labours is the about the same for both males (2%) and females (1.5%) while the percentage of males (17%, unlike the 2% for females) involved in non-agricultural labour is far more. None of the males were solely engaged in household chores.

Table 4.43 Employment Pattern in RHEP area

Particulars	Sex	Number	Percentage (%)
Agriculture	Male	91	28.54
	Female	144	43.37
Agricultural labor	Male	7	2.19
	Female	5	1.52
Non-agricultural labor	Male	13	4.07
	Female	4	1.20
Service	Male	54	16.93
	Female	7	2.10
Business	Male	20	6.27
	Female	2	0.60
Rural Artisan	Male	2	0.63
	Female	0	0.00
Student	Male	109	34.18
	Female	90	27.10
Household	Male	0	0.00
	Female	42	12.65
Infants	Male	20	6.27
	Female	31	9.34
Un-employed	Male	2	0.63
	Female	0	0.00
Non-workers	Male	1	0.31
	Female	7	2.10
Total	**Male**	**319**	**100.00**
	Female	**332**	**100.00**

Source: Baseline Demographic Socio-Economic Survey for RHEP carried out by SJVNL, Year 2005

Considering the multiple occupations within a family, agriculture is the main source of income for the families in the area with about 90% of the total households deriving income from agriculture. Wage labor is a source in some 41% of the families while about 39% derive their income from service. On the basis of the poverty line as recommended by the Planning Commission, Government of India of Rs. 289.31 per month per capita, no family in the project affected households' falls below the poverty line. The annual income range for the project area is between Rs. 16,000 – Rs. 4,000,000 as per census, 2001.

4.3.5 Economic Activities

The villages falling under NJHEP and RHEP project areas mainly depend on natural resources for water, fuel, food and fodder. Agriculture is a main economic activity. With the variation in the soil conditions and the agro-climatic regimes across the study area, a wide variety of crops, including cereals, vegetables and fruits, are available (refer plate 4.5):

- Cereals - wheat, paddy, maize, barley and pulses;
- Vegetables – seasonal vegetables, seeded potatoes;
- Fruit trees - plum, apple, walnut, apricot, cherry, khumani, chilgoza, etc.

However, in general people are not solely dependent on agriculture but they are also involved in other occupational activities, basically non-agriculture as a other source of income. The main cash crops grown in the region are the horticulture trees like apple, plum, khurmani, badam, lemon etc. These are solely harvested for Cash and the demand for these fruits all over the country fetches good price. On an average, an apple tree can fetch between Rs. 3000 to Rs. 5000 per season, while plum tree can fetch Rs.1500 to Rs. 2000 per season. The average distribution of horticulture trees per family in the area is given below:

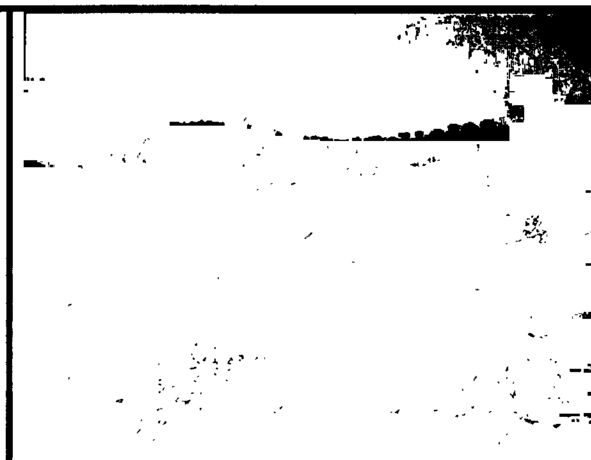
Table: 4.44 Details of Horticulture Crop trees owned by families in NJHEP influence area

Horticulture trees	No. of Trees
Apple	6135
Plum	265
Khurmani	86
Almond	9
Walnut	16
Nashpati	110
Galgal	8
Lemon	15
Total	**6644**

Source: EIA updation Study for 1500 MW NJHEP, Kinnaur, Himachal Pradesh, 2004

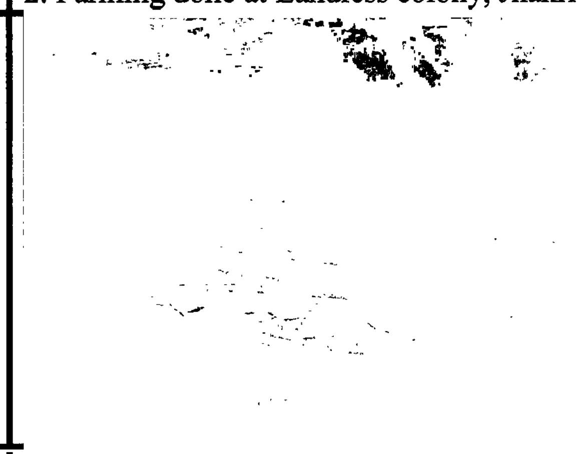
Plate 4.5. AGRICULTURAL PRACTICES OF THE REGION (Jhakri-Bael)

1.Agricultural fields near Bael

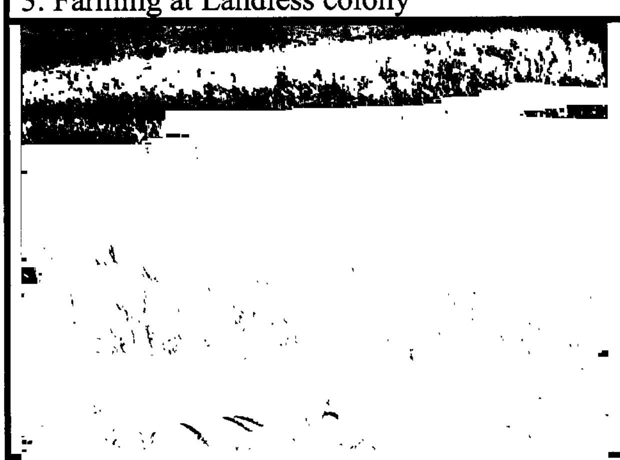


2. Farming done at Landless colony, Jhakri

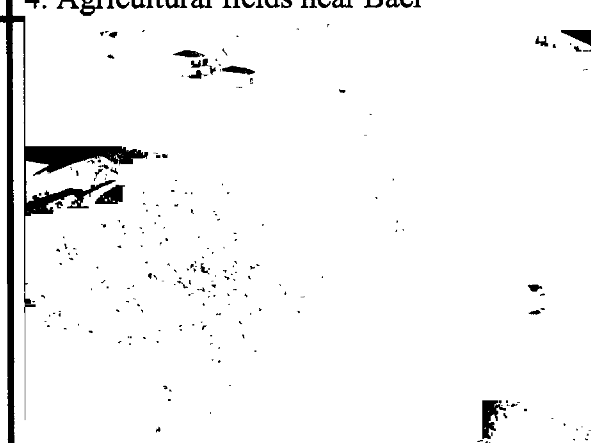
3. Farming at Landless colony



4. Agricultural fields near Bael



5.Crops near Bael



6.Plum plantation near Tunnan village

Livestock is also an important source of income in the primarily agro-based economy in the area. Most of the households are rearing cattle i.e. cows, buffaloes, sheep and goats. On an average livestock holding per family is about 4.5.

Table 4.45 Details on Livestock in NJHEP influence area (no. of Livestock per household)

Livestock	Control Area Villages	Project Affected Villages	
		Before Project	After Project
Milch cattles	1.19	1.55	0.8
Draught animals	0.64	1.90	1.1
Young stock	0.66	1.44	1.3
Sheep & Goat	1.90	7.69	1.3
Others	0.43	0.46	0.089
		13.04	4.60

Source: EIA updation Study 1500 MW NJHEP, Year 2004

According to the data collected from the field and the recent census report, the break up of the live stock population in the villages of RHEP influence area is given below:

Table 4.46 Livestock in all Gram Panchayat coming into RHEP influence area

Name of District	***Name of Gram Panchayat***	***Total Cattle Population (Cow/Ox / Sheep /Goat)***
Shimla	Racholi	506
	Singla	523
	Bharawali	782
	Duttnagar	231
	Lalsa	445
	Dansa	875
	Munish	3565
	Kuhal	2633
	Kashapat	3804
	Jhakri	-
Kullu	Sarga	1681
	Kushwa	1578
	Kharga	2524
	Tunan	1272
	Nishani	1054
	Arsu	1910
	Bari	3289
	Kot	4207
	Poshna	631
	Deem	1478

Source: District Census for Shimla & Kullu Districts, Year 2001 and Report on Catchment area Treatment Plan for Rampur Block, Forest Division, Rampur

Table 4.47 Livestock in RHEP influence area (for project affected villages as identified by SJVNL)

Livestock	Number per household		
	SC/ST	**Gen**	**All**
Milch cattles	0.67	0.60	0.63
Draught animals	1.32	1.21	1.26
Young stock	0.67	0.64	0.66
Sheep & Goat	0.56	0.42	0.48
Others	0	0.01	Neg
	3.22	2.88	3.03

Source: District Census for Shimla & Kullu Districts, Year 2001; Report on Catchment Area Treatment Plan for Rampur Block, Forest Division

Besides providing a source of supplementary income, livestock also serves as a source of balanced diet for the people in the rural as well as for the surrounding urban areas. Bee keeping is also being promoted in the study area as it helps in pollination of the apple crop.

4.3.6 Infrastructure Accessibility

The villages falling under influence areas of NJHEP and RHEP have accessibility to basic infrastructure amenities like:

- motor-able roads i.e. highways, access/approach roads
- electricity,
- piped water supply,
- health centers,
- primary schools and
- Banks/post offices etc.
- Canals (khuls) for irrigation

The development scenario in terms of infrastructure improvement in NJHEP and RHEP area due to implementation of development activities/ schemes shall be further discussed in later part of the report.

4.3.7 Health Profile

Information has been collected on disease profile of the area, while doing so; consideration has been given on prevalent water borne diseases in order to co-relate the disease profile with water quality and flow available in the river/streams.

Information has been collected from Rampur Hospital for the area (refer Table 4.48).

Table 4.48 Leading Causes of premature mortality (YLL) in male and Female of Himachal Pradesh, Year 2003

Male	%	Female	%
Road accident	12.75	Diarrhoeal diseases	13.25
Diarrhoeal diseases	10.77	Other unintentional injuries	11.32
Other unintentional injuries	9.34	Road accident	9.67
Ischaemic heart diseases	9.09	Lower birth weight	9.23
Tuberculosis	6.54	Tuberculosis	8.32
Lower birth weight	5.85	Ischaemic heart diseases	7.87
Self inflicted injury	5.78	Self inflicted injury	7.44
Other unintentional injuries	5.48	Other unintentional injuries	6.23
Chronic Obstructive Pulmonary Diseases	4.12	Other digestive diseases	4.82
Other digestive diseases	3.32	Chronic Obstructive Pulmonary Diseases	3.55

Source: Department of Health & Family Welfare, Himachal Pradesh

The common leading causes of disability (YLD) in both sexes of Himachal Pradesh are obstructive pulmonary disease, iron deficiency anemia, diarrhoeal disease, and other unintentional injuries as shown in Table 4.49.

Table 4.49 Leading Causes of disability (YLD) in male and Female of Himachal Pradesh, Year 2003

Male	%	Female	%
Chronic Obstructive Pulmonary Diseases	26.09	Iron deficiency anaemia	20.13
Iron deficiency anemia	14.19	Chronic Obstructive Pulmonary Diseases Other unintentional injuries	17.15
Other unintentional injuries	12.24	**Diarrhoeal diseases**	**13.04**
Dental caries	7.08	Other unintentional injuries	12.68
Diarrhoeal diseases	**6.15**	Other infectious diseases	11.64
Asthma	5.92	Dental caries	7.31
Other unintentional injuries	5.23	Asthma	5.87
Upper Respiratory Infection	4.80	Tuberculosis	5.61
Lower Respiratory Infection	3.24	Road accident	5.38
Otitis media	2.28	Upper Respiratory Infection	4.78

Source: Department of Health & Family Welfare, Himachal Pradesh

The information on prevalent disease for the area has been collected from Khaneri Government Hospital, Rampur and is tabulated below:

Table 4.50 Disease Profile (No. of patients) of the Study area, Year 2005

Name of Disease	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov.	Dec
G.Entritirs	12	15	15	21	42	31	44	27	10	14	10	-
Diarrhoea	1	2	-	-	4	10	4	5	1	7	-	-
Dysentry	9	-	2	1	3	2	1	3	2	-	6	7
Pneumia	5	4	5	7	10	11	3	4	7	-	6	7
Br. Pneumia	3	5	14	5	7	10	11	3	4	7	na	na
Br. Asthma	5	2	6	8	-	-	11	-	na	na	na	na
COPD*	36	31	48	38	29	11	16	25	31	29	29	12
PGO	15	12	4	8	5	15	13	4	6	13	-	-
AOD**	7	4	3	3	7	27	3	3	7	-	-	-

Source: Khaneri Government Hospital, Rampur

* COPD: Chronic Obstructive Pulmonary Disease; ** AOD: Arteriosclerotic occlusive disease

Special mention of HIV-AIDS

After interaction with the Project Director, HP State AIDS Control Society(HPACS), Kasumpti, Simla, which is managing various programmes for the control of HIV/ AIDS it was reliably learnt that number of HIV positive patients in the State has been increasing. The incidental cases are high in the districts of Hamirpur, Bilaspur, Kangra and Mandi. 84 full-blown cases of AIDS had been detected in the state.

A district-wise quantitative information, specially for Simla and Kullu districts were sought as they comprised our study area. However, being sensitive, the information could not be obtained.

Information on occurrence of HIV/ AIDS was also sought from Rampur Hospital, since there is significant risk involved with such long term projects due to following situations. The project involves:

- floating population of labour from outside the area
- significant numbers of project employees, separated from their families for long periods of time (e.g. a month or more at a time)
- creation of large, temporary construction camp(s)
- mobility of people in and out of the area (job seekers, formal and informal service providers)
- participation / resettlement of the local population

However, the hospital records showed no reporting of such cases. The topic is discussed in detailed in Chapter 5 under section 5.2.5. Management interventions have also been proposed.

4.3.8 Archaeological Structures

As such there are no archeologically or historically important sites existing in study area. This was confirmed by interacting with the Director, Department of Language and Culture, HP. Also, Dr. BS Chauhan, Registering officer, Simla, who was deputed for site inspection of the proposed Rampur Hydroelectric Project in May 2005, clearly stated that no monuments and site of archaeological and historical importance exists in the land acquired by SJVNL for the proposed HE project. The reference letter stating the above has been appended in the Annexure V. Also there is no archaeologically or historically important structure in the NJHEP influence area.

4.3.9 Development Scenario in the State

The following section discusses about the development scenario in Himachal Pradesh. It highlights the development witnessed in the State in the fields of Agriculture, Industry, Power and Animal Husbandry.

Agriculture

Agriculture contributes over 45% to the net state domestic product. It is the main source of income and employment in Himachal. Over 93% of the population in Himachal depends directly upon agriculture which provides direct employment to 71% of its people.

The main cereals grown are wheat, maize, rice and barley. Kangra, Mandi district and to some extent Paonta valley of Sirmur district are the major producers of the 1st three cereals, while barley is mostly grown in Shimla district. Although the state is deficit in food grains, it has gained tremendously in other spheres of agricultural production such as seed-potato, ginger, vegetables, vegetable seeds, mushrooms, chicory seeds, hops, olives and fig especially vegetables and seed potato which is disease free and good quality are providing a good source of income to the farmers. Seed-potato is mostly grown in Shimla, Kulu and Lahaul areas.

Fruit cultivation is another field which has proved to be an economic benefit to the farmers. There are vast tracts of land in Himachal suitable only for growing fruits. Fruit cultivation does not add to the problem of soil erosion and its employment potential is much more than that of conventional farming. The yield per acre in terms of money is also much higher. Apples yield the maximum income. Fruit growing in Himachal is presently fetching over Rs.300 crore annually. Special efforts are being made to promote cultivation of new crops like olives, figs, hops, mushrooms, flowers, pistachio nuts, sarda melon and saffron. Himachal has earned the name of the 'Apple State of India'.

The agrarian reforms undertaken in the state by the government has also helped a great deal in the advancement in agriculture. In 1954, a revolutionary land reforms legislation, the Himachal Pradesh (H.P) Abolition of Big Landed Estates and Land Reforms Act was enacted. This Act took away land beyond a certain limit from big landlords and erstwhile rulers and transferred these to tenants on payment of compensation amounting to 24 times of the land revenue paid on the land. In 1972, the H.P ceiling on hand Holding Act was passed which had the land ceiling fixed on various kinds of lands and tenants could not be evicted. It also directed that every agricultural family must be given at least five bighas of land. As a result of these measures, 2500 big landed estates were abolished and as area of about one lakh acres was declared surplus and distributed to the landless. In 1974, H.P Village Common Land Vestment and Utilization Act was passed to enable the government, to give sham let lands to the landless. Under these aggression reforms, out of about 5 lakh agricultural families, about 4.5 lakh families have become land owners.

The main sources of irrigation are Kuhls (small water channels) fed from perennial or seasonal springs. Well irrigation is possible in some areas near the plains. Lift irrigation is another source of irrigation. Efforts have been made to improve irrigation facilities since the beginning of the five year plans and about 1.60 lakh hectares have been provided with it so far.

Availability of cheap credit, organization of marketing facilities and provision of agricultural inputs are very important for the development of agriculture. Besides governmental agencies, co-operative societies are the only agencies which performs some of these functions. Some agricultural societies provide short and medium term credit facilities to their members. Other functions of the co-operatives, is the mobilization of deposits and the marketing of agricultural and horticultural produce. They also play a vital role in the public distribution system and are running a lot of fair piece shops in the state.

However, agriculture in the state suffers from certain limitations, especially in the production of food grains. One of the reason is that the area under cultivation cannot be extended to any appreciable extent. Reclamation of land on slopes of hills for cultivation of food grains is neither economical nor beneficial. The farmers can profit more by raising cash crops suited to the agro-climatic conditions. Another reason is that reclamation of land from the hills increases the menace of soil erosion.

Animal husbandry

Animal husbandry plays a vital role in the development of agriculture, specially in Himachal where cattle are the main instruments for ploughing and other agricultural operations. Indigenous breeds of cows, buffaloes and sheep are of poor quality.

A number of schemes for cattle development, cattle health and disease improvement in wood production, poultry development, feed and fodder development, dairy improvement, milk supply schemes and veterinary education have been undertaken to improve the livestock in the state. The many veterinary hospitals, dispensaries and outlaying dispensaries in the state provide veterinary aids and also take measures against various contagious diseases. A number of mobile dispensaries are also in operation. Thus the state has remained free from animal scourge.

Recently, Angora rabbits imported from West Germany were introduced in the Pradesh. Now seven units for their propagation have been set up in Kangra district.

Milk production has increased due to these measures. Milk chilling plants with a capacity of about 55 thousand liters have been set up at about 2 dozens places and departmental milk supply schemes are operational in half a dozen towns

Industry

Ecology has been given an important place in the state during the last few years. Industries which cause water or air pollution are not encouraged. Every industrial project has to obtain the clearance of the Environment Protection Organization before its establishment.

Himachal has to face many difficulties in the advancement of Industries. Lack of adequate and dependable means of transport was one of the main drawbacks. Other handicaps were the poor mineral resources of the state, non-availability of infrastructural facilities, shortage of capital and equipment, absence of modern skills and lack of entrepreneurship among the locals and over emphasis on cottage industries. One of the advantage was the availability of ample electricity. It is attracting entrepreneurs from the neighbouring states which are starved of power.

With a view to develop industrialization, a new industrial policy was adopted by the government providing various incentives such as cheaper power, 25% subsidy besides easier credit facilities through the State Finance Corporation and the nationalized banks for setting up new industries. Land was made available on 99 years low rate lease basis and new industries were exempted from sales or purchase tax and from octroi both on raw material and finished goods for 5yrs. Concession was given on freight charges for transport of raw materials from the nearest railhead outside the state besides provision of other marginal benefits such as assistance in the preparation of project reports. These concession helped in establishing industrial houses in the state.

Industrial areas have been established at Parwanoo, Barotiwala, Baddi, Paonta Sahib, Mehatpur, Shamshi, Nagrotu Bagwan, Bilaspur, Reckong-Peo and Sansar Pur Tera. As the dust free and cool climate of Himachal is extremely suitable for the establishment of electronic and precision industries, many electronic complexes have been set up at Solan, Mandi, Hanurpur, Shogi, Raga-Ka-Bagh, Chamba, Ambi, Taliwala and Keylong, like watch manufacturing units, thermometers, microscopes, hospital and laboratory equipment.

- Facilities available for setting up electronic industry for which a subsidy up to 50 lakhs is given, has encouraged manufactures to set up TV sets, tape recorder, video-cassettes, electronic toys and computer parts industries.
- Furniture making, rope making, bamboo products, manufacturing and specialized wood based industrial units have also been set up.

- Two vanaspati ghee plant have been set up, cement factories have come up in public and private sectors. Private sector industries are doing well. But in the public sector, with the exemption of country liquor bottling plant and turpentine factories, others are running at a loss.
- Sericulture, handloom and tea are other industries that have lately been given particular attention. Silk industry is providing employment to a lot of people.
- Tea is traditionally grown in Kangra and Mandi district at an altitude of 1000 to 1500 metres. With a view to encouraging this industry, subsidy is being provided to growers besides facilities for chemical analysis and co-operative tea processing in a factory. The Tea Board of India has given financial assistance for laying out demonstration plots and for undertaking research.
- Himachal has a rich heritage of handicrafts. These include woolen and pashmina shawls, gudmas, carpets, silver and metal ware, embroidered chappals, grass shoes, Kangra and Gompa style paintings, wood work, horse-hair bangles, wooden and metal utensils and various other house hold items. These aesthetic and tasteful handicrafts declined under competition from machine made goods and also because of lack of marketing facilities. But now the demand for handicrafts has increased within and outside the country.The Himachal Pradesh Handicrafts corporation is implementing schemes for the revival and rehabilitation of handicrafts. Apprenticeship schemes aiming at training in almost extinct crafts like Kangra and Compa painting and metal wares were undertaken. The handicrafts design centre was set up to provide new design adaptations to the artisans. The corporation has introduced a procurement scheme under which master craftsmen are provided work at their door steps and the finished goods are collected from them and marketed.

Minerals

Himachal is poor in minerals. The state accounts for only 0.2% of the output of minerals in the country. There are some limestone, building stone, slates, gypsum and rock salt deposits which are commercially valuable. Other than that, there is nothing much of significance.

Power

Himachal is extremely rich in hydel resources. It has been estimated that about 20,463MW of hydel power can be generated in the State by constructing various major, medium, small and mini/micro hydel projects on the five river basins. The state government has been giving the highest priority for its development, as hydel generation can not only meet the growing need of power for industry, agriculture and rural electrification, but can also be the biggest source of income to the state by way of sale of electricity to the neighbouring states

The most prestigious and major project on river Satluj in the state is the Nathpa Jhakri (1500M.W). It is constructed in collaboration with the central government. The foundation stones were laid of 300MW Chamera II Hydel Project in June 1999, of 2051 MW Parbati Hydel Power Project in December 1999, and of 800 MW Kol Dam project in

June 2000. Other major ongoing projects are : Bhaba Augmentation Scheme, Ghanvi Hydro Electric Project (22.5 MW), Larji Hydel Project (126MW) and Khauli Hydro Electric Project (12MW). The state government has given eight hydel projects for private sector participation. These are Baspa Hydro Electric Project (300MW), Holi Hydro Electric Project (231 MW), Dhamwari Sunda Hydro Electric Project (70MW), Project (15MW), Allian Duhangan Hydro Electric Project (192 MW), Swara-Kuddu (162MW) and Budhil (70MW).

The state has electrified each one of its 16,807 inhabited villages. It is very impressive, looking at the location of its villages in far off areas and their isolation.

The water resources also provide valuable food in the shape of fish. A national fish seed farm and fish farmers development agencies have been set up. A pilot project is being set up with Norwegian assistance for commercial trout farming in Kulu valley.

Energy development is pivotal to the growth of economy in the state and hydro power being the most eco-friendly source would play most useful role in state development. A little careful planning for environmental detrimental aspects of hydro development would help in increasing the life cycles of the projects thus reaping the benefits for longer duration as well as keeping environmental stress on the eco system in vicinity to the lowest possible levels. The terrain of the state is advantageous that keeps the cost of hydro energy production to less costs per unit of production. The major concern should be to harness this energy in a sustainable manner.

Impediments for development in state

Although Himachal Pradesh has shown remarkable development in Tourism, Power, Horticulture sectors, the State has its own limitations for an overall development in other fields such as Industry, Agriculture, Irrigation. The issues that limit State's overall development are:

- Topography/ Fragile Terrain
- Lack of adequate and dependable means of transport.
  - Railway tracks are very difficult to be laid down.
  - Roads get blocked due to extreme weather conditions
- Poor Mineral resources of the State
- Difficult weather conditions
  - Development of channels and kuhls for irrigation schemes get adversely affected by the bad weather conditions
- Agriculture, specially in the production of food grains, suffers from land limitations. Reclamation of land on slopes of hills for cultivation of food grains is neither economical nor beneficial.

For Satluj River Basin development, Governmnet needs to work out specific strategy with the various stakeholders, different Departments like Agricture, IPH, Industry, Tourism, Power Public Works, Health to bring about a combined document for a holistic development in the basin.

In a social context, the main causes of concern for the State in today's time are increasing evidence of AIDs, widening sex ratio and high incidence of Tuberculosis among women. Hence efforts are being made to conduct awareness camps , introduce mobile health vans etc.

The Annual Plan for Himachal Pradesh for the year 2005-06 was finalized in Februay 09, 2005. Plan size for the current year was agreed at Rs 1600 crores. This includes additional Central assistance and special plan assistance of Rs.400 crores. A provision of additional one-time market borrowings of Rs.32.71 crores has also been promised by the Planning Commission. Efforts are on to improve fiscal position and a Public Service Tariff Board to operationalise cost recovery, is in the offing. It would cover education, health, water supply and irrigation sectors. The tax incentives provided by the Central Government for setting up industrial units in Himachal Pradesh has helped the State in reviving industry and investments to the tune of Rs.8,000 crores are coming up. A single window clearance for new industrial units has been introduced.

CHAPTER –5
IMPACT ANALYSIS AND ASSESSMENT

5 DATA ANALYSIS AND IMPACT ASSESSMENT

Many hydro-power generation activities have come up and many are proposed on Satluj River. This starts right up from the upper reaches with projects like Khab, 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 completed in 1963. Downstream of Bhakra too there are structures on the river, including the Nangal diversion dam and Ropar barrage. The cumulative impact of number of dams on a river is not simple addition of impacts of individual dams. A study should be carried out with a wider perspective.

Though dams are 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 ill-effects associated with them too. These structures transform river ecosystems over a range of spatial and temporal scales. Through impoundment and increased residency times, dams alter water temperatures and chemistry, which in turn influences rates of biological and chemical processes. Dams create barriers to the upstream-downstream movement of nutrients and organisms, thereby affecting physical and biological exchange processes. They also alter the timing and magnitude of downstream fluxes of water, sediment, and ice, which modify biogeochemical cycles and the resulting structure and function of aquatic and riparian habitat. As dams occasionally collapse, they also present a risk to the built environment and downstream ecology.

The Chapter presents an appraisal of the anticipated positive as well as negative environmental and the socio-economic impacts which would surface after the commissioning of the proposed Hydroelectric projects along with the already operating projects in the area.

5.1 Environmental impacts

5.1.1 Change in hydraulic regime

Due to construction of dams at several places on river, change in the hydraulic system is bound to occur. The actual river path gets altered due to the diversion of flow at several places all along it course. With the construction of a reservoir, generally two major hydraulic changes occur. First, the water area above the dam changes from lotic (i.e., running water) to lentic (i.e., standing water) in nature, with associated changes in hydrologic and ecological processes. Second, diurnal and seasonal variations in the demand for water or power cause short- and long-term variations in discharge quite different from those seen in an undammed/ unblocked river. On large rivers, the physical and ecological effects of flow regulation can be experienced several hundreds of kilometres downstream, with compounding effects occurring on systems with series of dams.

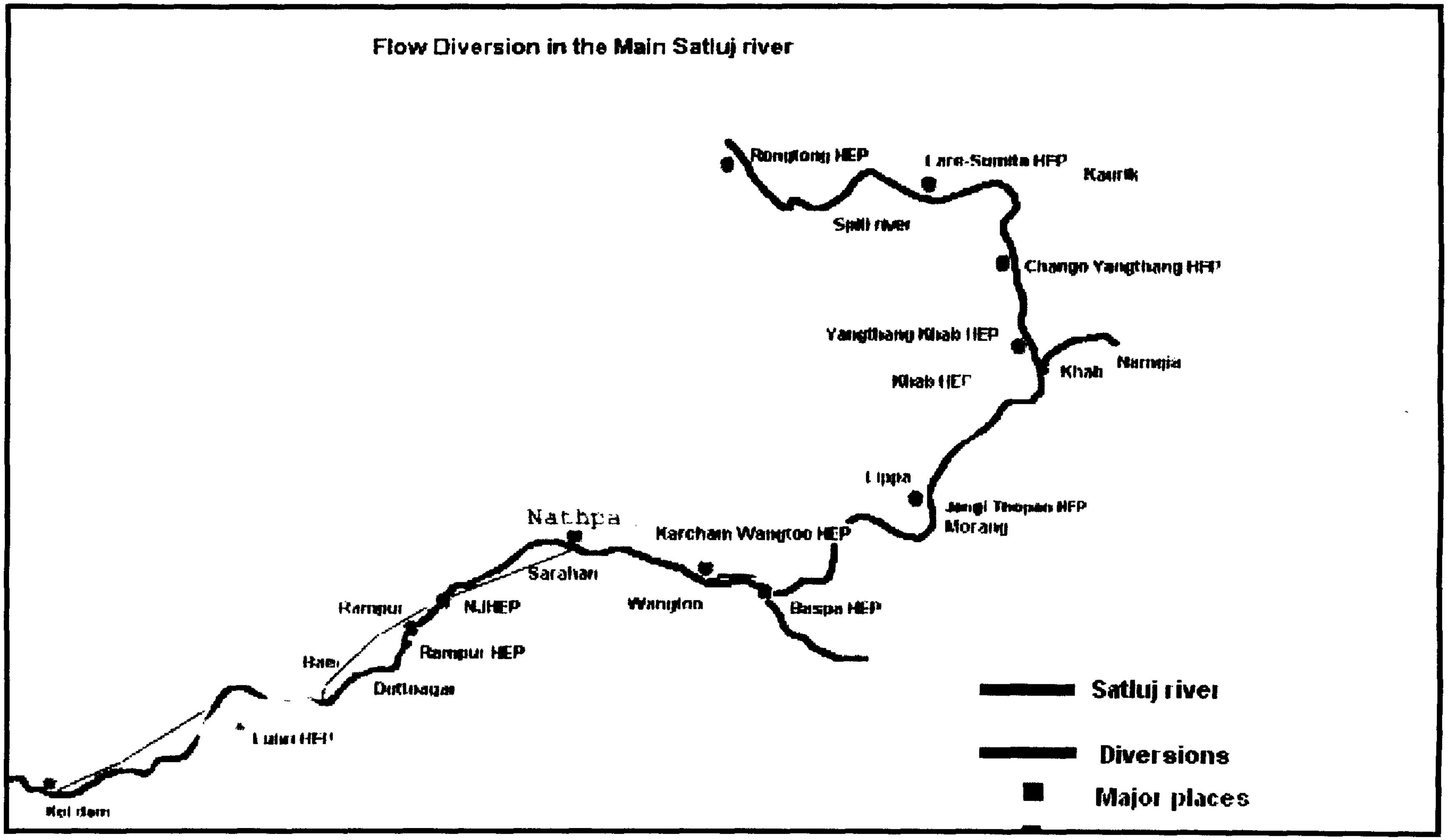


Fig 5.1: Flow diversions in Main Satluj River and various hydroelectric projects planned on the river

Water Storage in the Basin

There are two main categories of large dams viz,

- the reservoir-type storage projects
- and the run-of-river dams

The former category includes impoundment of water behind the dam for seasonal, annual and, in some cases, multi-annual storage and regulation of the river, whereas the run-of-river dams (weirs and barrages, and run-of-river diversion) have no storage reservoir and may have limited daily pondage. These create a hydraulic head in the river to divert some portion of the river flows to a canal or power station.

Typically, the reservoir has two purposes: to increase the hydraulic head or difference in water level across the plant, and to provide storage for periods of low inflow from upstream. Run-of the river projects are common additions downstream of large reservoirs. They require only sufficient upstream storage to balance flows and to develop the necessary head across the plant.

For the Khab HEP, a 69 m high straight gravity dam across river Satluj to provide a live storage of about 36.38 Mm^3 with Full reservoir level (FRL) at El. 2592m and Minimum Draw down Level (MDDL) at El. 2568m. The dam has a provision of passing about 5600 cumecs of 10,000 years flood. The Karcham Wangtoo HEP envisages construction of a concrete gravity dam about 90m high (from deepest foundation) at Karcham. The Nathpa Jhakri Hydro-Electric Project originally envisaged the construction of a 60.5 m high diversion dam at Nathpa on river Satluj. The FRL of the dam is El. 1488.50 m. and MDDL is at El. 1474.00 m. The pondage available is 205.18 ha m. The Luhri project envisages construction of a 60M high (above sea bed) concrete gravity dam on the river near the village Nathan for diversion of a design discharge of 477 cumecs.

