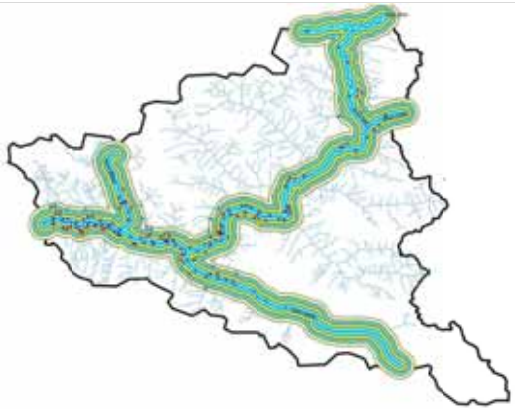
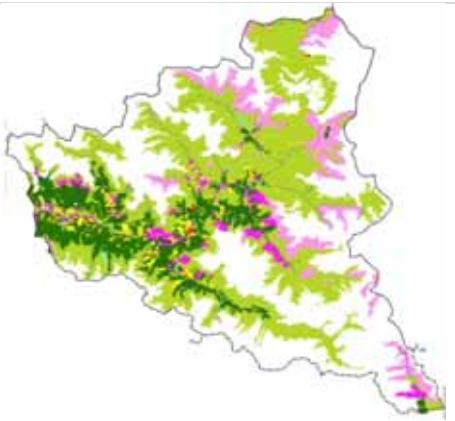
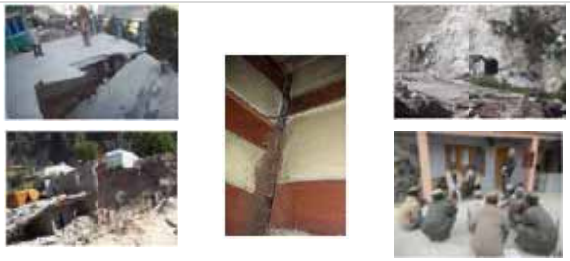


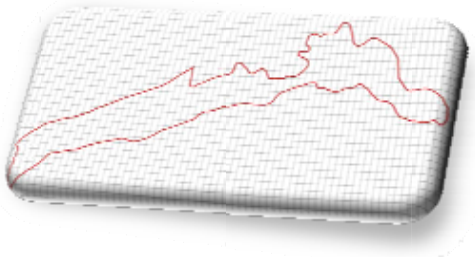
HYDROPOWER PROJECTS IN THE SUTLEJ RIVER BASIN

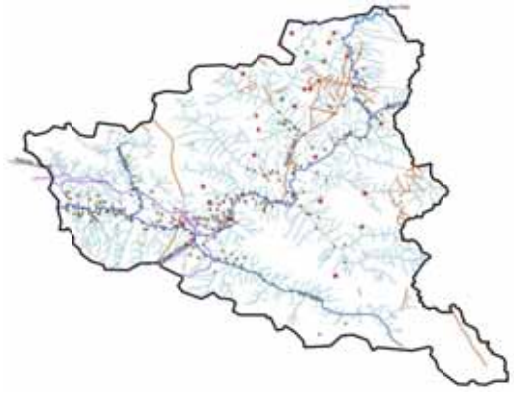
NORTH WESTERN HIMALAYAS

2014







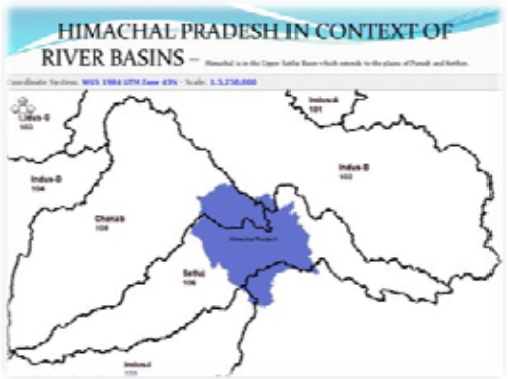


ENVIRONICS TRUST
IN ASSOCIATION WITH
HIMALAYA NITI ABHIYAN – HIM JAN LOK JAGRITI MANCH

HYDROPOWER PROJECTS IN THE SUTLEJ RIVER BASIN

NORTH WESTERN HIMALAYAS

REPORT 1: KINNAUR DISTRICT, UPPER SUTLEJ BASIN 2013-14



ENVIRONICS TRUST

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Commonly Used Abbreviations in the Report

Cumec – represents flow of water in Cu.m.per second or m^3s^{-1}
HRT – Head Race Tunnel
MSL – Mean Sea level
EIA – Environment Impact Assessment
EMP – Environment Management Plan
CAT – Catchment Area Treatment
Cr. – Crores (Rupees)
TRT – Tail Race Tunnel
FRL – Full Reservoir Level
TWL – Tail Water Level
HEP or HP – Hydroelectric Projects
WLS – Wildlife Sanctuary
NDVI – Normalised Difference Vegetation Index
LULC – Land Use Land Cover
NoC – No Objection Certificate or No Objection
NGT – National Green Tribunal
FRA – Forest Rights Act
UTC – Coordinated Universal Time

Contents

Executive Summary

Rivers as natural watercourses have remained the most efficient systems to sustain lives and livelihoods of millions of people irrespective of whom they are serving but the scenario has been transforming as the pressures on these water systems and attached ecology has seen changes leaving the Rivers to be managed in a way that suits development of varied nature and interests. Rivers are polluted, rivers are being mined, rivers are being trained to respond to changes, rivers are dammed for energy but there is no effective mechanism to increase the knowledge about river and its morphological behaviour in order to best address the user & socio-cultural interrelationships. Himalayan Rivers have drawn their path while going through immense geological processes and the *writing is clear on the wall* that Himalayan systems are evolving natural systems and are required to be dealt with careful development planning. While Himalayas have been credited as 'Water Tower of Asia' for their immense potential of serving the humanity, increasing challenges of climate change and intensification of hydro potential with micro to macro impacts on forests, land, livelihood, modulating hydrological flow regime suggests rethinking about rationalization of development schemes or planning where changes are irreversible and *one approach fits all* is not at all a welcome method.

The Upper Sutlej catchment is about 19,000 km^2. Almost the entire District Kinnaur forms a part of the catchment, except for a small portion in the east. The upper Sutlej portion of the river cuts across the three administrative units along its south-westerly axis. The gradient from upstream to downstream of the river within Kinnaur is steep, falling about 1830 m over a distance of 130 kms. The distance between confluence of River Sutlej & Spiti and River Sutlej & Baspa is 73 kms., mean altitude of River Sutlej is 1635m, highest being 2950 m upstream of khab. With an estimated hydropower potential in excess of 27,000 MW for Himachal Pradesh, several projects are lined up to cash upon the water resource and with long gestation periods of hydropower realization the *'loss of environment good'* has not been equated with the feasibility of having so many projects. Nearly 4600 hectares of forest land is expected to be diverted for projects and this will increase as more and more projects reach the clearance stage.

Kinnaur District is the High Himalayan landscape separating Himalayas from the Tibetan plateau and several localities of active seismicity surround this district, with the Main Central Thrust passing through it. River Sutlej enters Himachal Pradesh near Shipki La Pass before it completes its 260 kms run through the Tibetan Plateau, the confluence of River Spiti & River Sutlej at Khab is where 65m high concrete gravity dam is proposed and at the downstream stem in Kinnaur district is where Karcham Wangtoo Project is operational, between these there are 16 hydroelectric projects to come up and at are various stages of development. Active tectonics in the region is indicative of narrow valleys or low valley floor to width ratio (sharp V) which is noticed in this region, Kaurik fault passes through Akpa upwards towards River Spiti where micro seismic activity is not ruled out.

Majority of the engineering works of hydroelectric projects are carried out in the vicinity of river channel, we find that majority of the population lives within 1-2 km buffer from the respective River, in the selected 198 villages in the 4 km buffer from the River, 64.64% population resides in 1 km buffer from the River and these become particularly vulnerable to changes occurring due to construction,

blasting, deforestation activities. Over 41% of the district's area is under snow and glaciers, the habitable zones are largely within 1-3kms from the river depending upon the altitude of the region. Of the 18 earthquakes, 13 of these occurred within the 4 km river buffer marked for a better understanding of risks. Several marked faults in the district are active like the Kaurik Chango fault extending from Akpa-Rispa to Dhar Chango Uparla and runs for almost 52 kms and network of faults are seen, Syarma and Guimal fault zones are also seismically active, the shifting of Spiti river course towards west indicates upliftment of eastern block of Kaurik Chango fault near Sumdo. One can imagine developing 27,000 MW and resultant cumulative externalities it will cause in terms of loss of forests, manifestation of landslides, changes in river regime, post construction damages; the CEIA by ICFRE does not brings any clarity to the cumulative impacts these projects can cause.

The rainfall pattern in the Himalayan Crest and the Tibetan Plateau is marked with no rainfall and is a typical cold-desert. Nichar, South of Recongpeo, the District Headquarters was considered the northern limit of rain. However, in the recent decade rain has transgressed and has been noticed immediately north. These changes in effect add to the changes being brought up by development projects in the region and very thin spread of weather monitoring and lack of authoritative assessment of role played by climatic pressures is another bleak area which requires time and monitoring regime to gear up for taking concrete decisions. The inducement of LLOF (Landslide Lake Outburst Flood) in 2005 is not history, the damages caused in 2013 reminds about the need for a policy that require a best fit to the local geological, spatial and climatic regime which are undergoing changes in the Himalayas, fast pace to encash the resource will only leave such policies as post response measures which would indicate lop sided planning because changes taking place cumulatively affect agriculture, horticulture, housing, public infrastructure as these are closely knit along the river system.

Lack of vegetation in the orogenic interior coupled with steep slopes (low valley floor to width ratios) and rainstorm events mobilize exposed alluvial fans, increase in sediment yield and riverbed load require a more robust morphological understanding of the basin as whole and river systems as micro elements building up the basin to arrive at management and functional issues. The 2013 Kedarnath event is a reminder of why intensification of projects can be a cause of triggering damages downstream, muck deposition and incapacities to handle it and nature of hydroelectric development becomes a cause of concern for public safety and disaster management. The current development pace to mindlessly exploit the river waters has only increased the process of disintegration of ecological units, not even common resource like Pinus Gerdiana which is nearly threatened species has been spared, the Shukla Committee has dealt with how lax approach for Catchment Area Treatment (CAT) has not generated any positive outcome and more than permitted forests and trees have been removed.

River Valley projects take a very macro view of the spatial extent with least utility for the communities as far as their sustainability coupled with livelihood systems is concerned, slope and aspect is important from the standpoint of maximizing production systems and most of the communities, except at fewer instances which may have circumstantial restrictive production systems, have well thought about systems but the pertinent question arises whether projects developed so far have addressed these critical issues with sincerity.

1. Background

A National programme to increase hydro power generation by 50,000MW[1] through Himalayan Rivers was initiated in 2003 by the Central Government. This programme in its urgency considered only the basic parameters for power generation such as the head and flow, but has severely overlooked the seismic and other geological issues apart thus undermining the ecologically fragile existence of the Himalayan communities. People have been protesting across the Himalayas on the impacts and implications of these projects and yet there has been a complete stone-walling by the State.

This programme of Environics Trust and Himalaya Niti Abhiyan, supported by Duleep Matthai Nature Conservation Trust is conceived as a joint effort with local groups in each of the river segments. Him Jan Lok Jagriti Manch, a platform of local community groups in Kinnaur partnered in this segment and a lasting relationship has been built. The effort is enabling creation of a sustained partnership among various groups to systematically address issues of natural resources management in the Sutlej Basin.

The programme aims to progressively cover the entire Sutlej Basin and contribute to a rational river basin management system. Kinnaur district in the most vulnerable parts of Himalayas and at the head of the Sutlej River is the epitome of such disastrous projects. Over the past year, this region has been extensively visited and studied and the report focuses on the district and draws up an action plan for further action in Kinnaur and next downstream segment.

Hydropower depends solely on the River, the quantity of flow and the gradient. Nearly 20 large and several small hydro projects have been conceived as a cascade and several of them are in different stages of planning and implementation.

Often its development neglects the carrying capacity as a natural course of water, providing minerals, silt, life forms and fulfilling cultural-social and livelihood needs. Thus the risks posed due to poor understanding; impact of altering the course of the Rivers; facade and structure of the hills is grossly underestimated.

[1] Refer annexure I

2. Hydropower Projects in Upper Sutlej

Within India, an average annual surface water potential of 73.3 km^3 has been assessed in this basin. Out of this, 46.0 km^3 is utilizable water. Culturable area of the basin is about 9.6 M ha, which is 4.9% of the total culturable area of the country.

Source: National Institute of Hydrology, Roorkee

The lower and upper Kinnaur sub-divisions and landforms depict wet, dry temperate and arid areas supportive of horticulture and other invasive species on valley slopes. Any disturbance along the valley coupled with the tectonic settings of the area makes this landform vulnerable to risks of landslides, instability of species and tree forms. The landform facilitates drainage of upper Sutlej basin with wide network of khads and streams both on the left and right banks of River Sutlej; Baspa joins Sutlej at Karcham thus forming an extended elongated valley through Nichar, the lower Kinnaur sub-division. The tightly knit Sutlej and Baspa Valleys are regulated by the Great Himalayan Range (GHR) and forms a similar climatic zone with mouth of this zone (near Nichar) also influenced by climatic variations of mid Himalayan region downwards and near Nichar which more or less receives similar amount of rainfall as received in the mid-hills. But as one moves upstream of Sutlej from Nichar the rainfall reduces considerably and more snow clad mountains are seen, even further up the region becomes semi-arid. The large expanse of this GHR has sparse vegetation and it is the middle portion of the district i.e. along River Sutlej that land based activities like orchards, agriculture are seen.

Himachal Pradesh has an estimated Hydropower potential of 27,436MW. Out of this 4820.61MW (17.57%) is under consideration which means 82.43% capacity has been implemented and under progressive stages of hydropower development with a portfolio of 635[2] projects. Among this 82.43%, commissioned capacity is 33.54% (9202.89MW), 13.57% (3722.28MW) is under construction, 8.96% (2457.62MW) under clearance stage, 18.88% (5181.1MW) under investigation and another 7.48% is disputed[3], cancelled or foregone (2051.5MW) *(see figure 1)*. In terms of sectoral classification *(see figure 2)*, 8641.07 MW is held by private sector (including 960MW - see footnote 3) among which 1194.87 MW under small projects; State including HPPCL, HPSEB, Himachal share from Yamuna Projects & Ranjeet Sagar Dam has a stipulated capacity of 3973.09MW; Central Sector and Joint Schemes have a stipulated capacity of 8929.73MW.

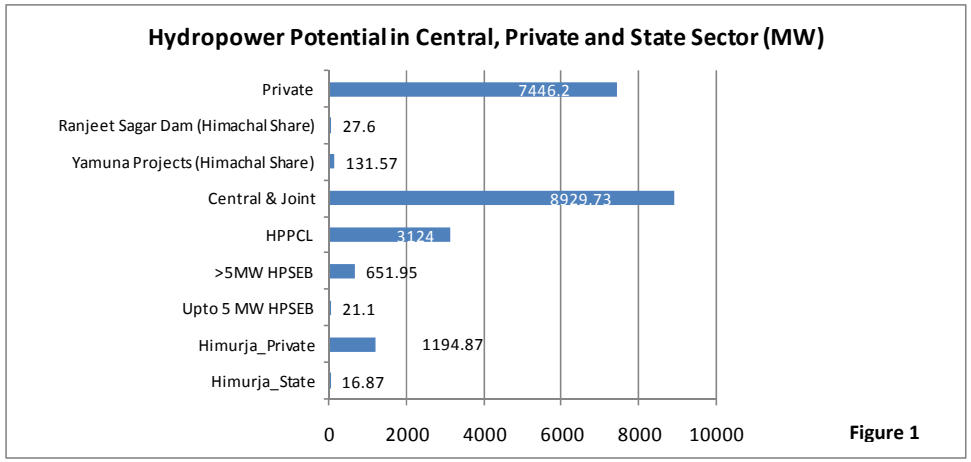


Figure 1

[2] Subtracting 6 foregone projects and 7 disputed projects from the total of 648 projects, one disputed project is most likely to get resolved so it is included (see footnote below)

[3] 960 MW is Jangi-Thopan-Powari Hydroelectric project which is most likely to be offered for re-bidding following dispute with the first bidder (Brakel Corp.)

So the effective capacity under implementation and under progress is 21543.89MW (plus 4820.61MW under consideration)

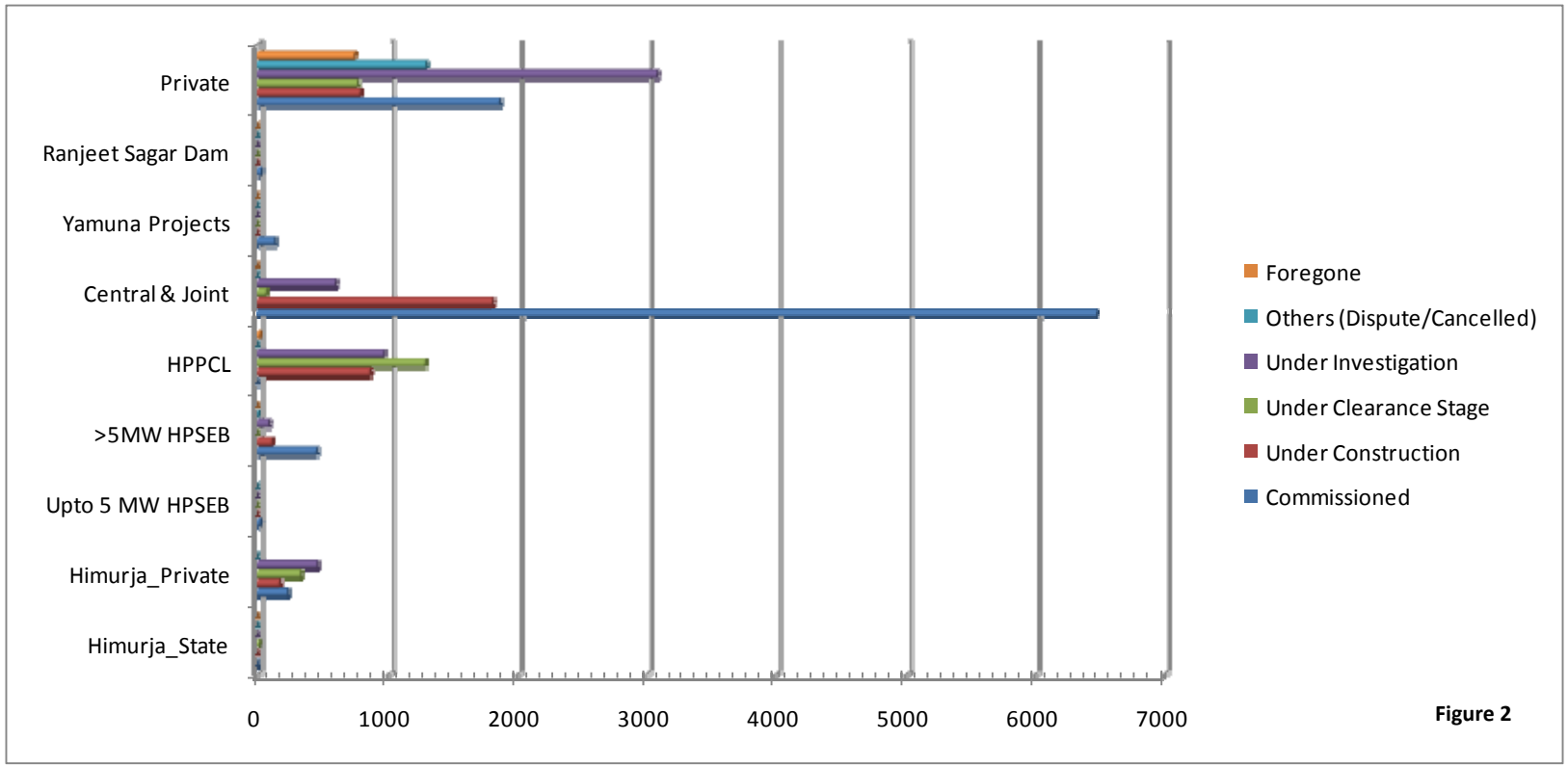
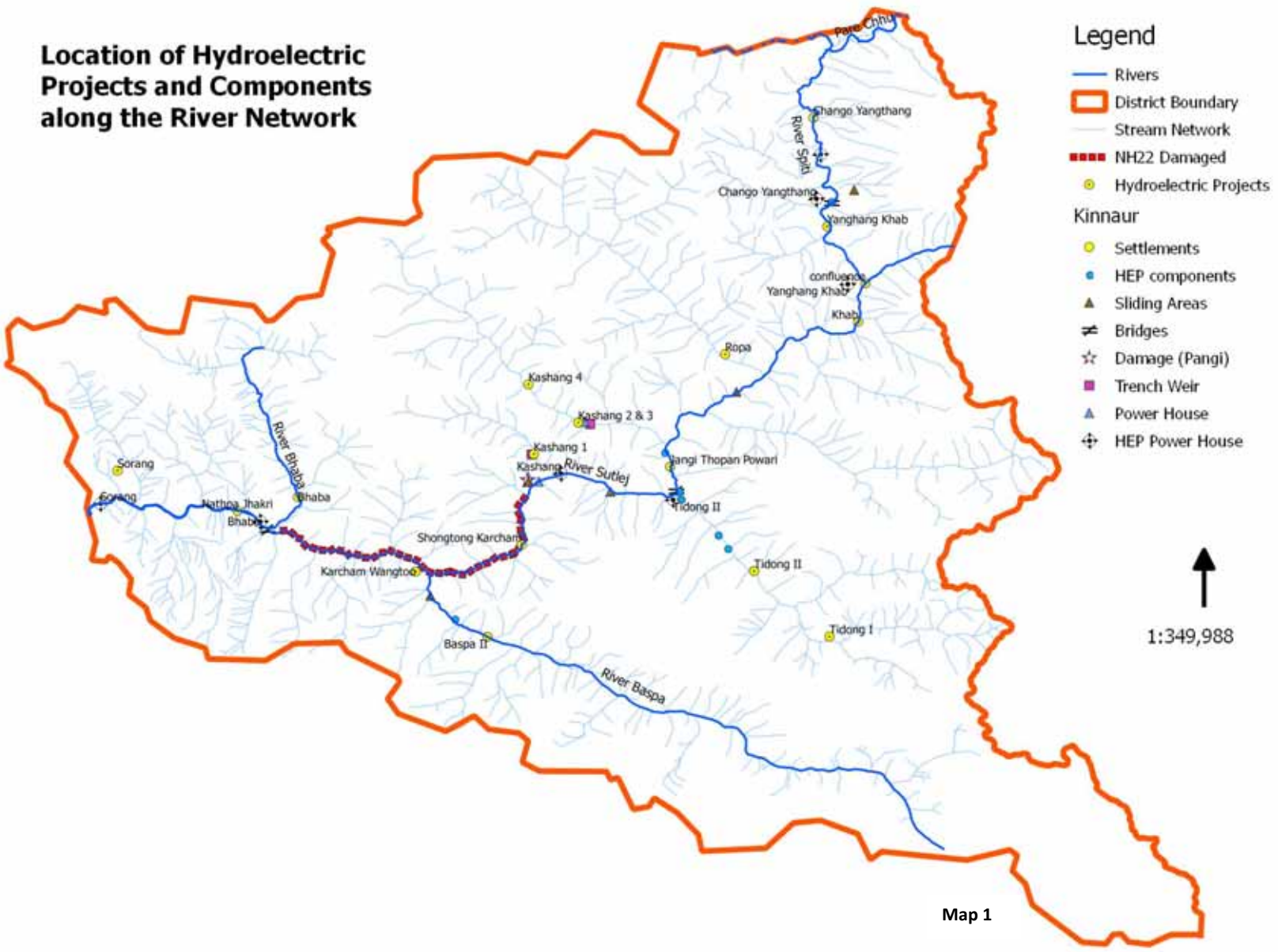


Figure 2

A staggering 4834 MW capacity is being installed in the small but fragile districts of Kinnaur and Lahaul-Spiti. Of these 21 major projects *(see table 1)*, only two are commissioned, 4-5 are at construction stage and rest of them are being investigated or obtaining clearances. An estimate of forest area diverted for these projects is 2386.42 hectares or 23.60 km^2 for hydropower project development. Transmission lines and pooling stations for evacuating power become another pressure on requirement of land for laying towers (estimated 591.25 hectares, Annexure II); NH-22 which is the main arterial road connecting this remote district is always at a risk of damages due to construction activities and plying of heavy vehicles and leakage of water towards valley side, it was worst affected during June 2013 *(see map 1)* from the available records, upgradation and realignment of certain stretches for about 83 kms has led to diversion of 100.19 hectares and in one instance 26.40 hectares for a road from Khab to Namgia. The cumulative forest diversion area is to the tune of 4430.66 hectares (based on the available statistics) and with several projects designed and investigated, the figures are likely to increase taking into account diversion for projects and infrastructure development.


Location of Hydroelectric Projects and Components along the River Network
Legend
Rivers
District Boundary
Stream Network
NH22 Damaged
Hydroelectric Projects
Kinnaur
Settlements
HEP components
Sliding Areas
Bridges
Damage (Pangi)
Trench Weir
Power House
HEP Power House
1:349,988
Para Chhid
Chango Yangthang
River Spiti
Yanghang Khab
confluence
Khab
Ropa
Kashang 4
Kashang 2 & 3
Kashang 1
Jangi Thopan Powari
River Sutlej
Tidong II
Tidong I
Sorang
Nathpa Jhakri
Bhaba
River Bhaba
Shongtong Karcham
Karcham Wangtoo
Baspa II
River Baspa

Map 1

Table 1 Large Hydropower Projects in Upper Sutlej Basin Upto Karcham-Wangtoo[4]					
Project	**MW**	**Agency**	**Forest Diversion[5] (hectares)**	**Status**	**Description**
Shongtong-Karcham	450	Himachal Pradesh Power Corporation Ltd.,(HPPCL)	63.5015	Under Construction	A run of the river scheme, envisages 22 m-high barrage across the Sutlej River near Powari. The HRT for the project is 8.04km with a catchment area of about 53792sq.km. Total forest diversion is of 63.50ha and about 158 households are directly affected. Muck generation: 4.72 Mm^3
Kashang-I (Under Construction)	65	Himachal Pradesh Power Corporation Ltd.,(HPPCL)	18.7142	Under Construction	A run-of-the-river scheme with diversion of major part of Kashang stream (near Dollo Dogri village) to an underground power house located on the right bank of the river near village Powari. It has a catchment area of 124.03 sq.km.
Kashang-II	65	Himachal Pradesh Power Corporation Ltd.,(HPPCL)	17.6857 (630 trees out of which 69 Deodar & Chilgoza trees)	Under Construction	A trench weir type diversion structure is proposed, with crest at El. 2872 m of the Kerang stream into an underground water conductor system located in a narrow valley, some 60 m below the road from Lippa to Asrang. The link tunnel made for Kerang-Kashang will be 6.5km.
Kashang III	65	Himachal Pradesh Power Corporation Ltd.,(HPPCL)		Under Construction	Augmenting the generating capacity of stage-I powerhouse using Kareng water over the 820 m head available in Kasang stage-I powerhouse.
Kashang IV	48	Himachal Pradesh Power Corporation Ltd.,(HPPCL)	25.500	Obtaining Clearances	Almost an independent scheme harnessing the power potential of Kerang stream, up-stream of the diversion site of stage-II. The diversion Structure to be located near village Tokytu with an underground powerhouse near village Lippa.
Tidong-I	100	Nuziveedu Seeds Ltd	39.0546+ 33.0036 (T/L to Kashang-Bhaba at Purbani)	Under Construction	A run-of- the-river project with a HRT of 8.46 km, the project has a design discharge of 13.45cumecs. The slope of the river at the diversion site is 1:50. Total catchment area up to dam site is 497.86Sq.Km. Forest diversion of 39.05ha, mostly of *Chilgoza* (751 out of 1261) and total displacement of village Lumbar. Rs. 14.78 Cr. (combined NPV[6], cost of trees, CA[7], CAT[8]) Muck generation: 4.14 lakh cu.m. (1.43 utilisable, rest in 4 dumping sites). 590 trees not approved for felling have been irretrievably got damaged – penalty of Rs. 83.39 lakhs
Chango-Yangthang	180 (revised as of Sept. 2012)	Chango Yangthang Hydro Power Limited	146 (overall)	Obtaining Clearances	23 m-high diversion dam is proposed on river Spiti. An underground powerhouse is proposed on the right bank with 2 units of 70 MW each. Discharge diversion is of 150cumes. The total land requirement will be of 146Ha. 72 ha is barren un-demarcated forest land of which about 40 ha will be submerged. This includes private land and some portion of NH-22.

[4] Power evacuation map can be seen in Annexure II

[5] Forest Diversion for transmission lines, road upgradation and SHEPs can be seen alongside annexure II

[6] Net Present Value

[7] Compensatory Afforestation

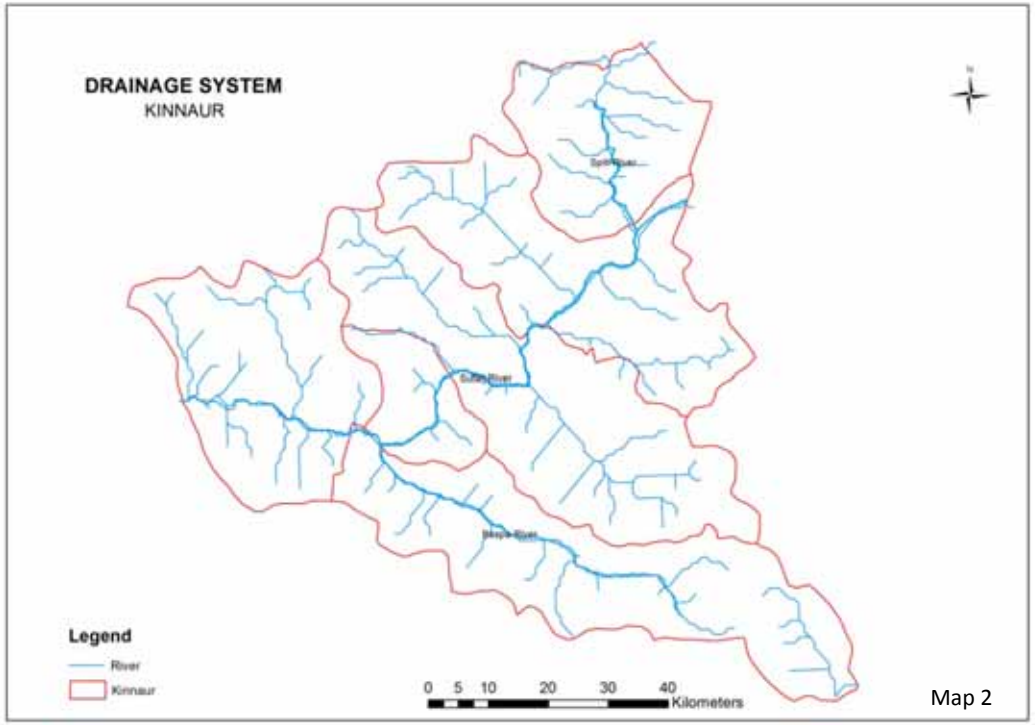
[8] Catchment Area Treatment

Table 1 Large Hydropower Projects in Upper Sutlej Basin Upto Karcham-Wangtoo[4]					
Project	**MW**	**Agency**	**Forest Diversion[5] (hectares)**	**Status**	**Description**
Yangthang - Khab	261	Yongthang Power Ventures Limited		Under Investigation	A run-of- the-river on River Spiti between Yangthang and Khab villages. A 57 m high (above river bed) concrete gravity dam on the river Spiti near village Leo, about 100 m u/s of bridge to Leo village for diversion of a design discharge of 160 cumec, through two intakes and underground desilting arrangement into a 9.05 km long HRT. A gross head of 205 m will be utilized to generate 261 MW (3x 87 MW).
Ropa	60				No details available, shown in Annexure II
Khab	636	Himachal Pradesh Power Corporation Ltd.,(HPPCL)	1307	Under Investigation	A 69 m-high straight concrete gravity dam with a capacity of 450MW at an elevation of 2597 MSL with catchment area of 440ha. The discharge diversion is of 294.4 cumec and designed flood of 5600 cumec. Total forest diversion will be of 1307ha.
Tidong-II	90	Tidong Hydropower Limited	9.489	Under Investigation	A 65 m-high concrete gravity dam proposed with a capacity to generate 70MW. It will have an HRT of 8.25 km. The discharge diversion will be of 13.50 cumec. The slope of the river at the diversion site is 1:7 Muck Generation: 2.82 Lakh Cu.m.
Jhangi Thopan	480	This project is under dispute and is now conceived as a single project of 960MW for which bidding process is proposed to be carried out, Brakel Corp. (a Dutch Company) and GoHP are in dispute and the matter is before the H'ble High Court of Himachal Pradesh.			
Thopan Powari	480				
Karchham Wangtoo	1000	Jaypee Karcham Hydro Corporation Ltd.	496.61 (1287+3924&5229 saplings for T/L)	Commissioned	Compensatory Afforestation Rs. 2.67 cr+1.73 Cr (Transmission Line) = Rs.4.40 Crores CAT – Rs. 31.94 Cr. Muck Generation: 9.01Mm^3
Baspa II	300	Jaiprakash Hydro Power Pvt. Ltd.	44.1795	Commissioned	
Sorang	150	Himachal Sorang Power Pvt. Ltd.	14.4885+ 4.69	Under Construction	
Sumte Kathang	130	Sumte Kothang Hydro Power Private Ltd.	87	Under Investigation	22 m high barrage is proposed on Spiti river near Hurling Village An underground powerhouse is proposed on the right bank of the river near Chango village with 2 units of 65 MW capacity. (HRT) is about 10.84 Km with 6.20 diameter and 286 m long tail race tunnel (TRT) with 6.20 m diameter. The total land requirement for the project is about 110 ha. Out of which 87 ha is forest land 23 ha is private land. Total submergence area is 32.20 ha. The catchment area of the project is about 5560 Sq.km. Free riverine stretch between FRL of downstream Chango Yangthang HEP and TWL of Sumte Kothang HEP is about 3.12 Km.
Lara Sumte	104	Lara Sumta Hydro Power Private Ltd.	79.50	Under Investigation	22 m high barrage on Spiti (tributary of Sutlej) river near Tabo Village in Lahul & Spiti District. (HRT) is about 8.47 Km with 6.1 diameter and 190 m tail race tunnel (TRT). underground powerhouse is proposed on the right bank of the river near Tipta village with 2 units of 52 MW capacity. The total land requirement for the project is about 97.75 ha. Out of which 79.50 ha is forest land 18.50 ha is private land. Total

Table 1 Large Hydropower Projects in Upper Sutlej Basin Upto Karcham-Wangtoo[4]					
Project	**MW**	**Agency**	**Forest Diversion[5] (hectares)**	**Status**	**Description**
					submergence area is 26.30 ha. The catchment area of the project is about 5210 Sq.km. Issue of less free reverine stretch between FRL of Lara Sumta & TWL of Mane Nandang (2.5km) & 8.5 km between FRL of Sumte Kothang & TWL of Lara Sumata HEP. 10kms from Kibber WLS. Likely impact of Chilgoza pine. Investigation of trans-Himalayan sensitive species like Snow Leopard, Bharal (Himalayan Blue Sheep), Brown bear suggested
					There are other projects under 100MW like Mane Nadang (70MW), Lara (60MW) and Killing-Lara (40MW). Shown in Annexure II
Total	**4834**		**2386.42**		

Table 2 Small Hydro Projects (Himurja)					
S.No	**Project_Name**	**Stream**	**Capacity MW**	**Elevations in Meters**	
	Projects Allotted			**± Weir**	**± PH**
1	Barua	Barua	5	2520	1923
2	Chaunda	Chaunda	2.4	1843	1318
3	Himani Chamunda Thingri	Listrang	5	2985	2635
4	Melan	Melan	4.5	1828.5	1625
5	Pangi	Pangi	3	2471.2	2039
6	Panwi	Panwi	4	1807	1562
7	Roura-II	Raura	5	2835	2185
8	Rukti-II	Rukti	5	3010	2753
9	Sailan	Sailan	1.5	1868	1289
10	Kachrang	Salring	5	1880	1725
11	Rakchad	Salring	5	1720	1445
12	Shaung	Shaung	3	2628.5	2136.25
13	Shyang	Shyang	3	2283.2	1884
14	Soldan	Soldan	5	2122	1795
15	Barakhamba	Sorang	1.5	1820	1710
16	Tangling	Tangling	5	2283.2	1884
17	Rupi-Tikada	Tikada	5	1985	1275
Application received for 100 KW projects					
18	Sorang	Sorang	0.1	2250	2205
19	Titang -I	Titang	0.1	2588	2566
20	Bari	Bari	0.1	2200	2100
21	Melam	Malan	0.1	1960	1850
22	Pangi	Pangi	0.1	2750	2600
	TOTAL		**68.4**		

3. River Sutlej



Map 2

The Sutlej River is the largest tributary of the Indus River and drains the third largest catchment area in the Himalaya (approximately 55000 km^2 above 500 MSL. Approximately two-thirds of this area is located in China and drains the Zhada Basin (Fig. 1, adapted from Wulf et al. showing characteristics and features of Himalayan Rivers), which stretches NW–SE between the southern edge of the Tibetan Plateau and the Mount Kailash Range. To the west, the Indian part of the Sutlej Valley covers a wide range of elevations between the Indo-Gangetic Plains (400 MSL) and the Himalayan Crest (6400 MSL) (Fig. 1).

It is the easternmost tributary of the Indus River. Its source is Lake Rakastal in Tibet on the southern slopes of Mt Kailas. From there, it flows at first west-northwest for about 260 kilometres to the Shipki La pass, entering India in Himachal Pradesh state. It then turns slightly, heading west-southwest for about 360 kilometres to meet the Beas River near Makhu, Firozpur district, Punjab state. Continuing west-southwest, the Sutlej enters Pakistan about 15 kilometres east of Bhedian Kalan, Kasur District, Punjab province. About 17 kilometres north of Uch Sharif, lies the confluence of Sutlej and Chenab River. From here the combined stream is called the Panjnad River. Panjnad meets the Indus River, nearly 100 kilometres west of Bahawalpur. The Indus then flows through a gorge near Sukkur and the fertile plains region of Sindh, forming a large delta region between the border of Gujarat, India and Pakistan, finally terminating in the Arabian Sea near the port city of Karachi, Pakistan.

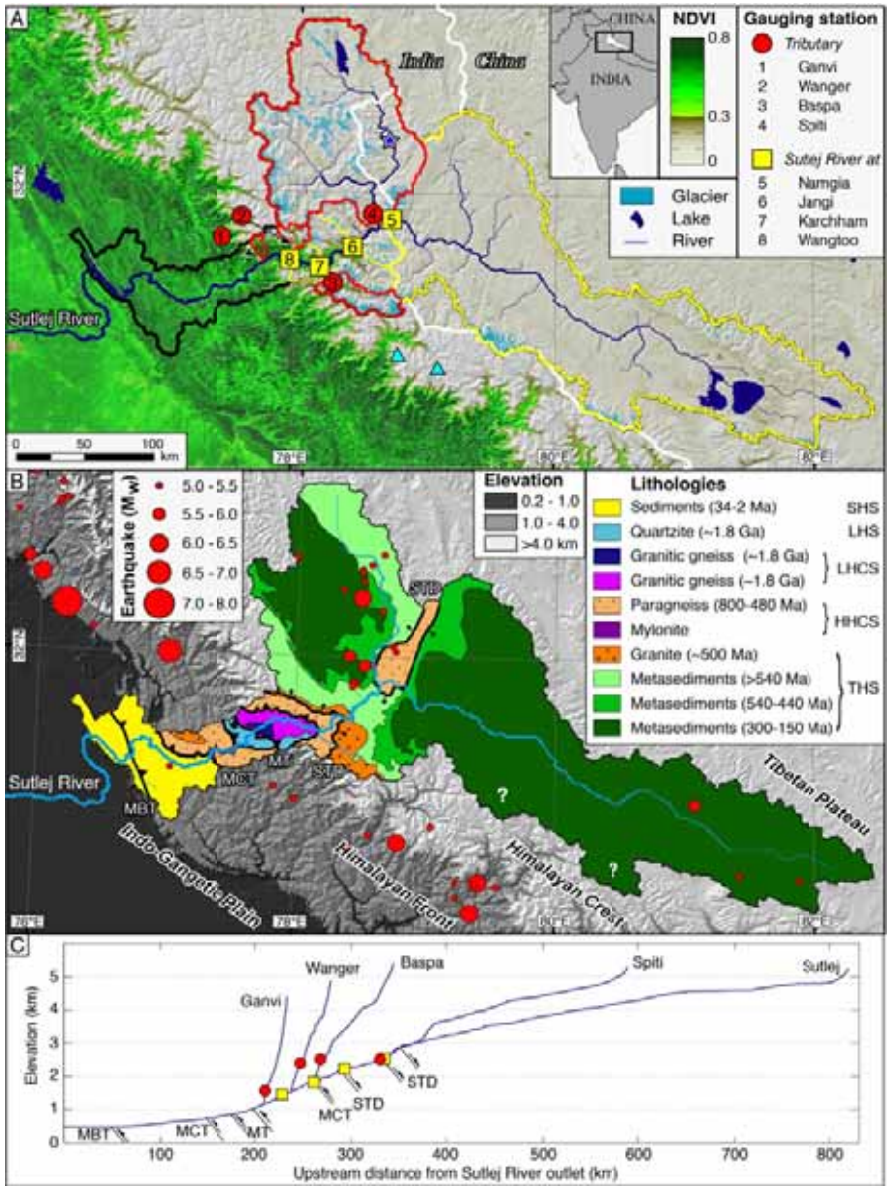


Fig. 1. (A) Map of the Sutlej Basin, showing the normalized difference vegetation index (NDVI) based on MODIS data (Huete et al., 2002), draped over a shaded relief map, and overlain by glaciers, lakes, and the Sutlej River network. Numbers denote gauging stations where river discharge and suspended sediment concentration were measured. The Baspa River (no. 3) joins the Sutlej River downstream of Karchham (nr. 7). The corresponding upstream areas of the Sutlej River and its tributaries are indicated in red and yellow, respectively. The star marks the location of the temporary Parechu Lake, and the triangles indicate the locations of the Dokriani (east) and Gangotri (west) glaciers. The glacial shapefiles are based on Landsat classification data of debris-free ice and manual delineation of debris-covered glacial areas in Google Earth.

(B) Geologic units and major tectonic structures (modified after Thiede et al., 2004; Vannay et al., 2004; Webb et al., 2011) within the study area together with earthquake locations (http://www.iris.washington.edu) (Table A2). Lithologies are grouped into the Sub-Himalaya Sequence (SHS), Lesser Himalayan Sequence (LHS), Lesser Himalayan Crystalline Sequence (LHCS), Higher Himalayan Crystalline Sequence (HHCS), and Tethyan Himalayan Sequence (THS). Major tectonic faults along the Sutlej River are indicated by the following abbreviations: MBT (Main Boundary Thrust), MCT (Main Central Thrust), MT (Munsiari Thrust), STD (South Tibetan Detachment). Surrounding areas show elevation draped over a shaded-relief map to differentiate different orogenic compartments.

(C) Longitudinal river profile of the Sutlej River and its tributaries analyzed in this study.

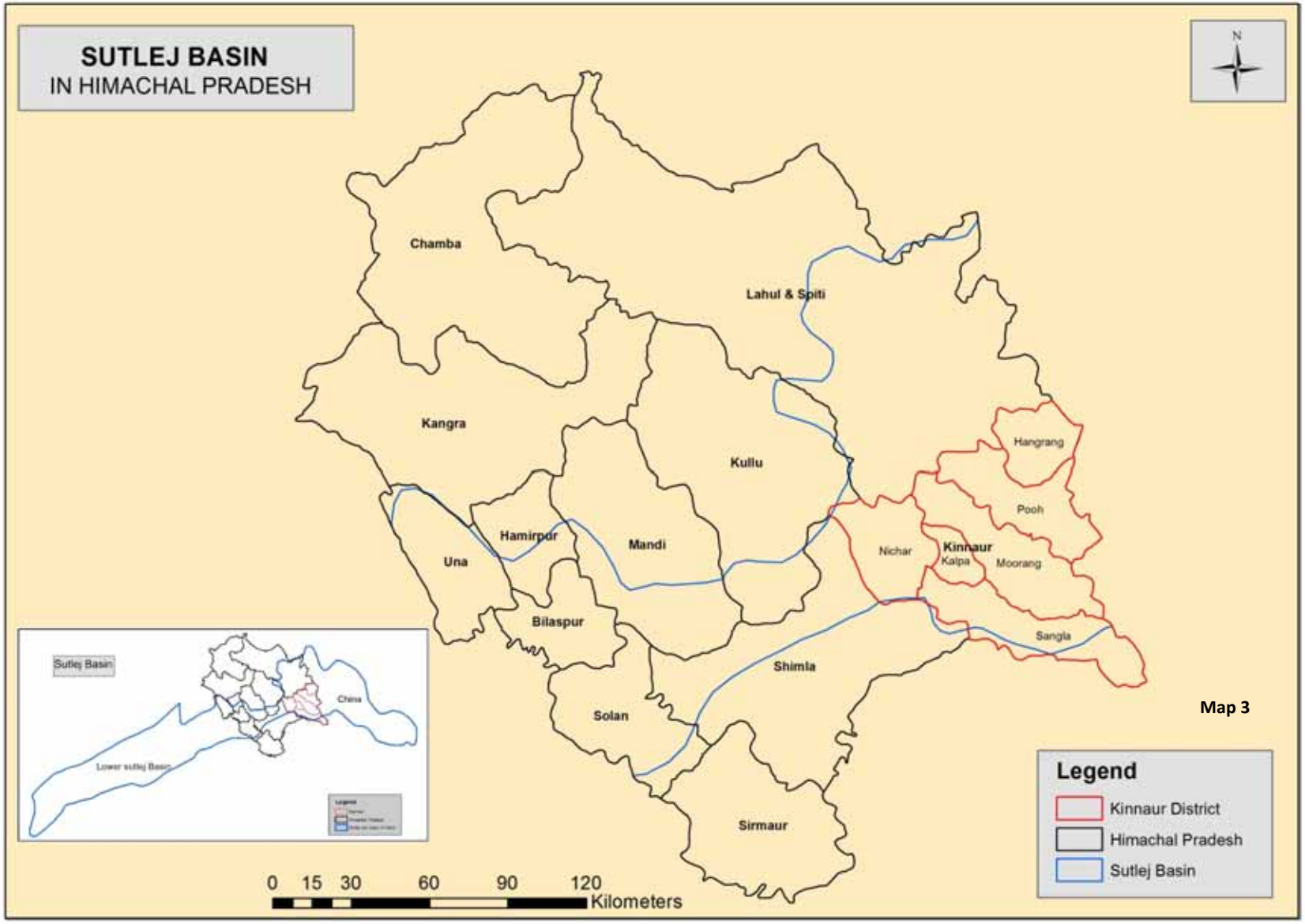
Red circles and yellow squares denote gauging station locations as indicated in **(A)**.