Other major projects such as Baspa HEP, Bhaba HEP, Sorang HEP, Ganvi HEP, and Rampur HEP are run-of-the-river type of projects. Hence they do not include the construction of a reservoir/ dam. These are weir- or barrage- or tailrace developments. As has been reported in past studies, majority of the silt carried by the river comes mainly from Spiti River, where due to degraded status of the catchment, high soil erosion rates are observed. The same could also be referred through Map Soil Erosion Map prepared for entire Catchment area (fig 5.2), which shows high erosion intensity at upper reaches.

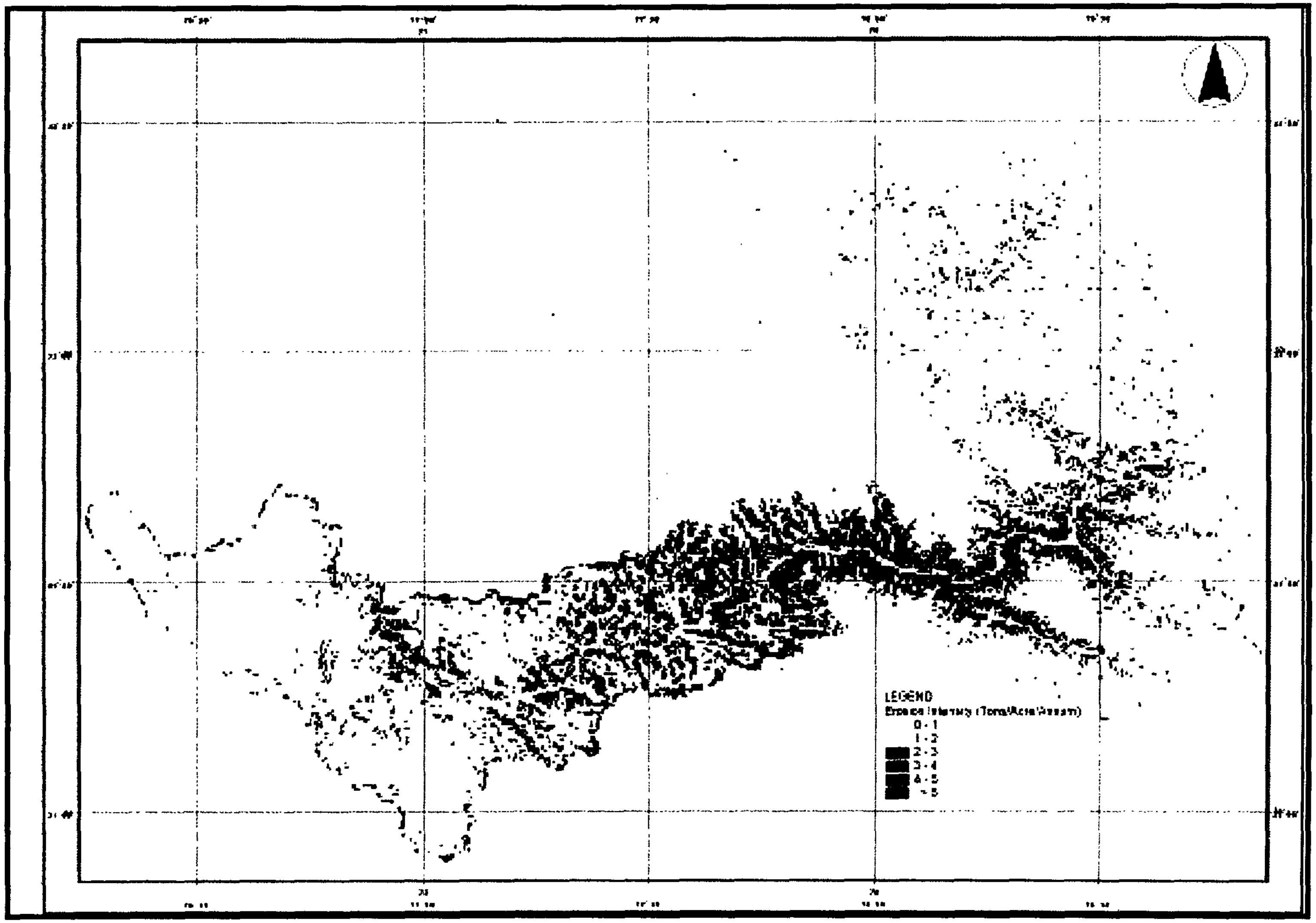


Fig 5.2 *Soil Erosion Map of Satluj Basin in Himachal Pradesh*

Significance of the Khab Project

The upstream Khab project was specifically designed with the objective of protecting the downstream hydroelectric projects from damage due to excessive silt and floods. Initially, two separate projects, Khab-I and Khab-II, with a combined generation capacity of about 1,100 MW, were planned but the problem of excessive silt, which led to repeated shutdown of the 1,500 MW Nathpa Jhakri project, forced the engineers to go for a storage project upstream. The three de-silting chamber would remove silt particles of size 0.2 mm and above.

Past studies conducted by the Satluj Jal Vidyut Nigam (SJVN) indicated that a high dam is required to arrest the 12 million cubic metres (MCM) of silt which the snow-fed Satluj and Spiti, its main tributary, bring down annually. Accordingly, it has proposed a 275 m dam with a storage capacity of 95 million cubic metres and life span of 28 years. It will be the second highest concrete gravity dam of the world after the 285 m high Grand Dixiens Dam in Switzerland. At present the 261 m Tehri dam is the highest in the country, followed by 225 m Bhakra Dam. It has been calculated during many studies that the life of the Bhakra reservoir will be increased by nine years and that of Kol Dam reservoir by 14 years. Further, two more dams are proposed upstream on the Spiti River at Rangrik and Pooh to enhance the life of the Khab Dam reservoir.

This would reduce the sediment load of the river upstream which comes down to feed the requirement of .projects downstream.

River diversion works at various Project sites

The Nathpa Jhakri Hydro-Electric Project originally envisaged the construction of a 57.5 m high diversion dam at Nathpa on river Satluj. Later on it was proposed to increase the dam height by 5 m i.e. from 57.5 m to 62.5 m. The headrace tunnel is lined along the left bank of the river Satluj. The tunnel traverses below the bed of Manglad Khad in the shape of a Syphon aqueduct. The flow in Shoulding khad is diverted fully through a trench weir which is dropped into the HRT through drop shaft. Tailrace tunnel conveys the tail race discharge from the power house back into river Satluj. With the increase in the dam height by 5 m, the storage capacity of the dam will increase from 165.07 ha.m to 343.39 ha.m. The flow in river Satluj downstream of the dam site will reduced significant upto the point of disposal tail race discharge at Jhakri for a stretch of about 40 km. The only flow in this stretch will be the contribution of flow from various small streams and khads meeting river Satluj (refer Table 4.7 of Chapter 4).

The **Rampur project** is designed to divert 405 cumecs of de-silted water of the Satluj from the tailrace pool of NJHEP through 15 km headrace tunnel to a surface power station near Bael on the right bank of the river. The length of HRT on left bank is 484 m before it crosses the river Satluj with a 43.2 m long Cut and Cover Conduit. The water will then be returned to the river Satluj at Bael.

For the **Luhri project**, the proposed river diversion is to be done through a tunnel located on the left bank, capable of carrying non-monsoon flood of about 1,267 cumecs.

For **Kol Dam**, the river water will be diverted to the powerhouse. The powerhouse will be constructed upstream of the Dehar project and the tail race water will be again diverted into the river through an open channel.

5.1.2 Impact on Water Availability and Quality

Water Availability: As mentioned earlier, the river Satluj is not the main source of water in the area. The natural springs and 'chashme' are the key sources of water for people living in the area for their own domestic consumption, livestock use and irrigation purposes. In most of the villages except those situated on high hills, IPH Department has laid down the pipelines to connect the natural springs (at upper reaches) to the households through storage tanks for water supply after providing primary treatment. The villages those are located on higher reaches depend directly on natural springs or khads flowing in vicinity.

Hence, massive hydropower development in the area, which is causing diversion of flow from river for power generation, will not directly put an impact on availability of water for consumption purpose for village population.

However, complete drying of natural springs (at its original location) has been reported by the villagers due to construction and blasting activities. It has been reported that more than 30 chashme have dried up in Yangpa village due to the construction works for Sanjay Vidyut Pariyojna. Also, it was found out during primary surveys conducted for the study that more than 8-12 chashme have dried up in Nathpa-Jhakri areas due to NJHEP project. Considering a post project measure, SJVNL has conducted a monitoring campaign for examining the flow of springs. It was established that blasting/digging activities can cause building up of excessive water pressure at particular location, which may lead to shift in the position of a spring or reduction in the flow rate of spring, but complete drying of springs is not likely.

Due to construction of NJHEP, the IPH water supply scheme was badly affected in following villages:

Table No 5.1 Affected Water Supply of IPH due to NJHEP project.

S. No.	Name of Scheme	Name of Habitation	Present Population
1.	WSS Maghara Majholi Koshgar	Majhewali Koshgar	490 130
2.	WSS Kartot Chandpur	Kartot Chandpur	437 138
3.	WSS Khasha Shah Jaleend	Gaso Shah	622 326
4.	WSS Sharn Rattanpur	Rattanpur Rattanpur II	151 50

		Basara Sanarsa Halti	329 282 229
5.	WSS Jhakri	Jhakri	4980
	Total	**12 habitation**	**8164**

Source: IPH Department, Rampur

Presently, restoration of these schemes is going on and SJVNL is providing financial support to IPH department for restoration of these schemes. SJVNL has kept a budget provision of 5 crore for renewal of water provision in areas where the water resources have been dried up. Immediate measure under the scheme will be lifting of water directly from river Satluj to the affected villages to maintain the minimum water supply to the affected areas.

Under the proposed Rampur Hydroelectric project, SJVNL is taking pre-project measurement and started monitoring the flow of existing natural springs in the influence area.

Water quality can be significantly affected by impoundment. Physical, biogeochemical, and biological processes occurring within a reservoir can affect the temperature and chemical composition of the water leaving the system to an extent that its quality upon release no longer resembles that of the inflows. The degree to which water quality is affected on a diel, seasonal and/or annual basis depends on factors such as surface to volume ratio and depth of the reservoir; geology and soil geochemistry of the surrounding catchment; latitude of the reservoir; rates and magnitude of sedimentation; magnitude and timing of incoming flows and their residency time; and level of biological productivity in the reservoir.

Chemical changes in water quality are less predictable due to the complexity of interrelated physical, biological, and chemical processes occurring in the reservoir, both in the open-water season as well as under-ice in the winter. Chemical changes include altered nutrient levels and dynamics, modified water-column and sediment oxygen regimes, nitrogen super saturation in downstream waters, and increased mobilization of certain metals. In newly formed reservoirs, water quality is often also affected by a trophic upsurge due to release of materials from the newly flooded area, which can be of short duration or last several years in the largest impoundments. One of the more predictable water-quality effects of impoundment is release of mercury from flooded sediments. Bacteria present in decaying vegetation can also change mercury, present in rocks underlying a reservoir, into a form which is soluble in water. This mercury in its methylated form enters the food chain and is bio-concentrated, with highest concentrations occurring in piscivorous fish and birds. These elevated tissue levels can often exceed those recommended for human consumption (particularly in older biota), thereby creating associated human and environmental health risks.

The water quality of river Satluj, in general, is designated as good (ref. Table 4.37 a-b of Chapter 4). There are no major sources of domestic or industrial pollution, hence the DO levels are found to be good, and BOD and COD values of the river are found to be low.

However, as such there is no direct disposal of domestic sewage into the river but due to open defecation; human/animal waste finds its way to Satluj through seasonal and perennial streams due to natural slope of area. Further, due to less population density and sparse location of human settlements, the impact on river quality gets insignificant due to dilution of sewage.

The use of agro-chemicals in the area is low but it has been seen (and confirmed during the village level survey conducted especially for the study) that over the last few years the rate of consumption has increased. This can be one of the sources of water pollution; it can also lead to production of excessive organic matter, which would further deplete the DO content of the river.

The river water quality at Rampur has been designated as Class A, which indicates that water can be used for drinking purpose after disinfection without conventional treatment. However, as per the monitoring carried out by the Consultant, DO observed was in the range of 8.0 to 8.5 (mg/l) between Jhakri to Bael. The pH value as observed was 7.88 and 8.1 at Jhakri and Bael respectively. The level of Biochemical Oxygen Demand (BOD) observed in the river was about 1.0 mg/l and value observed at Rampur d/s was 1.2 mg/l. Water Quality in terms of pathogenic bacteria appears to be fine except at Rampur d/s. The value detected for faecal coliform at Rampur d/s was 4 MPN and total coliform was 14. Iron and Zinc levels were found to be < 0.05 at Jhakri outfall and at Bael but value of Mercury was observed on higher side. Mercury was found 7.11 at Jhakri outfall.

5.1.3 Ecological Impacts

5.1.3.1 Change & loss of forest

Khab The forest in the study area falls under the jurisdiction of Pooh forest range of Kinnaur forest division. The forest existing in the this region is designated as a protected forest and not a reserve forest, which means although the human disturbance is allowed, but activities like burning, new agriculture (no expansion of existing) etc should not take place without permission from the forest department. However, in the Khab-I and Khab II project areas, no forest stands or sufficient crowns are present, therefore no significant impact on forestry would be anticipated in this region.

The **NJHEP** entails a total loss of 147.50 ha of forestland[1] due to various project appurtenances. The entire land belonged to HP Forest Department. The land was generally degraded and barren and did not support any vegetation. No rare or endangered species were observed in this area. Likewise no medicinal plants or species of economic importance were observed in this acquired land.

[1] *EIA for NJHEP, Year 1998*

The proposed **Rampur HEP** project entails acquisition of 50 ha of land. The tree density in the forest to be acquired for the project is low. It is reported to be only around 128-184 trees/ ha (refer table 5.2), whereas in a good forest, the tree density is of the order of 1000-1100 trees/ ha. No rare or endangered species were observed in this area. Likewise no medicinal plants or species of economic importance were observed in this acquired land. Thus, no significant impacts on account of acquisition of forest land are anticipated.

Table 5.2 Density of trees in the Rampur forest area

Location	Density (No./ ha)
Nogli (Left bank)	128
Bael (Right bank)	184
Duttnagar (Left bank)	133

Source: EIA Study Rampur HEP, H.P

Mitigation measures

Afforestation programmes are undertaken for the loss of forests. This includes; tree plantations, silvipasture development and vegetative shrubs. Some of the mitigation measure guidelines could be:

- Large areas of pasture lands, grazing lands should not be taken up for afforestation.
- Exotic species should be avoided but if introduced, they should be carefully monitored for their spread.
- Dry deciduous specious should be avoided. Ever green species should be preferred as they do not become flammable during dry summers.
- Local community should be involved in selection of area process.
- Participatory management practices for conservation of natural resources should be encouraged.

5.1.3.2 Change & loss of bio-diversity

Terrestrial Flora and Fauna

The proposed Rampur Hydroelectric Project neither involves construction of dam nor submergence of forest. Hence, any adverse impacts on existing forest in terms of reduction of either forest cover or loss of forest flora is not anticipated.

One of the major factors, which have an impact on flora, in and around the project area, is the increased level of human interferences. The workers/ labours working on the project, cut trees to meet their requirements for construction of houses and other needs like fuel. Thus, if proper measures are not undertaken, adverse impacts on terrestrial flora is anticipated.

Various reports[2] have been referred to for studying the impact of these envisaged projects on bio-diversity. They all indicate that no major wild fauna is observed in the neighbouring areas of these projects. It is also stated that the wild animals do not come below an altitude of 2000m in the project area because of low density of forest and lack of proper habitat in the region. Hence, impacts on terrestrial fauna are not expected to be significant. The NJHEP area has very low density of forest and lack of a proper habitat in the submergence and surrounding area of NJHEP, no major wildlife is reported in the region. However, about 8 ha of submergence lie in Rubi-Bhaba sanctuary (i.e. about 0.06 % of the total sanctuary). Since this area is small and it does not support a good habitat for wildlife, the impact on reduction of wildlife habitat may be considered as insignificant.

However, there are only a few factors, which may affect the fauna:

- During construction phase, large number of machinery and construction labour are mobilized to the area. The operation of various construction equipment and blasting is likely to generate noise. These activities can lead to some disturbance to wildlife population. Likewise, siting of construction equipment, godowns, stores, labour camps, etc. can lead to adverse impacts on fauna in the area.

- The increased accessibility to the area due to human interferences could have some adverse impact on the fauna of the area like migratory birds etc.

None of the wildlife[3] was either observed during survey of the area or has been reported by forest department. These area no records of any endangered, rare, threatened or endemic species from the project area. The project activities affecting directly to animals present in the project area are not envisaged, in terms of direct loss of any animal due to any proposed project activity.

Likewise, it has also been reported that all these regions do not appear to be on the migratory route of animals. Therefore, the construction of these projects does not have much significant effect on migration of animals as well.

Indirect impact on Flora

Traditional Timber Rights

Himachal Pradesh has the highest percentage of rural population (90.21%) in the country residing in more than 20000 villages across the state. The predominantly rural population is primarily dependent on agriculture base economy for livelihood. The natural forest in the area provides wood for building of houses, bridges, furniture, and agricultural implements, in addition to providing much needed fuel wood. People are also dependent upon

[2] *PFR Khab HEP, EIA study for Updation of NJHEP, EIA for RHEP, PFR Luhri*

[3] *Also re-checked with CES, Biodiversity report, 2006*

the native land races of livestock for agricultural purposes and their daily needs of milk, meat, wool and hide. A large proportion of this livestock feeds on grasses and leaves obtained from forest. Overall the dependency of local people on naturally available resources of forest is very high.

The forest of Himachal Pradesh have an estimated growing stock of 10.26 crore m^3 and more than 4.5 lakh m^3 of timber is harvested every year in the form of salvage and to meet the demand of right holders. As per one estimate timber worth Rs. 60 crore is allocated to the right holders at nominal coast every year (HPFSR, 2000). The forests also contribute an estimated annual income of Rs 25 crore to the rural communities in the form of minor forest produce.

The right to the timber is admitted under section 28 of Indian Forest Act (1927). People have a right to get timber at nominal rates for construction/repair of houses/dwellings. The right holders must be bonafide native agriculturist, holding land in settlements in forest areas. A right to the timber is for building & repair of households, construction of temple arch, cremation of dead bodies etc.

As regards the timber rights of project influence area total forest cover of Rampur division is 40372 ha and there are 250 villages under 48 Panchayats as right holders. The local villagers have rights to get timber for construction of house/ cattle sheds. It is estimated that nearly 800 trees are cut/felled to fulfill the demand of local people. The data on timber rights for five years i.e. 1987-92, has been collected from Rampur Div. A total of 8695 trees were felled/ cut to meet timber demand. Important timber trees are Pinus roxburghii(Chir), Pinus wallichiana (Kail), Cedrus deodara(Devdar) and Picea smithiana (Rai). The maximum number of 5743 trees of Kail was felled followed by 2018 of Deodar, 717 of Rai and 217 of Chir. The year wise details of species felled along with number & volume of trees is given below.

S.N	Year	Deodar		Kail		Rai		Chir	
		No	Volume	No	Volume	No	Volume	No	Volume
1	1987 – 88	533	1646.71	1058	4291.62	277	941.68	58	35.70
2	1988– 89	408	1085.58	955	2597.34	53	786.79	70	99.36
3	1989 – 90	109	543.04	655	2397.98	236	1118.43	23	26.99
4	1990 – 91	344	1773.625	1414	378.85	86	363.99	25	58.63
5	1991 – 92	624	2448.14	1661	6694.68	65	996.29	41	116.45

Source : Working Plan for Rampur Forest Division

The right holders have rights to remove all Chir & Kail trees uprooted by natural process such as rain, wind & snow. Deodar trees normally granted for door & windows only, but it is seen that, right holders manage to get Deodar for whole of the building. Besides this, right holders get timber at very nominal rate which are decided at the time of settlement i.e. Zamindari rate. The Zamindari rate or concession rates at which a right holder get timber is given below.

S.N.	Girth Size	Class	Deodar	Kail	Fir	Chir
1	90 – 120	ID	5.0	1.0	0.25	0.50
2		IC	4.0	1.0	0.25	0.50
3		IB	4.0	1.0	0.25	0.50
4		IA	3.0	1.0	0.25	0.50
5	60 – 90	IIB	2.0	0.75	0.19	0.37
6		IIA	1.5	0.50	0.19	0.28
7	30- 60	III	0.75	0.25	0.12	0.12
8	> 30	IV	0.19	0.12	006	0.06

Source: Working Plan , Outer Seraj, Kullu District

It revealed that, the rates for high quality timber Deodar is sold at the rate of Rs 0.19 to 5.0 depending on class of timber followed by Kail Rs 0.12 to 1, Fir Rs 0.06-0.25 and Chir Rs 0.06-0.50. This concession has resulted in considerable depletion of forest near habitats/settlements as demand of timber is growing day by day. The prices for non-right holder are decided by Himachal Pradesh Forest Corporation (1978). The average sale price/cubic centimeter timber in the depots of Forest Corporation is given below.

TABLE 5.3 Timber Rates for Non-right Holders

S.N.	**Name of Species**	**Size(cm3)**	**Grade**		**Rate**
			I	II	
1	Deodar	305x25x13	20,744	18,372	14,048
	Kail	- do -	14,978	12,226	10'262
	Fir	- do -	7,288	6,455	5,381
	Chir	- do -	6,876	6,089	4,690
2	Deodar	240x21x10	14,112	12,497	11,874
	Kail	- do -	13,401	11,869	9,183
	Fir	- do -	6,728	5,960	4,968
	Chir	- do -	5,991	5,305	4,087
3	Deodar	240x16x16	14,112	12,497	9,557
	Kail	- do -	10,765	9,537	7,378
	Fir	- do -	6,294	5,574	4,647
	Chir	- do -	5,821	5,156	3,971

Source: Working Plan , Outer Seraj, Kullu District

The rate of best quality swan timber is Rs 1,421, for Deodar, Rs 900 for Kail, Rs 798 for & 743 m3. It seems that rates of timber allotted to right holders are 1000 time less than prevailing market rate. Leading to increase of timber demand by local people.

Increase in timber demand attributed to increase in population of right holders, as well as partition in the family, all round development of the people in their financial position

& good return of horticultural crops/activities and most importantly the low rates (two to four rupees/tree) at which trees are granted to right holders as compare to the prevailing market rate. It is also observed that, local right holders misuse rights by selling timber obtained in confessional rates to non-right holders & city dwellers of nearby town. The concession with respect to rights to the timber has been reduced due to non-availability of trees in Rampur Forest Division.

Thus it revealed that major impact on project influence area is due to various rights given to villagers residing in forests. The necessary steps should be taken to reduce the extraction of timber from the forest.

Aquatic flora and fauna

Changes in the physical and chemical characteristics of water from impoundment inevitably affect distribution and abundance of aquatic biota and resulting community structure. Within new reservoirs, fish populations are often quite large during the first few years, largely because of increased nutrients leached from flooded soils and vegetation, enhanced productivity throughout the food chain, and provision of secure sites for spawning and predator protection. Once established, the new physical/ chemical characteristics of a reservoir can pose challenges to biota, primarily because they are not in synchrony with natural cycles. Disturbance to spawning resulting from the drawdown/ raising of water levels, changes in seasonal temperature cycles, and blocked migration for fish are some major examples.

Similarly, downstream biota are exposed to a new disturbance regime (e.g., diel and/or seasonal alterations in discharge and thermal regimes), the degree of disturbance depending on the severity of the change and the distance downstream of the dam. For instance, lotic fish species select their preferred habitats by depth, water velocity, and type of substrate. If these change rapidly, as they would immediately downstream from a peaking hydroelectric station, the area would likely be abandoned by these species. In general, damaged communities of colonizers, tolerant species and temporary residents established nearest to the dams are replaced by more natural communities downstream as conditions ameliorate and tributaries and groundwater exchanges return the river to a more natural regime.

Dams, designed to meet daily to weekly hydroelectric demands, have more variable water levels and flow regimes than large storage reservoirs. Consequently, they can produce higher disturbance effects on in-channel and riparian processes and related biota. Hence, regulated discharges are often directly responsible for reduced habitat diversity and biodiversity in downstream reaches. Although most responses to flow regulation are site-specific, general patterns of large-scale downstream effects are being observed worldwide and a synthesis of these is emerging.

The labour may resort to fishing in river Satluj and its tributaries, using low level dynamites, etc. Although this technique leads to the death of only a few fishes, but it destroys a large habitat specially the floral species on which the fishes feed. However, such impacts are not expected to be significant in view of the magnitude of the riverine system.

During lean season, the downstream flow in the river is contributed by the perenial khads between Dam & Power house. Due to reduction of flow and increase turbidity between river stretch from dam to power house, several groups of micro-benthic organisms especially diatoms could be adversely affected.

Dredging operations often have deleterious affects on the aquatic fauna of the area:

1. It has been proposed to extract fine aggregates from the shoals deposited on the right bank of river Satluj from Tapri towards Karcham and Morang. The areas from where construction material is excavated, benthic fauna get destroyed in such areas. Although in due course of time the area gets recolonized, but the density and diversity of benthic fauna, is much lesser as compared to the pre-dredging levels.

2. The second important impact is on the spawning areas of cold water fisheries. Almost all the cold water fish breed in the flowing waters. The spawning areas of these fish species are found amongst pebbles, gravel, sand etc. The eggs are sticky in nature and remain embedded in the gravel and subsequently hatch. Any disturbance of stream bottom will result in adverse impacts on fish eggs. Even increase in fine solids beyond 25 ppm will result in deposition of silt over the eggs, which would result in asphyxiation of developing embryo and also choking of gills of young newly emerged fry. Thus, adequate precautions during dredging operations need to be undertaken.

Impacts on fish growth due to disruption of hydrologic regime

The ecological changes brought by the any hydro-electric project may affect the fish fauna in the river. Consequent to dam construction and reservoir formation substantial morpho-ecological changes occur in the river both upstream and downstream of the dam site. These include radical transformation of long established and inter-relationship between organisms, some species shift to new spawning and migration ranges; intra-specific biological differentiation of fish occurs and egg laying substrata undergoes changes. Other changes that could occur include inundation of spawning grounds; fluctuation in water levels, alteration in the physio-chemical conditions of spawning area in the upper reaches; disappearance of feeding ground of fishes.

The construction of a dam on river Satluj at **Nathpa** and therefore, reduction of flow has already affected the riverine ecology by converting lentic system to a lacustrine system. As reported in the EIA study for Updation for NJHEP, the ecology in the lacustrine system has already developed over an area of 16.5 ha. As a result of reduction in flow, downstream of the dam i.e. from Nathpa-Jhakri-Bael, the fish stock would be affected adversely. *But since this stretch already has negligible fish population and the fish predominance is more in the side streams/ tributaries, not much impact is envisaged.*

Impacts on migratory fish species
As mentioned earlier, Schizothorax richardsonii is the only commercial species of river Satluj in the project area. When the temperatures start rising above 22 °C to 25 °C, sometimes during Feb-March, *S. richardsonni* species in Satluj starts migrating upstream to colder reaches of the river from downstream. But there again they experience an unfavourable low temperature of 8-9.5 ° C, due of the influx of snow-melt water, which is not conducive for the ripe fish to spawn. Hence, these trouts enter the side streams of the river, which receive warm ground waters (17.5-21.5°C) and spawn profusely (density of fertilized eggs 20-23 per sq. m and hatchlings 37-40 sqm) (Ref D Sc dissertation Dr. K. L. Sehgal).

Mahseer is migratory fish and its migration is affected by construction of Bhakra dam on the Satluj. Its availability in project area is a remote possibility due to low water temperature.

5.1.4 Impacts on Soil Erosion and Muck Disposal

5.1.4.1 Increased Soil Erosion

River regulation can modify the sediment regime of a river through retention of material within the reservoir and through modifications of downstream erosion and deposition processes. Short reservoir life expectancies are associated with small-scale dams that impound rivers with high levels of sediment influx. Continued reduction in storage capacity of such reservoirs through sediment accumulation results in a decreased water-retention capacity, and may lead to an inability to retard the passage of floodwater downstream.

Changes in the flow and flood regime have implications relative to the competence of the channel to carry sediment and to the ability of the system to flush sediment deposited during low-flow events.

In downstream, where tributaries add more material to the river, aggradations may be more common than degradation. Lower regulated flows, especially without the natural freshet peaks, do not have the conveyance power to carry material produced by upstream degradation as well as that contributed by the tributary flow. Where aggradation occurs, the nature of the morphological response depends on the character of the alluvial deposits. Typical responses may include lateral scour, channel widening, braiding, and a reduced mean flow depth. Successive species advance of vegetation down the banks onto abandoned floodplains, however, can lead to an adjustment in the overall flow pattern and, ultimately, to a narrower channel. The river downstream of the dam is also deprived of silt, which fertilizes the river's flood plain during high water periods.

One critical aspect of changes to a river-sediment regime is time scale. Although some dramatic changes can be observed in the first few years after regulation, the time required for a system to achieve a new equilibrium depends on manner of regulation, form and composition of the channel and rate at which vegetation becomes established. Because of the huge volumes of sediment involved on large rivers and the associated slow rate of vegetation change, the time scale for adjustments can be in the order of centuries.

In general, the runoff from the unprotected excavated borrow pits and muck disposal sites lead to increased soil erosion and therefore, increased sedimentation rate downstream of the area. The erosion rates are generally significant during construction phase. This results in the increased sediment concentration in receiving water bodies, downstream of the construction site.

High turbidity levels in the Satluj river water due to sediments reduce the light penetration, which reduces the photosynthetic activity and therefore the primary productivity as well. It should be noticed that Satluj River, during its course of travel from its origin in Tibet, flows through a large tract of terrain having very little or loose vegetation. This type of vegetation does not hold the soil tightly and which further enhances the rate of erosion (Refer Figure 5.2). Most of this loose soil is flushed into the river. As a result, suspended solid content of the river is rather high and the river remains turbid for a significant part of the year.

Effective implementation of CAT plan and construction of storage dam upstream can greatly solve the problem of erosion in Satluj Basin.

5.1.4.2 Impacts due to quarrying and muck disposal

During the construction work of NJHEP, the Central Soils and Materials Research Station (CSMRS) had conducted the survey for the availability of the construction material during construction of main dam. The construction material was procured from quarrying sits at Pashada, Tapri and Morang. Based on the findings of survey, quarry near Pashada was used for extracting quartzite. The gravel and boulders were extracted from the shoals deposited along the right bank of river Satluj, 5 km from Tapri towards Karcham and Morang. The fine aggregates for the construction works were excavated from the shoals deposited on the right bank of Satluj from Tapri towards Karcham and Morang. It is proposed to use the same sources for extraction of required material for construction of the proposed increase in dam height and other project appurtenances.

The Rampur project requires a significant amount of construction material, coarse aggregates of the order of 2.72-lac m^3 and fine aggregate requirement of the order of 1.38 lac m3. The excavated material of the Headrace tunnel (between Kajo and Kunni khads) is proposed to be used as coarse aggregates as the geology is similar to that of the Pashada Quarry, used for NJHEP. The remaining requirements of coarse and fine aggregates will be excavated from the Koel Quarry, located near Bael powerhouse site.

The impacts of excavation of construction materials such as clay, rock and sand for construction of hydroelectric projects on environment depend on excavation process, local hydrological conditions, climate, rock types, size and type of operations and topography. Impacts also vary with stages of development at quarry sites e.g. development of working platforms has a less impact compared to the excavation of aggregates and sand. Physical changes in the soil, water and air associated with excavation activity affect the biological environment directly or indirectly. The major environmental impacts would be due to excavation and degradation of land around the quarry and the biotic life on it.

For the NJHEP, the total quantity of muck generated was of the order of 6003250 m3 and it was disposed at 10 dumping sites viz. two at Jhakri, one each at Koshgarh, Kotla, Dharali, Negulsari, Plingi, Sakichran, Punspa, Linge. The capacities of these sites were:

Table 5.4 Muck Disposal sites and respective capacities under NJHEP project

Site	Capacity (in cum)
Jhakri-I, Jhakri-II	14,16,530
Koshgarh	2,50,000
Kotla	4,10,000
Dharali	7,20,000
Negulsari	5,78,000
Plingi	5,92,000
Sakiaharan, Punspa	20,15,000
Linge	21,721

Source: EIA Study NJHEP, Year 1998

The dumping site at Sakicharan was used to dispose the muck generated due to the construction of the main dam. Later, when the dam height was increased by 5 m, as a compensatory measure, an alternate Tail Race Tunnel was provided to the Bhaba Power House because with increase in the dam height, the tailrace of Sanjay Vidyuit Pariyojna (SVP) Bhaba came in the submergence zone. The construction of this compensatory TRT generated about 2170 m3 of muck. This muck was disposed over the previously disposed material in the existing dump yards at Sakicharan.