(Map and Figure from H. Wulf et al. Hydrol. Earth Syst. Sci., 16, 2193–2217, 2012)

4. Characteristics of Upper Sutlej Basin

The Upper Sutlej catchment is about 19,000 km^2. Almost the entire District Kinnaur forms a part of the catchment, except for a small portion in the east. The upper Sutlej portion of the river cuts across the three administrative units along its south-westerly axis in the Kinnaur District. The gradient from upstream to downstream of the river within Kinnaur is steep, falling about 1830 m over a distance of 130 kms. The major tributaries are River Spiti with a confluence near Khab (2768m) and River Baspa near Karcham. Several streams Hojis Gad, Guamthing gad, Tidong gad near Rispa (2393m), Dilang gad near Chargaon, Rapu gad, Taiti gad near Lippa, Kashang gad behind Pangi, Bora gad near Urni and Wangar gad near Wangtoo (1550m) contribute to the flow.

The Spiti River has its source far north on the eastern slopes of the mountain range between Lahaul and Spiti. The river is formed at the base of Kunzam range by the confluence of Kunzam La Togpo and the streams Kabzima and Pinglung. The main stream of the Spiti River, which is fed by the glaciers, is a perennial one, while some of the tributary streams disappear in the loose moraine at the feet of the plateau. During its course through the difficult, complex terrain, the Spiti River is joined by a number of tributaries from both the sides. Those which join its right bank include: *Chiomo, Gyundi, Rahtang, Ulah, Pin, Lungze, Mane, Surahl, Pomograng, Mamdang and Sumra*; the left bank tributaries are: *Thamar, Hanse, Thumna, Tagting, Thumpa Lumpa, Shila, Kaza, Lingti, Poh, Tabo, Karati, Gimdo and Parechu*. The River follows a long wide course and interlocked by spurs that project from the foot of the plateaus on both sides. The length of the River within Spiti on the south-east is about 130 km. It continues in Kinnaur district up to a place known as Namgia (Khab) and is about 14 Km upstream of Pooh (Kinnaur), where it joins the Sutlej.


SUTLEJ BASIN
IN HIMACHAL PRADESH
N
Chamba
Lahul & Spiti
Kangra
Kullu
Hangrang
Pooh
Hamirpur
Mandi
Nichar
Kinnaur
Kalpa
Moorang
Una
Bilaspur
Sangla
Shimla
Solan
Sirmaur
Sutlej Basin
China
Lower sutlej Basin
0 15 30 60 90 120
Kilometers
Legend
Kinnaur District
Himachal Pradesh
Sutlej Basin

Map 3

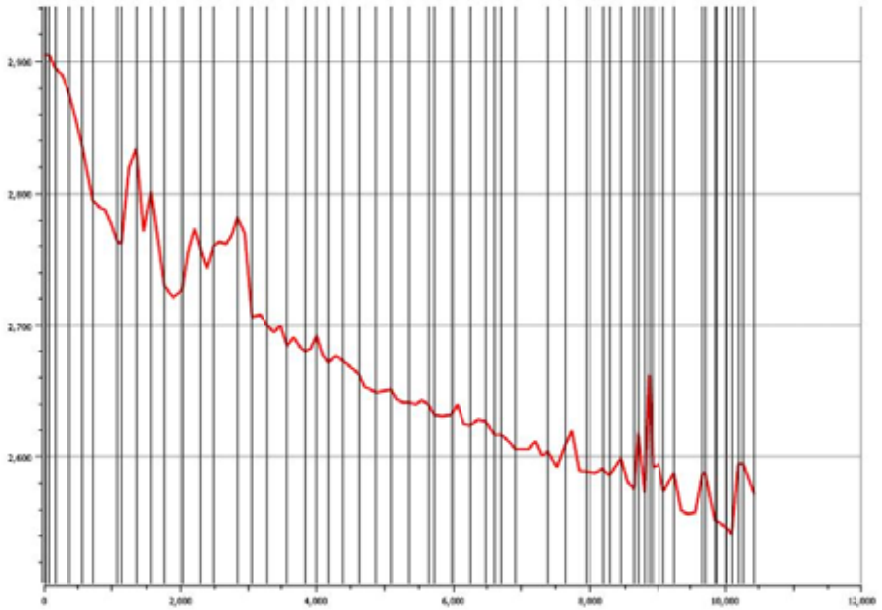
The Baspa River rises on the north eastern slopes of the outer Dhauladhar Ranges of the Himalaya. It is bounded on the south-west by the Dhauladhar and on the north-east by the huge Raldang peak of the Great Himalaya. The channel of the river is wide. At Chitkul its width is roughly twenty meters, lower down, the width varies from twenty-three to twenty-five meters. After coursing in a north westerly direction it meets Sutlej at Karchham. The Baspa is next to Spiti in size and is about seventy-two km in length. Its entire course lies within the district. As compared to other rivers the Baspa is fairly turbulent and frequently changes its course thereby doing extensive damage to the cultivated fields on its bank. It receives the various streams and streamlets on both of its banks. On the left side mentionable tributaries are Zupkia, Thatang, Bering and Rukti and on the right Suthi. This is the most inhabited valley and there are now permanent bridges at many places.

The distance between River Sutlej-Spiti confluence to Sutlej-Baspa confluence near Karcham is 73 kms and from River Sutlej-Baspa confluence to River Sutlej-Bhaba confluence is 18.80 kms. The length of River Spiti in District Kinnaur is 54 kms.

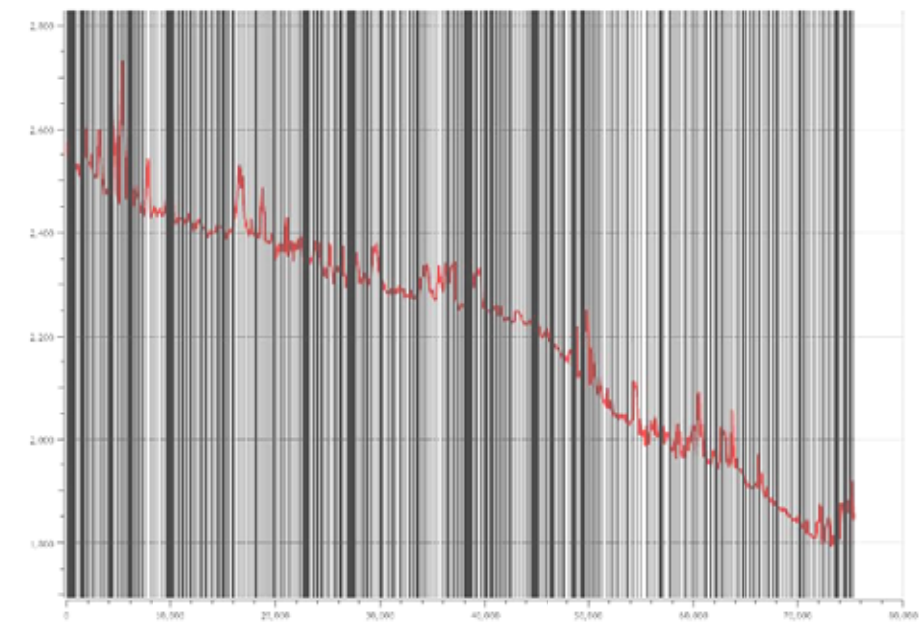
The mean river profile of Sutlej through its length in the district is around 1635 m with the highest being 2950 m upstream of Khab. River Spiti negotiates a higher altitude before it meets Sutlej, the average relief is 14 m per km. *(See figure 3).* In comparison, the national highway which runs at an elevated level from River Sutlej has a mean altitude of 2338m, with minimum of 1463m and maximum of 3925m, the median value being 2277m.

[The map has been sourced from Hydrological Information System, NATCOM]

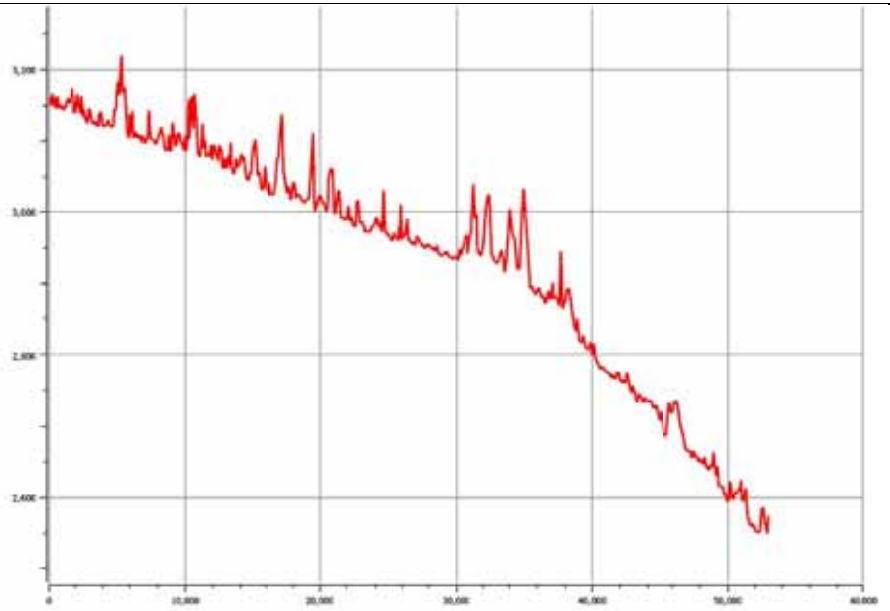
Figure 3 Cross Section Altitude Profiles in the Sutlej Valley Depicting Several Incised Valleys



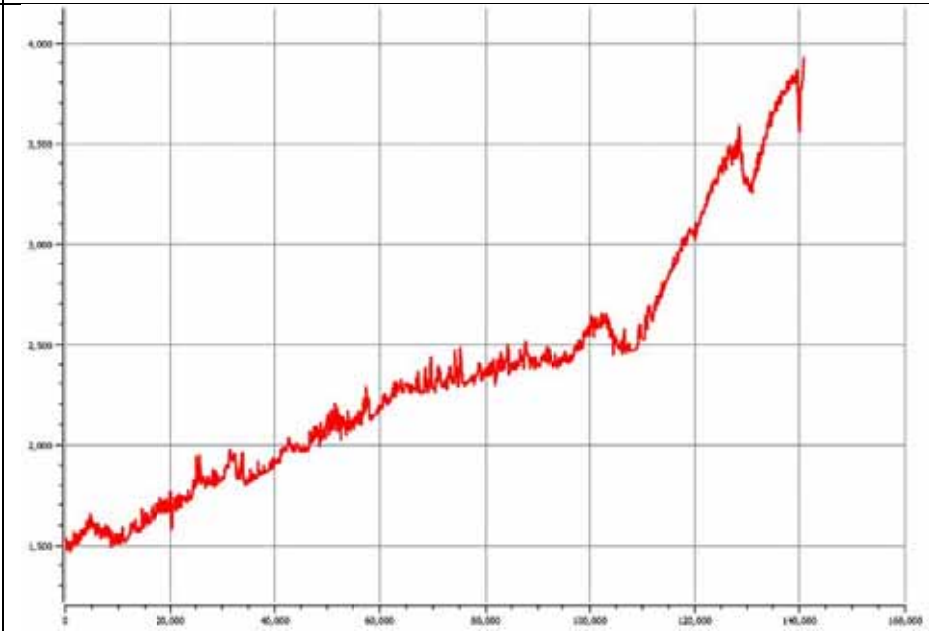
Profile of River Sutlej from Kinnaur Boundary to Confluence with Spiti | Relief: 332 m over 10.5 kms distance



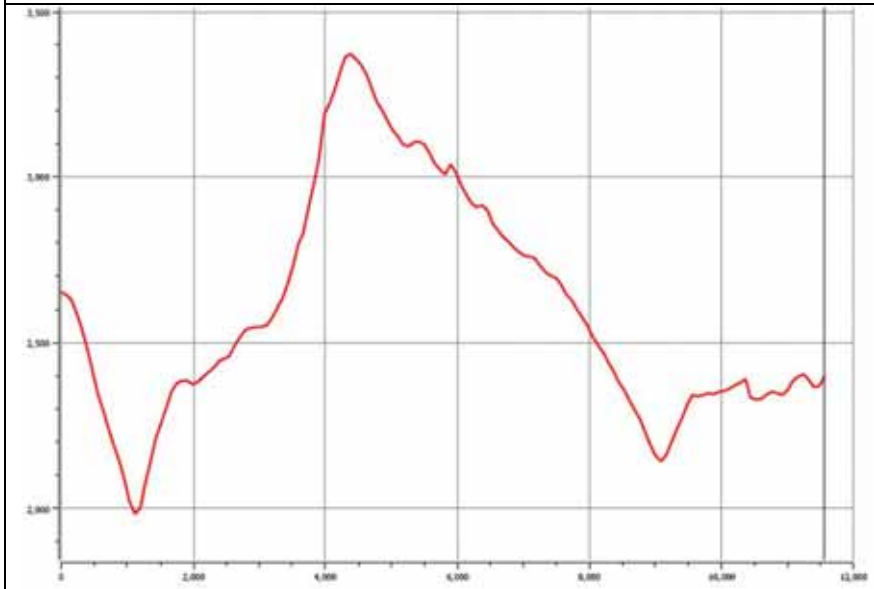
Profile from Sutlej-Spiti Confluence to Sutlej-Baspa Confluence (units in meters) | Relief: 940 m over 75km



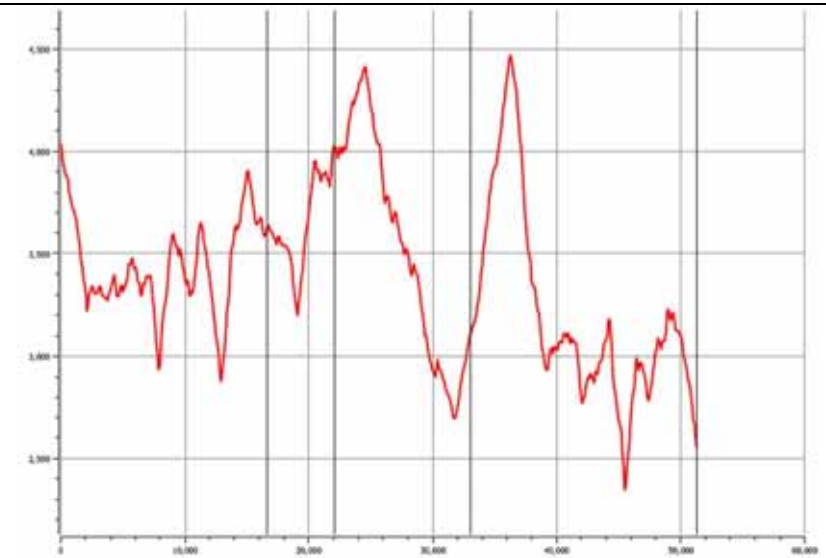
Profile of River Spiti in Kinnaur | Relief: 680 m over 48 km



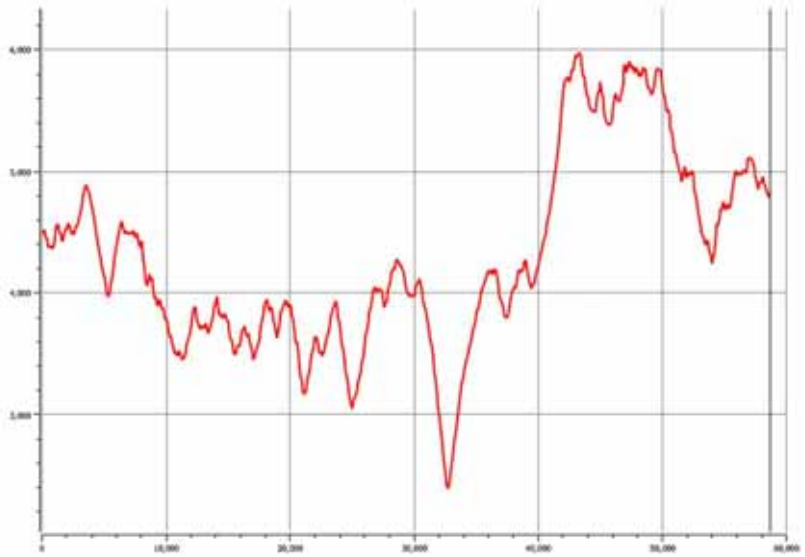
Profile of NH 22 in District Kinnaur



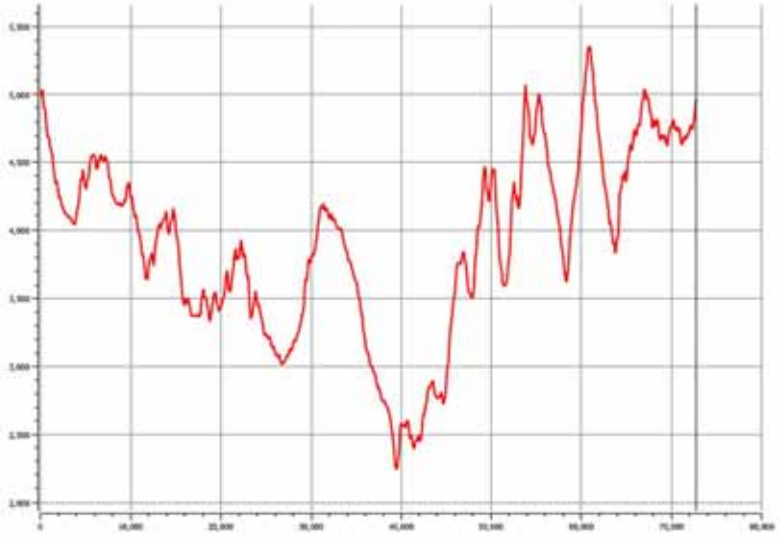
Pangi – Akpa Cross Section Profile – two sharp V shape dips



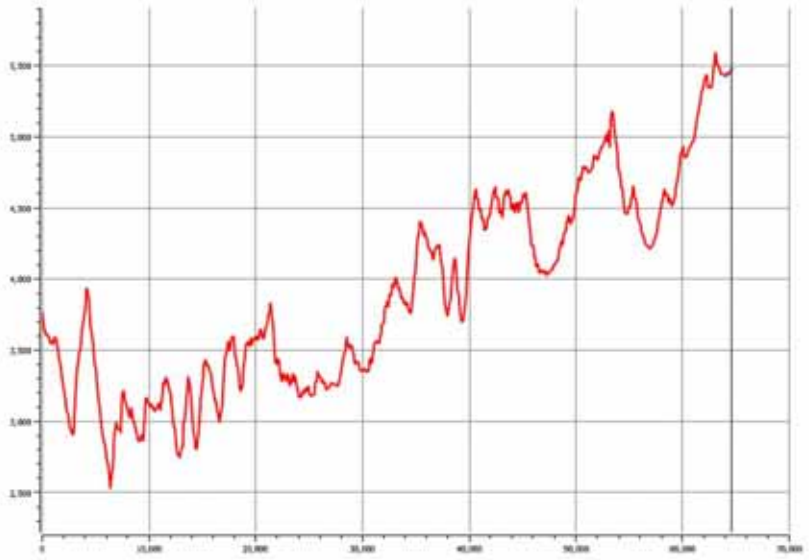
Along Kaurik Chango Fault Profile, Several sharp dips can be seen



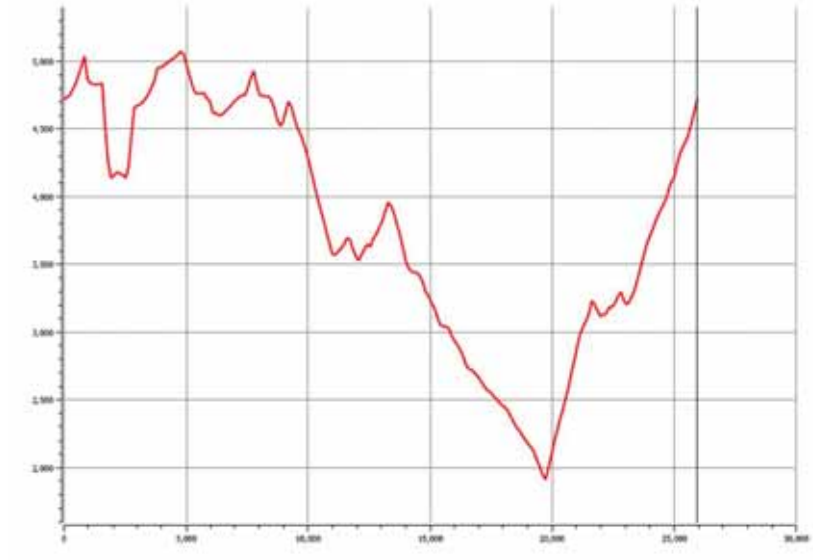
Pooh Tehsil Cross Section Profile



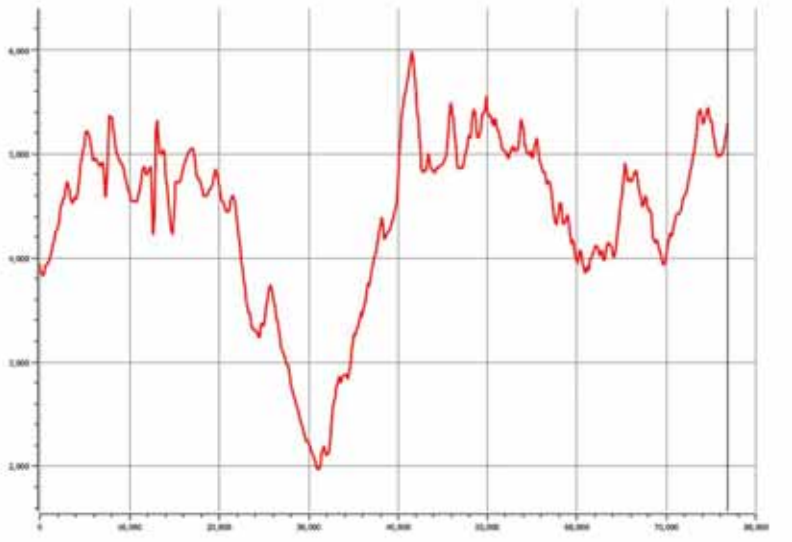
Moorang Tehsil Cross Section Profile



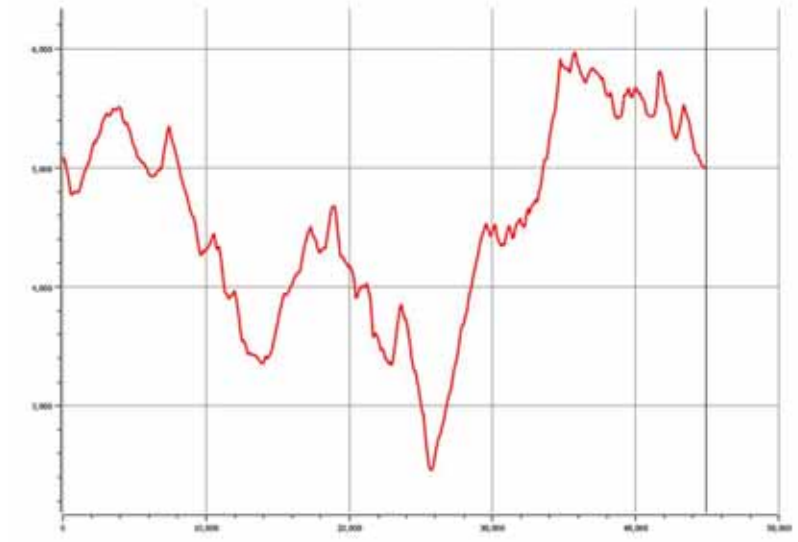
Sangla Tehsil Cross Section Profile



Kalpa Tehsil Cross Section Profile



Across Nichar-Kalpa-Sangla



Across Pooh and part Hangrang

5. Kinnaur District: Demography, Slope and Aspect and Land Use

5.1 Demography

Kinnaur District has a population of nearly 80,000 persons which is predominantly tribal. Kinnaur has a high work force participation ratio, with horticulture and agricultural occupations. A significant number of people are also employed with the Government, with a relatively high literacy rate for a far-flung region.

Kinnaur registered a nominal population growth rate of 6.61% over a decade (2001-2011) and many parts of the district are inhabitable or with very low density owing to higher Himalayan terrain and snow bound areas in the upper reaches of the District, Himachal Pradesh's growth rate during this period was 12.95%. Almost 41% of the total area is under snow and glaciers, 10% is under forests and 34.56% is grass and grazing lands. Agriculture (crop land and plantation) constitutes 2.71% and is mostly concentrated in the 4 kms range of River Sutlej *(table 6 & Map 7 & 8)* on either side which divides the district into two parts. Scheduled tribe population constitutes 58% of the total district population with maximum in Hangrang followed by Moorang and Sangla tehsils. There are 55,809 total workers in the District as per Census of India 2011 which means about 66.83% of the total population and out of which 83% is categorized as main workers. 55.50% of the main workers are cultivators and the region is well known for its apple, famously known as

Table 3: Demographic Profile

Number of households	18641
Total population (Persons)	78334
Total Population (Males)	42173
Total Population (Females)	36161
Total SC Population	7625
Total ST Population,	56268
Literate (Persons)	51913
Illiterate (Persons)	26421
Total worker persons	47811
Total worker males	28041
Total worker females	19770

'Kinnaur Apple', among others this region has a good wealth of Chilgoza trees. Although the district as a whole has low density of population but certain settlements have high density due to compact settlements and are located close to the Rivers.

5.2 Slope and Aspect

One of the important themes in fragile environments is slope and aspect classification *(see Map 4 & 5)* and the natural spatial challenges people face in ensuring food security, land is limited and the climatic and topographic features provide tree crops as one of the most economic avenues for the people. Apple, apricot, Pinus Gerardiana[9] nut fruit (*chilgoza*) and many others exist in this environment and many on the hill slopes which become vulnerable owing to harsh weather (like in July 2013) and invasion by developmental activities. Pinus gerardiana grows in the mountains from about 2,000 m to 3,350 m above sea level. In the Himalayas this means that this pine is restricted to valley floors between very high mountain ranges, which isolate different populations to a certain extent. It prefers dry, sunny slopes where the vegetation is more or less open[10]. Damage to this specie has been due to anthropogenic and development aspects like dam building as well as natural events like heavy downpour over a short time period in July 2013. As per one study[11] (Gupta 2007), almost 100-120 tons of chilgoza nuts are exported out of the district but the area under chilgoza forest has shrunk to merely 2000 hectares.

Table 4 Habitations within Slope Classification

S.No.	Slope Class	No. of Habitations	%
1	< 15	32	13.79
2	15 – 24	49	21.12
3	24 – 35	91	39.22
4	35 – 45	44	18.96
5	> 45	16	6.89
	Total	232	100.00

Table 5 Habitations within Aspect Classification

S.No.	Aspect	No. of Habitations	%
1	NE	60	25.75
2	SE	62	26.60
3	SW	64	27.46
4	NW	47	20.17
	Total	233	100.00

Most of the settlements are located within the 4 km River buffer, the maximum habitations apart from those which are extended enclosures are located at a moderate to steep slopes and face challenges during extreme events, almost 54% of the settlements are located in the southern slopes. A study[12] conducted in 2008 indicates Kinnaur with 10,452 hectares ranks highest among districts followed by Chamba and grown

[9] IUCN's assessment dated 28.01.2011, published in 2013 puts this species in Near Threatened category. The justification is "*Pinus gerardiana* forests have declined and continue to decline throughout their extensive range. While there is insufficient range wide information to quantify this decline accurately, it is strongly suspected that it is approaching at least 30%

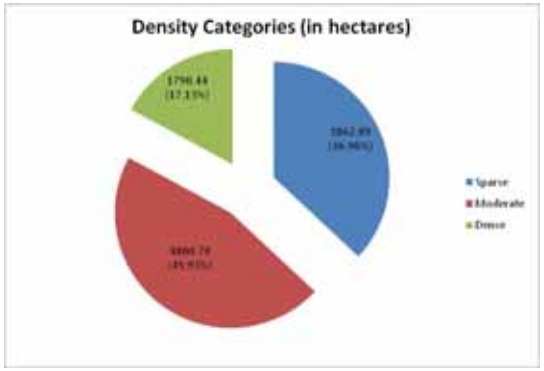
[10] www.iucnredlist.org/details/full/34189/0

[11] Malik et al.: Natural regeneration status of Chilgoza pine (Pinus gerardiana Wall.) in Himachal Pradesh, India

[12] Project Report, Apple orchard characterization using remote sensing and GIS for Kinnaur, Chamba and Sirmaur districts in Himachal Pradesh, State Department of Horticulture, November 2008

between 2000-3000m elevation and slope of 21-40^0 and these correlate well with the slope classification. Kalpa and Pooh block have almost similar areas under apple orchards and are also dense and contiguous.

Nearly sixty eight percent apple orchards grow on slope facing North- East (NE) and South-East (SE) and have better density and growth. The settlements are almost equally distributed in broad four aspects and in correlation to the findings of the study as quoted above, almost 52% settlements are located in NE & SE aspect. Almost 63% of the apple area is in moderate to dense category and is equally distributed in Kalpa and Pooh, the two high altitude blocks than Nichar.



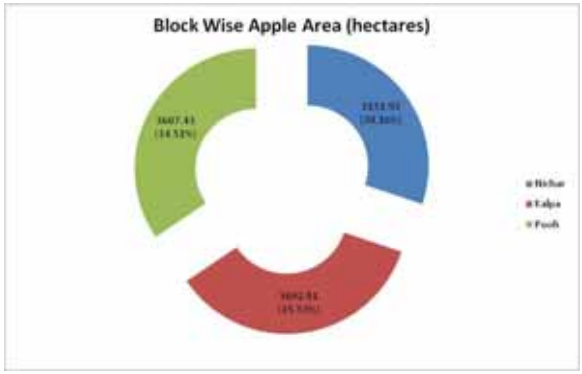


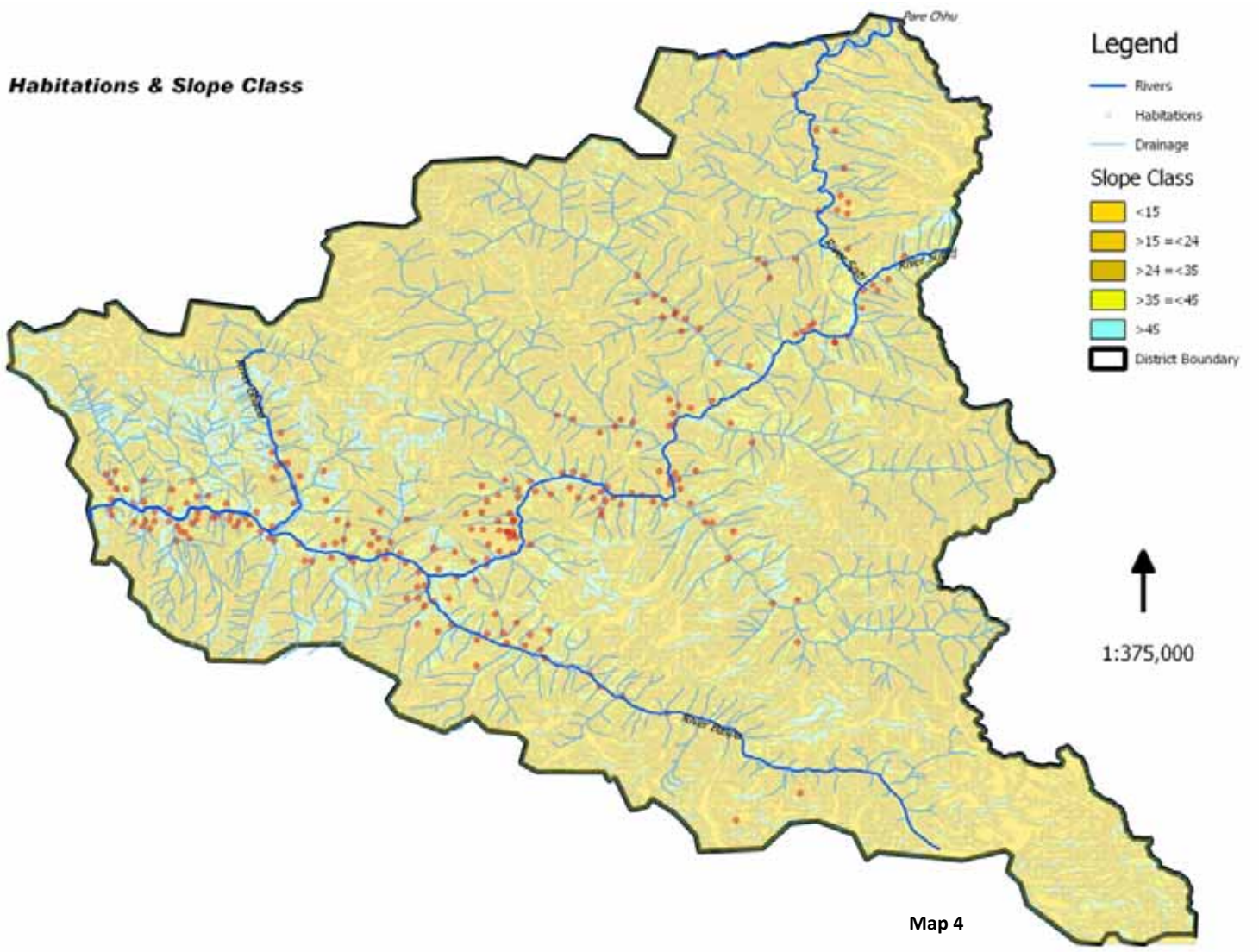
Figure 4 & 5 Source: Refer Footnote 9

The predominently rural population of the area is primarily dependant on agriculture and horticulture. Almost every family owns land and is engaged in agriculture or horticulture for their day to day requirements. Over the years, the state has become known for its production of off-season vegetables and flowers. The average land holdings are very small and less than a hectare per family, with many fields being on steep land that do not lend themselves to mechanisation. Most agriculture is of the subsistence type and depends on suitable climate for good yields. The agricultural based economy is therefore, inadequate to fulfil the total livelihood requirement for most of the families. Increasingly, most rural families have access to off-farm incomes to supplement the shortfall from agriculture. Tourism and craft industries provide some supplementary income.

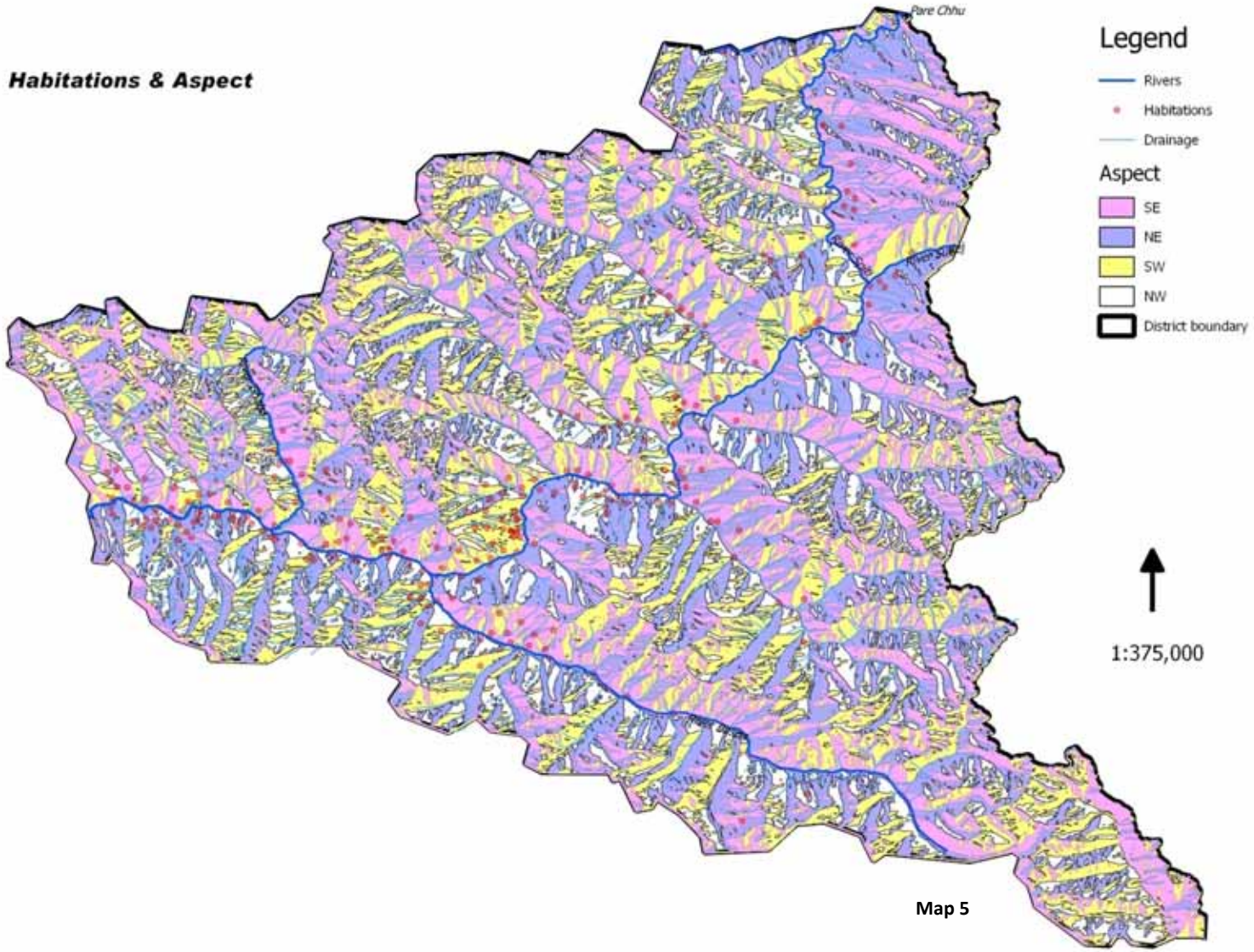
Animal husbandry is another source of income; almost every family raises livestock for its day to day requirements for subsistence as well as for generating cash income. Owing to the very small land holdings, families rely heavily on natural fodder resources including the forest areas to feed their livestock. Livestock kept by tribal communities are subject to transhumance (seasonal movement to new areas) to get the best

pastures. Economically vulnerable groups including the scheduled tribes and castes have high dependence on the forest resources including collection of fodder, medicinal plants, and firewood.

It is evident that local communities are now observing the impact of climate change. The traditional knowledge which was quite advanced and which has been sustaining the communities for generation is becoming inadequate to deal with rapid changes. Every day changes in climate can be experienced, parameters include shifting of apple orchards to higher altitudes, loss of various plants species, trees and medicinal plants, drying of traditional water sources, migratory bird population has decreased and different species are found, reduction of crop yields, and increased vulnerability of crops due to drought and delays in planting. Previously unknown pests are now becoming apparent.


Habitations & Slope Class
Legend
Rivers
Habitations
Drainage
Slope Class
<15
>15 =<24
>24 =<35
>35 =<45
>45
District Boundary
1:375,000

Map 4


Habitations & Aspect
Pare Chhu
Legend
Rivers
Habitations
Drainage
Aspect
SE
NE
SW
NW
District boundary
1:375,000

Map 5

5.3 Land Use and Land Cover

Table 6: Land Utilisation, District Kinnaur		
Land Use	Area (sq. Km)	%
Builtup, Urban	2.23	0.03
Agriculture, Crop Land	18.99	0.30
Forest, Evergreen / Semi Evergreen	633.69	9.90
Forest - Forest Plantation	0.5	0.01
Grass / Grazing	2212.4	34.56
Barren / Unculturable / Wastelands, Barren Rocky	499.22	7.80
Snow and Glacier	2634.2	41.15
Builtup, Rural	14.67	0.23
Agriculture, Plantation	154.1	2.41
Forest - Deciduous	1.59	0.02
Forest, Scrub Forest	18.45	0.29
Barren / Unculturable / Wastelands, Scrub land	154.38	2.41
Wetlands/ Water Bodies, River / Stream / canals	56.57	0.88
TOTAL	6400.99	100
Source: Bhuvan LULC 2005-06 & 2011-12, See Map 1		

Note: (i) Maps are available for both the periods mentioned above but the Land classification is available for 2005-06.
(ii) for further classification of land, read technical document at http://bhuvan-noeda.nrsc.gov.in/theme/thematic/tools/document/2LULC/lulc1112.pdf

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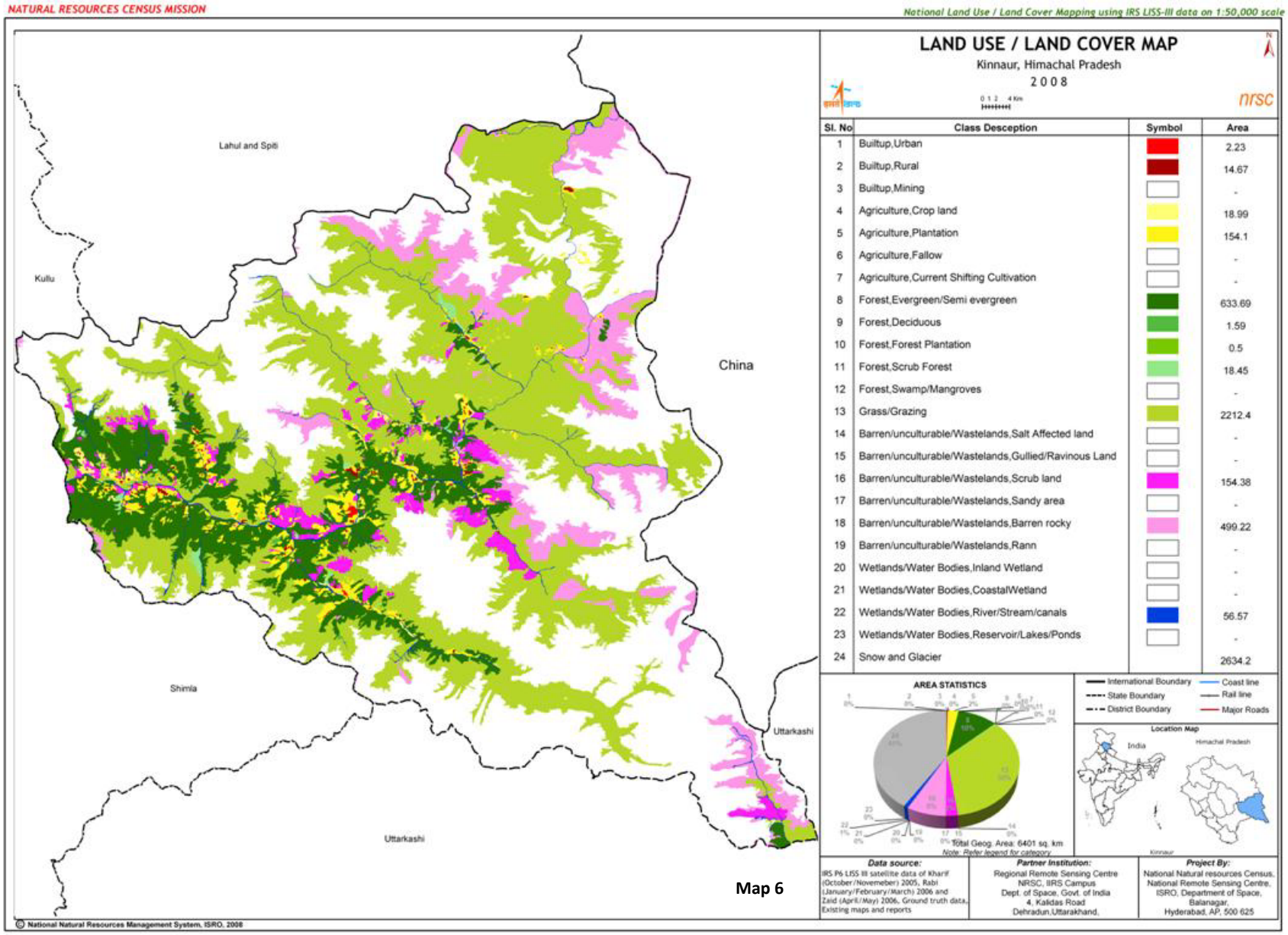
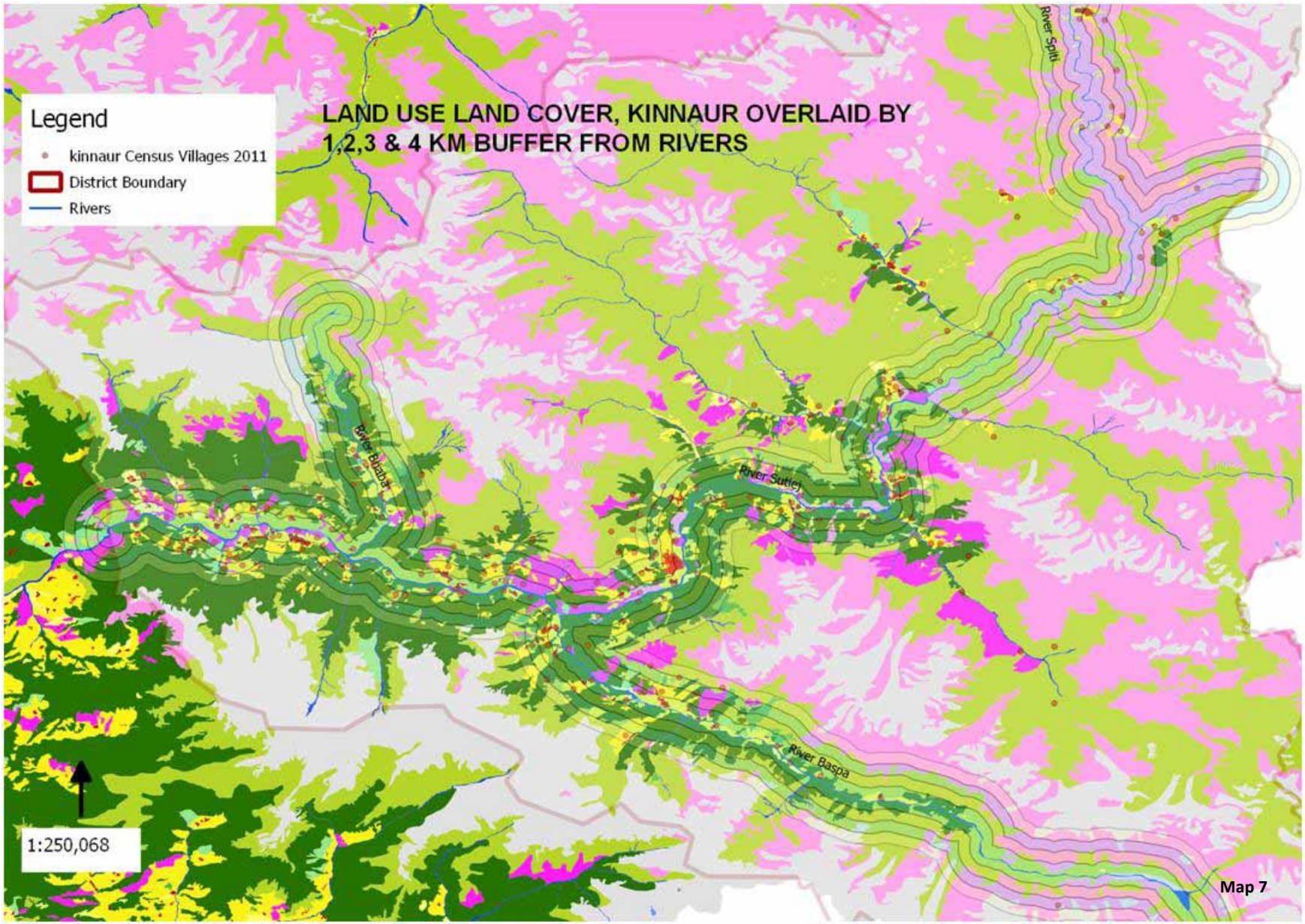