The proposed project at Rampur is expected to generate approx. 2.72-lac m^3 of muck, which is propsed to be disposed at the following designated sites:

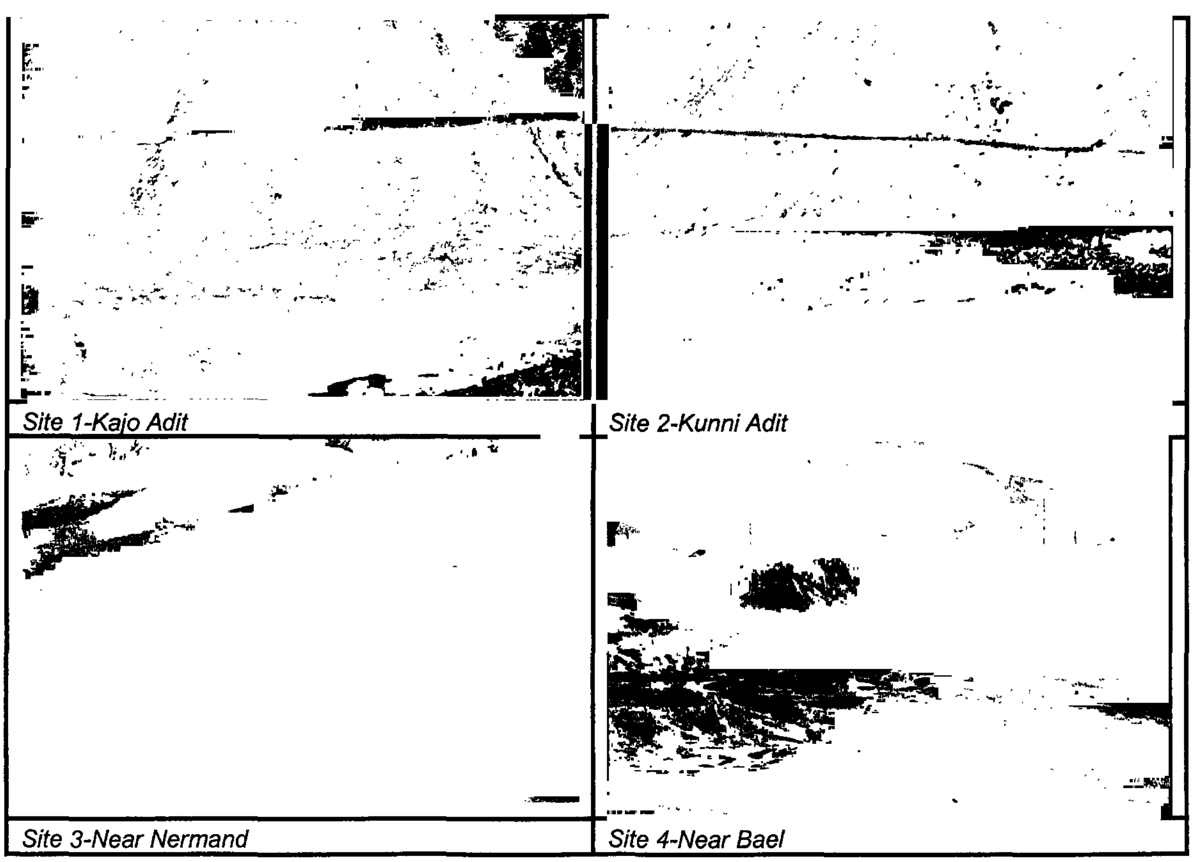
- Dumping area near Kajo adit (Tehsil Nermand, Fatti/ Tunan, Kothi 15/20)
- Dumping area near Kunni adit (Tehsil Nermand, Fatti/ Tunan, Kothi 15/20)
- Dumping area, Tehsil Nermand , Fatti Nermand.
- Dumping area in Bael

These sites have been identified at right bank of the river, close to four edits of proposed tunnel so as to minimise the risks involved in terms of affecting human settlements due to blow of dust and frequent movement of heavy vehicles. The sites need attention in terms of surface preparation and fencing of boundaries to avoid environmental risks i.e.

land sliding, sedimentation of river, air pollution etc. SJVNL is already taking care of this aspect with great care. The measures include construction of retaining wall before actually dumping the material. So this aspect doesn't seem to pose any such threat.

At Luhri, the volume of muck to be disposed off has been estimated to be about 35-40 lakh M^3 (Luhri HEP PFR). It is expected that about 25 % of this will be used for making aggregates. The rest will be disposed of in a planned manner. It is intended that suitable dumping locations will be identified. Retaining walls will be constructed. Rehabilitation of the site will also be done after the site is filled. Plantations, wherever possible, will also be done on these sites so that these get stabilized over the time. Despite the provision of establishment of embankments down the slope to stabilize the deposited muck, the likelihood of the muck entering the Satluj is high thus reducing the depth of the river at these sites and downstream of these sites. This would result in increased turbidity of the water in the river stretch making it less usable and aesthetically appealing. The problem is going to be more pronounced in the lean period where the flow is even less than normal.

Dump sites identified by SJVNL



Site 1-Kajo Adit | *Site 2-Kunni Adit* | *Site 3-Near Nermand* | *Site 4-Near Bael*

Making available a suitable muck dumping area and then a well planned dumping schedule before the start of construction activities is a very important aspect in addressing this issue in Satluj basin.

5.1.5 Impact of Blasting on Agricultural & Horticultural Yield

Simla is one of the biggest apple growing districts in HP. Half[4] of the State apple crop is produced in the district. But for consecutive 5-6 years from 1992-93 to 1997-98 the apple crop was very poor due to continuous rains and widely fluctutating temperatures (maximum and minimum) at the time of flowering during March- April. In 2001-02, there was virtually no crop in apple growing areas situated at elevations below 6500 ft msl. (Refer table 5.5).

Table 5.5 Production of Apple in Himachal Pradesh

Year	Apple Production ('000 tonnes)
1980-1981	118.01
1981-1982	306.79
1982-1983	139.08
1983-1984	257.91
1984-1985	170.62
1985-1986	174.61
1986-1987	359.32
1987-1988	259.27
1988-1989	165.15
1989-1990	394.86
1990-1991	342.07
1991-1992	301.73
1992-1993	279.05
1993-1994	294.73
1994-1995	122.78
1995-1996	276.68
1996-1997	288.54
1997-1998	234.25
1998-1999	393.65
1999-2000	491.3
2000-2001	376.73
2001-2002	180.53

[4] *District census handbook 1991Series 9 part XII, Simla*

2002-2003	348.26
2003-2004	459.49

Source: HP, Statistical outline of Himachal Pradesh, 2003-04, Department of Economics and Statistics (Horticulture Department data)

This kind of reduction in apple production was attributed to dust pollution caused by various hydropower project-related activities in Satluj Basin. Projects of these kind include activities like blasting for various construction purposes like excavation of underground tunnels for channelising the waters of river, open blasting for mining operations and other works of the project. A committee was formed by Horticultural Department, HP to inspect the case. The following areas were surveyed by the experts[5], to inspect the level of air pollution and to study whether the particulate air pollutants emitted from blasting operations were causing any adverse effects on the production of apple and other fruit crop:

a) Project sites at:

- Nathpa;
- Jhakri;
- Pashada quarry;
- Mini hydroelectric project at Kafnu/ Katgaon ;
- Piwa crusher plant at Tapri.

b) Orchards near project/ quarry sites at:

- Pachchada and Dhar Gaura
- Ponda and adjoining areas
- Katgaon/ kafnu
- Kacksthal
- Tapri

Although atmospheric pollutants adversely effect the plants in various ways, such as causing closure of leaf stomata, growth retardation, injury to leaves, plasmolysis, other physiological effects like reduced photosynthesis etc, in this particular case, the findings of experts are given below:

- No evidence of dust pollution were recorded being responsible for the low and declining yield of apple in Shimla and Kinnaur areas falling within the boundaries of SJVNL projects.

- Though dust deposition on flowers may reduce the period of stigma receptivity or may hinder pollen dehiscence and pollination, or may affect pollen germination but for all these effects to show up, the dust pollution must be very high so as to form a sufficient thick layer of dust particles on the flower parts. But it was found that the

[5] *Sh TCP negi, Joint Director, Horticulture, Dr. SA Ananda, Professor of Pomology and Dr. PS Chauhan, Horticulturist*

level of dust on the plants in the adjoining area of Jhakri, Pashada and Dhar Gaura villages were not high enough to cause such adverse effects on flowers of fruit plants, including apple.

- No such dust deposition was noticed at orchards/ sites at Ponda, Nichar area, Katgaon, Kafnu and Kacksthal. The SPM at a site near Jhakri at a distance 250 m from Pashada quarry as recorded during the time of inspection was around 350 $\mu g/m^3$, which was much lower than the threshold admissible limit of 500 $\mu g/m^3$ for industrial areas.

- At the Pashada Quarry, although open blasting was being carried out, the levels of dust pollution caused by blasting appeared to be low because these operations were carried out entirely on solid stone rocks. Also, most of the components of NJHE project work were carried underground; hence underground blasting could not cause such serious pollution problems. Similarly, no pollution could have been caused by dumping of excavated sites as these sites were away from fruit plantation.

- Similarly in villages of Jhakri, which is located just near Pashada quarry and Snarsa and Shah, which are located on Kacha approach road to surge shaft and in the villages of Ropru, Pashada, Dhar Gaura, Dobi and Gopalpur, it was found that the although the fruit set for stone fruits like apricot, plum and almond was good, the fruit set in apple in Shah, Pashada and Dhar Gaura areas was average. It was concluded that had dust pollution been responsible for poor fruit set in apple, it should have played a similar adverse role in fruit set in stone.

CONCLUSION

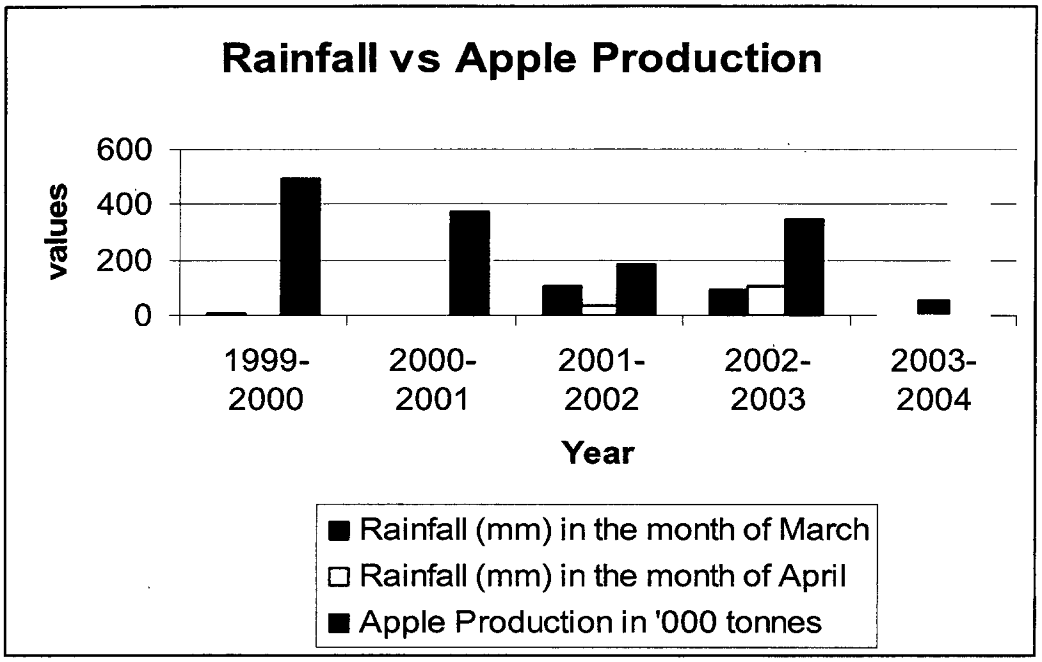
It was observed that the extent of fruit set in apple in above-mentioned areas was low, but it is due to some other factors. The main causes might be:

1. Continuous rains and low temperature during the time of flowering (March April) results in poor bee activity, inadequate cross pollination and poor fruit set. An attempt was made to correlate the rainfall with fruit production. Table 5.4 shows drastic reduction in the production of apple in the year 2001-2002. The rainfall data (table 4.8, produced below again) shows that in this particular year, there was continuous rainfall in the months of March-April.

Historical monthly Rainfall (in mm) Data for Rampur

Year	*Jan.*	*Feb.*	*March*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Total*
1999	*78.9*	*19.9*	*5.4*	*0*	*31.4*	*19.6*	*185*	*60.9*	*18.5*	*0*	*0*	*5.2*	*424.8*
2000	*0*	*0*	*0*	*0*	*0*	*244.9*	*337.9*	*21.3*	*12.1*	*0*	*0*	*0*	*616.2*
2001	*20*	*40*	***105***	***34***	*103*	*113.9*	*60*	*123.1*	*60*	*0*	*16*	*41*	*716*
2002	*61.5*	*142*	***93***	***104***	*13*	*45*	*10*	*152*	*104*	*0*	*0*	*1*	*725.5*
2003	*55*	*110*	*60*	*61*	*11*	*41.5*	*264*	*132*	*107*	*0*	*4*	*41*	*886.5*
2004	*67*	*4*	*0*	*69*	*57*	*114*	*93*	*244.5*	*24*	*81*	*2*	*6*	*761.5*

However, the areas located at higher elevations i.e. above 6500 ft msl had good crop because in such area flowering took place a little later which escaped the adverse effects of rain and low temperatures.



2. It may be due to lesser number of pollinizer trees in the orchards[6]. It was observed that the fruit was very good in pollinizer trees of Golden Delicious variety and adjoining trees of Royal Delicious variety, but was poor in trees away from pollinizer's trees. Hence, the reason of lesser extent of apple could be due to the inadequate and improper placement of trees of pollinising varieties in orchards.

5.1.6 Impacts on the frequency of Disasters

5.1.6.1 Earthquake

Earthquake in seismically active areas, a reservoir may advance the occurrence of earth tremors (possibly resulting in more frequent but smaller magnitude events). This is due to either a change in stress because of the weight of water, or more commonly due to weakening of fractures and faults under the reservoir by increased water pore pressure. The energy released in a reservoir-induced earthquake is normal tectonic strain energy, released prematurely. It may be put that the reservoirs may induce increased seismic activity through:

[6] *Survey report on the effect of Blasting operations on Fruit production in NJ HEP areas, by Dr. SA Ananda, Professor and Head, Department of Pomology, Dr. PS Chauhan, Senior Horticulturist, RHRS and Dr. KN Ojha, SMS, Deptt of Horticulture, Simla*

- change in the normal effective stresses in the underlying rock due to increased pore pressures
- transmitting hydrostatic pressure through discontinuities in the underlying rock

General characteristics of induced earthquakes are:

- occurrence within the vicinity of the reservoir;
- small focal depths;
- the frequency of small earthquakes is higher than that of large earthquakes;
- high chance of occurrence in an area of normal or lateral faults.

Medium sized earthquakes tend to occur in situations where:

- the generating head is large (typically over 100 m);
- the impounded water volume is considerable (typically over 1 km3)
- there are many fissures and faults in the crust.

Satluj Basin largely falls in Seismic zone IV and V. Refer to the sections 4.1.5 and 4.1.7 of Chapter 4 for details.

5.1.6.2 Floods

The most obvious impact of hydro-electric dams is the flooding of vast areas of land, much of it previously forested or used for agriculture. The size of reservoirs created can be extremely large. Reservoirs can be used for ensuring adequate water supplies, providing irrigation, and recreation; but in several cases they have flooded the homelands of native peoples, whose way of life has then been destroyed. Many rare ecosystems are also threatened by hydro-electric development.

Catastrophic flash flooding occur when a dam fails and the impounded water escapes through the breach into the downstream valley. Usually the response time for warning is much shorter than for natural floods. Numerical simulation models are powerful tools to assess the impacts of floods due to dam failure events

Refer section 4.1.7 of Chapter 4.

5.1.6.3 Landslide

Landslides are another common geological hazard in the area. The vulnerability of the geologically young, unstable and fragile rocks of the state has increased many times in the recent past due to various unscientific developmental activities. Deforestation, unscientific road construction, terracing and water intensive agricultural practices, encroachment on steep hill slopes are the activities that have increased the intensity and frequency of landslides.

Also, landslides are often triggered due to road construction because of the loosening of rocks by water trickling from various streams. Steeply sloping banks are liable to landslides, which can largely be controlled by provision of suitable drainage. The basic principle is to intercept and divert as much water as possible, before it arrives at a point, where it becomes a nuisance. The construction of road is one of the leading causes of increased landslide occurrence in the study area. The quantum of damage by unscientific road construction can be judged by scientific research, which states that, one kilometre of road construction in the Himalayas needs 60,000 cubic meters of debris. The construction of roads in the recent past has been extensive with the development of various hydropower projects in the study area, as has been the increase in the incidence of landslides due to this and other reasons, especially during the rainy season.

The other erosion hazard is that of surface erosion of the bank, which is best controlled by vegetation. However, in a steeply sloping terrain, difficulty lies in growing vegetation on steeply sloping banks. Engineering solutions such as surface drainage, sub-surface drainage, toe protection and rock bolting can be used. Landslides can be stabilized by several methods-engineering or bio-engineering measures alone or a combination of these. The cost required for implementation of various measures has already been incorporated in the overall budget earmarked for construction of roads.

Also refer Section 4.1.7 of Chapter 4.

5.1.7 Extreme events and Climate Change risks

The river Satluj carries the maximum amount of silt among the Indian rivers. The river has been affected by three floods which submerged the entire Satluj basin in 1997, 2000 and 2005. It not only led to damages but the entire topography has been reported to have changed along with the catchment areas. The riverbanks eroded badly. The original plans that were made when the project was envisaged regarding silt contents (5,000 parts per million) had to be changed and are in the process of revision.

Last year in June 2005, there was a sudden breach in the artificial lake on river Pareechu, in Tibet (China) which led to an unprecedented rise in the water level of river Satluj and caused flash floods in five districts of Himachal Pradesh. Due to a timely alert sounded by the ITBP post at Lepcha and prompt action initiated by the State Government and Government of India for evacuation of people residing on the bank of rivers Spiti and Satluj, that lives of villagers in Indian region, were saved. Three hydro-electric power projects in the State viz. Naptha Jakhri, Chamera II and Baspa, had to be temporarily shut down due to heavy siltation caused by the flash floods. The flash floods caused extensive damage to roads, bridges, agricultural crops, Government & private properties and other infrastructure.

However, no loss of life was reported from anywhere in the state after more than 40 to 50 feet high water breached the banks of the river and caused an estimated loss of property, worth Rs 100 crore in Kinnaur district alone. Large parts of the Kinnaur district are cut off from the rest of the country as all communication links were snapped with the Indo-Tibetan road breached at several places. The water level, which was 12 to 13 feet last night, at Tatapani town in Mandi district, has steadily come down and there was no flood threat in the low lying areas downstream. Water entered the Powari village of the district and submerged three shops and washed away a silt monitoring station at Khab. Twenty houses besides a primary school and a Mahila Mandal building were washed away at Leo village in the district.

Five bridges on Satluj River at Khab, Karcham, Leo, Akpa and Kharo had been washed away. Other bridges at Morang, Kaanam and Apka appear safe but have sustained some damage and would require reconstruction. A bridge at Shlkar had been damaged, while two orchards and two houses at Chango were washed away by the Satluj waters. Two bridges of Jagatkhana and Bajja Bowri at Brau area of Rampur and two bridges of Nathpa Jhakri power project have been washed away.

About 500 metres road of the National Highway no 22 was washed away at Leo village besides Tangling, Tanlik, Powari and Choling areas of the district.

Also refer Section 4.1.7 of Chapter 4.

5.2 Socio-Economic Impacts

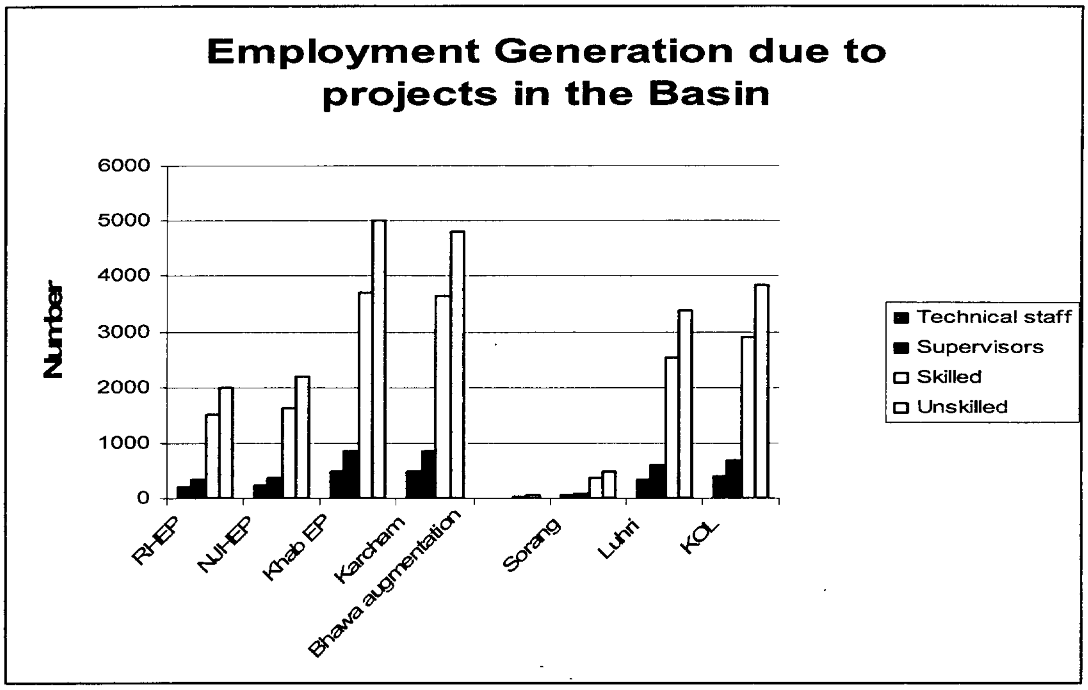
5.2.1 Employment benefits

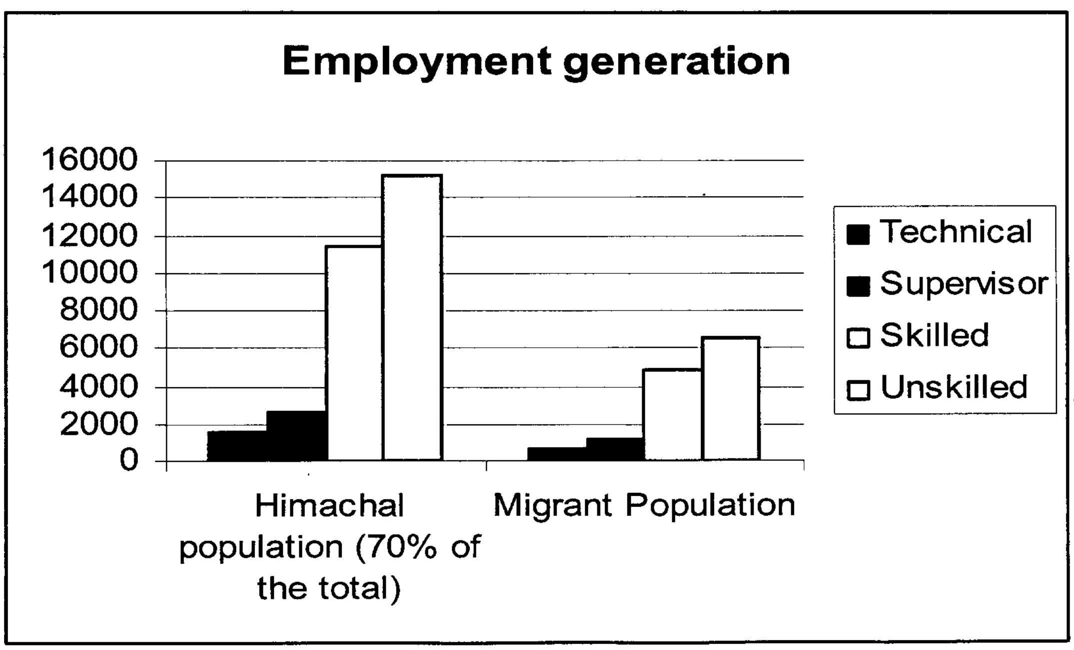
A large number of hydro projects are planned in the entire Satluj basin. The development of these over the time would generate many employment opportunities in the basin directly as well as indirectly in the form of various service providers. A tentative estimate of potential employment opportunities have been worked out on the basis of hydro generation capacity. As per MOU signed by government of Himachal Pradesh with all hydro developers, 70% is to be engaged from the state. Hence around 30000 staff is expected to be employed from the state. Rest of the staff would contribute as migrant population. The migrants will also bring their families along with them and thus the migrant population will be around 38000. It is also expected that 2 % of the migrant population will start some petty business or business establishments for their daily needs.

Table 5.6 Employment generation

Project	Capacity	Staff expected to be employed				
		Technical	Supervisor	Skilled	Unskilled	Total
RHEP	412	200	350	1500	2000	4050
NJHEP	1500	215	378	1628	2200	4421
Khab EP	1020	490	860	3700	5000	10050
Karcham	1000	480	842	3626	4802	9750
Bhawa augmentation	4.5	5	9	37	49	100
Sorang	100	48	84	362	480	974
Luhri	700	337	591	2545	3371	6844
Kol	800	385	675	2908	3851	7819

TOTAL	5536	2160	3789	16306	21753	44008





In absence of time series data (before and after) for all hydroelectric project sites that are in operation or proposed, change in employment pattern and employment benefits has been assessed and quantified only for NJHEP and RHEP influence areas which would be helpful to understand the kind of scenario which could be foreseen for the region, once all proposed hydro power projects get started

There is clear indication of shift of type of economic activities from agriculture to business due to massive hydropower development projects in the region. The statement has been substantiated with the help of following:

Table 5.7 Occupational Activities (%) in NJHEP project.

Occupational Activities	Areas, which are not directly affected	Project affected areas	
		Pre Project	Post Project
Cultivators	51.89	49.39	40.07
Agri-Labour	0.84	1.70	2.13
Daily Wages	1.68	13.59	18.29
Service	29.95	20.15	24.35
Others	7.17	20.15	20.15
Business	8.43	11.65	12.79
Pensioners	0.84	-	-
Non-working	74.78	76.10	74.15

Source: EIA for Updation of NJHEP, Year 2003

A comparison of pre and post project employment scenario as given above and as already discussed in Chapter 4 for NJHEP, reveals the following:

- Average annual employment of those households who were given land for land has increased from 393 days to 550 days per household. The average annual income has increased from Rs.45, 222 to 1,07,422. However, the share of agriculture in the household income has declined because of reduction in the size of their land holdings. But their income from wage labour and services has more than doubled as compared to there past income six years ago.

- The average income of those households who got compensation for house construction has increased from 28,333 to Rs. 50,933. The employment and income from regular jobs have increased in the group.

- In the case of those households who were allotted alternative shop plot average annual income was Rs. 79,867/- in 1996, which increase4d to Rs. 1,81,107 in year 2002. This change has been mainly due to increase in pretty business/trading activities, which have increased due to increase increased demand for daily need items from residents of new NJPC colony and also due to increased purchasing power of project affected families. Average income of those families who have been provided employment in the NJPC has increased from Rs. 68,874 to Rs. 1,41,759 per annum. The increase in household income has been mainly due to increase in employment in non-farm activities.

- Those households who were provided cash compensation only have also improved their economics position. Average annual employment of these families was 350 days in 1996, which has now increased to 401 days. Similarly the average annual household income has increased from Rs. 77,677 to Rs. 98,721 in year 2002.

- Out of 62 families of project affected areas and who are rendered landless under the project, one person each from the 51 families has already been provided a regular employment in the NJPC, and it is to be noted that 29% of employed persons are women.

Further, in case of RHEP, apart from students, the largest number of males is engaged in service and females have agriculture as a main activity. The analysis indicates that annual income of the sampled households from different sources, at overall level was Rs.1,07,408 per annum, which was Rs. 77,351/- for SC/ST and 1,32,748 for general category. The largest share of the total income was generated from employment including service and wage labour. This was followed by agriculture; accounting for 18.61% and other sources, 17.71 %. Business was observed to be last in this respect and generated only 0.98% of total household income at overall terms.

It is foreseen that after operation of RHEP project, the business activities will definitely have some impact and this would flourish due to increase in influx of the people resulting in demand for all daily-need products.

A similar trend is predicted for the whole Satluj basin when construction of the envisaged hydropower projects will start. Business establishments like vegetable shops, grocery shops etc, taxis, auto rickshaw etc will come up in respective regions. Hence, the development of the basin, in-general, would improve the living conditions of the local population by generating employment.

5.2.2 Accessibility to Basic Infrastructure

Infrastructure is a key facilitator of economic development. With the hydropower development in the region, improvement in basic infrastructural amenities i.e. roads, highways, public health institutes, telecommunications, water supply, electrification and hence, the economic development of the area is bound to happen.

For the various projects envisaged along the Satluj basin, from upstream Khab to downstream, which comprise the extreme boundaries of our study stretch, various infrastructural developments have occurred due to the progress of hydro power projects. These developments would, in the long run, i.e. even after when the projects are well-commissioned, be of great use to the inhabitant population.

However, the villages falling under influence areas had already had accessibility to basic infrastructural amenities like motor-able roads i.e. highways, access/approach roads, electricity, piped water supply, health centers, primary schools, Banks/post offices and Canals (khuls) for irrigation but due to hydropower project development, there has been improvement in road facilities. At various places pathways have been made, bridges have been constructed across nullahas and rivulets, which has significantly reduced the travel time and distance of the villages with nearby towns and also among villages of the area.

Generally, for the area, infrastructure building could be discussed under two different heads, one is building up of these facilities which are directly must for hydro power project development during construction stages, it could be of use of local people as well. Second category is these infrastructure facilities, which have been built up or proposed by the implementing agencies for the project-affected areas or indirectly catering to those areas as well, which are not directly affected by the projects. Below is the complied information on infrastructure amenities that have been built up under different hydropower projects:

Infrastructure building to cater the needs during project construction:

- For the movement of heavy trailer/ machinery up to Karcham, for execution of NJHEP and Baspa HEP –II, the highway has been widened with the quality improvement of road surface as well.
- For movement of heavy machinery during construction of NJHEP project, 15 m wide road has been constructed at right bank of the river up to Jhakri along with the connecting bridges, which has helped in connecting the local villages to the highway and hence, in improving their quality of life.
- From Karcham up to Khab, the widening of the road and strengthening of bridges (five in number from Jhangi to Khab) has been kept in the purview under Khab project.
- At Luhri, the existing High way from Shimla to power house site/ dam site will be suitably widened/ improved to 7-10 m wide specifications in about 80 km length to serve as approach road to the project site for construction. In addition, NH way will be re-aligned at some stretches where blind curved exist. Also a 70R bridge for crossing over to the right bank of river Satluj will be constructed near dam.
- Under proposed Luhri project, it has been proposed that schools and college education institutes, hospitals, market, recreational facilities at Nathan and Suni would be constructed for the staff posted on the project, which would also cater to the local village population.

Infrastructure building taken place during operation of projects also cater the needs of local village people:

- Under the NJHEP project, infrastructure has been created for nearby rural areas which, helped farmers in switching from the traditional subsistence farm production system to the high value cash crops in the area, which would ultimately helped in increasing the employment opportunities.
- A mobile Health Unit has been started under NJHEP project, which is functioning since January 2000. The unit makes four visits per week to nearby villages that include two in project-affected villages of Kinnaur district and two Shimla district. Through this, doctors of the team are also helpful in making the local people aware about common health diseases and ailments.
- A project hospital in NJPC colony at Jhakri at the cost of Rs.13.22 million has also been established under NJHEP project, which is also serving local people of villages.
- A 200-bed hospital has been constricted at Khaneri, Rampur by the State Government with the financial assistance of Rs. 80 million from the NJPC.
- A school has been established at Jhakri with a grant of Rs. 20 million from NJPC for the children of the staff. It is also providing quality educational facility to the local people and helping other schools to improve their existing level of infrastructure and quality of education. The project affected area villages have to pay subsidized fees for their children in this school, which is otherwise a very costly affair for them as compared to any other government school.
- NJPC also helping in building up of new infrastructure facilities or in improving the existing ones in government schools of the area in terms of construction of classrooms, play grounds etc. A sum of Rs. 70 lacs has already been spent on school building and playgrounds by the ER&R department of the NJPC. The school at Sansara village has been provided playground with the financial assistance from NJPC. Financial assistance has been provided for construction of school building at Shah village.
- The displaced shopkeepers were provided alternative shop plots in the market complex. NJPC has provided water supply, sewerage system, streetlight and other amenities in the market complex. All shops in the new market complex are of permanent type, unlike the old shops, which were kuccha structures.
- All the project-affected villages have been electrified and have provision of piped water supply.
- IPH has various schemes for renovation of water supply schemes for the local village people and the places where water sources have been dried up, alternate sources would be provided. NJPC is providing financial support to IPH for such schemes.

Similar provisions are expected to be provided by various project proponents of the various envisaged hydropower projects in the Basin. The living standards, access to infrastructure, education and health and hygiene will improve considerably. The State Development Plan of the Government may incorporate such changes in anticipation.

5.2.3 Power Generation and Transmission Benefits

There is a broad consensus in the government to expand power generation by developing the country's hydropower potential, of which only 30 percent has been harnessed so far. The government has set the target for India's optimum power system mix at 40 percent from hydropower and 60 percent from thermal/nuclear power. The present ratio – at 25:75 – falls far short of this optimum, causing severe power shortages particularly during peak periods and technical and economic problems in grid operations. The country, therefore, plans to increase hydropower's share in power generation to 28 percent by fiscal 2007, and to reach the target of 40 percent over the longer term.