NATURAL RESOURCES CENSUS MISSION
National Land Use / Land Cover Mapping using IRS LISS-III data on 1:50,000 scale
LAND USE / LAND COVER MAP
Kinnaur, Himachal Pradesh
2008
nrsc
Lahul and Spiti
Kullu
China
Shimla
Uttarkashi
Uttarkashi
Sl. No | Class Desception | Symbol | Area
1 | Builtup,Urban | 2.23
2 | Builtup,Rural | 14.67
3 | Builtup,Mining | -
4 | Agriculture,Crop land | 18.99
5 | Agriculture,Plantation | 154.1
6 | Agriculture,Fallow | -
7 | Agriculture,Current Shifting Cultivation | -
8 | Forest,Evergreen/Semi evergreen | 633.69
9 | Forest,Deciduous | 1.59
10 | Forest,Forest Plantation | 0.5
11 | Forest,Scrub Forest | 18.45
12 | Forest,Swamp/Mangroves | -
13 | Grass/Grazing | 2212.4
14 | Barren/unculturable/Wastelands,Salt Affected land | -
15 | Barren/unculturable/Wastelands,Gullied/Ravinous Land | -
16 | Barren/unculturable/Wastelands,Scrub land | 154.38
17 | Barren/unculturable/Wastelands,Sandy area | -
18 | Barren/unculturable/Wastelands,Barren rocky | 499.22
19 | Barren/unculturable/Wastelands,Rann | -
20 | Wetlands/Water Bodies,Inland Wetland | -
21 | Wetlands/Water Bodies,CoastalWetland | -
22 | Wetlands/Water Bodies,River/Stream/canals | 56.57
23 | Wetlands/Water Bodies,Reservoir/Lakes/Ponds | -
24 | Snow and Glacier | 2634.2
AREA STATISTICS
International Boundary
State Boundary
District Boundary
Coast line
Rail line
Major Roads
Location Map
India
Himachal Pradesh
Kinnaur
Total Geog. Area: 6401 sq. km
Note: Refer legend for category
Data source:
IRS P6 LISS III satellite data of Kharif (October/Novemeber) 2005, Rabi (January/February/March) 2006 and Zaid (April/May) 2006, Ground truth data, Existing maps and reports
Partner Institution:
Regional Remote Sensing Centre
NRSC, IIRS Campus
Dept. of Space, Govt. of India
4, Kalidas Road
Dehradun,Uttarakhand.
Project By:
National Natural resources Census,
National Remote Sensing Centre,
ISRO, Department of Space,
Balanagar,
Hyderabad, AP, 500 625
© National Natural Resources Management System, ISRO, 2008

Map 6


LAND USE LAND COVER, KINNAUR OVERLAID BY
1,2,3 & 4 KM BUFFER FROM RIVERS
Legend
kinnaur Census Villages 2011
District Boundary
Rivers
River Spiti
River Sutlej
River Baspa
1:250,068

Map 7

The map *(see Map 7)* depicts the crop land or agricultural activity within the 1-4 km vicinity of major River network of the District and forest areas almost interwoven or forming an outer resource boundary. There are four major rivers, River Sutlej, River Spiti, River Baspa and Bhaba apart from extensive Himalayan streams draining into these river systems, NH22 is the main arterial road and its alignment follows River Sutlej. The spread of settlement correlate with the land use pattern and most of the census villages (82%) are located in the 1-4 km vicinity of major River systems, the table below provides demographic and area details of villages located in respective River buffer. These settlements are in immediate catchment of hydroelectric projects conceived, planned and operational and spatially different components of the project like head race tunnel, barrage, power house are within the 1-2 km buffer, except Kashang Integrated project which has four stages which goes beyond 4 kms buffer.

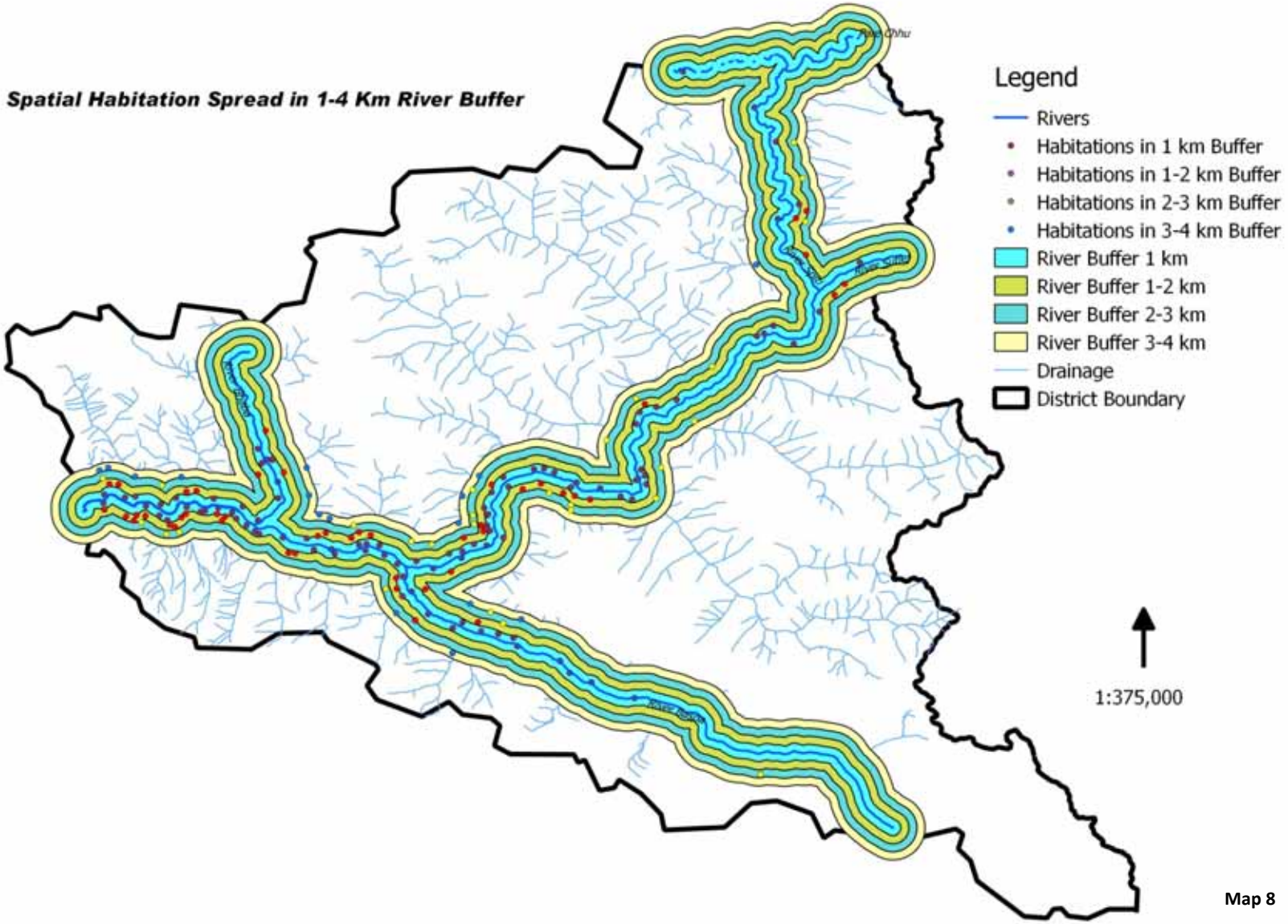
Table 7 Demographics and Brief Land Utilisation as per Census 2011 Village Directory

Parameters	1 km buffer	1-2 km buffer	2-3 km buffer	3-4 km buffer	Total*
No. of Villages	97 (48.98)	48 (24.24)	27 (13.63)	26 (13.13)	198
Population	48180 (64.64)	18327 (24.59)	5773 (7.74)	2249 (3.01)	74529
Minimum Population	4.0	1.0	1.0	4.0	-
Maximum Population	2669	1638	797	761	-
Median Population	373	269	141	37	-
Area (hectares)	24026 (47.98)	8673 (17.32)	10867 (21.70)	6500 (12.98)	50066
Forest (hectares)	1205 (36.05)	741 (22.17)	281 (8.40)	1115 (33.36)	3342

*excluded beyond 4km buffer[13] | **Total census villages marked are 234**

Note: Data used from Village Directory as released by Census of India, 2011. Point location of villages has been adapted from Google Earth and buffers marked from the river on either side 1 km each

[13] http://hp.gov.in/ddma-kinnaur/page/Statistical-Offices.aspx

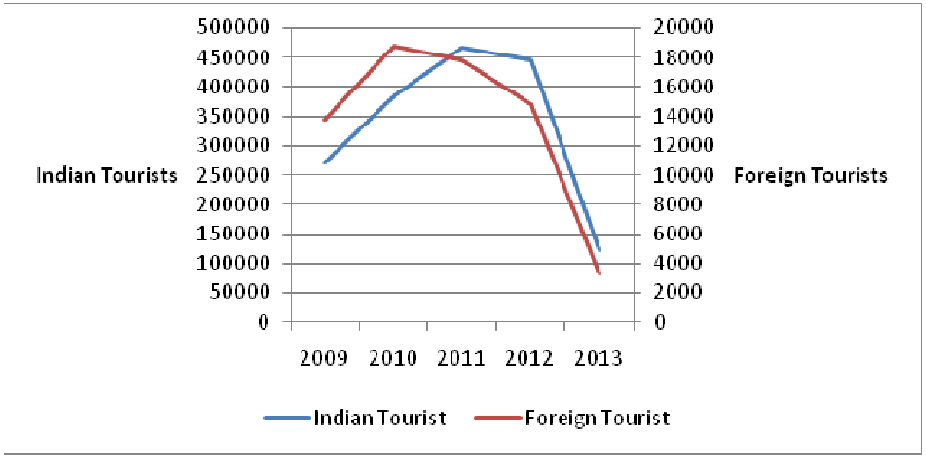

Spatial Habitation Spread in 1-4 Km River Buffer
Legend
Rivers
Habitations in 1 km Buffer
Habitations in 1-2 km Buffer
Habitations in 2-3 km Buffer
Habitations in 3-4 km Buffer
River Buffer 1 km
River Buffer 1-2 km
River Buffer 2-3 km
River Buffer 3-4 km
Drainage
District Boundary
1:375,000

Map 8

5.4 Major Valleys' in Kinnaur - River Valleys in Kinnaur And Growing Impacts

The Sutlej has 17 tributaries, joining it at various confluence points in an area of 52,146 sq km, the Spiti River has 10,170 sq km, Baspa 1,102 sq km and Tidong 726 sq km and others 14 sq km to 374 sq km. The tributaries of the Sutlej in this district are the Spiti, the Ropa, the Taiti, the Kashang, the Mulgoon, the Yula, the Wanger, the Shorang and the Rupi on the right bank and the Tirung, the Gyanthing, the Baspa, the Duling and the Solding running on the left bank. The important streams of the area are in Spiti, Hangrang, Baspa, Bhaba, Kashang, Ropa & Tidong. These form an overall trellis pattern whereas individual rivers have dentritic pattern indicating structural control on the drainage. The total watershed area of Himachal Pradesh is more than 18043sq.km, out of which Sutlej alone has more than 5118sq.km. Each valley has its own challenges and uniqueness which itself needs to be protected, the cumulative assessment by the Government of Himachal Pradesh has overlooked this and has only promoted construction of projects with mild recommendations.

People agitating against the hydel projects democratically for last 5-6 years and submitted number of memorandums and resolutions expressing their objections to mega hydel projects in Kinnaur, but of no avail. The state government in its bid to attract private capital has abdicated its role as regulator and protector. In the face of strong popular resistance, it has resorted to every means to subvert legal and constitutional safeguards and protection. Whereas the project proponents are flouting the provisions of tribal, environmental, forest and revenue laws in the execution of hydel projects in scheduled areas.



The recent events in Uttarakhand and Kinnaur have shown, more than ever, that we need a development strategy for the Himalayas that takes into account the vulnerability of the region and the need for environment protection. In a climate change scenario, rainfall in Himalayan range extending over a large spatial extent (June 2013) can cause havoc as witnessed in Uttarakhand and Himachal Pradesh. The riverbeds were used as dumping ground and the muck deposition became a primary cause for damages in Uttarakhand and less vegetative slopes of Kinnaur trigger high sedimentation load coupled with construction activity and reduced effective channel width.

Kinnaur has received tourists throughout the year but this drastically reduced in 2013 (see adjoining graph), due to already deteriorated road infrastructure by heavy machinery, blasting, heavy rainfall aiding landslides. Even the post construction impacts were seen in 2014 (Chulling nallah) where traffic was diverted from Chulling to Tapri through a risky terrain.

The cumulative impact of commissioned and under development HEPs in Sutlej basin on various factors like Geological instability, requirement of environment flow, environmental flows necessary for observing religious practices and sustaining biotic life etc., the extent to which hydropower potential identified in the basin should be developed without risking stability of landforms and environment.

Kinnaur can be broadly categorized into several valleys', namely the Sangla; the Tidong; the Kashang: the Ropa; the Hangrang & the Spiti. Every Valley has almost 2 large projects (say >100MW) except for Ropa Valley which has a 60MW Ropa Hydro Electric Project.

SANGLA VALLEY: Sangla Valley or the Baspa Valley starts at Karcham, the confluence of River Baspa with River Sutlej and extends to Chitkul, a tourist attraction. The valley is an alpine meadow[1] (P. S. Ranhotra and Ratan Kar, 2011) and is surrounded by forested slopes. The Baspa River flows in the Sangla Valley which is rich in Apple orchards, Apricot, Walnut, Cedar trees, and glacial streams with trout. It has two macro hydro electric projects Baspa I - 210MW (under investigation) and Baspa II- 300MW (commissioned 2009). Sangla valley remained cut-off from rest of the state during the 2013 deluge. The only connecting route from NH 22 to the valley was completely destroyed; it was only after two months that access could be retained. Tourism is an important source of income in the area apart from apple and potato cultivation, the road blockage affected the economy badly.

Although the MCT or Vaikrita Thrust engulfs Karcham and passes closely to Baspa, stability has weakened further after lots of changes to the landscape have been made to build hydroelectric projects. The steep terrain and loose strata results in landslide vulnerability for the locals and tourists

en-route Baspa II

Major slide while crossing the power house of BASPA II

Hours of traffic jam near the barrage site of BASPA II due to slide

Slide on left bank of the stream just ahead of BASPA II barrage site

Rocks are highly fractured, some naturally some due to blasting

TIDONG VALLEY: The valley is of Porous Formations constituted of unconsolidated sediments comprises of the quaternary sediments[2] (Ministry of Water Resources; GoI). Himachal Pradesh Power Corporation is constructing 100 MW Tidong I in Tidong Khad in Lambar and Charang villages. Total catchment area up to dam site is 497.86ha out of which 43.59ha of forest land will be diverted. The valley is in seismic zone IV, which means that it is highly vulnerable to earthquakes. Available data on seismicity within a radius of 150 kms of the project shows that earthquakes of magnitude greater than 5 on the Richter scale occur at frequent intervals. The diversion of two main streams Gara and Duba Khad irrigate about 128.44ha of land in the valley, these are likely to become dry due to tunneling of the project. Study does not take into consideration the flows required in the tributaries as many of the fishes migrate to these tributaries.


Construction Site- Tidong1


Muck Dumping at Adit 1

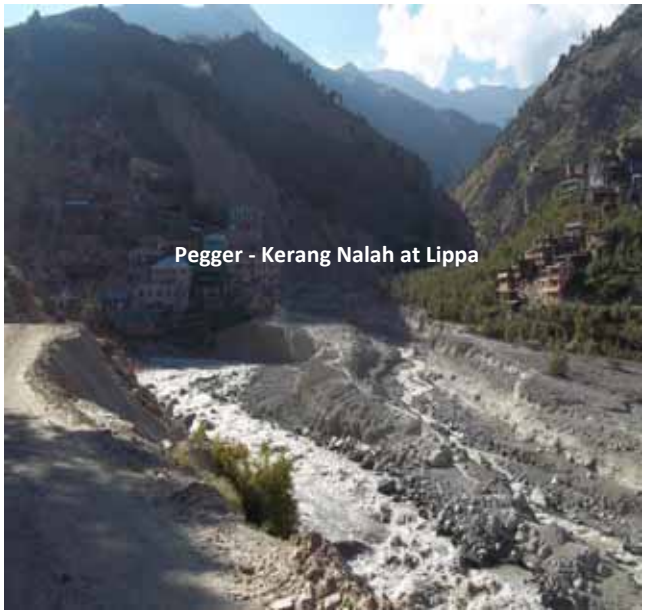
Apart from this the muck generated due to excavation / drilling will lead to changed landform and possibility of inundation of nearby areas posing risks for cultivable land. Suitable sites for dumping of excavated material were identified in consultation with the State Pollution Control Board and Forest Department but whether it will comply with conditions and River Morphology is unclear. 3 Gram Panchayats (Rispa, Thangi and Moorang) are in the project area including 5 villages. The directly affected village is Lumber where the barrage construction is going to displace 5 families and had got minimal compensation of Rs.18000/bigha *(a bigha is approximately 900 Sq. Yards)*. Huge wealth of Chilgoza trees has already been lost due to this project.

KASHANG VALLEY : The sinking and sliding village **PANGI** is highly effected by the hydro power project – INTEGRATED KASHANG (I). The area is sliding down, huge cracks are visible in the houses and the people are either shifting or living under the blanket of fear. Lippa Asrang WLS is located in vicinity of this project and few components are planned like diversion channel near Dollo Dogri village. Out of about 30-40 houses, 16-17 houses have suffered badly while rest others are in constant fear of the same. The instrumentation to measure seismic activity broke down on the first day itself due to the blasting activities. Houses with cracks on walls, joints and roof were seen. People complained regarding loud noise due to blasts. The people also complained about the sliding of the orchards and

agricultural lands due to blasting and other ongoing project activities. Some people have lost their land completely, while others have some portion left behind. The main source of livelihood depends on these lands, which are now completely or partially gone.

RARANG VILLAGE with a population of about 1500 persons is shadowed by proposed Jangi-Thopan project as well as Kashang II (Kerang tunnel). They are a secluded village with very rich quality of Apple cultivation. They have also filed case in NGT against Kashang HEP and even opposed NoC for the project. The only pasture land of the local people will be directly affected by the project (Jangi-Thopan) and hence will cause resource crunch for animal grazing.

Chilgoza trees of this area are the oldest and contribute majority of their annual income. People have been reporting increasing temperatures over several years. Due to temperature variation the plant diseases has increased drastically, which is again affecting their apple and walnut productivity. Vegetables like Beans are an important product of the area and its production has reportedly been reduced by 30-40% over 4-5 years.


Pegger - Kerang Nalah at Lippa

Lots of other local varieties like Fagra, Kodra, Chulli, etc is not cultivated any more as they need more water for sustenance, which is becoming scarce. The loss of biodiversity like Musk deer, Snow Leopard, etc has also been a cause of concern.

JANGI, a village of about 800- 900 people or about 120- 130 households is mainly dependent on Chilgoza trading. They sell minimum of 2 quintal (200kg) of Chilgoza per family per year. Other major products are Kidney Beans (5-10 quintal/year), Peas (50-80kg/year), Apple, etc.

They will be affected by the tunneling of the project of Jangi-Thopan hydro project as well as by the diversion of Kerang Khad of Integrated Kashang project as their source of recharge of local streams is Kerang Khad and the irrigation takes place from the same. Snowfall in summers (June 16/17, 2013) was a rare thing the people have seen in their lives. It affected the whole horticulture and the cropping had suffered dramatically. Fully loaded trees fell down with the load of the snow followed by soil erosion.

LIPPA, a village completely affected by the Integrated Kashang HEP, as the Kerang Khad (Stage II of Integrated Kashang HEP) is diverted from this area and the mountains are so fragile that the tunneling has acted as a catalyst for destruction. The Pegger Khad (a local stream) in the area is very high on siltation and floods every year [14],[15],[16]and deposits huge amount of silt on its way. As said by Mr. P.S. Negi, Kerang Khad aids such

[14] http://timesofindia.indiatimes.com/india/Himachal-Kinnaur-tribals-for-scrapping-hydro-project/articleshow/17880548.cms

siltation which will impact Pegger Khad and eventually the village due to this diversion whereas the EIA is silent on this. If the Kerang Khad will be diverted from here (i.e Lippa) the local people will lose all their cultivable land and the silt from Pegger Khad will engulf the whole of the fertile land. This is a major issue of the local people. They have also filed case against Integrated Kashang HEP in NGT[17].

[15] http://www.adb.org/sites/default/files/project-document/75043/41627-043-ind-semr-04.pdf
[16] http://admin.indiaenvironmentportal.org.in/files/EMP-Kashang.pdf (Page 31)
[17] **CASES FILED BY PEOPLE**:

1. Paryavaran Sanrakshan Sangarsh Samiti Lippa vs. Union of India &Ors (appeal no 28 of 2013) – Kashang II

Facts: (accd. to EC) The proposed project envisages construction of trench weir located near Dollo Dogri village in Kinnaur District of Himachal Pradesh. The proposed project is an integration of earlier Kashang HEP (66 MW). The integrated project has 4 stages with erstwhile Kashang (66 MW) HEP as 1st stage with 65 MW capacity. The Ministry accorded Environmental Clearance for Stage-1 project on 15.11.2002. The project envisages construction of trench weir and intends to use waters from Kashang and Kerang Khads, both tributaries of river Sutlej for generation of 243 MW hydropower. The stage-1 of the project involves a run-of-the river scheme with diversion of major part of Kashang stream (near Dollo Dogri village) to an underground power house located on the right bank of the river near village Powari. The Stage-II comprising diversion of the Kerang stream into an underground water conductor system. The Stage-III is consisting of augmenting the generating capacity of stage-I powerhouse using Kareng water over the 820 m head available in Kasang stage-I powerhouse. Stage-IV is comprising a more or less independent scheme harnessing the power potential of Kerang stream, up-stream of the diversion site of stage-II. The diversion Structure to be located near village Tokytu with an underground powerhouse near village Lippa. Total land requirement is 85.73 ha. out of which forestland is 61.89 ha. and private land is 23.83 ha. Total of 223 persons (all loose land) are likely to be affected due to this project. The total project cost is about Rs.1828.58 Crores and will be completed in 54 months.

a) The forest land required to be diverted is 119.6 hectare which is a huge chunk of forest land when seen in context when it is in cold desert region in an elevation which is from 200 meters to and 3155 meters (tree line limit). Such diversions causing decrease in forest cover in Kinnaur District. Piecemeal approach by FAC while giving forest clearance to integrated Kashang project so as to show low forest area required for the project as misleading. The FAC is not asking for total forest required for all the stages of the integrated project.
b) Project falls within 10 kms from the Lippa-Asrand wildlife sanctuary abd b impact on sanctuary has been considere by the FAC.
c) As a wildlife sanctuary exists at a distance of 1.5 km from stage IV, clearance from Steering Committee of NBWL under Wildlife (Protection) Act, 1972 has to be obtained however, no such permission has been taken prior to starting if work of the project. (Violation of Goa Foundation v UOI case)
d) There have been instances where ward 5 of village Pangi has come down because of construction of road, land slide activated by road built by Himachal Pradesh Power Corporation for Kashang project's dam site at Pangi Village clearly shows that damage is much more than what project generally claims. HPPCL is causing damage to the local ecology and livelihood of the people.
e) FAC did not consider the unique and fragile eco-system of the Himalaya. The flora and fauna of the Himalayas are unique and there are more than two hundred medicinal and aromatic plants identified by the tribal advisory committee cum tribal development department, Himachal Pradesh (Himachal Pradesh sub-state site (Lahaul & Spiti and Kinnaur) Biodiversity strategy and action plan, 2005). In the cold zone, nearly seventy species can be enumerated as rare and threatened. Large hydroelectric dam, roads and buildings destruct habitat and results in deforestation and excessive landslides. Also loss of biodiversity.

f) EIA/EMP silent on significance of the endangered species such as Juniperus Ploycarpos known as Himalayan Pencil Cedar found in the inner arid areas of the western-Himalayas. No mention of impact on fish fauna to be affected by diversion of Kerang stream.
g) No study done to assess the impact of drying u of Kerang stream on the vegetation and forest cover. Kashang stream is only 18 km in length and kerang is 44 kms. Kashang will be diverted at 8 kms and Kerang will be diverted 15.3 kms before its confluence with Sutlej. Kerang stream will be diverted through 6.3 kms long tunnel to kashang valley because of which this whole 15 kms will be dried up and trees like Alnus (high moisture demanding trees) will get affected.
h) Forest diversion has ignored the impact on Chilgoza Pine which is one the 5 pine species which are indigenous to India. It's rare and threatened species and found mostly in Kinnaur. Due to insufficient supply the price of Chilgoza is high in the market. Chilgoza forest exists in limited area and there s heavy dependancee of local community on it for cash needs and livelihood. Villagers and farmers close the forests traditionally collect chilgoza, anardana, guchhi, various medicinal and aromatic plants wither free or for nominal fee payment. Such diversions will be threat of existence to chilgoza specie. Respondents are blasting the chilgoza areas and debarking the valuable trees.
i) Settlement of rights under the FRA not done.
j) Gram sabhas or Panchayats are to be consulted before making acquisition of land in the scheduled areas for development projects and before re-settling or rehabilitating persons affected by such projects. The project proponents are yet to undertake this process in the proposed project area here 3 panchayats will be affected which is clear violation of PESA. The Panchayats have passed resolutions opposing the project.
k) Loss of livelihood and irrigation facilities has not been considered. 200 families in lippa village are on the verge of losing their existence. Almost 80% of families of lippa have agriculture fileds and 35 water sources for irrigation, these will be affected by construction of diversion weir structure for stage II and III but only one family has been considered as PAF.
l) Pollution free water and air is a FR under Art. 21.

2. Kashang I

The integrated project will produce total of 243 MW with four stages. EC granted in district Kinnaur on 16.4.2010.
a) The Deputy Conservator of forests has deliberately not mentioned the presence of chilgoza pine in the project area.
b) Study asked by FAC not carried out by the project proponent. The FAC asked for a study undertaken by GB Pant Institute of Himalayan Env &Development in 2010. But in 2011 the FAC accepted version of the state government that such a study has been carried out by Indian Council for Forestry Research and Education in the EIA report. FAC did not raise objection.
c) Suo motu cognizance taken on news item and order by HC of Himachal Pradesh to constitute one man committee of Avay Shukla. Shukla committee says the govt's present practice of indiscriminately allotting hydel projects all over the state is short sighted and unplanned and can result in serious depletion of state's natural resources in the long run. FAC ignored this report.
d) Snow is major form of precipitation in the area and any increase in local temperature will transform this into rainfall which in turn will wreak havoc in form of landslides. Restriction of projects in high altitudes.

2. Case No: CWP No. 1580 of 2010
a/w CWPIL No. 24 of 2009
Karcham- Wangtoo Hydro Power Project
a) Here the High Court of Himachal Pradesh passed an order against the project proponent for violation of environmental and social norms.

The project construction site is closer to Lippa - Asrang Wild life Sanctuary [18]with is violation of the rule as well as the area comes under Panchayat Extention to Scheduled Areas Act and the Gram Panchayats had not been informed or taken permission for construction of the project. About 80 streams will be affected due to diversion of Kerang Khad which will effect about huge chunk (approx. 500ha) of horticulture land. Lippa Asrang WLS is located adjacent to the project area and it is very likely to cause long term impacts in this alpine zone, especially on the wildlife and local streams that flow through this region but in the Impact Statements in EIA nothing has been described about the impacts on the ecological disintegration of the area with respect to Lippa Asrang WLS. The issue is being contested by the local people.

ROPA VALLEY : The valley is prone to erosion, like gully eroded landform. Many of the negative impacts of gully erosion are similar to those produced by tunneling. Gullies are open erosion channels at least 30 cm deep which conduct ephemeral runoff and are frequently characterized by steep sidewalls and a lack of vegetation (Ford et al., 1993; Boucher and Powell, 1994). 60MW Ropa HEP is proposed on the Ropa khad in the valley which is still under investigation. Being in seismic zone IV the area is tectonically active. Valley is rich in Apple cultivation but due to untimely rain in June 2013 which the villagers see as abrupt climatic change, the valley lost most of its fertile land.

SPITI VALLEY: Three projects on River Sutlej namely Lara-Sumte (104MW), Mane-Nadang (70MW) and Kulling-Lara (40MW) are proposed. Same as Hungrang Valley this is also a mountain dessert having tectonically active history along with flash flood. In July and August 2, 1991: A 1,500m road stretch of national highway-22 in Spiti valley was damaged due to flashfloods and landslides in Maling nalla. It caused damage to agricultural land in Leo village of Kinnaur, located downstream. The valley is rich paleontological information and many studies have been done on the Pin valley which is a part of Spiti valley.

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b) Lives of tribal are getting affected due to up-coming power projects were also mentioned as this makes a drastic change in their life style and future.
c) Hydroelectric and industrial projects have both direct and indirect impact on the environment.
d) With the setting up of the power projects, migrant labour comes to these remote areas leading to increase in crime.
e) What is done is an environmental impact assessment study which, more often than not , is a one sided study by the project proponent.
f) In certain areas, springs and natural sources of water are drying up because the water is percolating down to the dams and reservoirs of the projects being set up there. This directly affects the livelihood and lifestyle of the tribals.
g) FRA have not yet settled and as per FRA prohibits tribals from selling their lands in tribal areas to non-tribals, but on the other hand, the State plays an active role in transferring the land of the tribals to the project proponents for setting up these projects.
h) When these projects come some of these species of flora and fauna become extinct. The natural habitat of the fish and birds is being directly affected by these projects. These aspects need to be considered.
i) Due to continuous construction and on going heavy vehicles the infrastructure is being damaged. For example, roads needs to be rebuild, but it is not sure who is giving the money for it, the state government or the project proponent. This needs to be cleared.
j) These projects are also causing negative effects on tourism industry, as there creates scars on the hill slopes which never can be filled within once life span.
[18] http://www.indiawaterportal.org/articles/adb-funded-hydro-projects-himachal-pradesh-disastrous-experience-press-release-him-dhara

HANGRANG VALLEY : The valley (~ 8 villages) has a total population of about 5000 people and their sustenance depends on horticulture and livestock in this arid and non-fertile region, which is getting affected by these projects.

The Projects Sumte-Khotang (130MW), Chango-Yangthang (180MW) & Yangthang-Khab (261MW) are planned here. This region has witnessed a massive flood due to landslide lake outburst in 2005 from the Parechu River and this is also a tectonically active zone. Eight villages will be affected by these projects and they are completely opposing the upcoming projects. NoC has not been given till date for any of these projects, but still testing and studies have begun for Chango-Yangthang hydro power project. Frequent landslides occur and are a source of consistent impact.

According to paleontological studies the valley is rich in fossilized bio-strata and can be rich source of information about the evolution.

An 11th century monastery is going to be directly affected by the Yangthang-Khab Tunneling and its stressing the sentiments of the local communities as it's a religious as well as heritage site. Tourism has been the mainstay economy and equally important has been the economy of production systems which are undergoing high risks due to natural and anthropogenic factors, some villagers put the loss in Lakhs of Rupees.

At Khab, Sutlej receives the Spiti River where the bed of stream is still above 2,589 m high from the mean sea level. In August 2000 an unprecedented rise in Sutlej river right from Khab to downstream areas resulted in damages in the Valley. Around 200 km of NH-22 suffered extensive damage while 22 bridges were washed away. Loss was calculated at around Rs 1,450 crores. The project is proposed on Spiti River near village Leo, District Kinnaur of Himachal Pradesh. This is a run-of-the river scheme. The project envisages construction of 20 m high diversion structure (raised crest gated weir) across river Spiti just downstream of Chango-Yangthang HEP(140 MW) and upstream to the Khab-1 HEP (450 MW) to generate 261 MW hydropower. The underground powerhouse is proposed is located near village Khab upstream of the confluence of river Spiti with river Sutlej with 3 units of 87 MW each.

Going further downstream to Yangthang-Khab, a 450MW hydro project at Khab is proposed. In the 12th Five Year Plan (2012) the Khab HEP was proposed to be of 1020MW but due to the unstable geography of the area, it was said that the rock will not be able to sustain huge mass of dam. So it was reduced to 450MW. The slopes just above the river are extremely steep, at places almost too steep, such as at the junction between the Spiti and Sutlej at Khab where the river crosses the Great Himalayan Range. Construction of barrages and dams are affecting the natural flow of rivers and hence increasing the load in certain areas.

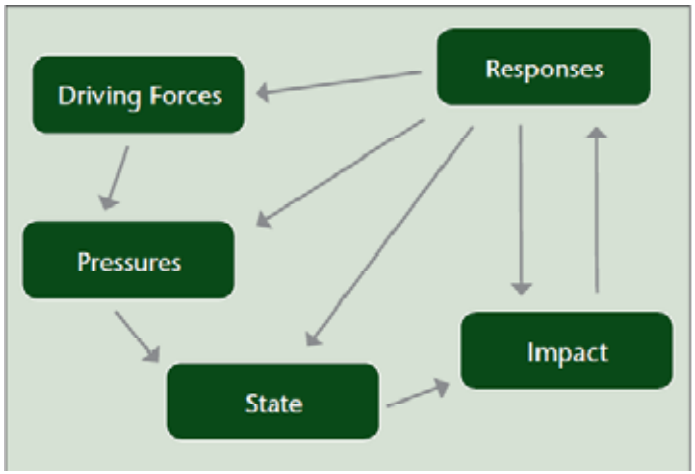
ORCHARD SLIDE in HANGRANG

SLIDE in Spiti River near MALLING

View of Fragile Valley of Hangrang

Sharp Meander

6. Evaluation through DPSIR Framework



The Driving Forces – Pressures – State – Impact – Responses [DPSIR] Framework was initiated in the seventies by global community and has evolved as a mechanism to understand the implications of various developmental activities. The DPSIR framework assumes that social, economic and environmental systems are interrelated. These links are illustrated conceptually by driving forces of environmental change, which create pressures on the environment. These in turn affect the state of the environment. The subsequent changes in status, or "impacts", include impacts on ecosystems, economies and communities. The negative impacts will eventually lead to responses by society, such as the development of policies for river basin protection. If a policy has the intended effect, its implementation will influence the driving forces, pressures, status (state) and impacts. (ECE Water Series No. 2, Protection and Sustainable Use of Waters– Recommendations to ECE Governments (ECE/CEP/10)).

6.1 Driving Forces

The National Programme on Hydropower, which aimed to produce additional 50,000 MW from the Himalayan Rivers initiated in 2003 has been the most significant driving force for the construction of hydropower projects across the Himalayas. The projects in Upper Sutlej Basin have also been initiated and are being implemented under this programme. The projects under this programme being implemented by the State and Private Agencies have the blessings of the Central Government and provide 12 percent free power to the State Government as a consideration for the use of its resources. Government of India (GoI) has embarked on a fast-track dam building program under which it aims to construct 292 dams throughout the Indian Himalayan Rivers to increase the contribution of hydro-power to India's primary energy demand to 6% by 2030. According to the 2008 GoI policy document, 132 projects ranging from 7 to 11,000 MW have been assessed and all are likely to negatively impact the bio-physical and hydrological environment even if most (90%) are the so called 'run of the river' projects.

If all projects are built, the Indian Himalayas would be the region with the highest average dam densities in the world, with one dam for every 32 Km of river channel[19]. Despite the understanding to the contrary, these projects also are said to provide succour in times of heavy

[19] http://www.orfonline.org/cms/sites/orfonline/modules/enm-analysis/ENM-ANALYSISDetail.html?cmaid=55905&mmacmaid=55906

rainfall and be able to moderate floods. Further, the tag of clean energy given to hydropower in the recent times has been an additional in building hydropower projects. In Himachal Pradesh alone over 23,000 MW of potential through 666 large and small projects has been identified and several are under various stages of implementation.

6.2 Pressures

There is always an appetite for construction and when private sector is allowed and provided with policy parameters in their favour the projects are taken up very rapidly. In the case of the Himalayan Hydropower projects both International finance and lax regulations and compliance mechanisms add to the pressure of building these projects as quickly as possible. It is already clear that some developers have established the projects and exited after making profits. The availability of concessions and also finance for the limited period when the scheme for development exists also prompts many developers. The constant cry of power-shortage and outages that people encounter, particularly from urban users, also creates an environment for mindlessly pursuing power projects. In the context of Kinnaur where the population densities are low, the justification for projects is enhanced as local communities cannot adequately voice their concerns but face a rampant degradation of environment and their livelihoods.

6.3 State

Over all 70% of the main Sutlej river stretch has been assessed to be affected due to diversion (168 km) and 22% due to submergence (52.65 km); thus a total of 92% of the Sutlej river length (220.65 km) will be affected due to the proposed intervention. In Spiti River 27% of the river stretch has been assessed to be affected due to diversion (47.30 km) and 2% due to submerged (3.95 km); thus 29% of the river length (51.25 km) will be affected due to the proposed intervention.

6.4 Impacts

A number of impacts are visible and their implications to the local communities are significant. Some of the specific ones are highlighted here:

Due to Recurring Landslides, Blasting in Project Area

Case Example I - **Landslide Urni & Surroundings**: The stretch from Tapri to Chulling (downstream of Karcham) is closed due to frequent landslides, rockfalls near village Urni, local villagers also point to leakage in tunnel as a probable cause for this trigger in the project zone of Karcham Wangtoo hydroelectric project. The distance between Tapri and Chulling (blockades) is merely 3.3 kms and can be covered in less than 10 minutes by normal course. Traffic during this peak tourist season is being diverted from the Chulling bridge via Urni and follows a trail of ascent and descent to meet NH22 a few metres before Tapri (see map below), this is almost 18 kms, almost 6 times longer, takes anywhere between 75-90 minutes (almost 9 times), increases fuel consumption and is a riskier route to manoeuvre through.

The Yellow line between Barricaded 1 to Barricaded 2 is NH22 which is closed, the red and brown paths are the alternate routes currently under operation. The road is not meant for heavy vehicles but during this tourist season and long days of diversion, the state carriage, army convoys, tourist maxi cabs and tempo travellers are bound to take this route. The route is so narrow through its length that even two small vehicles are difficult to pass by, manoeuvrability is further constrained by sharp turns, sudden climb and loosening of earth, especially at bends leading to skids. If one were to calculate the costs coupled with pollution, the impacts of such risks if applied across the transient environment where such risks of rockfall-landslides are instigated by disintegrating (tunnelling or construction works) this environment, will put hydropower development in negative frame from its already unacceptable state.

When a convoy of waiting vehicles (LMVs and HMVs) takes off after a desperate wait, dust clouds begin to emerge, with windows closed and air conditioners on the run and climbing up (max. 2300 m), the fuel consumption on an average would be 3.23[20] ~ 3 litres per vehicle (due to sudden breaking, acceleration to climb, air conditioning and load of passengers) which roughly comes out to be 150 litres (cumulative) which otherwise would have been 1/10th i.e. approximately 16 litres for all vehicles combined (considering average at 11kmpl w.r.t. 3.3 km). Vehicle and road wear and tear is another aspect which is unaccounted for and the burden is transferred to the user.

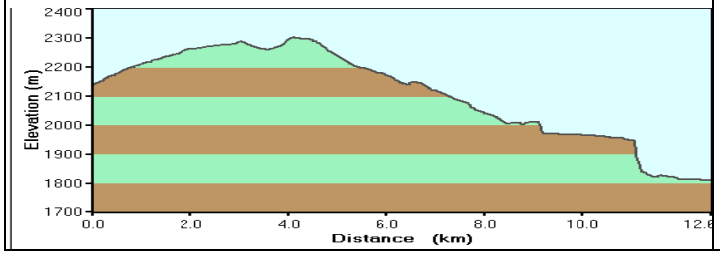
Considering 6 trips over a day (10 a.m. to 7 p.m.) of average 50 vehicles, the fuel consumption based on the above calculations would be 150L for 1 trip*6trips = 900 L for a day, an excess of 804 ~ 800 litres. Count the number of days of such an operation, a cumulative impact is therefore number of days to restore the normal route (x)* 800 L

Kinnaur is a fragile landscape with higher risk of landslides and rockfalls as shown in map . The emissions of Sulphur and Nitrogen oxides and Carbon Dioxide, emissions are higher for lower speeds, in the first leg (fig. below) the average speed was 18kmph over 12.6 kms. The

[20] Using average speed model (leg 1 it is 18kmph for 12.6 km) the fuel consumption comes out to 2.12 l using numerical formula F = K1+(K2/v), where F is fuel consumption, K1 is parameter associated with fuel consumed to overcome rolling resistance, approximately proportional to vehicle weight and K2 is proportional to fuel consumption while idling (litres/hr). For the last leg (6.6 kms), it comes out to 1.11 l.

psychological impact in terms of losing time is to cover up time in rest of the journey to avoid halting during night (as it increases cost, average Rs. 800/person) which may mean increased speeds and further vulnerability.

From Chulling toward Tapri (11.5 kms) Altitude Profile, it's a climb for 8 kms before a descend starts



The last leg of 6.6 kms towards Tapri ending at 1707 m

Case Example II: Villagers of Pangi indicate that construction work and blasting for the Kashang Integrated project which has rendered several houses unliveable and almost half of the 40 houses suffered heavy damages and are sinking and this is a growing problem. In a similar contrast, GSI report points three causes of rockfall / landslide in the Naptha village (Naptha-Jhakri Proect) which are heavy rainfall, heave and thaw action of freezed snow on peaks and vibration & resonance of blasting activities as the people attribute initiation of problem since the start of blasting. They evaluated the risk hierarchy of this village as High Risk Prone using Landslide Hazard Evaluation factors for Lithology, Structure, slope morphometry, relief, land use and hydrogeological conditions. This is one technical dimension but in this process almost 7 lives are lost and many got injured!


Damaged House in Pangi

Rarang is another village which is under the influence zone of tunnelling of Kerang nallah and also fall in the influence zone of Jangi Thopan project. The instance of local springs drying up due to road construction is one among other threats like impact on pasture land. This is a good apple producing agro-climatic zone and sliding instances has taken heavy toll on many trees in Pangi and are equally threatened in Rarang. Jangi, another village has the wealth of Chilgoza, apple, peas which makes them self-reliant but their prime source of water i.e. Kerang Khad and network of smaller streams is being diverted into a tunnel for the Kashang project.

Village Lippa's concern escalates from alteration in the local hydrology owing to water transfer through Kerang-Kashang tunnelling. Peggar Khad, a local stream bring in high silt & floods frequently but Kerang acts as a counter to carry this silt load along its flow but with diversion

of Kerang there is a risk of cultivated land to lose its productivity and as experiences of villagers indicate the land may be rendered uncultivable due to silt accumulation. As far as contribution of Kerang and Keshang streams flows to Sutlej is concerned, the EIA reports its flows as substantially less (3.53% and 1.58% of Sutlej's flow at Karchham) but when local hydrology and climatic controls are ought to be understood for sustainability of agriculture, risks have not been assessed.

Case Example III: Villages in the Hungrang valley located in tough region of Trans-Himalayas are often confronted by landslides and with limited livelihoods from horticulture and tourism, they also fear the sudden blockages through Kinnaur will also impact tourism in the region for which the Valley is well known in the Himalayas. Again, their local economy is wealthy and sustainable but frequent interventions by construction and dam agencies is posing risk to this fragile environment with lack of vegetation, any effort you do to stabilise the physical state of the region, it will again undo it as it is still evolving. The Tabo Monastery located here was damaged during the 1975 earthquake and was rebuilt; it is a national historic treasure and is protected by Archaeological Survey of India. A series of projects are proposed in this section and many believe that despite being protected by ASI, there is no mention of such an important place in the ToRs and the way tunnelling or other construction is being carried out in the Himalayas, risks to this ASI site cannot be taken lightly as it forms part and parcel of socio-cultural profile of population.

Impacts on Land Use and Natural Resources

Impact on Land Utilisation in Kinnaur:

With a total geographical area of about 604 km^2 (District Kinnaur), of which cultivable area is only marginal (7 km^2) and 317km^2 of permanent pastures forming directly linked livelihood and sustenance of communities; Forests, uncultivable land forming again a sub-set of livelihoods but regulated more by the state; people driven fruit economy of the state fetches more than Rs. 300 crore annually, with almost 11.80 km^2 [21] area brought under horticulture crops, especially apple in majority. Pinus Gerderiana (chilgoza) trees are grown naturally and are harvested as a community resource and it is a rare and endangered species but construction activities and dam building have taken over this rare species space which is endemic in this part of the Himalayas – 751 out of 1261 trees allowed for felling for Tidong-I were Chilgoza trees shows the insensitivity of the forest department to recommend such offset and in return the project has done irreparable damage to additional 590 trees which questions the whole design conception of the project and further raises a question How irreparable damages be written off by merely collecting fines. The enactment of the Forest Rights Act is still to unfold in the state as the State had taken a stance to negate forest rights by contemplating traditional rights as settled rights from the past, which is not in the right spirit of FRA. The reduced balance of land utilization has come to question in the spate of hydropower development and also the natural fury the state has to face from time to time. Pinus Gerderiana is a community resource and promotes an economy which is specific to this area, inspite of promoting it

[21] http://hpkinnaur.nic.in/HorticultureavocationDCKinnaur.pdf

conservation and grading, loss of this species is on the rise, greater impetus is also required on bringing it under Community Forest Resource and Rights, the process which is lingering in the administrative hurdles while project development is peaking and fragmenting its habitat.

Sedimentation, Rainfall and Snow

As per a detailed investigation conducted by scientists on understanding climatic and geologic controls on suspended sediment flux in the Sutlej River Valley bring some interesting facts[22]. The research correlated that the Parechu stream floods (induced by landslides and artificial lake breach) the sediment load increased substantially and extended over 8 day period, also there was rainfall in the upper catchment triggering snow melt leading to this runoff. They concluded that the Parechu flood in June 2005 was the dominant erosional event (35Mt Suspended Sediment Load or SSL) and accounted for 41% of the seasonal suspended sediment flux. They compared the catchments in the Sutlej basin like Wanger, Ganvi, Baspa, Spiti and Sutlej at Namgia, Jangi, Karchham and Wangtoo *(Table 2, page 2199 of the referred report)*, the rainfall derived from TRMM[23] per year is uniform from Jangi to Wangtoo i.e. between 0.38 m yr^{-1} to 0.41 m yr^{-1} or 380mm to 410 mm spread over a year which is relatively higher in the Wanger, Ganvi and Baspa Catchments; Spiti is again comparable to Sutlej. The high variability in rainfall (District level – Kinnaur) is therefore not a true reflection of what occurs in the Himalayan crest and the Tibetan Plateau.