The following table shows the major hydropower projects along river Satluj, their generation capacities and transmission benefits:

Table: 5.8 Power capacity and Transmission aspects for various HEP in basin

S.No.	Hydropower Project	Power Benefits/ capacity	Power Transmission
1.	Khab	Capacity: 1020 MW	The proposed evacuation plan is under review as suggested by CEA in view of the various upcoming projects in Satluj basin.
2.	Baspa II*	Capacity: 300 MW (100 MW x 3) Generation: 90% dependable year: 1213 MU 50% dependable year: 1391.61 MU	A 400 KV D/C transmission line between BASPA-II to Jhakri.
3.	Karcham Wangtoo	Capacity: 1000 MW (250 MW x 4) Generation: 90% dependable year: 4463.88 GWh 50% dependable year: 4810.56 GWh	Evacuation system planned by Himachal Pradesh State Electricity Board.
4.	Nathpa Jhakri*	Capacity: 1500MW (250 MW x 6) Generation: 90% dependable year: 6684 MU 50% dependable year: 7425 MU	About 12% of the energy at Bus Bar is to be supplied to the State free of cost and about 25% of the remaining 88% will be supplied at bus bar rates to Himachal Pradesh.
5.	Rampur	Capacity: 434 MW (144.67 MW x 3) Generation: 90% dependable year: 1946 MU 50% dependable year: 2206 MU	Power will be evacuated by LILO of 400 KV Jhakri-Nalagarh D/C line at Duttnagar.

6.	Luhri	Capacity: 465 MW (155 MW x 3) Generation: 90% dependable year: 2037.15 MU 50% dependable year: 2260.50 MU	Evacuation system planned by Himachal Pradesh State Electricity Board.
7.	Koldam	Capacity: 800 MW (200 MW x 4)	Evacuation system planned by Himachal Pradesh State Electricity Board.

Source: *PFR Khab, Year 2004; PFR Luhri HEP, Year 2004; EIA for Rampur HEP, Year 2005; EIA for NJHEP, Year 1998*

* Operational projects

The Himachal Pradesh State Electricity Board is planning the evacuation system in totality in view of the multiple hydropower projects in the State.

The power generation will improve the quality of electrical supply to existing consumers, especially at peak times, and also benefit farmers and other consumers in the northern Indian states who currently have either no access or constrained access to electricity. While the benefits from the additional power generated are indisputable, the financial benefits from the projects are also immense for the Government of Himachal Pradesh as the state is entitled to get 12% free power generated from the projects and there would also be additional revenue earnings by way of direct & indirect taxes by the sale of electricity.

Coordination among different projects for peaking power generation: An analysis has been carried out for peaking power generation synchronization among various projects. For this assessment, the following projects have been considered:

- Khab H.E Proejct
- Karchham-Wangtoo H.E Proejct
- Nathpa-Jhakri H.E Proejct
- Luhri H.E Proejct &
- Kol Dam H.E Proejct

The distances between Khab to Karchham, Karchham to Nathpa, Nathpa to Luhri and Luhri to Kol along with the river bed levels at all the above locations have been given in Table below. The travel time of the releases for peaking generation during the lean discharges as well as maximum discharges have also been calculated and given below:

Project	Distance in km	River bed level in m	Travel time at max flow in hrs	Travel time at lean flow in hrs
Khab	0	2550	0	0
Karchham	100	1700	3.0	5.0
Nathpa	125	1450	3.75	6.0
Luhri	200	710	6.00	10.0
Kol	295	600	11.0	18.0

Synchronization of peaking power generation has to be undertaken accordingly as per requirement and can be coordinated by a single agency as has been suggested in the later part of the report.

Environmental and Social issues in transmission projects

Construction and operation of transmission lines and substations may involve environmental and social concerns that are distinct from each other in terms of their nature of impacts. Some of the environmental and social issues that could arise from its projects are unavoidable, and the endeavour should be to seek to address them through its management processes outlined as below.

The environmental and social issues typically associated with its projects are identified as below.

Environmental issues

- Lopping of Trees within Right of Way
- Clearing of Ground vegetation for movement of Machinery
- Clearing of Ground vegetation for substations
- Used transformer oil

Social issues

- Loss of livelihood due to acquisition of private agricultural land
- Loss of homestead
- Loss of common property resources due to acquisition of revenue land
- Loss to standing crop
- Change in land prices.
- Temporary loss of access to Common Property Resources

It should be endeavoured to avoid orchards, plantations, and forests in line routing through studies of alternative routes. If inevitable, care is to be taken to route the line through a path of least disturbance. The following points while routing its transmission lines should be considered:

- the route does not involve any human habitation;
- the route does not affect any monument of cultural or historical importance;
- the proposed route does not threaten the survival of any community, especially tribal communities
- the proposed route does not affect any public utility services like play-grounds, school
- and other establishments, etc.; and
- the line route does not pass through any sanctuaries, National park, or similar ecologically fragile areas etc

These issues are required to be addressed effectively for the complete Satluj Basin in view of large scale proposed hydropower projects in the basin and planning of evacuation thereof.

5.2.4 Social and Resettlement Impacts

For resettlement and rehabilitation (R&R) of project-affected persons, the important parameters are water quality, soils, land use, erosion and siltation, afforestation, health aspects and water pollution.. The Environment & Rehabilitation & Resettlement (ER&R) Cell in SJVNL monitors some parameters related to Rehabilitation & Resettlement itself. The other aspects of water, air and soil quality are being regularly monitored by Himachal Pradesh Pollution Control Board. An amount of Rs.7.04 lakhs/year has been earmarked by SJVNL to fund these studies.

Under Nathpa –Jhakri project, the NJPC has acquired a total land of 386.10 ha to create facilities, infrastructure and to resettle the displaced families. The private land acquired as a part of the total land acquisition is 239.50 hectares and that affected around 480 families in 22 villages. The number of affected families include 54 families, whose houses have been acquired, 87 are those whose shops have been acquired and 52 are those families who have been rendered homeless i.e. those who were left with less than 5 bighas (0.402 ha) of land after acquisition.

However, in year 1994, the rehabilitation plan was prepared by NJPC which includes provision of developed agriculture land to project affected rendered families so that each family has 5 bighas of land, provision of a house with plinth area of 45 sq mt, allotment of plots for shops at Jhakri market complex for displaced shopkeepers and provision of suitable employment to one member of each landless family subject to availability. As per the planned schemes in place, several actions have been taken by NJPC in this direction.

For Rampur project, a total of 80 ha land is to be acquired. Location and alignment of many projects appurtenances pass through private property i.e. agricultural fields, other private land. 32 ha of private land that is proposed to be acquired for various project appurtenances, lies in 3 villges, viz, Nermand, Dutt nagar and Bael. A Memorandum of Understanding has been signed between Govt. of Himachal Pradesh, and SJVNL to protect the interest of (Project Affected family) PAFs. The PAF, which is rendered landless on account of acquisition of land, shall be eligible for rehabilitation grant and cash compensation as per the norms of Land Acquisition Act.

R & R Implementation Plan of RHEP

The Environment and R&R Policy of SJVNL believes in "sustainable development within the carrying capacity of supporting ecosystems and caters to human needs so as to improve the quality of life".

Involuntary displacement is unavoidable in the execution of hydro electric projects. The land required for setting up the project will be acquired under the Land Acquisition Act 1894 the State Governments after paying the compensation to the landowners. That such compensation will not restore the landowners the equivalent land or benefits is a known hard fact. Further, where the dependence of population is more on land for livelihood, the involuntary displacement results in loss of livelihood at least in the initial stage of displacement. To mitigate all these to the maximum possible extent, a Resettlement and Rehabilitation Scheme has been made an integral part of the MOU signed between the State Govt. and SJVNL Management on 20.10.04. The basic objective of this policy is to improve or at least to restore the standard of living of the affected population and also to improve Community and Area Development:

- To compensate families whose land or other assets are acquired for the construction of the project;
- To create better living conditions and to improve by and large the quality of life of people residing in the project area;
- To contribute to the overall development of the project affected areas.
- To create good rapport with the local people for long term relationship and mutual benefits.

Basic issues and need for R&R Action Plan

Acquisition of land generally induces change in land use pattern and can destroy the economic base. The R&R Action Plan is therefore formulated with an objective to resettle the oustees whose land/house/shop is acquired and to rehabilitate them in such a manner that they improve or at least regain their previous standard of living, earning capacity and production level. Besides, it is imperative that the transition gap is to be reduced to the minimum possible extent.

With proper resettlement and rehabilitation plan, an amicable relationship with PAPs can be maintained which is essential for efficient operation of the project. It is generally seen that the displacement during acquisition of land is involuntary and the PAPs have to face a new social set up. During such transition period, the rural economic environment is generally transformed into higher cost of living and reduction in traditional sources of income. In general, PAPs face difficulty to cope with the new environmental set up.

Domestic changes in the land use patterns substantially alter the agro based rural economy and life style of affected families.

Stakeholders

The project is for the benefit of entire nation and particularly for the region. The project involves various stakeholders. On one side we have Government of India , Government of Himachal Pradesh and beneficiary states as stakeholders; and on the other side we have local population consisting of following ;

- Project affected population;
- Residents who own land in the project area but the same has not been acquired;
- Residents who do not own land and work as laborers / shopkeepers / other wage earners in the affected area;
- People pursuing own occupations or partially depending on forest, land or common land which they do not own but is like common property resource / land, which is being acquired or effected by the project;
- Institutions like school/ hospitals / dispensaries etc.
- Local organized groups like Mahila Mandals, Youth Clubs etc.

Relief Rehabilitation Strategies

- Each project affected family will be suitably compensated by the benefits such as monitory compensation for land, house and for both etc.
- General population other than the project affected persons or land owners will be offered various facilities to improve their living conditions so as to enhance their standard of living;
- The local population will be provided suitable guidance in the sphere of better technology and better knowledge base for better living conditions and better livelihood.
- Confidence building measures amongst the local population and project affected persons in particular to induce a sense of feeling of being cared and heard.
- General Development of the project area such as roads, foot paths, foot bridges and community development works etc.
- SJVN will provide guidance to the Project Affected Families for utilizing the compensation amount in such a way so as to sustain their livelihood. A team of executives including R&R Personnel will be formed, who will meet the PAFs collectively and individually for proper guidance and utilization of compensation amount for a sustainable future.
- Each PAFs shall be issued an Identity Card. This card will be issued by Project Authorities which will facilitate PAFs entry and project offices and also for the purpose of association in various activities of the project.
- Wards of PAFs will be considered for admission in the project schools, and the fee will be charged same as being charged from the wards of the SJVN employees as decided from time to time.
- PAFs would be invited to attend various functions organized by SJVN like 26th Jan/15th Aug/Raising Day etc.
- A Public information Centre (PIC) will be opened in the project area which will contain necessary information/details regarding project components and information pertaining to R&R for the benefits of the PAFs and local people. The PIC will remain operative for a period of one year after completion of the project.

Rehabilitation Action Plan: Specific Interventions

Compensation for Property Acquired:

a) **Direct Compensation**: The property acquired from the affected families shall be suitably compensated under Land Acquisition Act 1894 immediately after notification to this effect is made by Government of H.P.

b) **Other Benefits for Acquisition**:
In addition to above-mentioned direct benefits, other specific benefits will be provided by SJVN as part of their R&R scheme. These are as under :

Resettlement plan:

- For the purpose of the RHEP, about twenty project-affected families will be rendered houseless/ displaced families whose dwelling houses are being acquired. This will be certified by the Deputy Commissioner concerned. The resettlement measures for the project affected families rendered houseless under the R&R Scheme of RHEP include:

- Each project affected family which is rendered landless as well as houseless (both) or houseless will be provided an independent house with a built up plinth area of 60 sqm. Alternatively PAF can also be offered a plot of land which allows construction of built-up houses of 60 sqm. Plinth area plus construction cost of the house @ Rs. 3000/ per sq. m.

- A family which does not opt for house / plot but wants to construct house at own cost with a plinth area of 60 sq. m. or more(upto 50%) shal be paid the construction cost of the house @ Rs. 3500/per sq.m. Options from such families will be asked at an appropriate time . In case any such family constructs house of less than 60 sqm. Plinth area on own plot or plot offered by the Nigam, then the amount to be given will be worked out on pro rata basis.

- Resettlement cost includes resettlement grant for project affected families, built up houses for houseless families, physical mobilization cost/ stamp duty etc, financial assistance for acquired cattle sheds, transit plan /temporary arrangement for resettling the houseless families etc.

- Keeping in view the enumeration done as above, the PAFs in the context of R&R Plan are classified under the following categories as per the scheme for R&R approved by State Govt. as well as SJVNL. The category-wise number of PAFs, their entitlements as per R&R scheme and options offered for rehabilitation are given in the table below:

S.No.	Description	Entitlement
	Family whose land before acquisition was more than 5 bighas and is left with 1 biswa or no agricultural land after acquisition.	Rs.65000/- as a Resettlement Grant
B	Family whose land before acquisition was less than 5 bighas and is left with 1 biswa or no agricultural land after acquisition.	Rs.55000/-
C	Family whose land holding is left with more than 1 biswa and less than 5 bighas of land after acquisition.	Rs.45000/-
D	Family whose cattle shed is acquired.	Rs.5000/-
E	Landless as well as houseless family or house less/displaced shopkeepers.	Landless grant & house to be provided as per R&R plan.
G	Project affected families who are covered under the definition of "Project affected family".	1 Merit scholarship scheme for the wards of PAPs . 2 Petty contracts to the cooperatives of eligible families under self employment scheme 3 Support services to PAPs. 4.Income Generating Schemes,etc.
H	Displaced shopkeepers	i) Shops will be allotted in the market complex of Project township. ii) Displacement grant of Rs.10,000/- (one time). In case SJVNL is unable to allot shops then financial assistance of Rs.40,000/- will be provided to displaced shopkeepers.

- Infrastructural facilities at Resettlement Colony:

Several infrastructural facilities will be funded by SJVNL in the resettlement colony as detailed below. The exact quantum of work involved and the time period/duration required in each item will be worked out at the time of preparing the layout/details in Resettlement Colony.

i) A main road connecting the resettlement colony.

ii) Internal roads/paths linking all the dwelling units.

iii) Drainage facilities.

iv) Tree plantation on either side of the roads and other vacant areas will be taken up in association with villagers.

v) Electrification in the Resettlement colony.

vi) Drinking water facility for the occupants of the resettlement colony.

vii) Other facilities like community hall, playground in the resettlement colony depending upon the requirement of the occupants of Resettlement colony

Rehabilitation Measures:
Satluj Jal Vidyut Nigam Limited is a well established Corporation. Because of very limited manpower in Hydro Power Project, employment in SJVNL has not been kept as Rehabilitation option. However, some other options have been kept under Rehabilitation measures i.e. Income Generation Scheme, Merit Scholarship Scheme for the wards of PAFs, Awards of Petty Contracts, to PAFs, Jobs with Contractors etc.

Transit plan for Resettlement of the Houseless Families:

A Transit plan has been for resettlement of the houseless families during the transition period i.e. the period compensation payment and allotment of new dwelling house. After the receipt of compensation, houseless families will have to vacate their houses and this period is traumatic to arrange new accommodation on their own. The following provisions have been kept under this temporary arrangement for houseless families:-

1. To provide financial assistance of Rs. 2000/- per month for 18 months or till the allotment of constructed houses in resettlement colony.

or

2 To provide leased accommodation of two rooms (area upto 60 Sq. mtr.) by SJVN tohouseless families till the allotment of constructed houses in resettlement colony.

This financial assistance or leased accommodation will be provided by SJVNL to the head of the houseless family untill the allotment of constructed house in resettlement colony. After the allotment of the constructed houses, the leased accommodation would be vacated by the occupant and would shift to newly constructed house in resettlement colony within a week. Transportation cost would be borne by RHEP/ SJVNL.

Other Schemes to Families / Individual:

1.Income Generation Scheme:

The other options/ alternatives available for rehabilitation (for other than landless PAFs) would be the income generation schemes.

It is to be ensured that entitled rehabilitation assistance by individual PAFs is properly utilized. It largely depends upon the attitude of the PAFs and their occupation & economic background. Some of the Income Generation Schemes are dairy farming, weaving, Bee keeping, Handicrafts (cottage units) /business.

2.Merit scholarship scheme for the wards of PAFs:

SJVNL will encourage the wards of the PAFs who qualify for vocational training courses. SJVNL will pay scholarships for studying the vocational courses. If the wards from PAFs are not available, only then this scheme would be extended to the wards of permanent residents of the affected panchayats declared by the project. Where as no job commitment will be given to the trained wards of PAFs/ permanent residents of the affected panchayats. They may be given preference in SJVNL as per job requirements. These measures are expected to yield good results in a meaningful rehabilitation of displaced persons who have minimum educational qualification for such training.

3. **Technical Education Scheme for Local Youths of Project area:**

This scheme envisages training to rural youths in the vocational streams to be arranged by SJVN in the local Industrial Training Institutes so as to enable the youth to become self sufficient to find a suitable employment in the industrial sector or to venture out their own plan in the acquired skill.

4. **Scheme for Infrastructural facilities and other aids to school:**

RHEP /SJVNL is committed to social upliftment of project affected families. In order to supplement these efforts, a scheme for providing infrastructural facilities and other aids to schools from primary level to Sr. Secondary level situated in and around RHEP has been formulated. Various provisions like providing desks/chairs, and other furniture, library books, laboratory equipments, education aids etc. has been kept.

Community Development Infrastructural Works

Various infrastructural works and community development would be done for development of the area / project vicinity.

Infrastructure for the Community:

RHEP affected areas/villages are under developed although some basic infrastructural facilities are available. Demands for additional infrastructural facilities & community development works may be raised for the development of this area such as approach roads, internal roads, paths/ construction of kuhl/canal, water supply schemes , construction of playground and augmentation of school, sanitation & drainage facilities/street lighting, construction of community welfare centers bus-stand, hospitals, rain shelters etc. These infrastructural works would be initiated on the resolution received from Gram Sabha of the concerned panchayats affected by RHEP.

- Infrastructural works & Community Development:

  The infrastructural works include approach roads, village paths, internal roads, construction of kuhls, construction of playgrounds, augmentation of schools sanitation & drainage facilities, street lighting, dispensaries, community welfare centres, cremation grounds etc.

- Total budget of Rs 1250 lacs is kept for the Infrastructural works and community development of the project vicinity and the area falling under RHEP. This fund would be spent in five years in eight affected panchayats of RHEP @ 2.5 crore per annum based on the fund allocated as per percentages of the total marks distributed to the panchayats i.e. panchayat population, population of the affected villages, numbers of affected families in the affected villages , area of Govt. land acquired etc.

- Infrastructural works after the construction of the project:

  Provision for the infrastructural developmental works in the villages falling under RHEP would be continued @ Rs 75 lacs per annum after construction of the project based on the resolution received from the Gram Sabha of the concerned eight panchayats falling under the affected area of RHEP.

Livelihood Support :

Petty Contracts & Jobs:

The project authorities will consider to award petty contracts to the cooperatives of the eligible families or PAPs on preferential basis so that some of them may be engaged in such jobs. Class-D contracts (financial limit of D-Class Contractor shall be as recognized by GOHP) will be earmarked exclusively for PAPs based on following preference criteria.

i) Project Affected Families.
ii) Project Affected Areas/Panchayats.

Jobs with Contractors:

Contractors will be advised to give unskilled jobs wherever possible to PAFs on preferential basis. Such a measure can provide employment to PAPs to a considerable extent until the implementation of Income Generation Scheme.

Hiring of light Vehicles:

Hiring of light vehicles is one of the employment opportunities for the PAFs. Light vehicles may be hired from the PAPs on preferential basis for RHEP.

General awareness , Community Development & Welfare :

Awareness Programmes /Camps/field visits to the affected families :

Awareness programmes will be organized for the affected families to make them aware of good measures in the field of Health and hygiene, nutrition, adult education etc.

Mobile Health Van for the benefits of project areas :

SJVNL is concerned about the health of Project Affected Families. Initially, a mobile health van has been put into operation for providing medical services to the PAFs and this will continue.

Support Services for Horticultural/Agricultural/Veterinary:

Support services for horticultural/agricultural/veterinary activities will be provided to PAFs through training programmes which will be organized to make them aware of the technical know-how to improve the quality of fruit/crops and breeds/health of their cattle. In these programmes, the participants will also be exposed to new practices by the experts in these fields. Some incentives will also be provided to the participants dealing with the horticultural/agricultural activities during training programme.

Protection/Promotion of Cultural heritage & old monumental property in project vicinity:

Displacement of people may disturb the pre-existing community structure and cultural heritage. Melas and local festivals etc. are cultural heritage in rural area. SJVNL will facilitate protection of the existing community structure by providing funds for promoting the cultural heritage and old monumental property in project vicinity.

Promotion of Sports activity in various Panchayats:

SJVNL is particular about overall development of the youth/children in project vicinity. SJVNL will facilitate promotion of sports activities in various panchayats falling under RHEP by way of organizing inter panchayats sports tournament including providing of sports kits etc.

Support for Local Fairs & Festivals :

SJVN support is also envisaged for the local fairs and festivals which are organized from time to time in and around the project area. Since local public has strong belief in holding these these fairs and festivals, support to such activities from time to time will imbibe a sense of belongingness to the project amongst the local persons.

Restoration of Infrastructure damaged due to Construction of the Project :

a.) Individual Infrastructure

Compensation in view of likely damages to private property due to blast damages:
As experienced in NJHEP, during execution of underground works in the project may affect the surrounding area and damages might occur in dwelling units/private property. Hence compensation may be paid to compensate these damages to the affected villagers, if damages occur in their dwelling units due to blasting works.

b.) Community Infrastructure

Drinking water supply schemes / Restoration of dried up water resources.

As experienced in NJHEP during execution of underground works may affect natural water resources and that some natural water resources may dry up due to project activities. This demand has already been raised in various meetings with local bodies and panchayats. If water resources are dried up due to project works, the same will be restored and drinking water supply schemes will be provided.

Other Infrastructure.

Any other infrastructure damage due to project activities shall be repaired by SJVN.

Major Infrastructural Works for the Area :

Bus stand and senior secondary School at Rampur: Keeping in view the area development, a provision of Rs. 1200 lacs has been kept for the construction of the bus Stand at Rampur and additional accommodation for the Sr. Secondary School at Rampur.

Following major works other than two referred above are also being constructed by the project authorities. These additional works are useful for the local public.

a. Bridges in the project area:

For the development of RHEP affected areas, it has been decided to construct three bridges in the project area.

a) Bridge at Jhakri of span +/- 78 Mtrs;
b) Double lane bridge at Duttnagar(+/-125 Mtrs);
c) Double lane permanent bridge at Kunni Khadd.

b. Widening of the existing roads from Wazir Bowrie to Bayal and approach road to bridge at Wazir Bowrie :

The existing road is narrow which will be widened for construction activities. This will also facilitate development of the area.

c. Electric Substation (31mva) at Bayal to be utilized for power requirements of nearby villages:

Electric substation will be set up to meet the requirements of RHEP. A fund of Rs. 20 crore has been kept for this purpose. The electric Power availability and voltage level of this area will considerably increase and the local inhabitants of this area may set up small industries for their livelihood.

d. Rampur By-pass Road:

Fund of Rs. 2317 lacs has already been spent by SJVNL for Rampur Bye pass road.

It can be said here that in all the projects being developed or proposed to be developed in the Satluj basin will also adopt rehabilitation and resettlement measures on the similar lines as MOU with the state government with the developer keeps such provisions to keep R & R impacts to the minimum and living conditions of the people to be better than the earlier. These could also serve as benchmarks for the future R & R plans in the basin.

5.2.5 Human Health Risks

The information on health profile of the area as provided earlier (ref. Chapter 4) does not indicate any prevalent disease in the area, however, the number of patients suffering from G. Entritis, Diarrhoea and Dysentery generally increases in month of April, May and June, which is lean season in terms of flow availability in the river/streams. The total no. of patients as reported in Khaneri Hospital, Rampur in year 2005 during these months was 22, 49 and 43 respectively.

An area has unique characteristics in terms of climate that mosquitoes do not breed, but due to large influx of floating population (labours etc.) especially during construction stage of the projects and due to formation of reservoirs at dam sites, there could be a possibility of spreading vector borne diseases like malaria etc. among labours. In case these vectors are established post-medical care may have to be intensified.

The dam construction involves many diversified activities and requires large number of human work force. The change in population density through immigrants/in-flux may cause new health problems in this region i.e. HIV/AIDS etc. People may carry different types of contagious diseases that may spread in locality. In flux of human work force may also bring stress on available drinking water sources and sanitary facilities. The additional domestic sewage generated may cause drinking water contamination resulting in spread of enteric diseases in the absence of proper precautionary measures.

Due to impounding, it is likely that in due course because of increase in water detention period, decrease in dispersion of waste and aeration, and thermal stratification, algal growth may occur which on decay create taste and odour.

Management Interventions

1. Community Health Outreach Programs to emphasize long-term improvements in region's health status:
   - Augment existing government and NGO health programs.
   - Place high priority on health education for local project workers and community residents.
   - Vaccination programs - meningitis, tuberculosis & tetanus

2. The lack of existing data on prevalence of STDs requires that an HIV/AIDS specialist study be conducted to determine mitigating measures that are required at appropriate stages of the project. A range of management interventions are given below to prevent HIV transmission and to manage the impact of AIDS:

   - **Specific HIV prevention activities**
     - HIV/STDs/AIDS awareness centres for IEC (information, education and communication) activities
     - Peer education programmes within the workforce
     - Condoms provision
     - Training of health personnel, social marketing of condoms, technical and material support to STD clinics, etc
     - Integration of HIV/AIDS into thematic projects (e.g. emergency training)
     - Workers periodically brought out of the field with pay to receive health and safety training

   - **Specific HIV/AIDS management & mitigation activities**
     - Voluntary counselling and testing for education, free condoms and screening for sexually transmitted diseases.
     - Treatment
     - Provision for ART (Anti-Retroviral Treatment)
     - Medical Aid policies for workforce

- **Addressing "vulnerability" of the workforce**
  - Adjust labour recruitment policies to:
    - support better distribution across gender groups
    - promote use of local labour
  - Improve labour housing to accommodate families and enhance integration into the local community
  - Recreation provision
  - Remittance provision
  - Labour transport

Various organisations and NGO's already are involved in organising such awareness programmes. CII Himachal Pradesh State Council organised a HIV/AIDS sensitisation programme for Industrial Workforce of GPI Textiles Ltd and Drish Shoes Ltd at Nalagarh, Himachal Pradesh, in June 2006. With a view to galvanise awareness and support of youth towards the issue of HIV/AIDS, staff from HP State AIDS Control Society also attended the seminar.

There is a need for meaningful consultation with local communities so that management measures are culturally appropriate locally, and will have community support. Wherever possible, HIV/AIDS/STD management plans should be compatible with and integrated with local, regional and national initiatives, and be implemented in consultation with government, CBOs, NGOs and potentially clients and suppliers.

It is recommended that preventive measures like conducting awareness camps and free health check ups be introduced at early stages in the regions where hydropower projects have been envisaged in the Basin, so that the local population is aware beforehand.

5.2.6 Cultural Heritage loss

As motioned n Chapter 4, no archeologically or historically important sites exist in the study area and hence no impacts are foreseen. However, few of the old structures like temples exist near Rampur, Sarahan and Khab. Due attention should be given for protection of these old structures before taking up any development/construction work under proposed hydroelectric projects because of their religious and tourism importance.

CHAPTER –6
SUMMARY RECOMMENDATIONS

6 SUMMARY RECOMMENDATIONS

A river as a natural resource comprises social, economic and ecological aspects that should be utilized optimally for the welfare of the people. Hence, in this particular section, broad solutions have been provided considering need of overall socio-economic and environmental development of Satluj River Basin. Also, the business solutions for effective utilisation of natural resources existing within the river basin have also been discussed.

For the overall effective environmental management of the Satluj River Basin, there is a strong need for managing water uses and water quality, for development of river environment and water-resources infrastructure, development of flood control measures and introduction of research and development (R&D).

The broad solutions have been framed for overall Effective Environmental Management in the Satluj Basin including following:

- Business solutions for effective management
- Water Management for managing the use of water for irrigation, human consumption etc.
- Socio-economic development of the region
- Involvement of all relevant government agencies including sectoral agencies, hydro power regulators and local government etc and their roles and responsibilities
- Special interventions needed for RHEP and NJHEP influence areas
- Interventions needed for flood management

To achieve goals of effective environmental management in the Satluj River basin, the following are recommended:

- For the development of entire Satluj river basin, all proposed hydro electric projects should be reviewed considering conservation of natural environmental resources, public service and economic viability as prior issues.
- Those who obtain the utilization and amenity benefits from the water and water resources of the Satluj and linked perennial and seasonal streams, infrastructure should gradually bear the cost of river-basin management including local habitat.
- For overall conservation and sustainable development of the Satluj River Basin, commitment is also required from local habitants. Local people should be involved in decisions on all management aspects i.e. planning, implementing, supervising, controlling and funding. A coordination body could be framed to keep a check on all planning and development work related to Satluj river system. This committee could be referred to as a Satluj Resources Management Committee (SRMC).

- For the management of entire river basin, major perennial streams/khads should be undertaken for the conservation and development work on priority basis by considering the socio-economic and environmental aspects linked to that particular stream/khad in terms of social status of the people, water demand, level of utilization, water availability and terrestrial /aquatic ecology etc.
- Efforts should be made to corporatize the development activities of Satluj river basin by using the potential of both central and local government-owned corporations, public-private cooperation and private companies.
- It is recommended to have zones of development along Main River and along main streams based on usage of water and other natural resources and paying capacity of local habitat in the area. Based on zoning mechanism, a Corporation may be formulated at Zonal level to keep a check on local development of the area.

Strategies for Hydro development

Himachal Pradesh has an enormous hydro-potential. Through preliminary hydrological, topographical and geological investigations, it has been estimated that about 20463.5 MW of hydel power 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.

From the Sixth Plan onwards, the hydro-power generation in the Pradesh 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 ad 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.

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 are 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.

A careful approach and a wider perspective have to be adopted to manage and sustain hydro development. Some of the approaches and interventions could be related to state government policies, involvement of state owned utilities, federal generating units or private participation as well as environmental and social commitments and compliance. These have been discussed in subsequent paragraphs.

The state government should adopt a multi-pronged strategy for speedy development of its hydro power potential. Its main elements could be:

- to involve 'proven developers' for the larger projects.
- to make for a 'time-bound and committed development' by the developer.
- to plan to facilitate development of 4-5 projects simultaneously at any given location by the various developers this helps to achieve benefits of time and cost-reduction by the state through 'competitive bench-marking' amongst the various developers operating at the same time.
- as per the nationwide studies undertaken by Central Electricity Authority, various potential sites in the state could be ranked to determine priority in their development. Preliminary and pre-project actions such as detailed surveys and investigation and preparation of DPR for the various sites should be undertaken in order of priority.
- Steps would be taken by the state government to enhance human resources in the area of hydro power through prestigious technical institutions

The thrust on hydro power should aim at a 'harmonious blend' of public-sector and private participation.

The state government is emphasizing more on doing business with the federal generating companies or though private participation as they had the manpower, the experience and the technical ability to undertake small, medium and large hydro projects. They could also raise financial resources easier, both from within and outside India. With their past precedents, they could also obtain the various domestic clearances and approvals more easily.

The engagement with these developers could have arrangements for to:

- Carry out a survey and investigation, prepare a detailed project report, including a catchment-area plan, and conduct an environmental assessment study.
- Prepare and implement a rehabilitation and resettlement plan as per the state guidelines and the federal policy on the subject.
- Obtain the various approvals and clearances, with help to be rendered by the state government where required.
- Arrange all finances required to implement the project.

- Acquire the project-land, with the help of the state government if so requested by the company.
- Endeavour to adhere to the deadlines for commissioning the project.
- Evacuate power to be generated by the project, through an integrated transmission system to be developed by the state/ federal agencies for that river-valley and which would connect the project to the national power grid.
- Render 12% of all power generated by the project, free, to the state government.
- Resolve all disputes through arbitration, where mutual discussions fail in that regard.

Most of the above parameters proposed above are in line with the federal guidelines.

6.1 Involvement of all relevant government agencies and their roles and responsibilities

The stakeholder involvement for the river basin development may be categorised in following three categories:

- The government, as the owner of the water resources and infrastructure, and to enhance the national welfare, should play the role of controlling, regulating and policing at the national and regional levels. It has also the right to have part of the revenue that the river-basin management institution gains while, on the other hand, it is obliged to contribute funding for activities towards public safety and welfare.
- The State level agency e.g. Satluj River Basin Management Agency (SRBMA) may be formulated and as the operator, it should have authority delegated by the government to manage water resources and infrastructure, perform river-basin management and develop the management system.
- The river-basin management institution should have the right to collect fees from the beneficiaries as well as to receive contributions from the government for public-safety and welfare activities.

To provide good services and promote public and private participation in the river-basin management, as well as give accountability for performing tasks for the government and society, the above mentioned three level stakeholder consultation has been suggested to have overt all river development and management .

Society, as users, has the right to receive good services and participate in decision-making processes, but it is expected to use water efficiently, take part in sustaining the environment, provide its financial responsibilities and, finally, provide constructive social control on river-basin management. Legal bodies and social bodies, such as water users associations, are also a part of this system.

Water-resources management should be conducted by a Satluj River Basin Management Agency (SRBMA), a neutral and professional institution, which applies a balanced approach in its undertakings as well as protecting public interests in water-resources management and relying on public and private participation.

The overall tasks of SRBMA could include the following:

- Development of Satluj river basin by conserving the river as an integrated part of the ecosystem, while preserving its economic potentials and functions for the people's welfare.
- Improve the performance of river-basin management in a useful manner.
- Improve public and private participation in water resources management, including payment for services, in order to reduce demands on the national and regional government budgets.
- Develop a harmonious and well-motivated working environment to sustain prime class service for public demands through competent management of water resources infrastructure for stakeholders' satisfaction.

Scope of work for SRBMA

The basin Agency should develop master plans (including coordination with related agencies) in conservation, water-resources development, water-pollution control, and flood control and land use of riverbanks. It should operate and maintain water-resources infrastructure, manage water and water resources and carry out watershed conservation in coordination with related agencies.

It may be highlighted that to address the ecological issues threatening the Satluj river's power potential, SJVN has already taken an initiative to launch a Satluj Basin Power Producers Forum and it has been launched formally in November 2005. The combined forum would develop a comprehensive approach towards problems of high silt content, flash floods and evolve a strategy for the plans related to environmental issues and data sharing systems for mutual benefits. The forum will offer technical expertise for environmental management and general area development. It is proposed to work out an integrated catchment area treatment plan and strategies so as to provide opportunities of joint learning and avoid duplication of efforts and expenditure.

6.1.1 Forum of Hydropower Developers of Satluj Basin

I. Preamble

The power potential of Satluj basin has been estimated at more than 10,000 MW installed capacity. 17 power plants of capacity 100 MW and above have been identified in Satluj basin, of which four are under operation, two under construction and others in the planning/ investigation stage. Presently, only Bhakra dam is a storage dam project on Satluj river. Kol dam project, immediately upstream of Bhakra dam, has a limited life of 18 years to function as a storage dam after which it has also to operate as a run-of-the-river plant. Nathpa Jhakri Project, the biggest power plant on Satluj with an installed capacity of 1500 MW is also a run-of-the river scheme. Although most of the other projects on main Satluj river and its tributaries are planned as run-of-the-river schemes, but keeping in view the acute silt problems in such schemes, a thinking has been generated that it is necessary to have some storage dam projects in the Satluj basin for improving functioning of downstream projects. Satluj river largely runs through a narrow gorge upstream of Kol Dam and enough storage at just one dam site with reasonable height of dam between 200-250m is not available. Reservoir flushing from the diversion structure at the existing/ proposed power plants is an essential part of operational strategy and flushing may also have to be resorted to through the envisaged storage dams to prolong their life.

As there are power plants in cascade in Satluj basin and there are numerous developers in the Private sector, State sector and Central sector operating in the basin, a consensus on co-operation strategy, for operating existing as well as planned power plants, is essential. It is also necessary to reduce the impact of silt which would yield beneficial results to all the power plants operating/ planned in the basin. Long term measures for silt control like catchment area treatment through vegetation, toe walls and bench development to stabilize slide prone areas, check dams etc. are essential. Since the benefits of silt control measures in the catchment shall flow to all the power plants in the basin, it is necessary to share the expenditure on these measures as it involves not only huge expenditure but one or two projects cannot be loaded with extra cost which would offset basic viability of the projects.

Further, the basic inputs for planning of the power projects in Satluj basin are the river discharge, silt load and other meteorological parameters. Presently, there is duplicacy in observing these data and agencies like BBMB, HPSEB, SJVNL, CWC, NTPC etc. are recording the data to meet the requirement of an individual organization. Since the planning and development of the power potential in the basin keeping in view peculiar considerations, has to be based on systematic basin analysis, it is necessary that a joint understanding on maintenance of these observation sites and exchange of data between various organizations be resorted to as per their requirement thereby not only curtailing recurring expenditure but also avoiding duplicacy. Similarly, testing laboratory could be upgraded with the state of the art facilities on shared basis.

Treatment of the catchment area through CAT plans and other measures may also be done in a comprehensive manner for the whole of the basin.

There are certain laws, regulations and guidelines issued by various authorities including Govt of India & State Govt. which have an impact on the working of power projects in Satluj basin. The latest is the requirement of minimum discharge in the river during lean season. There is a need for power producers to take up such matters jointly.

While operating power stations in cascade as is likely to be the case in Satluj basin, several issues are likely to come up and co-operation would be required amongst all the power producers.

It is to the above ends, that a permanent Forum of Hydropower Producers of Satluj Basin is desirable.

II. OBJECTIVES

***To** cooperate and monitor schemes & strategies under the following **"Five Point Programme"** as hereunder to achieve common goals and objectives and suggest means & measures for their effective / efficient implementation and to explore the possibility of fruitful cooperation in the energy sector, beyond the initial scope of Forum amongst the member organizations and other Regional / Basin wise or individual organizations engaged in Energy Sector.*

1. Environment:
To join efforts to pursue the goal of eco-friendly energy and to evolve integrated Catchment Area Treatment Plan for the Satluj Basin comprising afforestation, check dams and slope stabilization.

2. ***Operation of Power Stations & Sharing of Technical Expertise and Experience***

To join hands for comprehensive planning of operations of power stations in the Satluj Basin for unhindered operation and optimized utilization of run off and to pool the expertise to tackle eventualities of operation outages due to floods or mishaps to achieve reliable energy for the people of India for a sustainable economic growth.

3. ***Data Sharing***

To create, upgrade and share facilities to generate input data such as discharge data, silt data, meteorological data and share / utilize common Laboratory testing facilities.

4. ***Disaster Management and Planning***

To develop and implement effective flood forewarning and disaster management systems.

5. ***Common Issues with State Government & Government of India***

To share views and derive common approach towards implementation of guidelines and statutes of State / Union Government and communicate constructive suggestions / modifications / alterations.

III. CONSTITUTION

i) Chairperson:	*CMD/ CEO of one of the member Organizations by rotation.*
ii) Members:	*All CEOs of Member Organizations, one Director/Member and Nodal Officers appointed by the Member Organizations*
iii) Member Secretary:	*Nodal Officer of the Organization whose CEO is Chairperson.*
iv) Working Committee:	*All Nodal Officers appointed by the Member Organizations.*

IV. TENURE

The tenure of the representative body is perpetual and the Chairperson shall be one of the CMDs/ CEOs of the member organizations for one year on rotational basis.

V. SCOPE

The Forum shall deliberate issues concerning member Organizations, related to the Objective, suggest strategies/ programmes and take up common issues with the Union/ State Governments.

VI. PERIODICITY OF MEETINGS

The Forum shall meet on quarterly basis minimum or at such frequent intervals as deemed necessary at the level of Nodal Officers representing member Organizations. The Forum shall convene a Conclave of Member Organizations on Annual Basis to be attended by the CMDs/ Chief Executive Officers of Member Organizations. The Meetings / Conclave shall be hosted by the organization to which the Chairperson for the tenure, belongs.

Functions of Forum Of Hydro Power Producers Of Satluj Basin

*The Forum shall formulate / implement and monitor schemes & strategies under a **"Five Point Programme"** through cooperation amongst the member organizations.*

1. Environment

The Forum realizes the importance of preserving the environment and maintaining the nature's balance. Hydropower, utilizing an environment friendly & renewable resource flowing in our rivers can further contribute towards this end by devising the Catchment Area Treatment Plans in a manner suitable to the region and benefiting the local populace together with the control of soil erosions, landslides and taking up afforestation.

The Forum shall discuss amongst the member organizations to evolve an integrated Catchment Area Treatment Plan for the whole of Satluj Basin to avoid any duplication and use collective wisdom & experience in tackling the problem areas specific to the basin. The Forum shall hold discussions with the Forest Department, GOHP and seek their advice in the formulation of the Integrated CAT Plan. The Forum shall develop a mechanism to monitor amongst the power producers themselves, to monitor that the Projects in the basin do no harm to the river water by pollution and dispose the muck at designated sites in the prescribed manner.

2. Operation of Power Stations and Sharing of Technical Expertise & Experience

The Forum shall discuss and finalize the operation of already commissioned Power Stations in the Satluj Basin for avoiding any hindrance and optimized utilization of run-off. A plan shall be prepared for the upcoming Power Stations in the basin.

The Forum shall pool the expertise available with the member organizations to tackle eventualities of operation outages due to floods or mishaps to achieve reliable energy for the people of India for a sustainable economic growth.

3. Data Sharing

The Forum shall discuss and formulate a Plan to generate input data in respect of discharge, silt & meteorological observations and share / utilize common Laboratory testing facilities. For the purpose, the member organizations shall be asked to submit the information regarding the existing facilities concerning hydro-meteorological data and their extent on time scale along with the Laboratory testing so as to plan the requirement catering to the Basin as a whole, their up gradation and the fund needed/ sharing pattern for the same.

4. Disaster Management and Planning

The Forum shall share the experience of the member organizations in tackling the flash floods and eventualities arising out accidental flooding or massive landslides. The experience in crisis management and long term measures adopted for the remedies such as forewarning shall be discussed.

The data on the latest systems/ techniques available around the Globe shall be collected to plan and place in position the state of the art Flood Forewarning and Disaster Management System. Dedicated cells shall be planned to cater to the requirement towards this objective and the necessary training shall be organized for the concerned personnel in individual member organizations.

*5. **Common Issues with State Government & Government of India***

The Forum shall discuss the issues common to the Member Organization with respect to the guidelines and statutes of GOHP/ GOI and formulate a common approach for taking up the issues and shall present before the concerned Governments, constructive suggestions for any modifications or alterations.

The Forum shall also look into the possibility of enhancement of its scope of cooperation with the Power Developers engaged in the Energy Sector in general and those in the other river basins of Himachal Pradesh.

6.1.2 Issues related to Catchment Area treatment

It is well established fact that the reservoirs formed by weirs/dams on rivers are subjected to sedimentation. The process of sedimentation embodies the sequential process of erosion, entrainment, transportation, deposition and compaction of sediments. The study of erosion and sediment yield from catchments is of utmost importance as the deposition of sediment in reservoir reduces its capacity and thus affecting the water availability for the designated use. The eroded sediments from catchment when deposited on stream beds and banks causes breaches of river reach. The removal of top fertile soil from catchments adversely affects the agricultural production. Thus a well designed catchment area treatment plan is essential to ameliorate the above mentioned adverse process of soil erosion and maintenance of ecological balance including atmospheric equilibrium which is vital for sustenance of all life forms, human, animal and plants of valleys. Therefore proper soil and moisture conservation treatment, bio-engineering works, habitat improvement by way of incentive management of wildlife sanctuary and eco development activities are required to be carried out in the catchment area. The human and cattle population living and around the area are dependent on natural resources of forests because of which a greater emphasis has to be laid to undertake afforestation, pasture development, bio-diversity conservation with soil and moisture conservation works in the catchment area including eco development activities panchayats with the provision of alternative sources of domestic energy on a subsidized basis (50% cost to be given by beneficiary) to reduce pressure existing forest areas.

The Satluj river basin has been studied from the soil erosion vulnerability point of view. To ascertain soil erosion intensity parameters, a universal soil loss equation (USLE) modelling has been carried out. The following thematic layers were used for the modelling purposes:

- A latest land use map derived using latest satellite imageries of the basin
- Slope map derived using digital elevation model (DEM)
- Soil map of the area

Based on the modelling results, a thematic map for soil erosion intensities have been shown in Chapter 5, Fig 5.2. It is inferred from the modelling results that area in and around Karcham area up to little upstream of Nathpa dam is most vulnerable to soil erosion. Catchment area treatment measures should be undertaken in an integrated for vulnerable areas of the entire Satluj basin. The Forum for hydro power producers have already decided to discuss amongst the member organizations to evolve an integrated

Catchment Area Treatment Plan for the whole of Satluj Basin to avoid any duplication and use collective wisdom & experience in tackling the problem areas specific to the basin. As there are many protected areas in the basin, the CAT measures should keep focus on PAs also.

The Catchment area treatment should mainly focus on:

- To achieve in situ and ex situ conservation and also ecological rehabilitation in the projects areas leading to an all round eco-development activities on sustainable basis.
- To initiate measure to rehabilitate the degraded habitat through afforestation of native species and assisting of natural re generation
- To improve alpine pasture land for augmenting grass and fodder availability and to solve the problem of grazier
- To carry out soil conservation measure in the catchments to ensure longevity of projects
- To increase the potential/production of the bio mass in the area and to ensure sustainable use of natural resources
- To provide employment to the local people by engaging them in project activities such as afforestation, fire , anti poaching, rural infra structure activities and other works except soil conservation works
- To build capacity of PA's staff in wildlife management skills by providing training in India and abroad to meet the challenges of 21st century
- To strengthen the extension and follow –up activities i.e. monitoring and evaluation of wildlife management and forestry development activities, publicity, motivation and extension programme to be given the desired focus

Components of CAT

CAT plan project should be designed to develop the project area in an integrated manner by improving the vegetative cover over the degraded and blank areas and also to treat flood prone areas to stabilized nallah, river banks and landslips by providing suitable bio-engineering structure and various soil conservation measures. Apart from that one of the most important parts of successful wildlife management, habitat improvement and its manipulation as per the needs of wildlife conservation along with anti poaching, fire control measures with mitigation of human-wildlife conflict in PAs. The important steps to be undertaken in this regard during the project period are as under:

- Management of protected areas- in situ conservation
  - Habitat improvement
    - Biological works
      - Afforestation of degraded forest land
      - Enrichment plantation
      - Assisted natural regeneration
      - NTFP (non timber forest produces) plantations
      - Nursery development
        - New nurseries development
        - Maintenance of nurseries

- Treatment of culturable waste land
- Treatment of alpine pasture
- Construction of water holes

- Soil and moisture conservation
  - Landslides/slips stabilization
  - Nallah stabilization
  - River bank stabilization
- Protection of forest and wildlife
  - Fire protection
  - Anti poaching measure
  - Demarcation of boundaries and construction of boundary pillars/check pillars
  - Construction of forest barriers/check posts
  - Communication network in Pas
  - Sign and slogan boards
  - Reward/incentive to informers
  - Wildlife census operation
  - Compensation against wild life depredation

- Mitigation of human-wildlife conflict

  - Eco-development activities
    - Village support activities
      - Distribution of CGI sheets
      - Distribution of GI pipes for installation of religious flag
      - Construction of Sulabh shauchalayas
      - Construction of cattle pond
      - Construction /repair spring water bowaries
      - Vaccination of domestic cattle
    - Fuel saving devices
      - Distribution of LPG cylinders
      - Construction of crematoria
      - Distribution of solar lights
    - Income generation activities (IGA)
      - Vermi composting and organic farming
      - Raising of nursery and cultivation and sale of NTFP
      - Bee keeping
      - Flori culture
      - Extraction and sale of oil from stone fruits
      - Agricultural improvement/horticulture and vegetable farming
      - Animal husbandry support and dairy development
    - Sustainable eco-tourism development
      - Construction of trekking routes
      - Development of camping sites
      - Training of local youths for tourism activities
      - Maintenance of local temple as local cultural, heritage and hill architecture
    - Field equipment and medicines for management of wild life sanctuary
    - Development of forest infrastructure in PAs
      - Construction / maintenance of B/paths and I/paths

- Construction of I/hut
    - Construction of building/transit camp
    - Construction of information hall/training hall
    - Construction/repair of bridges
- Research and studies
- Training of forest officers/officials in India and abroad
- Publicity nature awareness camp, exposure visit and extension programmes/workshops/meeting and evaluation etc
- Operation support/establishment

CAT measures formulation objective should also be to improve the productive potential of natural resources and increase incomes of the rural households using socially inclusive, institutionally and environmentally sustainable approaches. Improvement in soil fertility of the existing arable lands though environment friendly technologies by emphasizing the use of biological inputs should be considered. The synergies between different watershed development programmes in the basin would lead to favourable impacts in the form of reduced soil erosion, increase in green cover, fodder sources, people's participation, equitable sharing of benefits, transparency leading to enhanced incomes etc. The implementation of catchment area treatment measures should be over by the dam construction is complete. Only maintenance could exceed beyond the construction periods.

6.2 *Institutional Issues*

Recommendations for state

Out of total geographical area of 55673 sq km, the reported area of Himachal Pradesh is 34024 sq km up to the year 1994-95 which means that an area of 21648 sq km is yet to be surveyed. Though there are two settlement circles working in the state yet the priority assigned for taking up settlement operations does not seem to have adequate considerations. It is also observed from State of Environment report that state owned forests have increased merely by 35 sq km during past 29 years which can not be termed as satisfactory progress for a hilly state HP. Suitable policy guidelines are required for government to document on forest for right holders for extracting timber and from grazers for grazing their cattle needs.

- The vestment of village common lands in the government since early seventies the village community believes that maintenance, preservation and regeneration of forests in general is the duty of state government.
- There is also a need of proper management of vast wasteland for which demarcation programme is already going on. This requires monitoring and proper coordination
- The problem of soil erosion in vast wasteland for the depleted and degraded forest produce must insure that the off take is less than regeneration. The average annual removal of trees is about 4 lakh cubic m which is quite high. Afforestation programmes must reckon on with this rate.
- It is also important to initiate necessary measures to preserve the run-off water and also to strengthen the irrigation base by making maximum use of available

water resources as this will help in improving land use pattern. It has been observed that net irrigated area has increased from 16.6 % to 17.7 % for last 29 years which is not at all an encouraging trend.

- Landuse pattern improvement has to be planned properly by state landuse board (SLUB) whose functioning is yet to be improved.
- Flori-culture needs to be strengthened along the stretch of Satluj basin
- Realizing the role pof irrigation in agricultural production, the ministry of water resources has laid new thrust on farmer's participation in management of irrigation. This needs an improvement in HP
- Tourism is being developed as stand alone development in the region. However carrying capacity analysis and EIA be used as pro-active development control tool in developing tourism projects.

The above issues make us to understand that so far, government of HP has not come up with a detailed development plan in the Satluj basin in view of various hydro and other developments. The state must introduce an integrated development plan of various sectors in Satluj basin for which a sincere effort based on detailed carrying capacity study of the basin keeping in view environment and development side by side is an urgent an important solution.

6.3 Business solutions for Effective Management

To achieve sustainable development in river basin, the budget for river basin management needs to be secured. This requires beneficiaries to gradually bear the cost for the river-basin management through the application of the following principles.

- The beneficiaries-pay principle consists of the users-pay principle, where the water users pay water use fees and taxes; and the polluters-pay principle, where the water polluters pay pollution fees and taxes.
- The government-obligation principle applies for funding semi commercial water use (hydro-power, irrigation etc) and social services (flood control, water-quality control, water-resources conservation).
- The participation of Private-Sector should be explored and promoted in all hydro development projects taking place in Satluj /river Basin to keep a regular flow of capital in order to take up the various development activities in the river basin

The basic concept of private sector participation is as follows:

- Private sector participation means a concession given by the government.
- The private sector has a right to have revenue.
- The government gives protection, assurance and regulation.
- Private-sector participation does not overburden the users.

Water and water resources may be developed by the private sector under the conditions that:

- The water user should have a license from the government.

- The water use is based on a principle of cooperation.
- The water user should keep conserving the ecosystem.

Water is an economic good that has a social function as well so that it should not be managed merely commercially or merely socially. Based on this concept, private sector participation in the development and management of water resources could be carried out through a partnership with the SRBMA. The SRBMA functions as the government's agent in managing water resources to keep the balance of the two, in order to achieve the business purpose as well as to keep the public service.

To improve governance in water-resources policy, a cost-allocation concept of beneficiaries' contribution to the water-resources management cost should be prepared by applying economic instruments, e.g., the full cost-recovery principle.

6.4 Water Management in Satluj river Basin for managing the use of water for irrigation, human consumption etc.

Water-resources development is an attempt to optimally use water potentials and prevent loss of capacity. Considering the uneven distribution of water availability during the year, it may be necessary to carry out water-resources development so that economic development could be achieved without compromising the water needs linked to people and ecology of the area.

In the upper reaches, reservoirs are built/ proposed to control floods and silt, store water during the rainy season and to supply water in the dry season. In the middle and lower reaches, barrages and intakes are built for various purposes (irrigation, industry, drinking water, etc.). Water resources development should use a holistic approach, well planned, with sustainable and environmentally sound management, performed in stages, reviewed and adjusted to the government's national policies.

Adoption of Water-resources management practices in the Satluj river Basin will enhance the development benefits and prolong the life of the water-resources infrastructure. In water resources management, O&M are the main activities during the post- development phase of managing the water-resources infrastructure. Operation is an attempt to control and allocate water and its resources to achieve optimum utilization according to the purpose and minimize negative impacts, such as flood and drought. Maintenance is an attempt to securely sustain water resources, infrastructure and the environment.

Watershed conservation should include re-greening of the area, reforestation, terracing, and other related activities in the frame of increasing sustainability of the watershed. To implement watershed conservation, it is necessary to establish coordination among related institutions. The Satluj River Basin Management Agency (SRBMA) shall play an important role, especially preparing recommendations on the water-resources conservation program based on a Watershed Conservation Master Plan.

The SRBMA should issue technical recommendations on applications for water use licenses. Water allocation is an attempt to manage a reservoir operation pattern (planning) based on demand proposals and water availability prediction. This allocation plan could be discussed with all concerned governmental agencies for their common consensus and approval for implementation. Water distribution is an attempt to operate water resources infrastructure in order to distribute water to beneficiaries according to the agreement.

6.4.1 *Satluj River-environment management.*

River-corridor maintenance controls river corridor land use to protect the function of the river-safety area and to increase the benefit of the river for tourism and water sports. In any management practices, the river basin management agency cooperates with related institutions and authorities. The SRBMA should implement the river-environment land-use management practices by preparing land use patterns (planning) based on local and regional spatial planning through close coordination with related institutions in the basin.

6.4.2 *Water-resources infrastructural management.*

The SRBMA should implement the water resources infrastructural management practices mainly related to maintenance. Preventive maintenance takes the form of routine and periodic maintenance, and small repairs to prevent serious damage. Corrective maintenance covers large-scale repair, rehabilitation, and rectification to restore and increase the functions of the water resources infrastructure. Emergency maintenance involves temporary repairs that have to be done urgently due to an emergency condition, such as a flood. A water-sector apex body should manage coordination framework for water resources. The apex body, comprising various regulators concerned with development and management of water resources, together with stakeholder representatives, should be responsible for guiding the development and management of water resources. The apex body will give guidance in policy formulation, resource allocation, program implementation and regulatory control in general and inter-sectoral coordination and issue resolution in particular.

6.4.3 *Research & Development Work (R&D)*

To carry out water management activities, it is necessary to follow knowledge development and proactively try to introduce innovations both in technology and management systems. To properly carry out water resources management in the Satluj River Basin, the SRBMA should carry out R&D programmes, through cooperation with both national and international institutions.

6.4.4 *Data networks and management information systems.*

Data sharing and information systems among government agencies should be developed and operationalized. The SRBMA should develop a water resources data center for society and concerned agencies.

To promote sustainability of hydrological operations and data, hydrology institutions and organizations should have appropriate administrative and budgeting arrangements along with a personnel program.

6.4.5 *Stakeholder Representation*

To promote stakeholder participation, a permanent group of stakeholders, NGOs, and public representatives should be part of the apex body. These committees, are supposed to be coordination bodies where decisions on management policies (planning, implementing, supervising, controlling, and funding) in their respective areas are made.

This basin committee should also has a technical team for each activity area including activities related to water allocation and flood control but it should be expanded to cover other areas as well, such as watershed management and water- quality control.

6.4.6 Technical aspects.

To improve water-resources management by means of enhancing R&D activities, individual capacity-building and demand- and supply-management techniques, the decision support systems in all engineering aspects of water-resources management, covering database management systems should be considered.

6.4.7 Management aspects.

To promote protection and conservation of resources in the river basin, the following activities should be considered by SRBMA:

- Public and private participation in water-resources development and management will be more widely opened.
- Due to the decentralization policy, the local governments are supposed to receive part of the revenue from the natural resources in their respective areas.
- Water-resources management should be undertaken in an integrated (multi-sector), comprehensive (upstream-downstream), sustainable (intergeneration) and environmentally sound concept, for fair and just results. In line with this ideal, the river basin as a hydrological unit is considered as one management unit, under implementation of the decentralization concept in an autonomous spirit that embraces river-basin management trans-boundary aspects.
- Entire river basin should be managed by a neutral and professional institution that applies healthy corporate principles and general utilization norms in water resources, based on public and private participation. Participation of the public and private sectors and of the community is an important aspect in performing better water-resources management in the context of the paradigm shifts.

6.4.8 Decision Support System (DSS)

A spatial distributed system has to be considered which is subdivided into a number of spatial elements. A DSS should also be able to handle different temporal scales (e.g. based on different scenarios of future developments). As the object of planning is a natural system which depends on a complex of influencing factors, a large variety of data and information has to be considered. These data are provided by different disciplines. Sustainable river basin management requires a cooperation of ecologists, hydrologists, water managers, computer scientists and socio-economists (refer Figure 6.1).

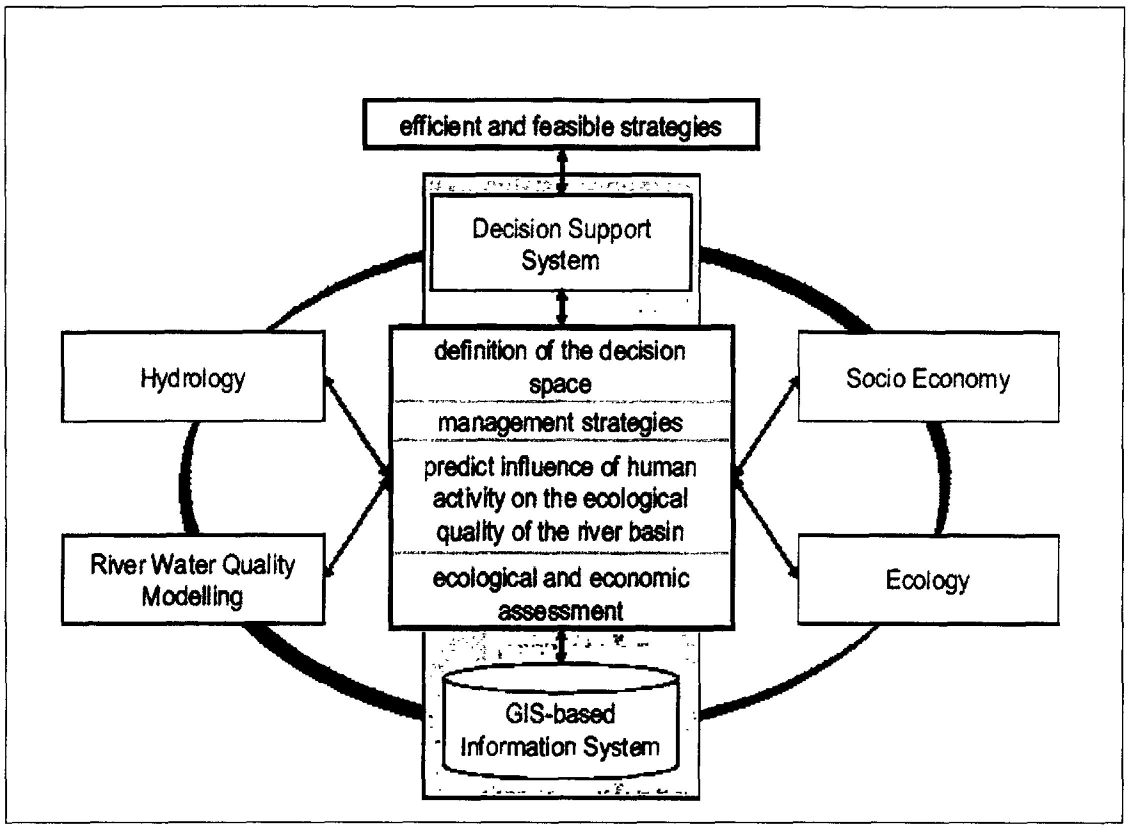


Fig 6.1 *Decision Support system*

Local measures and regional management strategies should be planned and synchronized in cooperation with local and regional authorities and stakeholders. Under consideration of their different spatial scales the possible ecological consequences of measures have to be assessed based on simulation models or expert knowledge.

In some cases monitoring programmes have to be initiated to provide better data and information about the different quality elements. Costs, benefits and possible conflicts have to be estimated with socioeconomic methods under different management schemes and under consideration of different baseline scenarios. Resulting from these activities a multi-criteria analysis has to be applied in order to find the most cost-efficient, feasible combinations of measures according to the preferences of decision makers. The most cost-efficient, ecologically effective management strategy has to be selected combining different measures. But not only efficiency and costs of technical measures have to be considered but also the social impacts of these measures which depend on the transfer of benefits and burdens related with them.

Decisions about the River Basin Management Plan should be based on an assessment of the cost efficiency of various possible management strategies at river basin scale mainly. The possible exceptions from the environmental objectives at water body scale demand a comprehensive consideration of the socio-economic circumstances as well as the interdependencies within the river network. Setting exceptions at one water body can influence the achievement of the good ecological status of other water bodies (e.g. regarding ecological continuity for long-distance travelling fishes). Here decision makers need aggregated information about possible strategies and their effects. But also the boundary conditions which form the constraints have to be analysed to determine the chances to realize these strategies. The economic importance of existing water and land uses and existing legal restrictions should be known. To implement this, many different criteria have to be considered to ensure the one, but very complex objective of a good ecological status. This results in a problem of multi-criteria decision making (MCDM).

The different steps of the decision process developed in the Satluj basin are shown schematically in Figure 6.2.

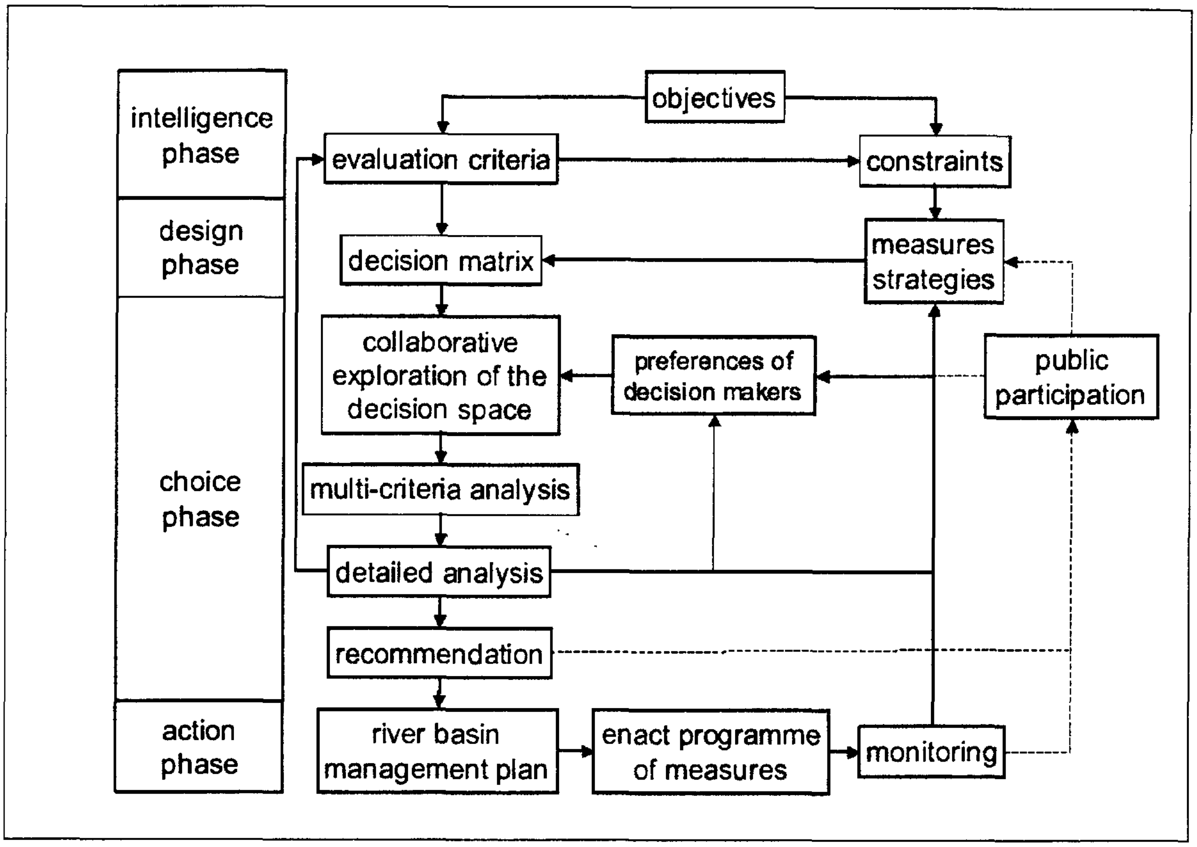


Fig 6.2 Steps involved in decision making

Measures are prepared in the design (or planning) phase, where they are also aggregated into alternatives (= alternative proposals for the programme of measures on basin scale). Decision making is seen as a collaborative process. Thus the exploration of the decision space and the application of a multi-criteria analysis take part in the choice phase. Public participation can be supported at different levels: information, consultation or active involvement. The participation demands new tools which ensure transparency within the decision processes. These tools should be able to visualize the different criteria mentioned above in a way that supports the negotiations among stakeholders.

Tools for decision support in the implementation

The design of the spatial decision support system for integrated management of the basin is based on a central logical model of work- flow, objects and methods on the one hand. On the other hand software services are provided to planners, decision makers, administration, NGO's and stakeholders for support of decentralized collaborative negotiation and decision procedures:

- display and analysis of the state of the water bodies, deficits, spatial representations of measures and their consequences using an internet enabled Geographic Information System;
- support for access, organization and documentation of the different steps of decision making via an assistant like, internet based user interface;
- multi-criteria exploration of the decision set, setting of a reasonable goal and search for efficient measures close to the goal.