Muck Generation, Dumping Sites and Missing Assessment of River Morphology

It's the nature of Hydro power construction that such exploitative activities result in encroachment / burden over public lands and it is likely that these impact the river morphology in a bigger way as series of projects are on the anvil. For under construction projects, the quantum of muck generation is huge, cumulatively for Shongtong Karcham (4.72 Mm^3), Kashang Integrated (1.17 Mm^3), Tidong – I (0.414 Mm^3), Tidong – II (0.282 Mm^3) the quantum of muck is 6.586 Mm^3 (almost 50% utilisable as reported) and for the commissioned Karcham Wangtoo it is reported to be 9.01 Mm^3. The dedicated dumping sites are allotted alongside river and NH-22 and it has been found that Phytosociology of Species is high (density) in areas like Barrage, Trench Weir, Dumping sites and at certain foregone areas, Chilgoza has been a dominant species. Although the project may have specific sites allocated for dumping but in the Himalayan system, land is a constraint and in the absence of detailed River Morphology assessment, the functions of River, its environmental flows and cultural linkages are largely excluded from the framework of impact assessment. Cumulative assessment of these linkages along the length of River with back and forth causative factors helps in building scenarios to understand River systems and as a decision making framework for development but has never become part of the assessments. The recent example of June 2013 Flooding event is a showcase of how public infrastructure and private properties are damaged and made redundant as the muck from the River Alaknanda (Srinagar Hydro Project) has gushed onto the Road level and

[22] Climatic and geologic controls on suspended sediment flux in the Sutlej River Valley, Western Himalaya in the Hydrology and Earth System Sciences, 2193-2217, 2012 | Authored by H.Wulf, B. Bookhagen and D. Scherler

[23] Tropical Rainfall Measuring Mission of Nasa

above, in some cases even 5-6' above the plinth levels. In this case, dumping was done irrationally without understanding the morphology of River. This has huge implications towards public lands as well as small land parcels in the valley.

Extractives and Connected Links

Apart from the impacts caused directly by the hydro power stations, the northern region is seeing a spurt of limestone mining and cement plants which will aid the construction sector. Especially, in Himachal Pradesh there are already many cement plants (Darlaghat, Bagha, Barmana) with approximate capacity of 12 million tonnes. There is a direct linkage for making available materials within the state to fast track construction activities of hydro power projects and to real estate sectors largely focusing in the foothills of Himachal and Punjab-Haryana region where satellite towns are being developed.

6.5 Response

The response of the State and Private Developers and the financial institutions has been to negate the impacts and wherever such outright negation cannot be feasible in the light of empirical information on impacts, is to under estimate the impact or even make "promotional assessments". The fact that every project is disputed on the ground, and each of them is increasing the vulnerability is constantly being noticed and is being the cause for uncertainty and agitation among the local communities. Added to this, the State has been denying the legitimate rights of the citizens, particularly the tribals. This is being challenged administratively and legally[24].

The State Administration was forced to appoint a commission to enquire into the impacts and implications of the projects by the court with the following objectives: i) Whether the hydel projects while undertaking the construction of projects have followed in letter and spirit the mandatory conditions of environmental clearance and forest clearance granted by the Central and State Agencies; ii) Whether precautionary/necessary steps have been taken by the companies to restore environment and ecology in the projects areas; iii) Whether it is advisable for the State Government to sanction construction of hydel projects at the height of more than 7000 feet above sea level. The alpine forests grow at the height of 7000 feet above sea level; The Committee shall visit all the projects to assess the damage already caused and the essential steps required to restore the same.

The Committee is strongly of the view that the Government's present practice of indiscriminately allotting hydel projects all over the state without any consideration to their impact on the larger environment - which mere EIAs and EMPs cannot address - is short sighted, unplanned and could result in serious depletion of the state's natural resources in the long run. This is not, however, an issue of altitude alone, as vulnerable areas in dire need of protection exist at even lower altitudes. Protection has to be provided, for example, to dense forests (which, according to successive reports of the Forest Survey of India itself, have been declining in HP year after year), protected wild

[24] See examples of cases filed on Kashang and Karcham-Wangtoo Projects

life areas, critical catchments of river systems, critical wildlife habitats outside Protected Areas, permanent glaciers, alpine pastures and so on by declaring them as eco-sensitive zones under the Environment Protection Act. Only this would ensure that these vulnerable but vital natural buffers remain inviolate.

Currently no area in the state not even National parks and Sanctuaries are exempt from hydel exploitation, but this has to change, and change fast given the speed at which the hydel tentacles are crawling up the valleys and side valleys of the state. This requires the setting up of an interdisciplinary body of experts in which the MOEF which accords the final clearances should also be associated. However, pending that, there are some recommendations which this Committee would like to make which need to be adopted immediately so that the environment of the state can be somewhat protected in the interim."

The court later observed, “The first and foremost interest should not be generation of power and earning of revenue. We must also realize that a large number of these projects are being set up in tribal areas where the entire lifestyle of these communities is being changed due to the setting up of the projects.

Hydro-electric and industrial projects have both direct and indirect impact on the environment. When we are talking about the environment of the area, we are not only talking about the flora and fauna of that area but also about the traditions, the lifestyle, the manner of livelihood, which are endemic to the areas in question. With the setting up of the power projects, migrant labour comes to these remote areas leading to increase in crime. Nobody has measured these factors while looking at the adverse impact of the projects. On the one hand, the project proponents will always extol the virtues of the projects and the profits to be got out of the projects, on the other hand, we find that there is no proper inquiry being conducted with regard to the adverse impact of the projects.

At best what is done is an environmental impact assessment study which, more often than not, is a one sided study. We have already in some other cases given directions that in future, the studies be carried out only after giving notices to the local residents of the areas. While conducting the environmental impact studies, we request the State Government to consider the other adverse effects on the social lifestyle of the people of that area and also other adverse impact of such projects.

We have been told that in certain areas, which were almost deserts, rainfall has increased and in certain areas dramatic climatic changes are taking place. In certain areas, springs and natural sources of water are drying up because the water is percolating down to the dams and reservoirs of the projects being set up there. This directly affects the livelihood and lifestyle of the tribals.

On the one hand, we have laws, such as the Forest Rights Act, as well as laws which prohibit tribals from selling their lands in tribal areas to non-tribals, but on the other hand, the State plays an active role in transferring the land of the tribals to the project proponents for setting

up these projects. There can never be a true assessment of the value of the land because the tribals can only sell land to tribals and if they were in a position to sell the land to non-tribals, probably the land value would go up manifold. All these factors also need to be looked into before looking into the viability of the project.

In addition to the above, the direct environmental aspects are also not being looked into in totality. What is the impact of the projects on the fauna of the State? What is the impact of the projects on the flora of the State? Himachal Pradesh is host to a large number of plant varieties as well as animal species which are found only in Himachal Pradesh and nowhere else. When these projects are set up, some of these species of flora and fauna become extinct. The natural habitat of the fish and birds is being directly affected by these projects. These aspects have to be seriously gone into while considering the setting up of these projects.

Even coming to the economic benefits of the projects, we find that a very little attention is being paid to the negative economic impact of the projects. Some of the construction activities of these projects have led to damaging the roads to such an extent that they have to be rebuilt. We are not aware if the roads are rebuilt with the funds provided by the projects or is the State doing this job of rebuilding the roads. These matters may be clarified in the affidavit to be filed by the State. If due to the construction of the project, heavy machinery moves on public highways and this causes damages to the road, we see no reason why these costs should not be recovered from the project proponent. Sometimes, the material produced in the projects, such as cement, has to be transported to distant places. This leads to the introduction of hundreds of trucks on roads which were not designed to carry so much traffic. We have not come across any case where the impact of the project on the roads has been taken into consideration while evaluating the feasibility of the project.

There is a negative economic impact of these cement and hydroelectric projects on tourism, which is one of the main sources of the economy of the State. This is directly and adversely affected by setting up of cement and hydroelectric projects which mar the beauty of the State and creates scars on the hillsides which can never be healed up. Therefore, while expanding the scope of the Interdisciplinary Committee, all the above factors shall also be taken into consideration. In remote hilly areas at high altitudes, where there are heavy winds, but the sun shines throughout the year, alternative renewal sources of energy, such as Solar Energy and wind based energy should also be looked into as alternative means of generating the electricity." *This has led to the mandating of the Cumulative Impact Assessment, a critique of which is provided in the next chapter.*

7. Critique of the Draft Cumulative Impact Assessment by ICFRE

The Environment Appraisal Committee (EAC) of Ministry of Environment and Forest (MoEF), Government of India (GoI), directed the Department of Energy (DoE), Government of Himachal Pradesh (GoHP) to conduct Cumulative Environmental Impact Assessment (CEIA) Study of Hydro power Projects in Sutlej basin, Himachal Pradesh. The DoE, GoHP in association with the Forum of the Hydro Power Producers (HPPF) and other stakeholders awarded the above study to Indian Council of Forestry Research and Education (ICFRE) Dehradun, which in turn appointed 1) Alternate Hydro Energy Centre (AHEC), Indian Institute of Technology (IIT), Roorkee; 2) Directorate of Coldwater Fisheries Research (DCFR), Bhimtal; and 3) Salim Ali Centre for Ornithology & Natural History (SACON), Coimbatore for their respective area of the expertise. The study claims to have conducted studies on 38 hydropower projects but in indicating cumulative impacts has not considered all of them in reflecting the effects. Neither does it look at the long-term implications of the altered ecosystems.

The study mentions about the important concept of "no-go" rivers, rather abruptly and is not reflected in its analysis in the voluminous report and seems to relate the same only to conservation of fish – "In many countries, river fragmentations by hydropower development have contributed to the approach of leaving few rivers /tributaries in their natural state within the basin. WWF emphasis, that the governments should designate some of the remaining unregulated rivers in areas of high conservation value as "no-go" areas for hydropower schemes. Accordingly, in the study area while optimizing: River Spiti and upper Kinnaur that falls in trans Himalaya ; few stretches that influence with the protected area in the middle Sutlej basin and lower Sutlej basin where the fish has good habitation should be considered to declare as no-go area for hydropower project development and undertake conservation measures."

7.1 Categorization of Impacts

The categorisation of impacts itself is questionable. The impacts have been divided into two categories, viz., Localized and Cumulative. The idea of cumulative impacts is how combination of localised and regional impacts will affect the ecosystems and the communities dependent on it. However the study starts with the premise that generally, "the impacts of HPs on most of the ecosystem components are localized, i.e., confined to the area of influence of a specific project, impacts on some of the components are cumulative i.e., the impact of one HP adds on to the impact of the downstream project". Thus the very purpose of a cumulative assessment is defeated.

Further the impacts are mentioned qualitatively and in a vague manner, as low, moderate and high and issues that affect the communities are not considered in depth, effectively providing no basis for local communities to understand and articulate their concern which was one of the key objectives of the exercise.

The statement on the impact assessment and its critique is provided here only considering the summarised impact. The study completely undermines the fragility and complexity of the terrain, particularly with regard to the geodynamic characters and its implications. These are relegated to a brief section as natural disasters.

Assessment by ICFRE	**Critique**
Impact on water availability in the diverted stretch	
The altered river flow for the four commissioned projects; Baspa, Ghanvi-I, SVP Bhaba and Karcham-Wangtoo were assessed. Water availability is a local phenomenon and therefore the impact is categorized as Localized. The requirement of environmental flow takes into consideration the depth and velocity of the flow in the diverted stretch to maintain the ecological security. Thus, the cumulative impact on water availability has been assessed to be cumulatively low.	The assessment is based on only four out of the 38 projects, which is a miniscule proportion of all the projects. The report begins with very limited data and states "Due to non availability of long term water availability data for the entire study area, measured flow data available at very few locations and BBMB data were obtained for assessment. In addition, flow data from the available sites in DPR were used to assess the water availability using Flow Duration Curve. Further, it states that "Upper Sutlej catchment snowmelt has been reported to contribute to 80-90% of the mean annual discharge in tributary catchment, while glacial melts account for 1020% of their annual budget. The middle Sutlej catchment sustains high snow and glacier melts derived discharge throughout the ablation period (May- September)." It has no scientific basis to say that "water availability is a local phenomenon", whereas it is common knowledge that the Himalayan rivers have significant bearing all the way downstream as a significant portion of the catchment lies above and variations due to climate change particularly of snow-melt is crucial for any consideration of river flow downstream. Thus its conclusion is contradictory to its assessment that the impact is localised and low is both false and misleading. In reality the impact will be very severe with the river losing its fundamental character and the principle the report talks about of "mimicking" the natural flow will never be realised.
Impact on Flashiness	
The flashiness is expressed in terms of Flashiness	The assessment states of lack of data on flows and states "Flow and Flow Duration

Assessment by ICFRE	Critique
Index (FI) and reflects the frequency and rapidity of short term changes in runoff values. The slopes in the banks are high; the area covered by flashiness fluctuations is very small in relation to the catchment area and thus will not have adverse impact. Further it may not be uniform for the entire project area as the impacts are project location specific, and thus the cumulative impact has been assessed to be cumulatively low.	Curves (FDC) for the un-gauged locations were computed from the data for the gauged location in area of close vicinity or from representative area. The gauged data obtained were adjusted in proportion to the catchment areas and average rainfall using standard formula for the un-gauged locations. Further, where rain fall data was not available for the project sites, flow was estimated using only by the catchment area proportion of the gauged data. • The flow duration curves assessed recorded variability of the flows for various sites. The flow curves observed significant seasonality. " Further there are also diurnal changes due to intensification of production of peak power. Since the topography is not uniform and the river systems vary in width and depth, the implications could be severe and continuing for several communities.
Impact on Sedimentation	
The impacts of hydro-electric projects (HEPs) on soil erosion and sediment transport commence with project construction activities such as construction of barrage, tunnels and approach roads, etc., and may continue up to generation of hydro power.	The report itself concedes that the sediment loads have significantly increased in specific projects. Increased sedimentation will have prolonged impact depending upon the manner in which the muck dumping takes place. A huge quantity of material is brought out will eventually find its way into the river system. Stabilisation is not effective as the region s prone to landslides and micro-seismic events. According to a GSI Report, "results of microearthquake (MEQ) monitoring indicated that the average seismicity (number of earthquakes per day) is 1-2 events at stations Tabo, Lalaung and Rangrik while it is 1 event per 2 days at Mikkim during the period of observation. The seismicity was comparatively higher in the north of Spiti river." http://www.portal.gsi.gov.in/gsiDoc/pub/cs_active-fault-spiti.pdf
Sediment load is mainly due to natural phenomenon, the construction activity adds to the sediment load during construction and pre commissioning till the mitigation measures for stabilization are undertaken. Seven HPs namely Khab, Powari (Shongtong and Karcham HPs), Baspa, Karcham-Wangtoo, Sutlej at Nathpa (Nathpa Jhakri), Sutlej at Rampur HP, Sutlej at Suni (Luhri HP) were	The assessment clearly points out to contradictory information and the immense variation in the sediment load and the lack of a clear relationship between the discharge and sediment load. This clearly indicates the continued non-compliance of the existing projects in terms of monitoring. The report also goes to state "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. In

Assessment by ICFRE	Critique
considered for the study. As per the study conducted, the impact of HPs on sediment is medium cumulatively.	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." Since compliance mechanisms are weak and unscientific methods are used in disposing of the muck and construction debris, the impact of hydropower projects on the sediment load is significant. In the recent floods of June 2013, the river courses altered in the light of places where dumping has taken place and took people by surprise.
Impact on Water Quality	
The water qualities of river Sutlej were assessed to be well within the standards prescribed by CPCB for Class –A, water. The marginally higher values of BOD, COD, TSS, TDS and Total Coliforms may be attributed to runoff generated for snow melt and organic waste from upper region. However, the reason for marginally higher BOD and COD on few locations might be due the fact that the samples were taken at the banks of the river where the concentration of organic matter and sediments were higher. The water quality in its journey in the tunnel does not undergo any significant changes. Over all the impact of individual HP on water quality is low and thus cumulative impact assessed is low.	While the overall impact of hydropower projects on water quality may be low, due to fluctuations in the flow and stretches having no or very little flow the quality could deteriorate significantly and this has not been highlighted. Further the study has found presence of mercury, but has not made any effort to trace the provenance. The representation of facts that higher BOD and COD values 'might be' due to the fact that samples were taken at the banks of river…….shows lack of pre-sampling instructions, coordination among the host of institutions. In case of cascading projects, the concern is on the alterations in flows, behaviour of river and its environs and extreme conditions in regions like in Upper Sutlej Basin but hardly any detailed investigation has been done to come to a conclusion.
Impact due to tunnel on ground water and spring	
The distribution and occurrence of the springs show that the density of springs is not homogenous in	The report has laboured on trying to prove that extensive tunnelling does not affect groundwater regime or spring flows rather unconvincingly. It further concedes that the

Assessment by ICFRE	Critique
different rock types. The occurrence of springs is not similar within same type of rock of the study area and is mainly due to typical geological formations, lineament density and other factors such as slope etc. During the field investigations at Nathpa Jhakri project site, it was noticed that few springs which were affected due to the tunnel construction (HRT) of the project, have regained their original position after construction of tunnel. The main reason for temporary impact is due to impervious nature of tunnel that affects the groundwater movement direction, not to recharge zone. Despite this however, to be on the side of caution it will be appropriate to assume that if the length of the tunnel is long the impact on springs could be higher. Thus cumulatively the impact is assessed to be medium.	groundwater movement direction is altered. In terms of people who use the spring water, whether the aquifer has been completely destroyed or the direction of flow has changes, the effect remains the same – they do not have the spring. The assumption that the tunnelling activity influences only the zone of tunnel per se is unfounded as extensive blasting takes place and the joints and other fracture systems are disturbed considerably. Whereas people have pointed out to a number of springs that have disappeared, the report hides behind the argument that communities have not provided any verifiable document in this regard instead of investigating specific sites. The impact of blasting on the buildings which has been repeatedly raised and the landslide caused have not been reported at all in the report.
Land use Change and impact on flora and fauna	
The land area required for hydropower development are proportional to the size and capacity of the project and majority of the land proposed to be acquired is forest land. Number of projects in the river or tributaries and their impact due to land use changes on protected area in terms of fragmentation (such as fragmentation of land) was considered for assessment. Further, floral diversity, faunal diversity, water birds and terrestrial birds specific to the project area were considered for impact prediction. The unique landscape, flora and fauna in Trans and greater Himalaya and the protected areas within the study area will have negative impact. Thus cumulatively the impact is	The report concedes that negative impacts will be there with changes in landuse on the flora and fauna and also affect the protected areas. The fact that very little land is available for cultivation, including horticulture, which is the mainstay of the economy the impacts on the communities is going to be severe. Already several specific damages have been highlighted by the communities. The report fails to mention that already due to changes in the climatic patterns key horticultural crops have to be shifted to higher altitudes and the uncertainity will rise with the changes brought about by the establishment of these projects. While with all the assessment the text points to severe impacts, the categorisation of impacts tends to place the impact as moderate. It is strange that most of the impacts are finally classified as low with very little scientific or quantitative basis.

Assessment by ICFRE	Critique
assessed to be medium.	A number of Protected Areas also are affected by the projects and these have implications to the larger policy issue of conservation of protected areas and also the impact on the ecological integrity of the region.
Impacts to the Aquatic Ecology	
The absence of fish above Rampur till Karcham and Tapri is inductive of adverse effect of barrage structure which has obstructed the longitudinal connectivity of the river. The blockage of migratory route due to construction of barrage in the middle zone (Karcham, Nathpa and Baspa-II) has reduced the breeding potential of the existing fish fauna (eg. Schizothorax richardsonii). The downstream of Kol Dam has good numbers of fish fauna and the migration will be affected due to construction of barrage. The area near Tattapani is breeding ground of endemic fishes as gravid female was found during the investigation. The formation of Kol Dam reservoir may change ichthyofaunal diversity due to the creation of lacustrine environment. The brown trout (Salmo trutta fario) is restricted to the Baspa River in the Sangla valley. The exotic trout is introduced in the stream has established itself due to the presence of environment conducive for growth and survival. Deep gorges and with steep slopes in the Sutlej River, the fish are restricted to the tributaries and Khads (Chera Khad, Pandoa Khad, Behna Khad, Nogli Khad, Manglad Khad and Ghanvi Khad, Near Chaba, Baspa). The slope and consequent change in water current and temperature are determining factors for the	The impact on aquatic ecology is already visible with drop in fish yield and also the breeding potential which has a long term impact. The report says that it has used the EIA report of the various projects. This report states that brown trout is restricted to Baspa River whereas the EIA of Luhri Project mentions the presence of brown trout further downstream of Baspa-Sutlej confluence.

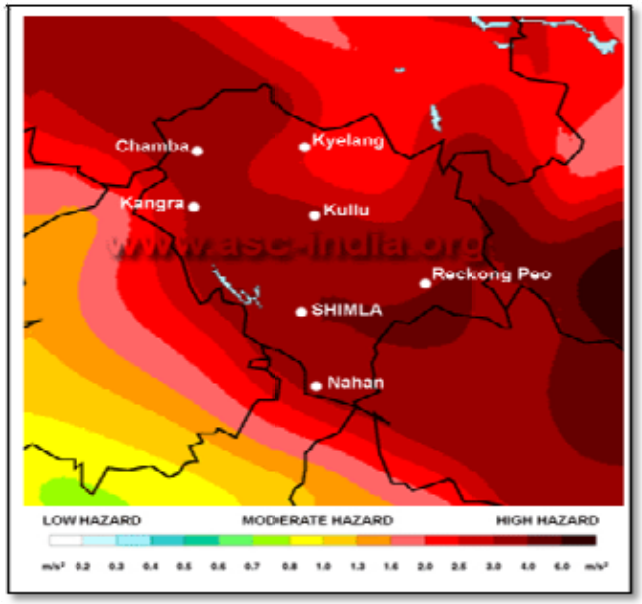
Assessment by ICFRE	Critique
distribution of fish fauna in the Sutlej Basin. Based on the fish occurrence in the study area the impact on diversity is assessed to be cumulatively medium and the impact on fish migration to be cumulatively high.	
Impact on water birds and terrestrial birds	
Birds are also dependent on water however, feeds on other benthic life forms and aquatic insects for their survival in the study area such as Behna khad, Luhri, Nogli Khad and Mangland Khad. The Cheer Pheasant terrestrial birds has important habitat in the lower region where the forest lands are already fragmented due to various anthropogenic factors such as landslides, cultivation, settlements, roads etc. These birds occur outside the protected area i.e. Majathal WLS near Kol Dam and Nogli Khad. Based on the occurrence of the birds species in individual HP and specific within the study area, the cumulatively impact is assessed to be medium for both terrestrial and water birds.	The report concedes that there will be impact but vaguely puts it as "anthropogenic" factors wherein it includes even landslides which are either natural or induced due to basting for hydropower generation and road construction. Thus it misleads about the cause of the disturbance.

Assessment by ICFRE	Critique
Impact on social environment	
The people are ethnic and practice traditional farming in the upper region of the study area. Land availability for cultivation is limited due to small fraction of soil in the mountain area and threat of landslide/slip. Land use changes due to the proposed hydropower development may have impact on the local livelihood and loss of various produce. Further during the survey it was conveyed by the public that the benefit proposed under various management plans has not benefited. The quantification of the benefits could not be made due to non availability of document. However, assessment of impact on employment and infusion of HP investment in to the local economy and per capita income were made with secondary sources of information. Based on the employment, per-capita income, energy consumption, contribution of CSR, LADF and the infrastructure available, it is assessed that the impact due to hydropower development and the investment has not contributed positively except for the compensation to the project affected family. Thus, the positive cumulative impact on social environment is low.	This was one of the critical aspects for which the entire exercise was mandated. The study has used secondary data and it is clear that there is very little benefit to the local communities. Similarly, where the local fund (Local Area Development Fund) is deposited at the state level to be spent on activities identified for local development has been missed out completely on the pretext that details were not available to comment upon. If such is the case for non-assessment of implementation of such local funds or even reaching out to the respective impacted areas to get a first hand information on the implementation, nothing more could be expected and displays a complete failure to capture it and reflects a hurried approach to finish off the report in one or the other way.