6.5 *Interventions for reducing the impacts of flood*

Flood losses are most devastating natural disasters in the area. The frequency of floods has increased in past few years (ref. Figure 6.3). Last flood was occurred during year 2002 that caused huge loss in terms of human lives, infrastructure loss, investment loss in form of failure of hydro power projects etc., loss of agriculture etc. Climate change phenomenon compounds the existing challenge of managing the flood loss.

It becomes a necessity to come out with proper remedial action plan as a safeguard to natural flood hazard to avoid human and infrastructure losses. Our prime concern here is to come out with the interventions for concerned institutions to control the floods and flood related disaster risks. The following planning instruments are needed:

☛ **There is a need to avoid the institutional traps to make flood management practices to be successful. The following are suggested to incorporate under institutional mechanism:**

- review the existing water sector policies, strategies, priorities, and investment plans for management with particular emphasis on reducing the adverse impacts of floods in the down stream and review of institutional arrangement that influence who is at risk to flood and other interacting stressor;
- assess the completeness and adequacy of the existing flood management plan based on technical, institutional, environmental, social, economic, financial, and other relevant factors;
- assessing the institutional influence on capacities to cope and adapt the risk;
- adjustment of policies and strategies, and institutional strengthening, improvement of coordination, legislative reforms, financing, cost recovery, and standardizing the justification of proposed works;

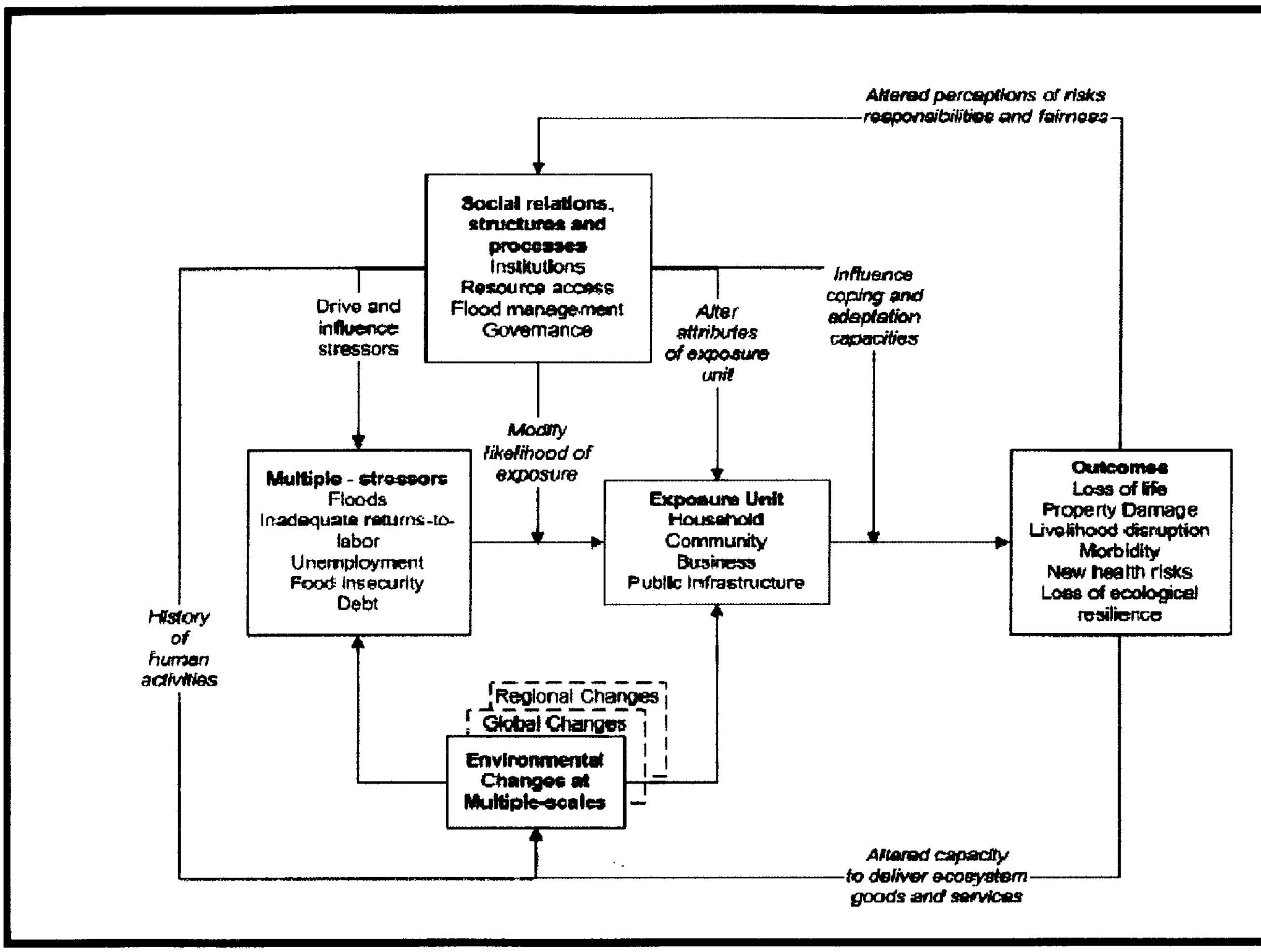


Fig 6.3 Various Environmental & Social aspects linked to natural Flood Hazard

- help integrate sound environmental management and increased social awareness into the planning, design, and implementation of flood management;
- assess the need for improved flood forecasting, flood warning, and disaster preparation; and
- prioritize flood management interventions in River basin.

☛ **There is a strong need of Policy Dialogues with respect to following**:

- coordination between central, sate and local level agencies whose activities relate to flood management;
- flood plain zoning and flood risk mapping
- financing of capital investment and operation and maintenance costs;
- cost recovery;
- control of encroachment in areas in downstream

- enhancement of positive environmental impacts wherever possible through adjustment of the arrangement and function of project interventions;
- rationalization of design standards and approaches to planning flood protection;
- environmental concerns adhere strictly to the Government's environmental laws/rules, the policies and guidelines.

Environment Impact and Mitigation

- by approaching flood protection as a particular application of natural resources management throughout the entire river basin, overall environmental improvement planning for the basin is required.
- environmental impact assessments (EIAs) and Summary EIAs should be made available to all stakeholders involved in the flood management work inside
- review and improvement of existing flood protection measures in a consistent manner to avoid the negative environmental impacts to be severe.
- integration of environmental considerations at provincial level into the planning, design, and implementation processes to ensure that potentially negative impacts will be avoided or reduced to an acceptable limit, and to enhance the long term sustainability of all such measures.
- there is also a need to increase the awareness throughout the community of the value of environmental safeguards as opposed to short-term solutions to isolated problems.
- planning for dam safety and related remedial measures in the area
- protection and restoration of flood retention basins;

Link efforts across government agencies and local communities: Effective flood management can protect million of people, their property and livelihoods if social aspects linked to the flood management programme are carefully handled

- flood management plan should include building controls and planning measures aimed at increasing the safety of humans against flood hazards, and the possibility of extending such initiatives should be reviewed from time to time.
- appropriate planning should be done to avoid adverse effects on poor households,
- plan should include all measures to ensure that benefits reach the poor and help alleviate poverty and this should consider the perceptions of the people in terms of discourses and social practices
- social analyses should be conducted, and detailed socio-economic profiles should be prepared for all vulnerable groups and for all groups who would be adversely affected by the proposed flood protection works.

- all local NGO's or village level groups working for flood management should involve right from the planning stages to make the local village people understand about the benefits of flood management work

6.6 Specific Recommendations for managing environmental and social issues

The flow of river at Jhakri outfall location is proposed to fully divert through 15.1 km headrace tunnel under Rampur Hydroelectric project and the same would be again released to the river at Bael, which is at d/s but since there are no existing or proposed irrigation/ water supply schemes linked to river Satluj, thus no significant impacts are anticipated. The natural springs, khads, chashme and bowli (kachchi and pukki) or tributaries flowing in vicinity are the key sources of water for villages falling along the river stretch. Majority of these sources are perennial with seasonal variations in the water flow. The discharge rate varies from 0.7 l/sec to 0.005 l/sec. The same source is used for all purposes, including drinking, cooking, bathing, livestock rearing, etc. Irrigation in the area is rain fed or water demand for agriculture practice is being fulfilled by khuls (canal). As reported by the IPH, Rampur, their water supply schemes are also dependent on natural springs/bowlis located on upper reaches of mountains, hence, the reduced flow in the river due to proposed project will not hamper the water supply schemes in the area.

It is advised to take following pre- project precautionary measures:

1. Adequate measures should be taken during blasting process for construction of tunnel so as to avoid /minimize the impacts on already laid IPH water supply lines or storage tanks.
2. Regular monitoring is proposed to be taken up by concerned agency to check the flow variations of springs/chasme to keep a check on any negative impact of blasting or construction activity on drying of springs. However, SJVNL has already taken up monitoring work for project affect areas, the same should be extended to adjacent areas depending on complains received from particular village.
3. The lesser flow in river especially during lean seasons would impact the dilution of sewage and hence, as pre-project measurements, SJVNL should take up the issue with IPH and other concerned agencies for strengthening and expansion of existing sewage treatment facility.
4. Awareness and education programmes should be planned and be executed with regard to the following:
   1. use of soak pits in all villages falling to avoid open defecation practice, which is prevalent in the area
   2. installation of bio gas plant should be encouraged in the area
5. use of soak pits and to avoid the open defecation in the area and to encourage the installation of bio gas plants in the region should be taken up in villages falling in the area

6. Periodic monitoring of stream flow should also be carried considering the long-term planning needed for the region.

The river water quality along different stretches should be regularly monitored to establish the time series variations in river water quality and to observe any changes on quality of river due to running of turbines at proposed powerhouse. The following parameters may be monitored considering the existing values in mind:

River flow measurement at two or three intermediate locations	Dissolved Oxygen
Temperature of river water	BOD
Conductivity	Alkalinity
Turbidity	Total Hardness
Total Solids	Calcium
Total Dissolved Solids	Sodium
Total suspended solids	Chromium
pH	Nickel
Sulphates	Mercury
Fluorides	Chlorides

Land Environment

To conserve the existing land use of the area, land areas taken for the purpose of muck disposal sites, borrow pits, temporary camp sites, landfill sites, waste dumps etc should be monitored and treated as per requirements. In addition, change in the existing land use pattern should be monitored once in five-year using satellite imageries.

Health of Habitats

The construction activities that are taking place because of the hydropower project in the area will involve the engagement of a work force in the area, thus changing the population density and increasing the floating population during construction activities. This may result in a change in the existing health scenario due to increased pressure on existing infrastructure i.e. water supply sources, sanitation, etc. It is required to take following precautionary measures:

1. make local people aware about the diseases through organizing village level educational programmes
2. Close monitoring should be done to keep check on no. of patients suffering from water borne diseases and data should be well procured
3. Health care infrastructure building including more number of ambulances, more number of beds in existing hospitals, adequate medical care equipments in hospitals and clinics and transfer of competent and senior doctors to Government hospitals .

Erosion and Siltation

Soil erosion rates, efficiency of Soil conservation measures, needs to be closely monitored periodically. To do this all concerned departments should be involved for data and information sharing.

Ecology

With the help of Forest department and Fisheries Department, status of afforestation programme, changes in species composition of the terrestrial and aquatic fauna and flora should be monitored and adequate steps should be taken to conserve the aquatic and terrestrial habitats in terms of endangered species i.e. identification of spawning grounds, conservation of stream flow, development of new paths for migratory fishes for spawning etc.. The parameters to be monitored regularly for aquatic ecology are discharge of water at Jhakri tail race point and at powerhouse in down stream.

Infrastructure Building

Due to heavy influx of floating population near the project sites, great pressure is observed on existing infrastructure i.e. water sources, sanitation, solid waste, road conditions, medical facilities etc. It is advised to take up the issue with concerned agencies for better infrastructural facilities especially at Rampur and Bael.

Any induced development directly attributable to RHEP project

The increasing population of Rampur and near by areas due to massive project development will definitely put pressure on existing infrastructure facilities which, will further affect the health of the local environment including human population, aquatic & terrestrial ecology and of course the river/streams. Diversion of water from Jhakri to Bael through tunnel will leave dry conditions in river, which will restrict use of river water in future that could be otherwise foreseen in future with growing population and increasing needs of the area.

6.7 *Various Trade offs involved in Hydropower projects vis–a-vis. Decision making*

Hydropower has several advantages over most other sources of electrical power, including a high level of reliability, very low operating costs, and the ability to easily adjust to load changes. Also, hydropower does not contribute to air pollution, and reservoirs can also be used for recreation, water supply, and flood control. However, like all electricity options, hydropower involves trade-offs. Hydropower dams can cause environmental problems, such as modification of fish habitat through altering of stream and lake levels.

Advantages Of Hydropower	Disadvantages Of Hydropower
Renewable Resource	High Initial Cost Of Facilities
Fuel Saver	Precipitation Dependent
Flexible To Meet Load	Changes In Stream Flows
Efficient	Inundation Of Land And Wildlife

	Habitat
Reliable And Durable	Loss Or Modification Of Fish Habitat
Low Operation And Maintenance Costs	Fish Entrainment And Passage Restriction
Proven Technology	Changes In Reservoir And Stream Water Quality
No Atmospheric Pollutants	

Hence, before initiating the project development, the developers of dams and hydropower projects need to fully understand the ecological requirements of water bodies and downstream flow-related social consequences, and to account for the trade-offs between project benefits and the environmental and social costs involved and make well-informed and intelligent decisions. While careful planning and operation of hydropower facilities can minimize environmental damage, environmental costs may prohibit the development of hydropower in some areas.

With regard to this issue, The World Bank has developed special environmental and social "safeguard" policies. These policies define minimum requirements to be observed in projects and cover:

- Environmental assessment;
- Forestry;
- Indigenous peoples;
- Involuntary resettlement;
- Management of cultural property;
- Natural habitats;
- Pest management;
- Projects in disputed areas;
- Projects in international waterways;
- Safety of dams.

Projects affecting one or more of these categories require special attention throughout their selection, planning, implementation, and operation.

Structured Decision-Making is a concept especially relevant for large and/or regional dams and multi-purpose hydro projects, where multiple decision makers (not only at the national level, but also at the regional and local level) and many stakeholders with multiple objectives, working under highly complex political and socio-economic environments need to make the most effective decisions they can. SDM can improve the decision-making process by incorporating a structured process in the evaluation multiple issues involved in the preparation of a complex infrastructure project (i.e jurisdictional overlaps and dependence on cooperation outside of laws and legislation, scientific uncertainties, social and environmental issues, and trade offs across high-stake values, among others). As demanding as it is, the ability to make clear, effective decisions about dams and river management in an efficient manner is critical.

Dams and multipurpose hydro projects, if designed and developed in a sustainable manner are key components in both energy and water security. As mentioned before in Chapter 1, the electricity deficit figures for all India are 12.9% and 12.3% respectively for 2006-07. It is not longer adequate to debate the theoretical nature of the pros and cons of dams and hydraulic infrastructure. Generalized discussions that hold back efforts to make sustainable decisions run the risk of exacerbating environmental, social and economic degradation in some of the poorest countries so of the world.

International standards set up by different international organizations offer many lessons on how to assess natural resource investments. They identify the need for consultation, good science, environmental and social assessments and especially attention to affected people. But, much is left to practitioner, including some of the more challenging and sensitive issues in decision-making. For example, a decision process needs to consider how to:

(i) ensure each investment/management decision supports declared development objectives,
(ii) identify stakeholders, address their expectations and nurture meaningful consultation,
(iii) create the right balance of analysis (data and information collection) and deliberation (consultation and dialogue),
(iv) develop a common, decision-focused information base and manage inevitable gaps in knowledge and information, and
(v) articulate and incorporate values of governments, experts and stakeholders, among others.

The intent of structured decision processes should be to build better insights for decision makers (particularly with respect to alternatives and trade offs), enable more meaningful stakeholder participating and instill greater transparency in planning and resource management decisions.

APPENDICES

Annexure I

ANNEXURE I

Village-level Survey

(Environment cum Socio-Economic profile)

Bayal - Jhakri stretch, Distt. Shimla and Kullu Himachal Pradesh

1. Name of district:____________________
2. Name of village:____________________
3. Name of the tributary/(s) nearest to the village:____________________
4. Name of respondant: ____________ Age : ☐☐
5. Occupation:____________________
6. Designation in panchayat, if at all a member:______________
7. For how many years you have been living in the village:____________

[I] WATER SOURCES, AVAILABILITY AND USAGE

8. What are the three most common sources of **drinking water** in the village as a whole:

- ❑ Direct from Satluj river/ tributaries
- ❑ Piped water
- ❑ Hand pump
- ❑ Protected wells
- ❑ Dug well/open well
- ❑ Ponds, canals
- ❑ Other

9. What are the sources of water for **other uses**?
Direct from Satluj river/ tributaries/ Piped water/ Hand pump/ Protected wells/ Dug well/open well/ Ponds, canals/ Others

Information about Neighboring villages?

10. What are the different uses of water?

Direct ____________________ Indirect ____________________

____________________ ____________________

____________________ ____________________

11. How much flow is generally seen in the tributary?
In Lean period: __________ In Peak Flow:______

[II] SOCIO ECONOMIC ASPECTS

12. Approx. number of households in the village and average no. of members in each family:_____; _____

Information about Neighboring villages?

13. Which are the sources of livelihood for households in this village
    Ask for the three most important sources:
    - ❑ Own farm activities
    - ❑ Casual labour (farm and non-farm)
    - ❑ Long term agri. Employee
    - ❑ Salaried employment
    - ❑ Personal (jajmani) services
    - ❑ Petty business/trade/manufacturing
    - ❑ Major business/trade/
    - ❑ Manufacturing
    - ❑ Collection/foraging
    - ❑ Charity/alms
    - ❑ Interest income, property,
    - ❑ Land rentals, etc.
    - ❑ Public transfers/pensions
    - ❑ Private tranfers/remittances
    - ❑ Other

    Information about Neighboring villages?

14. In agriculture, what kind of pesticides/ agrochemicals do villagers use?
    a. Manure
    b. Chemical Fertilizers (like NPK)
    c. Pesticides (like DDT)
    d. Fungicides
    e. Herbicides
    f. Rodenticides

    Information about Neighboring villages?

15. How much land do you own? __________
    Do you think it will get affected adversely /expropriated because of the project?____

16. What kind of plot is it?
    - ❑ Irrigated cultivable
    - ❑ Grazing land
    - ❑ Orchard -Fruits, other economic important trees

17. How is the cultivated land generally irrigated?
    - ❑ Satluj river / tributary
    - ❑ dug wells
    - ❑ tube wells
    - ❑ canals
    - ❑ tanks

18. Majorly what kind of livestock is there in every family?

Livestock	**Number**
Cattle	
Sheep	
Goat	
Horse- Donkey	
Beehives	
Poultry	

Approx. how many livestock does each family has?
Relatively well-off:_______
Poor:_______

19. Are there any industries in the area?
    - ❑ Yes
    - ❑ No If yes, which category
        - Mining/Quarrying
        - Agro-based
        - Food processing
        - Textile

- Handicraft/ Handloom
- Others

20. Is there any mining/ quarrying going on in your area?
    - ❑ Yes
    - ❑ No

21. What kind of sewerage system is present in the village?
    i. Soak pits
    ii. Septic Tanks
    iii. Municipal Corporation sewerage system

22. Are there any prevalent health diseases in the area?
    - ❑ Dysentery
    - ❑ Diarroehea
    - ❑ Malaria
    - ❑ Cold/cough
    - ❑ Fever
    - ❑ Asthma
    - ❑ Others

23. Do you catch fish from the river/ tributary?
    - ❑ Yes
    - ❑ No   If yes, is it for self-consumption or for sale? ___________________
      Quantity? _________________________

24. Names of following:

Common Trees/Shrubs	Common Animals	Common Birds

25. Significance of Forest

    Do you collect firewood from the forest?
    - ❑ Yes   If yes, is it for self-consumption or sale?
    - ❑ No

    Do you collect mushrooms/ herbs etc from the forest?
    - ❑ Yes
    - ❑ No

    Do you only work in forest as wage labour?
    - ❑ Yes
    - ❑ No

    Do you only graze the animals?
    - ❑ Yes Where?
    - ❑ No

26. Are there any archaeological monuments in the area?
    - ❑ Yes
    - ❑ No   If yes, which all? ___________

26. Is muck from the river being disposed off in your village (near Jhakri)?
27. What is the frequency of flooding in this region?

28. Are there any major landslides in the region?
    a. Yes
    b. No
29. Are there any logjams?
    a. Yes
    b. No

If yes, what is the frequency?

30. What are the cultural activities villagers generally indulge in?

31. Are there any cultural practices like worshipping the river or immersing some deity?

Annexure II

						ANNEXURE II (A
		Name_Tehsils		Total_Pop		
	Kullu District	Nermand		47917	*Primary Survey was done at gram panch estimated nos. as told by local village re are concentrating only on villages comir*	
	Panchayat					S
Name District	Name Panchayat	Name Village	Stream in Vicinity	Total _HH(Primary Survey)	Total_ Pop as per survey/Total Pop as per 2001 census	Occupation
Kullu	Kushwa	Kindla	Sumej	25	150	Agri (P)/ Labor/Empl
		Roprikater	Sumej	10	60	Agri (P)/ Labor/Empl
		Kushwa	Sumej	18	108/1330*	Agri (P)/ Labor/Empl
		Seri	Kajo	2	12	Agri (P)/ Labor/Empl
		Kimcha	Kajo	8	48	Agri (P)/ Labor/Empl
		Narku	Kajo	6	42	Agri (P)/ Labor/Empl
		Shaich	Kajo	7	42	Agri (P)/ Labor/Empl
		Kafti	Kajo	9	54	Agri (P)/ Labor/Empl
		Kund	Kajo	10	60	Agri (P)/ Labor/Empl
Kullu	Kharga	Kumahar	Kajo	75	400	Agri/ Labor/Empl
		Duwari	Kajo	40	240	Agri/ Labor/Empl
		Kharga	Kajo	70	350	Agri/ Labor/Empl
		Suraage	Kajo	65	390	Agri/ Labor/Empl
		Tharwa	Kajo	64	320	Agri/ Labor/Empl
		Bakhan	Sumej	100	600	Agri/ Labor/Empl
Kullu	Tunan	Bishlai	Kunni	70	350	Agri / Labor/ Empl
		Tunan	Kasholi	75	450/4115*	Agri/ Labor/Empl
		Sharshaya	Kasholi	63	378	Agri/ Labor/Empl
Kullu	Nishani	Pujarli	Stream next to Bael	85	500	Agri/ Labor/Empl
		Nishani	Stream next to Bael	68	400/1047*	Agri/ Labor/Empl
		Tawar	Stream next to Bael	20	100/1347*	Agri/ Labor/Empl
Kullu	Arsu	Arsu	Stream next to Bael	70	420/1436*	Agri/ Labor/Empl
		Sohach	Stream next to Bael	64	320/1475*	Agri/ Labor/Empl
Kullu		Damehli	Kasholi	150	750	Agri (P)/Labor/Empl

	Bari	Pankwa	Kasholi	220	1320	Agri (P)/Labor/Empl
		Palli	Kasholi	75	450	Agri/ Labor/Empl
		Kasholi	Kasholi	100	600/1018	Agri/ Labor/Empl
Kullu	**Poshna**	Poshna	Kasholi	33	198/3552*	Agri (P)/Shop
		Brow	Kasholi	20	120	Agri (P)/Labor
		Panasha	Kasholi	50	250	Agri (P)/Shop
Kullu	**Gadej**	Bael	Satluj	120	636	Agri(P)/shop/labor
		Koel	Satluj			Agri(P)/shop/labor
**** The population from Census 2001 also includes the population of sub-villages***						
						A II -(A)-1

)			
ıayat level. Total no. of households as shown in primary surveys results are the sidents or gram panchayat heads our during surveys . As per our scope of the work we ıg under villages of Nermand Tehsil			
ocio-Economic_Profile			
Agri Produce	**Live stock**	**Type Ind**	**Fish Catch**
Veg/Plums/citrus/cherry	Sheep &Goat (M)/Cow/Ox	NA	no
Veg/Plums/citrus/cherry	Cow & Ox (M)/Goat/Sheep	NA	no
Veg/Plums/citrus/cherry	Sheep/Goat/Cow/Ox	NA	no
Veg/Plums/maize/cherry	Cow/Ox	NA	no
Veg/Plums/citrus/seed potatoes/almond/cherry	Sheep/Goat/Cow/Ox	NA	no
Veg/Plums/citrus/cherry	Sheep/Goat & Cow (M)	NA	no
Veg/Plums/citrus/cherry	Sheep &Goat (M)	NA	no
Veg/Plums/citrus/cherry	Cow/Sheep &Goat (M)	NA	no
Veg/Plums/maize	Sheep &Goat (M)/Cow/Ox	NA	no
apple/citrus/vege/plums/khubani	Sheep/Goat/Ox (M)/cow/donkey	NA	no
apple/citrus/vege/plums/khubani	Sheep/Goat(M)/Ox/cow/donkey	NA	no
apple/citrus/vege/plums/khubani	Cow & Ox (M)/Goat/Sheep/donkey	NA	no
apple/citrus/vege/plums/khubani	cattle/donkey	NA	no
apple/citrus/vege/plums/khubani	cattle/donkey	NA	no
apple/citrus/vege/plums/khubani	cattle/donkey	NA	no
vege/wheat/apple/potato/tomato/radish/kulth	Cow & Ox (M)/Goat/Sheep/donkey	NA	no
vege/wheat/apple/potato/tomato/radish/kulth	Cow & Ox (M)/Goat/Sheep/donkey	NA	Occasionally from tributary
vege/wheat/apple	Cow/Goat/Sheep (M)/donkey	NA	no
vege/appl/citrus	Cow & Ox (M)/Goat/Sheep/donkey	NA	no
vege/appl/citrus	Cow/ Ox/Goat/Sheep/donkey	NA	no
vege/appl/citrus	Cow (M)/Ox/Goat/Sheep/donkey	NA	Occasionally from tributary
Cereal/pulses/appl/citrus	Cow & Ox (M)/Goat/Sheep	NA	no
Cereal/pulses/appl/citrus	Sheep/Goat(M)/Ox/cow/donkey	NA	no
Cereal/pulses/appl/citrus	Cow & Ox (M)/Goat/Sheep	NA	no

Cereal/pulses/appl/citrus	Sheep/Goat/Cow(M)/Ox/donkey	NA	no
Cereal/pulses/appl/citrus	Sheep/Goat/Cow(M)/Ox/donkey	NA	Occasionally from tributary
Cereal/pulses/appl/citrus	Cow/Ox/Goat/Sheep	NA	no
Plum/appl/veg	Sheep/Goat(M)/Ox/Cow	NA	Occasionally from tributary
Plum/appl/veg/cereal	cow/goat/sheep	NA	no
Plum/appl/veg	Sheep/Goat(M)/Ox/Cow	NA	no
cereal/vege (M)/plums	Sheep/Goat/Ox/Cow/donkey/poultry/piggery	NA	Occasionally from trib
cereal/vege (M)/plums	Sheep/Goat/Ox/Cow/poultry	NA	Occasionally from trib

		ANNEXURE II (A)			
Primary Survey data					
Water Usage			Pollution Load_Satluj		Helath Scenario
Direct			Direct	Indirect	
Source Drink	Source Irrigat	Cattle Bathing	Disposal Sewage	Use Fertilisers	Prevalent Diseases
Spring(P)/ streams in vicnity	R.F (P)	Spring/Stream in vicnity	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Spring(P)/ streams in vicnity	R.F (P)	Spring/Stream in vicnity	Pits (M)	Manure(P)/ Fer	cold, cough, gastroentritis
Tap/spring	R.F (P)	Spring/Stream in vicnity	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Spring(P)/ streams in vicnity	R.F (P)	Spring/Stream in vicnity	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Spring(P)/ kajo stream	R.F (P)	Spring/Stream in vicnity	Pits (M)	Manure(P)/ Fer	cold, cough, gastroentritis
Spring(P)/ streams in vicnity	R.F (P)	Spring/Stream in vicnity	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Spring(P)/ streams in vicnity	R.F (P)	Spring/Stream in vicnity	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Spring(P)/ streams in vicnity	R.F (P)	Spring/Stream in vicnity	Pits (M)	Manure(P)/ Fer	cold, cough, gastroentritis
Spring(P)/ streams in vicnity	R.F (P)	Spring/Stream in vicnity	Pits (M)	Manure(P)/ Fer	cold, cough, gastroentritis
Springs (P)/KajoStream	R.F (P)	Spring/Kajo,Kunni & seasonal Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Springs (P)/KajoStream	R.F (P)	Spring/Kajo,Kunni & seasonal Stream	Pits (M)	Manure(P)/ Fer	cold, cough, gastroentritis
Springs (P)/KajoStream	R.F (P)	Spring/Kajo,Kunni & seasonal Stream	Pits (M)	Manure(P)/ Fer	cold, cough, gastroentritis
Springs (P)/KajoStream	R.F (P)	Spring/Kajo,Kunni & seasonal Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Stream	R.F (P)	Spring/Kajo,Kunni & seasonal Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Springs (P)/KajoStream	R.F (P)	Spring/Kajo,Kunni & seasonal Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Springs (P)/Tap/KajoStream	R.F (P)	Spring/Kajo & seasonal Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Tap/Kasholi Stream	Canal/R.F	Spring/Kajo & seasonal Stream	Pits (M)	Manure(P)/ Fer	cold, cough, gastroentritis
Springs (P)/Kajo & other seasonal stream	R.F (P)	Spring/Kajo & seasonal Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Springs (P)/Kajo & Kunni Stream	R.F (P)	Spring/Kajo,Kunni & seasonal Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Tap & /Springs (P)/KajoStream	R.F (P)	Spring/Kajo,Kunni & seasonal Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Stream	R.F (P)	Spring/Kajo,Kunni & seasonal Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Tap &Springs (P)/KajoStream	R.F (P)	Spring/Kajo & seasonal Stream	Pits (M)	Manure(P)/ Fer	cold, cough, gastroentritis
Stream	R.F (P)	Spring/Kajo & seasonal Stream	Pits (M)	Manure(P)/ Fer	cold, cough, gastroentritis
Springs (P)/Kasholi Stream	R.F (P)	Spring/Kasholi & seasonal streams	Pits (M)	Manure(P)/ Fer	No Prevalent diseases

Springs (P)/Kasholi Stream	R.F (P)	Spring/Kasholi & seasonal streams	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Springs (P)/Kasholi Stream	R.F (P)	Spring/Kasholi & seasonal streams	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Springs (P)/Kasholi Stream	R.F (P)	Spring/Kasholi & seasonal streams	Pits (M)	Manure(P)/ Fer	cold, cough, gastroentritis
Tap/Kasholi Stream/Spring	R.F (P)	Spring/Kasholi & seasonal streams	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Springs (P)Kasholi/Kuni Stream	R.F (P)	Spring/Kasholi & seasonal streams	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Springs (P)/Kasholi Stream	R.F (P)	Spring/Kasholi & seasonal streams	Pits (M)	Manure(P)/ Fer	No Prevalent diseases
Springs /Handpump/Kurpan stream	Canal/R.F	Spring/Kurpan & other streams	Pits (M)	Manure	cold, cough, gastroentritis
Springs (P)/Kurpan stream	R.F (P)	Spring/Kurpan & other streams	Pits (M)	Manure	No Prevalent diseases
		A II -(A)-q			

General Scenario				Calamity
Forest Use	Cult/Rel Festivals		Avail Grazing Land	Type
Fuel wood/ Grazing	Lavi and Fag, Local Melas		Forests	Flood/Landslide
	Lavi and Fag, Local Melas		Forests	Land Slide
	Lavi and Fag, Local Melas		Forests	Flood/Landslide
	Lavi and Fag, Local Melas		Forests	Land Slide
	Lavi and Fag, Local Melas		Forests	Land Slide
	Lavi and Fag, Local Melas		Forests	Land Slide
	Lavi and Fag, Local Melas		Forests	Land Slide
	Lavi and Fag, Local Melas		Forests	Land Slide
	Lavi and Fag, Local Melas		Forests	Flood/Land Slide
Fuel wood/ Grazing	Lavi and Fag, Local Melas		Forests	Flood/Land Slide
	Lavi and Fag, Local Melas		Forests	Land Slide
	Lavi and Fag, Local Melas		Forests	Land Slide
	Lavi and Fag, Local Melas		Forests	Flood/Land Slide
	Lavi and Fag, Local Melas		Forests	Flood/Land Slide
	Lavi and Fag, Local Melas			Flood/Land Slide
Fuel wood/ Grazing	Lavi and Fag, Local Melas		Forests	Flood/Land Slide
	Lavi and Fag, Local Melas		Forests	Flood/Land Slide
	Lavi and Fag, Local Melas		Forests	Flood/Land Slide
Fuel wood/ Grazing	Lavi and Fag, Local Melas		Forests	Land Slide
	Lavi and Fag, Local Melas		Forests	Land Slide
	Lavi and Fag, Local Melas		Forests	Land Slide
Fuel wood/ Grazing	Lavi and Fag, Local Melas		Forests	Land Slide
	Lavi and Fag, Local Melas		Forests	Land Slide
	Lavi and Fag, Local Melas		Forests	Land Slide

Fuel wood/ Grazing	Lavi and Fag, Local Melas	Forests	Land Slide
	Lavi and Fag, Local Melas	Forests	Land Slide
	Lavi and Fag, Local Melas	Forests	Land Slide
Fuel wood/ Grazing	Lavi and Fag, Local Melas	Forests	Land Slide
	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
Fuel wood/ Grazing	Lavi and Fag, Local Melas	Forests	Flood
	Lavi and Fag, Local Melas	Forests	Flood

Name of District	Tehsil	Range	Name of Panchayat	Name of Village	Area	Total_Households	Total Population	Occupation	Nearest Tributary/khad	Source_Drinking	Source_Irri	Type_Fertiliser
Simla		Rampur	**Jhakri**	Jakhri	90	47	227	Farm/ Shop	BARAUNI	TRIB / SPR/ PIPE	TRIB/PPT	MAN
				Gaso		80	391	Farm/ Shop	BARAUNI	TRIB / SPR/ PIPE	TRIB/PPT	MAN
				Badi		6	27	Farm/ Shop	BARAUNI	TRIB / SPR/ PIPE	TRIB/PPT	MAN
				Kharkag				Farm/ Shop	BARAUNI	TRIB / SPR/ PIPE	TRIB/PPT	MAN
				Landless colony				Farm/ Shop	BARAUNI	TRIB / SPR/ PIPE	TRIB/PPT	MAN
				Garora				Farm/ Shop	BARAUNI	TRIB / SPR/ PIPE	TRIB/PPT	MAN
				Shanti nagar				Farm/ Shop	BARAUNI	TRIB / SPR/ PIPE	TRIB/PPT	MAN
				Shokcha				Farm/ Shop	BARAUNI	TRIB / SPR/ PIPE	TRIB/PPT	MAN
				Shankari				Farm/ Shop	BARAUNI	TRIB / SPR/ PIPE	TRIB/PPT	MAN
			Racholi	Racholi	204	229	915	Farm/ Labor/ Empl	RACHOLI	TRIB / SPR/ PIPE	TRIB/PPT	MAN
				Khaneri	163	240	1038	Farm/ Labor/ Empl	RACHOLI	TRIB / SPR/ PIPE	TRIB/PPT	MAN
				Odda		89	437	Farm/ Labor/ Empl	RACHOLI	TRIB / SPR/ PIPE	TRIB/PPT	MAN
			Singla	Singla	294	181	890			TRIB / SPR/ PIPE	TRIB/PPT	MAN/ FERT
				Shaneri	150	129	713			TRIB / SPR/ PIPE	TRIB/PPT	MAN/ FERT
				Uru	140	45	220			TRIB / SPR/ PIPE	TRIB/PPT	MAN/ FERT
				Kalna	260	73	382			TRIB / SPR/ PIPE	TRIB/PPT	MAN/ FERT
				Besri						TRIB / SPR/ PIPE	TRIB/PPT	MAN/ FERT
				Khakrola	277	109	571					
				Batuna								
			Bharawali	Kumsu		214	937					
				Kamlahu		85	438					
				Rajpura		28	114					
				Masarna-kareri		59	337					
			Duttnagar	Bhadrash		51	227	Farm/ Empl				
				Duttnagar	852	250	1213	Farm/ Empl				
			Lalsa	Lalsa								
				Nalakhobar		23	92					
				Darshal		52	287					
			Dansa	Makroli	261	40	196					
				Karali	297	80	379					
				Thana	27	12	68					
				Jaguni	560	137	706					
				Dhar	185	157	743					
				Dansa	87	129	595					
			Munish	Munish		87	398					
				Jogni								
				Barkal/ Jhanthal	42	17	103					
				Matiana	45	15	82					
				Thala	521	54	294					
				Bhali	92	42	197					

				Urman								
			Kuhal	Chiksa	149	38	184					
				Kuhal/ Pataina								
				Majholi/ Jhali		88	418					
				Keem								
				Deothi								
				Prog/ Pharog								
				kareri								
				Anu Rakshi								
			Kashapat	Kandi		27	120					
				Pat		103	590					
				Kasha		117	626					
		Bahli	**Narain**	Sharna-jarashi								
				Krali-Brandali								
				Karsholi	130	29	167					
				Mandhog	164	86	457					
				Jakdhar-Sowali								
				Kurnu		51	293					
				Pelan								
		Nankhari	**Chakti**	Dadara		113	514					
				Thaily		77	390					
				Chakti		64	299					
				Jhinjnoo		25	138					
				Shorog		50	247					
			Sholi	Sholi								
				Kareli								
				Dharagla	137	79	477					
				Khanog	23	8	53					
				radaina								
				Garsu-Noti								
				Louhti-khadech								
			Khamadi	Khamadi								
				Deem								
				Dhansha		31	166					
				Dharunja								
				Chamada								
				karoli								
				Tangri								
				Bai								
Kullu												
			Sarga	Bagani								
				Badijan								

				Humku								
				Bahan								
				Dhar								
				Kailiage								
				Mohali								
				Thaledhar								
				Dhanikater								
				Thach								
				sarga								
				Shaogi								
				Barguridhar								
				Dugilog								
				Gad								
				Ropari								
				dogri								
				Neokunder								
				Firlioal								
				Kiundhar								
	NERMAND(T) [redacted]		**Kushwa**	Shroo								
				Bdari								
				Kindla								
				Roprikater								
				Kushwa	194	252	1330					
				Shoduwar	[redacted]							
				Seri	26	12	66					
				Shah								
				Kimcha								
				Narku								
				Shaich								
				Dogri								
				Bahan								
				Kafti								
				Kund								
			Kharga	Kumahar				Farm/ Labor/Empl	Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Duwari				Farm/ Labor/Empl	Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Kharga				Farm/ Labor/Empl	Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Suraage					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Tharwa					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Bakhan					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Naal					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Khaded				Farm/ Labor/ Empl	Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Twandi					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Seri					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Maava					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Chilage					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	

				Kalaya					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Dharmoth					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Azer					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Dugamatla					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Tharawa					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Muchka					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Dogri					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Tikkri		43	183		Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Tikkri kod					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Dwari					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
				Pipaldhar					Kajo/Kuni	TRIB/ SPR	PPT/TRIB	
	NERMAND (T) [redacted]		**Tunan**	Tunan	[redacted]	[redacted]	[redacted]	Farm/Shop	Kasholi	TRIB/SPR/PIPE	TRIB/CANL/F	MAN/ FERT
				Chhatti				Farm/Shop	Kasholi/Kuni	TRIB/SPR/PIPE	TRIB/CANL/F	MAN/ FERT
				Thachwa	[redacted]	[redacted]	[redacted]	Farm/Shop	Kasholi	TRIB/SPR/PIPE	TRIB/CANL/F	MAN/ FERT
				Jagathkhana				Farm/Shop	Kasholi/Kuni	TRIB/SPR/PIPE	TRIB/CANL/F	MAN/ FERT
				Chottu				Farm/Shop	Kasholi	TRIB/SPR/PIPE	TRIB/CANL/F	MAN/ FERT
				Sharshaya				Farm/Shop	Kasholi/Kuni	TRIB/SPR/PIPE	TRIB/CANL/F	MAN/ FERT
				Gunali				Farm/Shop	Kasholi	TRIB/SPR/PIPE	TRIB/CANL/F	MAN/ FERT
				Bishlai				Farm/Shop	Kasholi/Kuni	TRIB/SPR/PIPE	TRIB/CANL/F	MAN/ FERT
				Dunga				Farm/Shop	Kasholi/Kuni	TRIB/SPR/PIPE	TRIB/CANL/F	MAN/ FERT
				Pipiser				Farm/Shop	Kasholi/Kuni	TRIB/SPR/PIPE	TRIB/CANL/F	MAN/ FERT
				Chail	320	451	2045	Farm/Shop	Kasholi/Kuni	TRIB/SPR/PIPE	TRIB/CANL/F	MAN/ FERT
				Poshna	[redacted]	[redacted]	[redacted]	Farm/Shop	Kasholi/Kuni	TRIB/SPR/PIPE	TRIB/CANL/F	MAN/ FERT
				Kasholi	[redacted]	[redacted]	[redacted]	Farm/Shop	Kasholi/Kuni	TRIB/SPR/PIPE	TRIB/CANL/F	MAN/ FERT
			Gadej	Gadej	[redacted]	[redacted]	[redacted]	Farm/Empl	Kurpan khad	TRIB/SPR		MAN
				Bayal	[redacted]	[redacted]	[redacted]	Farm/Empl	Kurpan khad	TRIB/SPR		MAN
				Koel				Farm/Empl	Kurpan khad	TRIB/SPR		MAN
				Veri				Farm/Empl				MAN
				Dharopa				Farm/Empl				MAN

	NERMAND			CHAIL (15/40)	320	451	2045					
	NERMAND			SARAHAN (15/41)	89	153	651					
	NERMAND			JHALER (15/42)	179	204	986					
	NERMAND			NORE (15/43)	184	280	1333					
	NERMAND			KOTI (16/44)	195	215	1085					
	NERMAND			SHILI KOTE (16/45	298	398	1918					
	NERMAND			DETHOA (16/46)	302	292	1533					
	NERMAND			SARGHA (17/47)	284	282	1381					
	NERMAND			KUSHWA (17/48)	194	252	1330					
	NERMAND			BARI (18/52)	227	244	1160					
	NERMAND			ARSU (18/53)	241	299	1436					
	NERMAND			SOHACH (18/54)	276	284	1475					
	NERMAND			RAHNU (21/66)	359	434	2103					
	NERMAND			GHATHOO (21/65)	424	496	2467					
	NERMAND			NEETHER (20/63)	564	738	3224					
	NERMAND			LOTE (20/62)	545	642	2796					
	NERMAND			SHILHI-HIMRI (20/	288	258	1226					
	NERMAND			GADEJ (20/60)	148	156	749					
	NERMAND			NERMAND (20/58)	1076	1380	6200					
	NERMAND			BAEL (20/59)	76	114	636					
	NERMAND			TAWAR (19/55)	269	267	1347					
	NERMAND			NISHANI (19/56)	216	214	1047					
	NERMAND			ROSHANA (19/57)	282	776	3522					
	NERMAND			KASHOLI (18/61)	162	210	1018					
	NERMAND			THACHWA (17/50)	41	284	1134					
code					**TRIB**	Nearest Tributa	**CATL**	Cattle	Soak pits			
Farm	Own farm activities				**SPR**	Natural springs	**SHP**	Sheep	Septic Tanks			
Labor	Casual labour (farm and non-farm)				**PIPE**	Piped water	**GT**	Goat				
Empl	Salaried employment				**HP**	Protected well	**PLT**	Poultry				

Shop	Shop/ Petty business/small trade				**WEL**	Dug well/open	**FUEL**	Wood fuel				
Busi	Major business/trade				**PPT**	Rainfal/precipit	**GRAZ**	Grazing land				
Ren	Land rentals, etc.				**CANL**	Canal	**veg**	vegetable				
					FERT	Chemical fertili	**LAV/FAG**	Festivals-Lavi/ Fag				
					MAN	Manure	**T**	Temples				
				Apple	*Malus pumila*							
				japaani phal								
				Pear	*Pyrus communis*							
				Rice	*Oryza sativa*							
				Wheat	*Triticum aestivum*							
				Maize	*Zea mays*							

Type_Sewerage System	Agri_Produce	Live Stock	Type_Industry	Forest_Use	Fish_Catch	Prev_ Disease	Grazing Land	Cultural/Religious_Aspects	Type_Calamity	Other_Activities
SP	plum/apple/apricot	cattle	NO	FUEL/GRAZ		NO	FOR	LAV/FAG/T	FLO/LAN	
SP	plum/apple/apricot	cattle	NO	FUEL/GRAZ		NO	FOR	LAV/FAG/T	FLO/LAN	
SP	plum/apple/apricot	cattle	NO	FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	plum/apple/apricot	cattle	NO	FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	plum/apple/apricot	cattle	NO	FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	plum/apple/apricot	cattle	NO	FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	plum/applel/apricot	cattle	NO	FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	plum/apple/apricot	cattle	NO	FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	plum/apple/apricot	cattle	NO	FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	plum/apple/almond	cattle	NO	FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	plum/apple/almond	cattle	NO	FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	plum/apple/almond	cattle	NO	FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	apple/plum			FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	apple/plum			FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	apple/plum			FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	apple/plum			FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	apple/plum			FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP						NO	FOR	LAV/FAG	FLO/LAN	
SP						NO	FOR	LAV/FAG	FLO/LAN	
SP										
SP						NO	FOR	LAV/FAG	FLO/LAN	
SP						NO	FOR	LAV/FAG	FLO/LAN	
SP						NO	FOR	LAV/FAG		
SP						NO	FOR	LAV/FAG		
SP										
SP	veg/cereal	cattle		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP		cattle		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP				FUEL/GRAZ		NO	FOR	LAV/FAG		
SP				FUEL/GRAZ		NO	FOR	LAV/FAG		
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SP				FUEL/GRAZ		NO	FOR	LAV/FAG		
SP				FUEL/GRAZ		NO	FOR	LAV/FAG		
SP				FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		in Samej khad	FOR	LAV/FAG/T-Jahrunag		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG/T-Gasoli,Basada		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		

SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Cereal/pulses/appl/citrus	cattle/donkey		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	Plum/appl/veg	cattle/goat/sheep	NO	FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	Plum/appl/veg/cereal	cattle/goat/sheep		FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	Plum/appl/veg	cattle/goat/sheep		FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	Plum/appl/veg	cattle/goat/sheep		FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	Plum/appl/veg	cattle/goat/sheep		FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	Plum/appl/veg	cattle/goat/sheep		FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	Plum/appl/veg	cattle/goat/sheep		FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	Plum/appl/veg	cattle/goat/sheep		FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	Plum/appl/veg	cattle/goat/sheep		FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	Plum/appl/veg	cattle/goat/sheep		FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	Plum/appl/veg	cattle/goat/sheep		FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	Plum/appl/veg	cattle/goat/sheep		FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	Plum/appl/veg	cattle/goat/sheep		FUEL/GRAZ		NO	FOR	LAV/FAG	FLO/LAN	
SP	cereal	cattle		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	cereal	cattle		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	cereal	cattle		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	cereal	cattle		FUEL/GRAZ		NO	FOR	LAV/FAG		
SP	cereal	cattle		FUEL/GRAZ		NO	FOR	LAV/FAG		

Name_Dis	Name_Panch	Name_Vill	Total _HH	Total_Pop (Cen Data)	Occupation	Agri_Produce	Live stock
	Vill Panch_ Surveyed		Social_ Profile				Economic_Profile
Shimla	Jhakri	Jhakri	50	227		plum/apple/apricot	Cattle
		Gaso	80	391		plum/apple/apricot	Cattle
		Badi	6	27		plum/apple/apricot	Cattle
		Kharkag				plum/apple/apricot	Cattle
		Landless colony				plum/apple/apricot	Cattle
		Garora				plum/apple/apricot	Cattle
		Shanti nagar				plum/applel/apricot	Cattle
		Shokcha				plum/apple/apricot	Cattle
		Shankari				plum/apple/apricot	Cattle
Shimla	Racholi	Racholi	230	915	Agri / Labor/ Empl	plum/apple/almond	Cattle
		Khaneri	250	1038	Agri/ Labor/ Empl	plum/apple/almond	Cattle
		Odda	90	437	Agri/ Labor/ Empl	plum/apple/almond	Cattle
Shimla	Duttnagar	Bhadrash	50	227			
		Duttnagar	250	1213			
Kullu	Kushwa	Shroo					
		Bdari					
		Kindla					
		Roprikater					
		Kushwa	250	1330			
		Shoduwar					
		Seri					
		Shah					
		Kimcha					
		Narku					
		Shaich					
		Dogri					

		Bahan					
		Kafti					
		Kund					
Kullu	**Kharga**	Kumahar			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Duwari			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Kharga			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Suraage			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Tharwa			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Bakhan			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
Kullu	**Tunan**	Bishlai			Agri / Labor/ Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Tunan			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Sharshaya			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
Kullu	**Nishani**	Pujarli			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Nishani			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Tawar			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
Kullu	**Arsu**	Arsu			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Dandidhar			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Badhidhar			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Dishol			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Sohach			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Dhoul Bahau			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
Kullu	**Bari**	Damehli			Agri (P)/Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Pankwa			Agri (P)/Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Palli			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Kasholi			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
Kullu	**Chail**	Tharla			Agri/ Labor/Empl	Cereal/pulses/appl/citrus	cattle/donkey
		Jaon					
		Dogari					
Kullu	**Poshna**	Poshna	800	4115	Agri (P)/Shop	Plum/appl/veg	cow/goat/sheep
		Brow			Agri (P)/Labor	Plum/appl/veg/cereal	cow/goat/sheep
		Panasha	230	1134	Agri (P)/Shop	Plum/appl/veg	cow/goat/sheep
	Sarga	Bagani			Agri (P)/Shop	Plum/appl/veg	cow/goat/sheep
		Badijan			Agri (P)/Shop	Plum/appl/veg	cow/goat/sheep
		Humku			Agri (P)/Shop	Plum/appl/veg	cow/goat/sheep
		Bahan			Agri (P)/Shop	Plum/appl/veg	cow/goat/sheep

	Dhar			Agri (P)/Shop	Plum/appl/veg	cow/goat/sheep
	Kailiage			Agri (P)/Shop	Plum/appl/veg	cow/goat/sheep
	Mohali			Agri (P)/Shop	Plum/appl/veg	cow/goat/sheep
	Thaledhar	400	2045	Agri (P)/Shop	Plum/appl/veg	cow/goat/sheep
	Dhanikater	700	3522	Agri (P)/Shop	Plum/appl/veg	cow/goat/sheep
	Thach					
	Barguridhar					
	sarga	200	1018	Agri (P)/Shop	Plum/appl/veg	cow/goat/sheep
	Dugilog					
	Gad					
	Dogri					
	Ropri					
	Neokundar					
	Firliol					
	Kiundhar					
Gadej	Gadej	150	749	Agri(P)/Empl	cereal	cattle
	Bael	120	636	Agri(P)/Empl	cereal	cattle
	Koel			Agri(P)/Empl	cereal	cattle
	Veri			Agri(P)/Empl	cereal	cattle
	Dharopa			Agri(P)/Empl	cereal	cattle

Primary Survey data

Water Usage

		Direct		Indirect
Type_Ind	Fish_Catch	Source_Drink	Source_Irrigat	Cattle_Bathing
NA	Occasionally from Tributary	Springs(P)/Baruni Stream	R.F(P)	Baruni Stream
NA	no	Springs(P)/Baruni Stream	R.F(P)	Baruni Stream
NA	no	Springs(P)/Baruni Stream	R.F(P)	Baruni Stream
NA	Occasionally from Tributary	Springs(P)/Baruni & Gaura Stream	R.F(P)	Baruni & Gaura Stream
NA	no	Springs(P)/Baruni & Gaura Stream	R.F(P)	Baruni & Gaura Stream
NA	no	Springs(P)/Baruni & Gaura Stream	R.F(P)	Baruni & Gaura Stream
NA	no	Springs(P)/Baruni Stream	R.F(P)	Baruni Stream
NA	no	Springs(P)/Baruni Stream	R.F(P)	Baruni Stream
NA	no	Springs(P)/Baruni Stream	R.F(P)	Baruni Stream
NA	Occasionally from Tributary	Springs(P)/Racholi Stream	R.F(P)	Racholi Stream
NA	no	Springs(P)/Racholi Stream	R.F(P)	Racholi Stream
NA	no	Springs(P)/Racholi Stream	R.F(P)	Racholi Stream

NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/Kajo,Kunni & other seasonal Stream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	Occasionally from tributary	Springs (P)/Kasholi Stream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/Kajo & other seasonal stream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/Kajo & Kunni Stream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	Occasionally from tributary	Springs (P)/Kajo,Kunni & other seasonal Stream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/Kunni & other seasonal Stream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/Kunni & other seasonal Stream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/Kajo,Kunni & other seasonal Stream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	Occasionally from tributary	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	no	Springs (P)/KajoStream	R.F (P)	FUEL/GRAZ
NA	Occasionally from tributary	Springs (P)/Kasholi Stream	R.F (P)	Kasholi Trib
NA	no	Springs (P)Kasholi/Kuni Stream	R.F (P)	Kasholi/Kuni
NA	no	Springs (P)/Kasholi Stream	R.F (P)	Kasholi
NA	no	Springs (P)/Kasholi & Kuni Stream	R.F (P)	Kasholi/Kuni
NA	no	Springs (P)/Kasholi Stream	R.F (P)	Kasholi
NA	no	Springs (P)/Kasholi/Kuni Stream	R.F (P)	Kasholi/Kuni
NA	no	Springs (P)/Kasholi Stream	R.F (P)	Kasholi

NA	no	Springs (P)/Kasholi & Kuni Stream	R.F (P)	Kasholi/Kuni
NA	no	Springs (P)/Kasholi & Kuni Stream	R.F (P)	Kasholi/Kuni
NA	no	Springs (P)/Kasholi & Kuni Stream	R.F (P)	Kasholi/Kuni
NA	no	Springs (P)/Kasholi & Kuni Stream	R.F (P)	Kasholi/Kuni
NA	no	Springs (P)/Kasholi & Kuni Stream	R.F (P)	Kasholi/Kuni
NA	no	Springs (P)/Kasholi & Kuni Stream	R.F (P)	Kasholi/Kuni
NA	no	Springs (P)/Kurpan stream	R.F (P)	Kurpan khad
NA	Occasionally from tributary	Springs (P)/Kurpan stream	R.F (P)	Kurpan khad
NA	Occasionally from tributary	Springs (P)/Kurpan stream	R.F (P)	Kurpan khad
NA	no	Springs (P)/Kurpan stream	R.F (P)	Kurpan khad
NA	no	Springs (P)/Kurpan stream	R.F (P)	Kurpan khad

Pollution Load_Satluj		Helath Scenario	General Scenario			Type Calamity
Direct	Indirect					
Disposal_Sewag‹	Use_Fertilisers		Forest_Use	Cult/Rel Festivals	Avail_Grazing Land	
Pits (M)	Manure(P)/ Fer	Malaria, Asthma	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forest	Flood/Land Slides
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forest	Flood/Land Slides
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forest	Flood/Land Slides
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forest	Flood/Land Slides
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forest	Flood/Land Slides
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forest	Flood/Land Slides
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forest	Flood/Land Slides
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forest	Flood/Land Slides
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forest	Flood/Land Slides
Pits (M)	Manure	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forest	Flood/Land Slides
Pits (M)	Manure	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forest	Flood/Land Slides
Pits (M)	Manure	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forest	Flood/Land Slides

Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG/T-Jahrunag			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG/T-Gasoli,Basada			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	LAV/FAG			
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood/Land Slide

Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood/Land Slide
Pits (M)	Manure	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood
Pits (M)	Manure	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	Flood
Pits (M)	Manure	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	
Pits (M)	Manure	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	
Pits (M)	Manure	No Prevalent diseases	Fuel wood/Grazing	Lavi and Fag, Local Melas	Forests	

ANNEXURE II (B)

	Name_Tehsils	Total_Population	
Shimla District	Rampur	72026 (out of which only 5653 is urban)	***Primary Survey was done at gram panchayat level. Total no. of households as shown in primary surveys results are the estimated nos. as told by local village residents or gram panchayat heads during surveys . As per the scope of the work we are concentrating only on villages coming under Rampur Tehsil in the project area.***

Panchayat — **Socio-Economic_ Profile** — **Socio-Economic_P**

Name District	Name Panchayat	Name Village	Stream In Vicinity	Total _HH(Primary Survey)	Total_ Pop as per survey/Total Pop as per 2001 census	Occupation	Agri Produce	Live stock	Type Ind
Shimla	Jhakri	Jhakri	Barauni	47	227/5890*	Labor/Empl/Agri	Almond/ khumani/ plum/tomatoes/beans/cabbage/cauliflower/maize/cherry	Goat/sheep/cows/ox	NA
		Badı (SV)	Barauni			Agri (P)/ Labor/Empl	Almond/ khumani/ plum/omatoes/beans/cabbage/cauliflower/maize/cherry	Goat/sheep/cows/ox	NA
		Kharkag (SV)	Baraunı			Agri (P)/ Labor/Empl	plum/tomatoes/beans/cabbage/cauliflower/maize	Goat/sheep/cows/ox	NA
		Landless colony (SV)	Barauni	300	600	Labor/Empl	Self-consumptive purposes	Goat/sheep/cows/ox	NA
		Garora (SV)	Barauni			Agri (P)/ Labor/Empl	Plum/tomatoes/beans/cabbage/cauliflower/maize/cherry	Goat/sheep/cows/ox	NA
		Shanti nagar (SV)	Barauni			Agri (P)/ Labor/Empl	Plum/tomatoes/beans/cabbage/cauliflower/maize/cherry	Goat/sheep/cows/ox	NA
		Shokcha (SV)	Barauni			Agri (P)/ Labor/Empl	Plum/tomatoes/beans/cabbage/cauliflower/maize/cherry	Goat/sheep/cows/ox	NA
		Shankari (SV)	Barauni			Agri (P)/ Labor/Empl	Plum/tomatoes/beans/cabbage/cauliflower/maize/cherry	Goat/sheep/cows/ox	NA
Shimla	Lalsa	Darshal	Jakho	30	180/287	Agri/ Labor/Empl	Apple/Plum/cherry/Peas/tomatoes/beans/cabbage/cauliflower/tomato/almond	Sheep/Goat(P)/Ox/cow/donkey	NA
Shimla	Racholi	Khanari	Jakho	35	200/1038*	Farming (Agri /Dairy)/ Labor/Empl	Veg/Plums/citrus/cherry	Cow/Goat/Sheep (P)	NA
		Racholi	Racholi	20	120 /915*	Farming (Agri /Dairy)/ Labor/Empl	Veg/Plums/citrus/cherry	Cow/Goat/Sheep (P)	NA
		Odda	Racholı	30	180/437*	Farming (Agri /Dairy)/ Labor/Empl	Veg/Plums/citrus/cherry	Cow/Goat/Sheep (P)	NA
Shimla	Kashapat	Kandi	Racholi	150	900	Agri/ Labor/Empl	Plum/cherry/Peas/tomatoes/beans/cabbage/cauliflower/maize	Goat/Sheep(P)	NA
		Pal	Racholi	106	1020/608	Agri (P)/ Labor/Empl	Plum/cherry/Peas/tomatoes/beans/cabbage/cauliflower/maize	Goat/sheep(P)/cows/ox	NA
		Kasha	Racholi	320	1920	Agri (P)/ Labor/Empl	Plum/cherry/Peas/tomatoes/beans/cabbage/cauliflower/maize	Goat/sheep/cows/ox	NA
Shimla	M.C. Rampur	Rampur Town	Satluj	1000	6000/5653	Labor/Empl/Dairy	Nominal	Cow/Goat/Sheep (P)	NA
Shimla	Shingla	Shingla	Satluj	30	180/890	Agri (P)/ Labor/Empl	Peas/tomatoes/beans/Plums/maize/cherry/cabbage/cauliflower	Cow/Ox/Sheep	NA
		Shaneri	Satluj	15	90/713*	Farming (Agri /Dairy)/ Labor/Empl	Peas/tomatoes/beans/Plums/maize/cherry/cabbage/cauliflower/tomato	Cow (P)/Ox/Goat/Sheep/donkey	NA
		Uru	Satluj	25	150/220	Farming (Agri /Dairy)/ Labor/Empl	Peas/tomatoes/beans/Plums/maize/cherry/cabbage/cauliflower/tomato	Cow (P)/Ox/Goat/Sheep/donkey	NA
		Kalna	Satluj	5	30/ 382*	Agri (P)/ Labor/Empl	Peas/tomatoes/beans/Plums/maize/cherry/cabbage/cauliflower/tomato	Sheep/Goat/Cow/Ox	NA
		Besri	Satluj	15	90/ 293*	Farming (Agri /Dairy)/ Labor/Empl	Peas/tomatoes/beans/Plums/maize/cherry/cabbage/cauliflower/tomato/pears	Sheep/Goat & Cow (P)	NA
Shimla	Baharwali	Kumsu	Nogli	50	300/ 937*	Agri (P)/ Labor/Empl	Peas/tomatoes/beans/Plums/maize/cherry/cabbage/cauliflower/tomato/maize	Sheep &Goat (P)/cow/ox	NA
		Kamlahu	Nogli	40	240/ 438*	Agri (P)/ Labor/Empl	Peas/tomatoes/beans/Plums/maize/cherry/cabbage/cauliflower/tomato/maize	Sheep/Goat/Cow/Ox	NA
		Rajpura	Nogli	20	120/114	Agri (P)/ Labor/Empl	Plum/Apples/pear/cherry/Peas/tomatoes/beans/maize/cabbage/cauliflower/tomato/maize	Sheep &Goat (P)/Cow/Ox	NA
		Masarna	Nogli	30	180/ 337*	Farming (Agri /Dairy)/ Labor/Empl	Plum/Apples/pear/cherry/Peas/tomatoes/beans/maize/cabbage/cauliflower/tomato/maize	Cow/Sheep &Goat (P)/Ox	NA
Shimla	Dansa	Makroli	Nogli	15	90	Agri/ Labor/Empl	Apple/Plum/cherry/Peas/tomatoes/beans/cabbage/cauliflower/tomato	Goat/Sheep (P)	NA
		Karali	Nogli	20	120/379*	Farming (Agri /Dairy)/ Labor/Empl	Apple/Plum/cherry/Peas/tomatoes/beans/cabbage/cauliflower/tomato	Cow (P)/goat/sheep	NA
		Thana	Nogli	10	60/68	Agri/ Labor/Empl	Plum/Peas/tomatoes/beans/cabbage/cauliflower/tomato/maize	Cow/goat/sheep(P)	NA
		Jaguni	Nogli	60	360/706*	Agri (P)/ Labor/Empl	Plum/Peas/tomatoes/beans/cabbage/cauliflower/tomato/maize	Cow/goat/sheep(P)	NA
		Dhar	Nogli	20	120/306*	Agri (P)/ Labor/Empl	Plum/Peas/tomatoes/beans/cabbage/cauliflower/tomato/maize	Goat/sheep(P)	NA
		Dansa	Nogli	40	240/595	Farming (Agri /Dairy)/ Labor/Empl	Plum/Peas/tomatoes/beans/cabbage/cauliflower/tomato/maize	Cow/goat/sheep(P)	NA
Shimla	Duttnagar	Duttnagar	Satluj	10	60/1213*	Farming (Agri /Dairy)/ Labor/Empl	Plum/cherry/Peas/tomatoes/beans/maize/cabbage/cauliflower/tomato/maize/barley	Cow	NA

** The population from Census 2001also includes the population of sub-villages*

ANNEXURE II (B)

Primary Survey data

rofile	Water Usage			Pollution Load_Satluj		Helath Scenario	General Scenario			Natural Calamity
	Direct			Direct	Indirect					
Fish Catch	**Source Drink**	**Source Irrigation**	**Livestock Rearing**	**Disposal Sewage**	**Use Fertiliser**	**Prevalent Diseases**	**Forest Use**	**Cult/Rel Festivals**	**Avail Grazing Land**	**Type**
no	tap/stream	R.F (P)	Stream	Pits (M)	Manure	cold, cough, gastroentritis		Lavi and Fag, Local Melas	Forests	Land Slide/Flood
no	tap/stream	R.F (P)	tap/stream	Pits (M)	Manure	cold, cough, gastroentritis		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/stream	R.F (P)	tap/stream	Pits (M)	Manure	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap (P)/stream	Nominal	tap/stream	Pits (M)	Manure	No Prevalent diseases	Fuel wood/ Grazing	Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/stream	R.F (P)	tap/stream	Pits (M)	Manure	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/stream	R.F (P)	tap/stream	Pits (M)	Manure	Malaria, gastroentritis		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/stream	R.F (P)	tap/stream	Pits (M)	Manure	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/stream	R.F (P)	tap/stream	Pits (M)	Manure	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/stream	R.F (P)	Stream	Pits (M)	Manure(P)/ Fer	cold, cough, gastroentritis	Grazing	Lavi and Fag, Local Melas	Forests	Land Slide
no	spring/handpump/stream	R.F (P)	Spring/stream	Pits (M)	Manure(P)/ Fer	cold, cough, gastroentritis		Lavi and Fag, Local Melas	Forests	Flood/Landslide
no	tap/Spring(P)/ stream	R.F (P)	Spring/stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/ Grazing	Lavi and Fag, Local Melas	Forests	Land Slide
no	Spring(P)/ stream	R.F (P)	Spring/stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/spring/stream	R.F (P)	Spring/stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	Springs (P)/ Stream	R.F (P)	Spring/stream	Pits/open defecation	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/ Grazing	Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/spring/stream	R F (P)	Spring/stream	Pits/open defecation	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
Occasionally from Satluj	taps	na	tap	Pits	na	Bronchitis, gastroentritis	Fuel wood/ Grazing	Lavi and Fag, Local Melas	Forests	Flood/Landslide
no	tap/Spring(P)/ stream	R.F (P)	Spring/stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/Spring(P)/ stream	R.F (P)	Spring/stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/Spring(P)/ stream	R.F (P)	Spring/stream	Pits/open defecation	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/ Grazing	Lavi and Fag, Local Melas	Forests	Landslide
no	tap/handpump/stream	R.F (P)	Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/stream	R.F (P)	Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/stream	R.F (P)	Stream	Pits (M)	Manure(P)/ Fer	cold, cough, malaria		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/ stream	R.F (P)	Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/ Grazing	Lavi and Fag, Local Melas	Forests	Land Slide
Occasionally from Nogli	tap/ stream	R.F (P)	Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/ stream	R.F (P)	Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/spring/stream	R.F (P)	Spring/stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/stream	R.F (P)	Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
Occasionally from tributary	tap/stream	R.F (P)	Stream	Pits (M)	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/ Grazing	Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/spring/stream	R.F (P)	Stream	Pits/open defecation	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/spring/stream	R F (P)	Stream	Pits/open defecation	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/spring/stream	R.F (P)	Stream	Pits/open defecation	Manure(P)/ Fer	No Prevalent diseases		Lavi and Fag, Local Melas	Forests	Land Slide
no	tap/handpump/stream	Canal	Stream	Pits/open defecation	Manure(P)/ Fer	No Prevalent diseases	Fuel wood/ Grazing	Lavi and Fag, Local Melas	Pastures	Land Slide

Key for the Primary Survey Datasheet

S. no.	Field name	Remark
1	Name_Dis	District Name
2	Name_Tehsil	Tehsil Name
3	Name_Panchayat	Panchayat Name
4	Name_Village	Village Name
5	Total_HH	Total number of Households as per the primary survey
6	Total_ Pop as per survey/Total Pop as per 2001 census	The survey population has been calculated on the basis of total_HH and the average family size of 5-6 memebers/household
7	Agri_Produce	Agricultural output including produce of vegetables, cereals and orchards
8	Fish_Catch	Fish catch from the Satluj river
9	Type_Ind	Industry type existing in the area
10	Source_Drink	Source of drinking water
11	Source_Irrigation	Source of water for Irrigation
12	Livestock_Rearing	Water use for livestock rearing
13	Disposal_Sewage	Mode of sewage disposal
14	Use_Fertilizers	Fertilizer usage in the village
15	Avail_Grazing Land	Land in the area available for grazing
16	Forest_Use	Uses derived by people from the forests
17	Festivals	Cultural and Religious festivals
18	Type_Calamity	Nature of calamities in the village area

ST	Sub-Tehsil
SV	Sub-Village
Agri	Agriculture
Empl	Employment

Annexure III

ANNEXURE III

1. *Historical Flow data*
2. *Silt Data*
3. *Shanon Index and Evenness Index for trees, shrubs and herbs*
4. *Medicinal plant reported in the study area*
5. *Frequency, Density, Basal Area and Importance Value of Tree Species in Nathpa Jhakri region (Left Bank)*

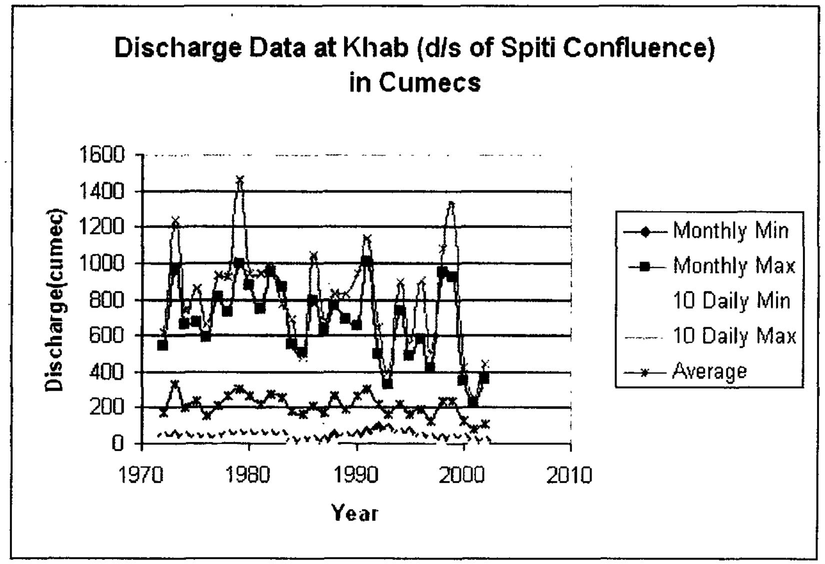
Historical Flow Data of River Satluj at various locations- Khab (d/s of Spiti Confluence), Nathpa, Rampur, Luhri, Kasol and Suni

Source: 1. Prefeasibilty Report on 465 MW Luhri H.E.P, March 2004; 2. Khab Detailed Project Report, SLVNL

a. Discharge Data at Khab (d/s of Spiti Confluence) in Cumecs

a. Discharge Data at Khab (d/s of Spiti Confluence) in Cumecs

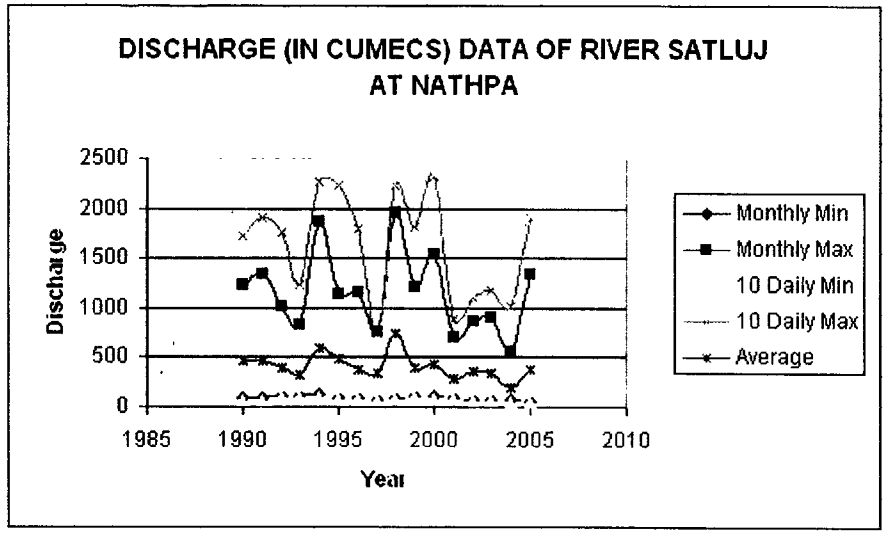
Year	Monthly		10-daily		
	Minimum	Maximum	aily Mini	0-daily Ma	Average
1972	45.63	543	44	617	171.83
1973	41.66	960	40	1238	334.58
1974	43.67	668	43	743	207.75
1975	41	670.66	39	858	242.17
1976	39	591.33	38	670	154.67
1977	37.66	814.33	40	938	208.33
1978	55	734.33	53	923	265.67
1979	55	1001.33	51	1459	307.92
1980	54.33	882	53	940	268.5
1981	57.66	753.66	55	945	223.5
1982	57.33	954.33	53	983	281.58
1983	51	867	52	775	259.5
1984	22	553.33	20	698	189.25
1985	17.66	511.66	17	478	170.25
1986	28	795.33	24	1041	217.08
1987	21.33	635.66	8	681	177.83
1988	44.66	769	21	828	263.64
1989	42.66	693.33	44	832	198
1990	45.66	659.33	40	947	264
1991	61	1011	44	1136	306.67
1992	88.33	500	60	643	218.67
1993	79	329	78	399	163.92
1994	64.33	735.33	64	898	218.92
1995	65	488	59	551	167
1996	49.66	580.66	49	906	195.83
1997	37.33	430	36	500	131.08
1998	26.33	950	22	1084	238.83
1999	39	925	40	1325	239.5
2000	36	349.33	34	426	128.92
2001	21	227	19	259	81.67
2002	17.33	365	17	440	114.42



b. DISCHARGE (IN CUMECS) DATA OF RIVER SATLUJ AT NATHPA

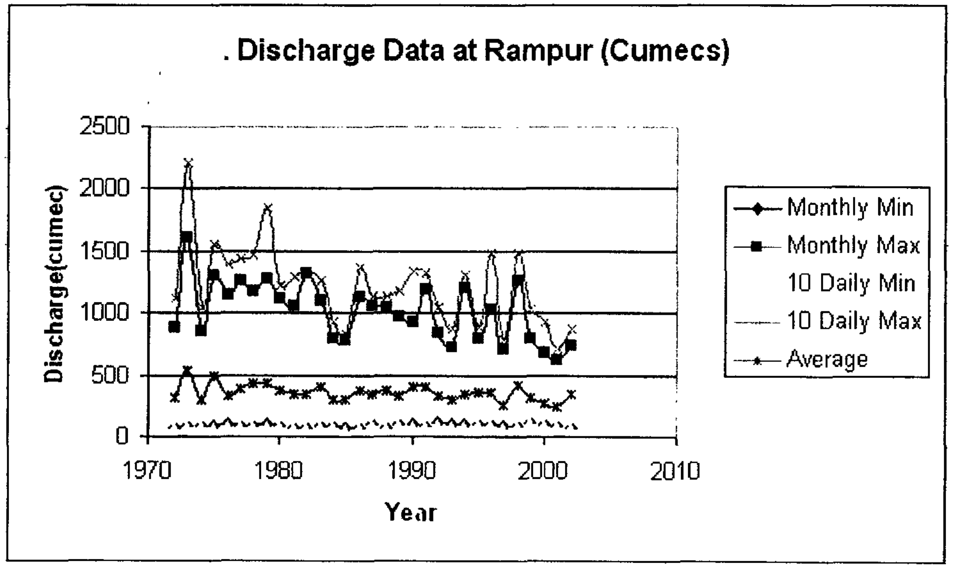
b. DISCHARGE (IN CUMECS) DATA OF RIVER SATLUJ AT NATHPA

Year	Monthly		10-Daily		Average
	Minimum	Maximum	Minimum	Maximum	
1990	82.89	1240.46	77.5	1718.54	476.115
1991	87.39	1332.94	74.89	1896.6	462.44
1992	117.49	1017.84	105.03	1760.99	399.89
1993	114.53	842.28	106.91	1223.08	321.75
1994	128.37	1867.785	113.62	2258.65	591.64
1995	90.45	1137.53	85.4	2230.46	486.54
1996	97.45	1164.28	93.13	1793.63	386.35
1997	74.76	761.635	71.21	741.51	344.61
1998	99.42	1962.39	94.7	2226.47	748.93
1999	106.17	1220.98	100.78	1808.21	407.075
2000	100.18	1536.48	95.91	2317.77	440.82
2001	92.44	701.33	83.2	880.25	285.64
2002	74.74	864.765	70.58	1106.5	355.81
2003	73.69	901.46	70.2	1172.64	336.54
2004	67.548	555.7	59.03	1019.92	203.51
2005	59.53	1347.21	47.53	1895.45	381.88



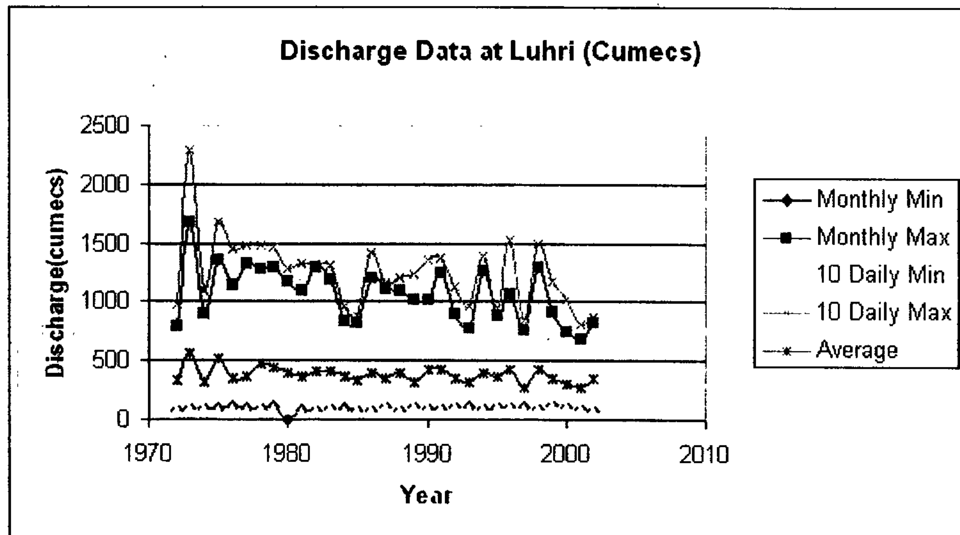
c. Discharge Data at Rampur (Cumecs)

Year	Monthly		10-daily		Average
	Minimum	Maximum	Minimum	Maximum	
1972	77.66	882.66	77	1116	313.42
1973	90	1618.33	88	2215	534.5
1974	88.66	851.66	85	1053	304.08
1975	87.66	1308	76	1551	492.42
1976	98	1143	94	1390	341.17
1977	87.66	1266.66	86	1433	396.5
1978	87.66	1176.33	88	1466	441
1979	94.66	1285	93	1840	431
1980	90	1124	90	1221	377.08
1981	72.66	1060	77	1293	347.92
1982	75.33	1318.66	78	1333	347.5
1983	87.66	1101.66	88	1270	411
1984	81	801.66	80	929	309
1985	69	780.66	65	833	305
1986	72.66	1138.33	67	1365	381.42
1987	104	1063.66	97	1133	346.58
1988	76	1039.33	71	1128	374.35
1989	103.66	979.66	102	1183	339.75
1990	96.33	935	89	1340	399.85
1991	86	1193	87	1318	404.08
1992	110	841.66	104	1047	340.83
1993	100.66	727.33	94	876	298.42
1994	98	1210.33	93	1308	355.42
1995	103	805.66	104	893	358.08
1996	103	1026.33	102	1483	365.42
1997	91.66	715.33	69	789	268.58
1998	81.33	1265.33	80	1487	426.92
1999	121	800.66	117	1037	324.33
2000	106	680.33	100	926	273.33
2001	84.66	622.66	82	712	247.67
2002	76.66	738.66	75	869	343.25



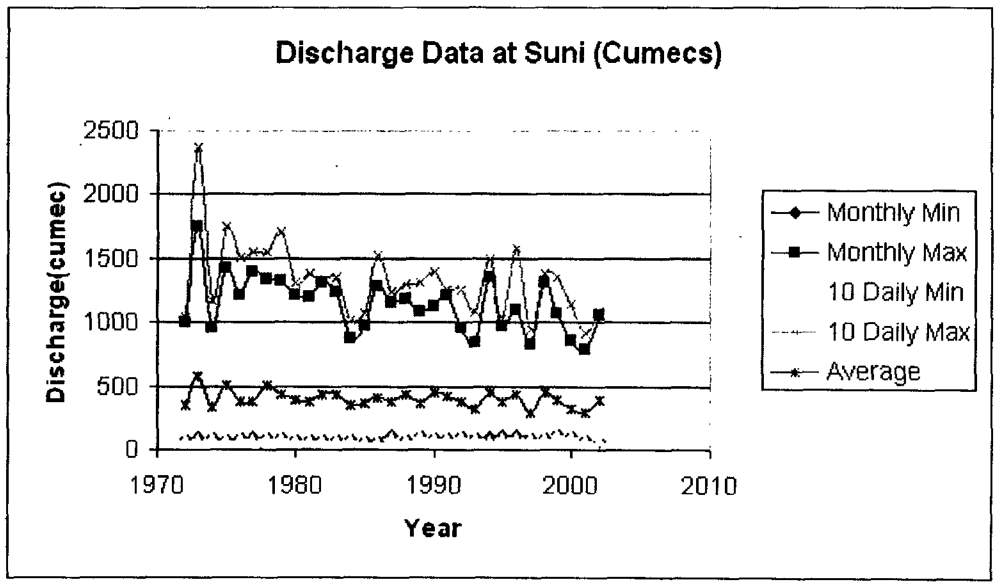
d. Discharge Data at Luhri (Cumecs)

Year	Monthly		10-daily		Average
	Minimum	Maximum	Minimum	Maximum	
1972	79.33	790.67	79	981	331.5
1973	90.66	1677	84	2283	557.83
1974	92	899.33	90	1102	321.42
1975	88.33	1360.67	78	1670	514.5
1976	99.66	1142	97	1444	355.83
1977	90	1329	82	1474	359.17
1978	90.67	1275	90	1483	469.42
1979	99.67	1302	95	1460	439.42
1980	90.6 7	1181	86	1277	390.67
1981	73	1104	56	1332	364
1982	79.67	1303	76	1317	418.25
1983	88.33	1183	86	1308	409.92
1984	85	831.67	81	964	371.33
1985	70	816.33	69	877	337.08
1986	74.67	1197.67	71	1419	396
1987	104.67	1106.33	102	1165	344.17
1988	78.67	1103.33	72	1199	395.83
1989	106	1023	104	1236	326.42
1990	99	1018.67	94	1364	426
1991	93.67	1244	90	1375	421.42
1992	111	892.33	105	1135	358.17
1993	103	778	99	966	319.17
1994	96.67	1270.67	89	1386	402.28
1995	107.33	878.67	104	951	365.92
1996	106	1059.67	102	1521	426.33
1997	101.67	765.33	92	841	281.08
1998	89	1288.33	88	1500	431.5
1999	124.67	915.33	118	1172	351.25
2000	112	754	105	1016	297.58
2001	85	687.67	84	801	273.83
2002	79	823.6667	76	868	352



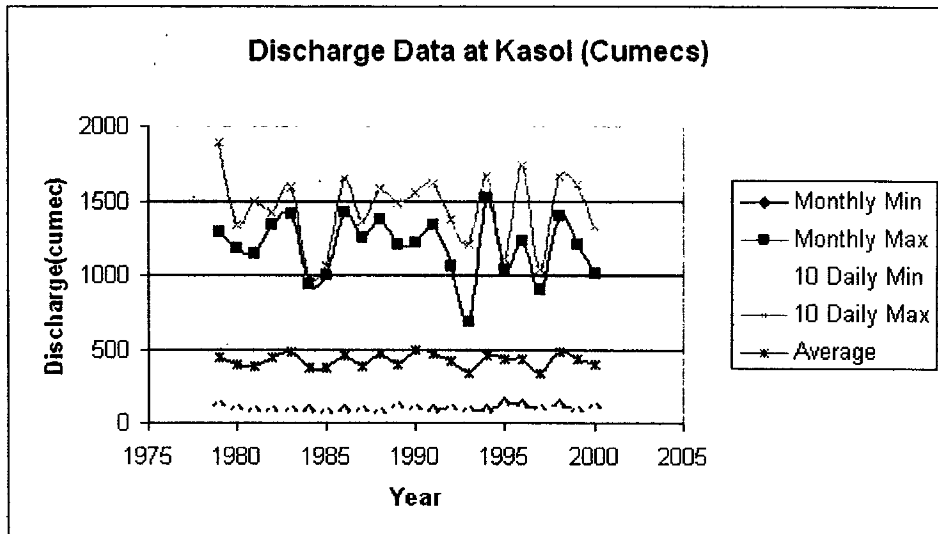
e. Discharge Data at Suni (Cumecs)

Year	Monthly		10-daily		Average
	Minimum	Maximum	Minimum	Maximum	
1972	82.33	999.33	82	1044	358.36
1973	94.33	1755.66	88	2375	580.31
1974	95.33	960.33	94	1168	338.61
1975	91.66	1425	81	1749	515.08
1976	104	1208.66	101	1517	387.33
1977	93.66	1399.33	86	1548	388.28
1978	93.66	1344	93	1557	511
1979	101	1328.66	94	1706	432.33
1980	88.33	1208.66	85	1317	394.86
1981	80	1195	78	1383	385.64
1982	83.33	1313.33	82	1332	434.68
1983	91.66	1241.33	88	1361	441.81
1984	87	871.33	81	1011	351.97
1985	72	975	71	1074	366.03
1986	77.33	1278.33	75	1527	415.14
1987	106	1165	104	1237	387.08
1988	82.66	1190.66	83	1295	435.97
1989	109.33	1081.66	111	1308	371.33
1990	102.33	1131.33	101	1396	455.92
1991	97	1213.66	96	1261	423.47
1992	112.66	963.33	106	1254	379.69
1993	105.66	847	105	1089	326
1994	94.33	1352	75	1491	454.83
1995	109.66	978	105	1035	383.33
1996	110.33	1105.66	103	1575	431.89
1997	102.33	836.33	101	948	298.53
1998	99	1319.33	97	1386	454.93
1999	126.66	1071.33	121	1355	397.57
2000	116.33	861	111	1139	330.09
2001	86	794	84	922	289.58
2002	75.66	1057	78	1089	393.96



f. Discharge Data at Kasol (Cumecs

Year	Monthly		10 daily		Average
	Minimum	Maximum	Minimum	Maximum	
1972	-	-	-	-	-
1973	-	-	-	-	-
1974	-	-	-	-	-
1975	-	-	-	-	-
1976	-	-	-	-	-
1977	-	-	-	-	-
1978	-	-	-	-	446.67
1979	121.66	1286.33	117	1892	402.58
1980	96	1182	94	1336	380.05
1981	82.66	1142	79	1499	441.58
1982	87.66	1341	85	1420	479.19
1983	90	1409.66	87	1586	368.19
1984	85.66	945	78	975	371.25
1985	74.33	996	73	1063	452.08
1986	83	1416.33	76	1653	379.58
1987	90	1258.33	83	1359	475.67
1988	75.66	1377	74	1584	400.58
1989	114	1205.33	111	1483	499.33
1990	94.66	1211.66	93	1553	472.67
1991	85.33	1336.66	76	1609	419.5
1992	100.33	1065.66	93	1369	333.25
1993	90.33	690	86	1205	460.92
1994	79.33	1517.33	77	1660	438.58
1995	131	1038	117	1104	434.35
1996	117.66	1230	111	1731	336.83
1997	95.66	899	95	1033	477.42
1998	125	1401.66	111	1657	428.75
1999	86	1209.33	83	1597	392.86
2000	111.66	1012	105	1320	-
2001	-	-	-	-	-
2002	-	-	-	-	-



DAILY DISCHARGE AT SATLUJ RIVER OBSERVED AT 10AM AT RAMPUR AT G &D SITES

February 2006

DATE	DISCHARGE IN CUMECS u/s of Rampur (atJagatkhana Bridge site)	d/s of Rampur (at SJVN Bridge site)
FEBRUARY		
4-Feb-06	127	128
5-Feb-06	150	151
6-Feb-06	134	135
7-Feb-06	137	130
8-Feb-06	106	106
9-Feb-06	134	137
10-Feb-06	109	109
11-Feb-06	106	150
12-Feb-06	113	114
13-Feb-06	106	158
14-Feb-06	104	105
15-Feb-06	126	126
16-Feb-06	112	113
17-Feb-06	106	109
18-Feb-06	116	118
19-Feb-06	145	143
20-Feb-06	142	144
21-Feb-06	103	104
22-Feb-06	105	106
23-Feb-06	112	113
24-Feb-06	122	124
25-Feb-06	116	117
26-Feb-06	109	110
27-Feb-06	128	129
28-Feb-06	127	128

March 2006

MARCH		
1-Mar-06	103	104
2-Mar-06	110	112
3-Mar-06	104	106
4-Mar-06	102	103
5-Mar-06	96	97
6-Mar-06	120	122
7-Mar-06	147	149
8-Mar-06	148	145
9-Mar-06	153	152
10-Mar-06	103	105

11-Mar-06	103	105
12-Mar-06	121	122
13-Mar-06	112	110
14-Mar-06	110	111
15-Mar-06	111	112
16-Mar-06	101	102
17-Mar-06	67	70
18-Mar-06	98	100
19-Mar-06	101	100
20-Mar-06	83	85
21-Mar-06	104	105
22-Mar-06	146	147
23-Mar-06	154	155
24-Mar-06	158	157
25-Mar-06	156	155
26-Mar-06	145	150
27-Mar-06	108	107
28-Mar-06	107	108
29-Mar-06	108	109
30-Mar-06	106	107
31-Mar-06	155	157

TABLE Shanon Index and Evenness Index for trees, shrubs and herbs

Group	Shanon Index	Evenness Index
Tree species		
Right Bank	1.05	0.94
Left Bank	1.29	0.94
Shrubs species		
Right Bank	1.12	0.95
Left Bank	1.17	0.95
Herbs species		
Right Bank	1.08	0.94
Left Bank	1.23	0.93

Source: EIA Study for Updation of NJHEP)

Table Medicinal plant reported in the study area

Species name	Type	Part of the Plant Used
Aesculus indica	Tree	Bark, Fruit
Asparagus filicinus	Shrub	Root
Berberis aristata	Shrub	Wood, Bark, Plant
Berberis lycium	Shrub	Leaf, Root
Bupleurum falcatum	Herb	Root, Leaf
Cannabis sativa	Herb	Leaf, Seed
Cedrus deodara	Tree	Wood, Bark
Daphire papyracea	Shrub	Leaf
Datura stramonium	Herb	Leaf, Fruit, Seed
Ficus palmata	Tree	Fruit
Jugalans regia	Tree	Fruit, Bark
Chenopodium album	Herb	Plant, Leaf, Seed
Jasminum grandifloram	Shrub	Leaf, Flower
Juniperous recurva	Shrub	Twit, Leaf
Polygonetum sp.	Herb	Root
Prinsepia utilis	Shrub	Seed
Ephedra gerardiana	Shrub	Stem, Fruit
Pinus roxburghii	Tree	Bark, Wood
Pinus wallichina	Tree	Bark, Wood
Prunus persica	Tree	Leaf
Pyrus pashia	Tree	Fruit
Ranunculus lingua	Herb	Leaf
Ranunculus arvensis	Herb	Leaf
Solanum indiaum	Shrub	Leaf, Fruit, Root
Ziziphus sp.	Shrub	Fruit

Source: EIA Study for Updation of NJHEP

Table: Frequency, Density, Basal Area and Importance Value of Tree Species in Nathpa Jhakri region (Left Bank)

Species	Frequency (%)	Density (No/ha)	Basal Area m^2/ha	IVI
Pinus wallichiana	25	18	4.38	22.33
Pinus roxyburghii	40	30	7.30	36.94
Cedrus deodara	20	12	3.09	15.96
Abies pindrow	20	28	6.82	31.39
Betula alnoides utiles	25	8	0.91	9.47
Junglans regia	20	5	0.25	5.79
Acer acuminatum	30	14	0.90	12.24
Acer oblongum	30	9	0.57	9.72
Aesculus indica	35	13	0.66	12.13
Albizzia lebbek	20	18	0.80	11.48
Ficus palmata	20	9	0.40	7.49
Cupressus sempervivens	20	12	1.37	11.14
Melia azadirch	15	5	0.61	5.92
Morus serrata	20	12	0.46	8.62
Prunus padus	20	18	0.70	11.20
Prunus persica	15	7	0.27	5.62
Pyrus pashia	20	11	0.56	8.57
Quercus incana	35	26	1.01	17.28
Quercus semicarpifolia	35	10	0.38	10.39
Picea smithiana	35	12	2.14	15.93
Pistacia integenria	20	6	0.30	6.25
Rhus panijabensis	25	18	1.73	14.95
Rhododendron arborcum	25	11	0.31	8.76
Total		320		229.57

(Source: EIA Study for Updation of NJHEP)

TABLE : Frequency, Density, Basal Area and Importance Value of Tree Species in the Nathpa Jhakri region (Right Bank)

Tree Name of the Tree species (*Right Bank*)	Frequency (%)	Density No. per ha	Basal Area m^2/ha	IVI
Abies pindrow	30	17	3.46	33.41
Picea smithiana	35	20	3.57	37.15
Rhus panjabensis	20	12	0.95	17.07
Acer acuminatum	20	8	0.51	12.79
Acer oblongun	25	7	0.45	13.39
Asculus indica	20	11	0.56	14.84
Albizzia lebbek	20	8	0.35	12.13

Cupressus sempervirens	30	9	1.03	18.46
Pinus wallichiana	35	13	2.64	29.02
Juglanse regia	20	5	0.25	9.88
Ficus palmate	20	7	0.31	11.36
Pinus roxburghii	40	27	5.49	50.84
Cedrus deodara	30	19	462	39.43
Total		163		299.77

(Source: EIA Study for Updation of NJHEP)

TABLE : Frequency, Density and Importance Value of Shrub species in the Nathpa Jhakri region (Left Bank)

Name of the shrub species *(Left Bank)*	**Frequency (%)**	**Density (No./ha)**	**IVI**
Asperagus filicinus	25	92	10.14
Berberis aristata	55	285	26.23
Berberis lycium	40	227	13.52
Daphne papyracea	15	128	9.51
Indigofera dosua	45	205	20.21
Juniperus macropoda	20	95	9.13
Cotoneaster microlophylla	25	82	9.67
Prinsepia utilis	15	95	7.96
Woodfordia floribunda	25	125	11.70
Salix hastata	15	78	7.15
Solanum indicum	20	115	10.07
Lonicera hypoleuca	20	118	10.21
Cotoneaster bacillaris	15	35	5.13
Adhatoda vasica	25	105	10.76
Desmodim tiliaefolium	15	70	6.78
Olea chspicata	15	45	5.60
Ziziphus sp.	40	220	19.67
Total		**2123**	

TABLE :Frequency, Density, Basal Area and Importance Value of Shrub Species In the Nathpa Jhakri region (Right Bank)

Name of the shrub species *(Right Bank)*	Frequency (%)	Density (No./ha)	IVI
Berberris aristata	60	340	28.03
Berberis lycium	50	280	23.25
Daphne oleoides	30	120	11.81
Daphne retusa	35	137	13.64
Indigofera dosua	40	235	19.05
Juniperous recurua	20	90	8.31
Prinsepia utilis	25	110	10.28
Woodfordia floribunda	30	120	11.81
Lonicera hypolecua	20	125	9.85
Rhus cotinus	15	60	5.90
Salix hastata	15	80	6.78
Solanun indicum	25	110	10.28
Asparagus filicinus	25	128	11.07
Jasminum humile	20	52	6.63
Ziziphus sp.	50	280	23.21
Total		2267	199.86

(Source: EIA Study for Updation of NJHEP)

Table Frequency, Density and Importance Value of Herbs species in the Nathpa Jhakri region (Left Bank)

Name of the Herb species *(Left Bank)*	Frequency (%)	Density (No./ha)	IVI
Carium carvi	20	10800	11.46
Chenopodium album	25	8500	10.72
Mentha sylvestris	35	7000	11.47
Saussurea lappa	30	4500	8.75
Podophyllum hexcendrum	10	1700	3.05
Atropa belladonna	10	1200	2.69
Agrimonia eupatorium	20	2000	5.10
Bupleurum falecatum	30	7500	10.91
Canabis sativa	45	9500	15.11
Datura stramonium	40	7000	12.38
Mentha longifolia	45	14000	18.36
Ranunculus arvensis	10	1600	2.98
Ranunculus lingna	20	1800	4.96
Strobilanthes alatus	20	8000	944

Polygonatume sp.	30	9000	12.00
Potentilla nepalensis	25	6200	9.05
Malva neglecta	15	3600	5.35
Thymus serphyllum	20	6500	8.35
Nepeta ciliaris	15	5000	6.36
Ricinus communis	30	3000	7.66
Cynodon dactyeon	50	20000	23.62
Total		**138400**	

Table Frequency, Density and Importance Value of Herbs species in the Nathpa Jhakri region (Right Bank)

Name of the herb species (Right Bank)	**Frequency (%)**	**Density (No./ha)**	**IVI**
Mentha sylvestris	30	5300	19.33
Bupleurum falcalum	20	3500	12.81
Canabis saliva	25	4300	15.86
Mentha longifolia	25	5000	17.30
Thymus serphyllum	20	2500	10.76
Polygonatum sp.	15	1700	9.71
Ranunculus lingua	15	2200	8.73
Datura stramonium	30	1200	10.91
Ricinus communis	35	2900	15.80
Cyndon dactylon	55	1200	40.13
Saussurea lappa	20	3200	12.20
Agrimonia eupatorium	15	1100	6.57
Ephedra gerardiana	25	1800	10.73
Fragaria vesca	25	2000	11.14
Total		48700	

Table :Frequency, Density and Importance Value index of different tree species at village Bael, located on the right bank, the powerhouse site for Rampur HEP

Tree species at Bael	Frequency (%)	Density No. per ha	Basal Area m^2/ha	IVI
Eucalyptus sp.	88	70	2.73	113.80
Dalbergia sissoo	40	15	0.43	27.67
Melia azadirchta	12	12	029	15.33
Cedrela toona	20	8	019	13.64
Mangifera indica	20	6	0.23	13.29
Citrus sp.	20	7	0.09	11.26
Alnus nepalensis	8	3	0.06	5.05
Sapindus mukurossi	20	7	0.07	12.73
Mallotus phillipinensis	8	4	0.20	8.16
Ficus palmata	24	22	0.28	24.06
Prunus persica	8	3	0.05	4.87
Pinus roxyburghii	16	5	0.32	13.23
Prunus communis	20	6	0.08	10.54
Salix daphnoides	20	9	0.18	14.00
Grewia opposilifolia	20	7	0.14	12.18

Table : Frequency, Density and Importance Value index of different tree species at Nogli located on the left bank

Tree species at Nogli	Frequency (%)	Density No. per ha	Basal Area m^2/ha	IVI
Eucalyptus sp.	80	84	3.26	180.59
Dalbergia sissoo	12	8	0.19	16.76
Mangifera indica	20	5	0.19	18.91
Mallotus phillipinensis	12	7	0.07	13.24
Cedrela toona	8	6	0.14	11.96
Pinus roxyburghii	8	3	0.17	10.47
Ficus palmata	24	18	0.17	30.12
Albizzia lebbek	20	6	0.11	17.78

(Source: EIA Study for Updation of NJHEP)

Annexure IV

Insert the photocopied pages

ANNEXURE IV

Annexure V

Add photocopy.

ANNEXURE V