Assessment by ICFRE	Critique
The cumulative impact study of Sutlej Basin has shown that a number of impacts from commissioned HP as well as from proposed HPs in study area will be unavoidable, but that their significance can be reduced or offset by appropriate mitigation. It is important to note that many impacts are cumulative, such accumulation is additive not interactive, hence the total cumulative impact is not greater than the sum of the parts. As a result of this cumulative impact assessment it is concluded that all major adverse cumulative impacts can be mitigated to acceptable levels through the measures proposed in EMP. The Sutlej Basin environmental, social, and economic assessment as well as basin wide yield estimations would be important and should take in consideration in every aspect of project planning and development. The gap between prospective projects in Sutlej Basin is sufficient for the river to recuperate itself.	The experience with the existing projects clearly indicates that mitigative measures have not been adopted or where adopted it has made very little change to the adverse situation caused by the projects. The entire exercise depends upon vague statements and without basis. As in the conclusion it says “cumulative is accumulative but not interactive” which is completely false as the study has not considered disaster scenarios. The measures suggested are only investigative in nature and cannot help mitigation. The unscientific basis of the report is clear from the statement “The criterion that is to be considered while deciding the minimum distance between two projects is whether the river would be able to recover to its normal status before encountering with another HP. The criterion such as water quality, biotic life in the river, depth and velocity shall be considered for determining the distance between two consecutive HPs. “ and having said this the recommendation without any reason concludes that “General recommendation may be adopted for HP projects located above 2000 m MSL, a distance of 500 m, between 2000 – 1000 m MSL, a distance of 1.0 km, between 1000 – 500 m MSL, 2.0 km and for below 500 m MLS, a distance of over 3.0 km. “ In conclusion, it is clear that this Cumulative study is more a “promotional” exercise of data gathering and selective analysis and fails to highlight the real problems caused and the tough decisions that need to be taken. The three-year study costing almost Rs. 3 Crores has provided very little in terms of new knowledge and has peppered its report with biased and totally unscientific and illogical conclusions.

8. Vulnerability: Trigger Factors – Seismicity and Extreme Weather Events

Seismicity and Climate Modification are the key natural triggers to the vulnerability of this fragile ecosystem. This is the most visible gap in the investigations on Hydropower in the region where there is no Disaster Management Plans despite having faced earthquakes in the past and severe floods in 2005 and most recently in 2013. The risk of earthquake is very critical as this could lead to a sequence of disasters, the worst-case scenario being an earthquake, followed by avalanches and landslides, blockage of streams, flash-floods all contributing to severe damage.



8.1 Seismicity in the region

Himalayan mountain range was created as a result of the collision of the Indian and the Asian plate. Ensuing tectonic turmoil is witnessed in the form of intra-continental deformation along major faults and thrusts. The Himalayan region is dissected by several NW-SE trending regional thrusts namely Indus Tsangpo Suture Zone, Main Central Thrust and Main Boundary Thrust. These thrust planes and their subsidiary fault systems are the foci of several devastating earthquakes. In the Sutlej-Spiti river valleys, a number of N-S trending faults have disturbed the Precambrian-Palaeozoic succession of the Tethys Himalaya. Kinnaur lies in the Higher Himalayan region between Main Central Thrust (MCT) and Indo-Tsangpo Suture Zone (ITSZ). (Joshi.M et al 2010, JGIS).

Large earthquakes have occurred in all parts of Himachal Pradesh, the biggest being the Kangra Earthquake of 1905 *(see figure 6)*. The Himalayan Frontal Thrust, the Main boundary Thrust, the Krol, the Giri, Jutogh and Nahan thrusts lie in this region. Besides that there are scores of smaller faults, like the Kaurik Fault *(see table 8 & Map 11)* which triggered the 1975 earthquake. However, it must be stated that proximity to faults does not necessarily translate into a higher hazard as compared to areas located further away, as damage from earthquakes depends on numerous factors such as subsurface geology as well as adherence to the building codes. Chamba, Kullu, Kangra, Una, Hamirpur, Mandi, and Bilaspur Districts lie in Zone V. The remaining districts of Lahual and Spiti, Kinnaur, Shimla, Solan and Sirmaur lie in Zone IV.

Neotectonic indicators such as the uplifted terrain, unpaired terraces, fluvio-lacustrine deposits, deformation structures, alignment of springs and landslides in the fault zone are strong evidences of the active nature of the N-S fault.

In 2001 Bilham et al estimated the present-day slip potential of the Himalaya by assuming that the currently observed convergence rate had prevailed for 200 years, and by calculating the accumulated slip that would be released at various points along the arc since the last earthquake at each of those points, should an earthquake occur there today (Bilham et al., 2001). The extension of the historical record to 1500, and geological evidence for surface rupture in a large earthquake in 1400 (Wesnowsky et al 1999, Kumar et al, 2001) permits a revised estimate of this slip potential. Its accuracy depends on the following assumptions: that we know of all significant earthquakes since 1500, that present geodetic convergence rates have prevailed for the past 500 years, and that no slow earthquakes have released slip during or after large earthquakes.

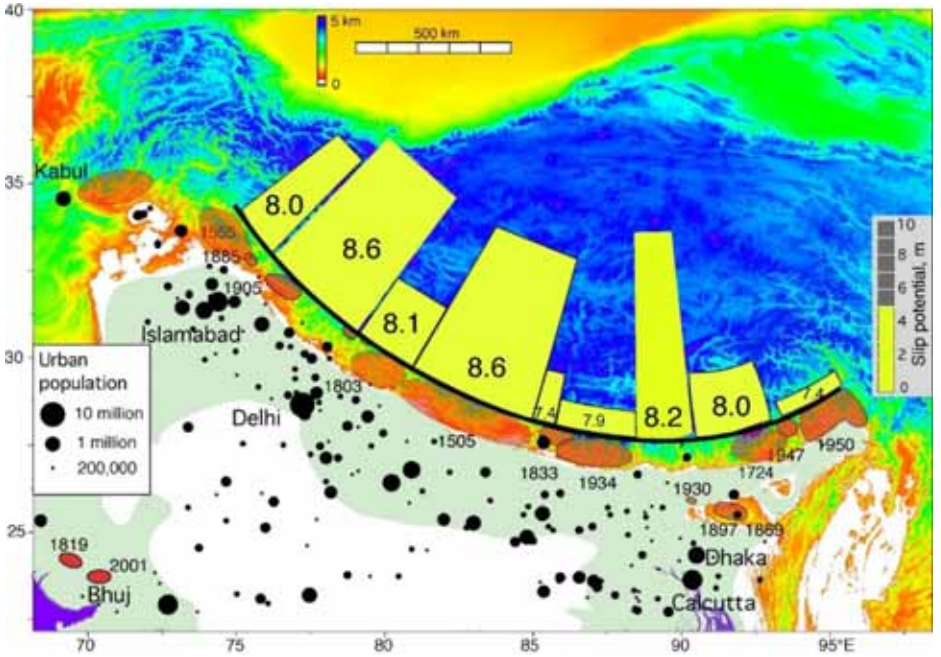


Figure 6 – A revised slip potential map

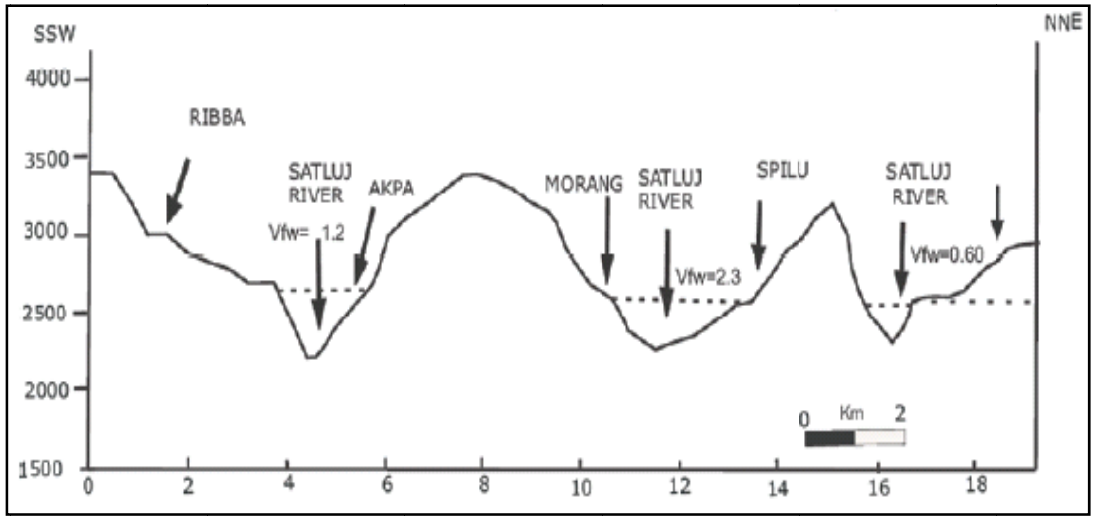
Bilham et al made no attempt to estimate the along-strike rupture length of potential future ruptures. Despite the different along-arc lengths of segments shown, the segment estimates do not necessarily represent the segment size of future earthquakes. Each trapezoidal figure represents the slip developed since the previous known earthquake at that location. We have no way of knowing whether a future earthquake will rupture the same area. Using the slip and rupture area of each of these regions we can estimate the magnitude of an earthquake should it occur today. The huge number of vulnerable population is clear from the map which indicated Urban population and slip potential in the Himalaya, based on elapsed time since the last major earthquake in various sectors along the arc since 1400 and the GPS-derived convergence rate across the Himalaya. The height of each trapezoid is proportional to the current slip potential in meters, and the numbers refer to the potential size of earthquake should the same segment length slip as is currently believed to have occurred in the last earthquake.

The consequences of the western Himalaya slipping in its entirety between 1400 and 1555 is that a 1200 km length of the Himalaya has matured sufficiently to experience two or more M>>8 ruptures. The total length, and the presence of relatively modest earthquakes in the intervening 500 years, suggests that the western Himalaya may be in a stress state somewhat similar to the Andaman plate boundary prior to 2004. ***`Although we have no historical examples of simultaneous rupture of contiguous segments of the Himalaya, we would, given the recent M=9 earthquake on India's Andaman boundary, be foolish to ignore the possibility of a similar great earthquake in the Himalaya' (Bilham et al, 2005).***

8.2 Basin Asymmetry

The geomorphology of the Sutlej valley indicates a rapid deep cutting and relief adjustment as a result of the Himalayan uplift, combined with the high erosivity of the stream. Because of the downcutting the river bed of the Upper Sutlej is situated at elevations about 200m lower than that of the neighbouring rivers (the Giri and Beas). The slopes just above the river are extremely steep, at places almost perpendicular, such as at the junction between the Spiti and Sutlej at Khab and between Shongtong and the Baspa confluence, where the river crosses the Great Himalayan Range.

Figure 7 – Birds Eye View of Nichar, Sangla and Moorang Valley



Basin asymmetry *(figure 8[25])* is yet another indicator along with traverse topographic asymmetry index to correlate the valley-stream-channel morphology; the tectonic tilting has resulted in uplifted zone (eastern block, *also refer Figure 3, 7*) with longer and larger streams joining onto the left bank of the River. In the past, River could not negotiate a climb i.e. erosion in the channel was not enough to keep up with the rate of uplift (Januari Anticline – abutting the Himalayan Frontal Thrust) and flows in its present form which is a result of deflection due to geological processes.

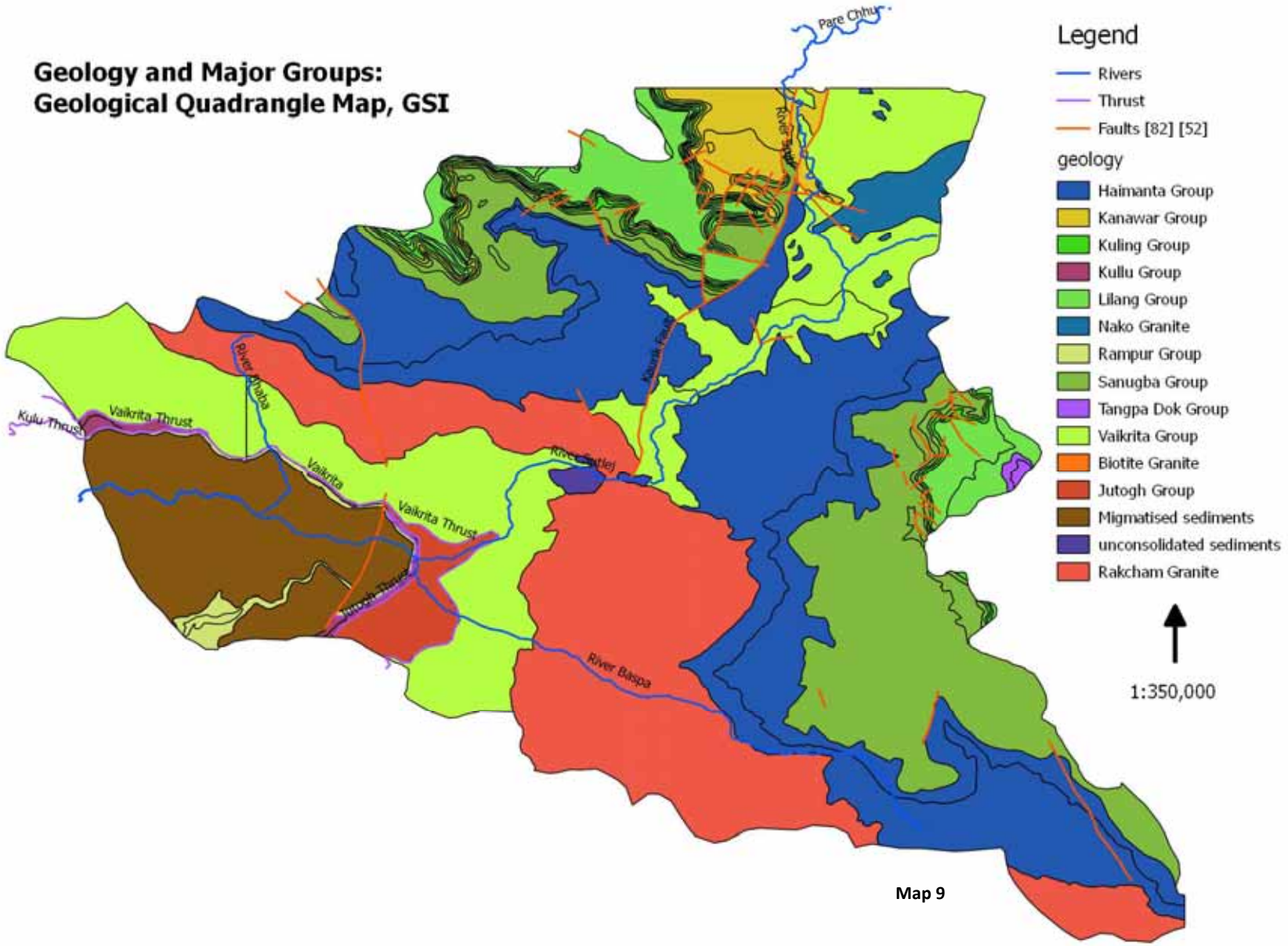
Figure 8 – Valley Floor to Width ratio (V_{fw}), X-axis & Y-axis represent altitude (m) and distance (km) respectively

But the geological processes are ongoing and NW Himalayas remain tectonically active as highlighted by various indexes like the Valley width to height ratio, Vfw (rationale being that narrower incised valleys indicate upliftment due to tectonic processes – lower the value, more tectonically active) and Mountain front sinuosity index S_{mf} (rationale being active fronts will show straight profiles with lower values and inactive or less active fronts are marked by irregular or more eroded profiles, with higher values).

The analysis of this neotectonic complex revealed deformation structures in the fluvio-lacustrine profile at Morang and similarly in Sumdo and Leo and presence of these deformed structures indicate that the area lies in tectonically and seismically active zone and has experienced several pulses of intense seismic activity.

[25] Neotectonic Evidences of Rejuvenation in Kaurik-Chango Fault Zone, Northwestern Himalaya, Published in Journal of Geographic Information System, 2010 | Authored by Moulishree Joshi et al.

Table 8 Brief Overview of Geology – Formation and Groups with Tectonic Features with Clustered HEPs and reported risks / problems			
Group	**Hydroelectric Project**	**Faults (Normal and Thrusts)**	**Risks/Reported Problems**
Vaikrita	Baspa – II, Shongtong Karcham, Ropa, Khab, Yangthang Khab *(refer map 10)*	Vaikrita Thrust, separates the Vaikrita group from the Migmatised Sediments in the South and runs along the western boundary of this group in NW-SE direction. A thin wedge of Kullu Group is brought up in the western portion by the Kullu Thrust, which merges with the Vaikrita Thrust. The Main Central Thrust is located 10 km south of Reckong Peo near Shongtong bridge. Predominant is the Kaurik Chango fault system; Network of faults upstream of Spiti and Kinnaur Boundary, alongwith Spiti, Guimal, Syarma faults which are active.	Sliding zones and damages to houses seen viz. Pangi village. NH damages Designated as Seismic Zone IV
Migmatised Sediments	Bhaba, Nathpa Jhakri, Karcham Wangtoo, Sorang	Vaikrita Thrust passed like an arc and continues EW alongwith almost parallel Kullu Thrust, Jutogh Thrust Fault system passes (NE-SW) through this migmatised sedimentary complex	Sorang: Cavity formation in HRT (1.5km) reported and erection of penstock due to difficult slope. As of March 2014, leakage occurred in penstock due to cracks (Nov, 2013) Recurring damages to National Highway Landslide - Tunnel leakage reported in May 2014
Rakcham Granite	Tidong – II, Kashang Integrated Project	Rakcham Granites are intrusives. Unconfirmity exists between the Rakcham Granites and Haimanta and Vaikrita Groups.	Proximity to the Lippa-Asrang WLS and cross tunnel across the Kirang and Kashang Khads.
Haimanta Group	Tidong – I	Kaurik Chango fault passes through North of Akpa	Active and could become a trigger
Kanawar Group	Chango Yangthang	Network of fault systems running parallel and perpendicular to Kaurik Chango Fault system *(refer map 11)*	Landslide dam lake outburst took place in 2005


Geology and Major Groups:
Geological Quadrangle Map, GSI
Legend
Rivers
Thrust
Faults [82] [52]
geology
Haimanta Group
Kanawar Group
Kuling Group
Kullu Group
Lilang Group
Nako Granite
Rampur Group
Sanugba Group
Tangpa Dok Group
Vaikrita Group
Biotite Granite
Jutogh Group
Migmatised sediments
unconsolidated sediments
Rakcham Granite
1:350,000
Pare Chhu
River Spiti
Kaurik Fault
River Bhaba
Kulu Thrust
Vaikrita Thrust
Vaikrita
River Sutlej
River Baspa

Map 9

Table 9 Vulnerability of region with reference to Past Earthquakes, present tectonic features like Faults & Thrusts (10 km buffer of projects)					
Parameter	**No. of Occurrences**	**Highest Value**	**Minimum Value**	**Median Value**	**Remarks**
Earthquakes#	18	6	3.5	4.6	
Faults (within buffer zone)	11	40.91 km (Kaurik Fault from Akpa-Rispa upto Dhar Chango Uparla	1.033 km	6.512 Between Shayso & Danmocche	Total length of Kaurik Fault is 52.38 kms
Faults (Crossing Buffer zone)	6	17.656 km Crossing river, in vicinity villages of Leo, Nako and Yangthang	6.234 km	11.416 (network of faults)	17.116 Karcham Wangtoo Project (villages of Meeru Khas, Chooling and Thikru)
Thrusts	3	Vaikrita Thrust, Kullu and Jutogh Thrust			

Note: # 13 of these events (refer Map 12) have occurred within the 4 km buffer from River which are detailed in table10

There are 220 census villages within the project buffer and they run the above risks of historical and recent earthquakes, flash floods from numerous streams, fault and thrust systems prominent within this area, it is to mention here that almost 46% (2952 Km^2) of the district area (and even more if Lahaul & Spiti projects are also included) is under 10km influence of these power projects which are supposed to carry out impact assessments.

Table 10 Earthquake Occurrences in Kinnaur with specific spatial correlation to 4 km River Buffer around River Sutlej, Baspa and Spiti					
S.No.	**Magnitude**	**Description**	**Date & Depth**	**X**	**Y**
1	4.6	M 4.6, western Xizang-India border region	November 12, 1963 15:28:43 UTC Depth: 33.00 km	78.49924	31.69951
2	4.8	M 4.8, western Xizang-India border region	May 11, 1975 06:48:38 UTC Depth: 26.00 km	78.581	31.96273
3	5.3	M 5.3, western Xizang-India border region	July 19, 1975 06:10:54 UTC Depth: 40.00 km	78.60486	31.91918
4	4.5	M 4.5, western Xizang-India border region	May 06, 1976 08:21:35 UTC Depth: 51.00 km	78.66949	31.78609
5	4.7	M 4.7, western Xizang-India border region	January 28, 1977 03:48:54 UTC Depth: 55.00 km	78.2749	31.53867
6	4.3	M 4.3, Kashmir-Xizang border region	April 14, 1977 18:26:48 UTC Depth: 33.00 km	78.54698	32.02353
7	4.6	M 4.6, western Xizang-India border region	April 28, 2000 00:17:17 UTC Depth: 33.00 km	78.30523	31.60066
8	4.4	M 4.4, western Xizang-India border region	December 15, 2003 23:56:07 UTC Depth: 33.00 km	78.15098	31.52685
9	4	M 4.0, western Xizang-India border region	July 20, 2006 00:10:58 UTC Depth: 35.00 km	78.03794	31.64168
10	3.5	M 3.5, Himachal Pradesh, India	July 20, 2006 00:35:00 UTC Depth: 35.00 km	77.90504	31.60385

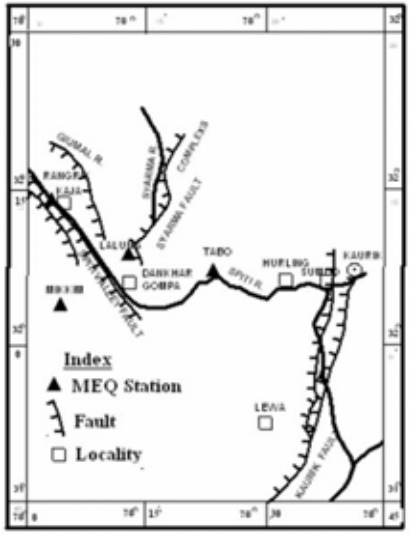
11	3.5	M 3.5, Himachal Pradesh, India	July 20, 2006 07:52:29 UTC Depth: 10.00 km	77.92822	31.57994
12	3.6	M 3.6, Himachal Pradesh, India	February 21, 2007 00:33:24 Depth: 33 km	78.00893	31.67932
13	3.4	M 3.4, Himachal Pradesh, India	August 13, 2010 17:11:07 Depth: 6 km	78.0078	31.70273

Source: ASC & Google Earth Earthquake Inventory, Accessed May 2014
Note: There are more such earthquakes in the 10km buffer of HEPs (18 in no.)

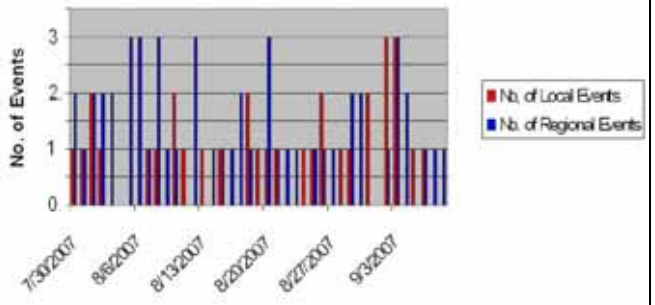
The map indicates Kaurik-Chango Fault system, the major geological groups indicated are Granite (light pink), Vaikrita (horizontal lines) and Haimanta (light blue).

Kinnaur and Lahaul Spiti districts of Himachal Pradesh were severely rocked by a major earthquake of magnitude > 6.8 in 1975. The earthquake was associated with movements along a subvertical N-S trending normal fault named Kaurik-Chango fault[26]. Luminescence chronology of seismites in Sumdo suggests that activation of Kaurik-Chango fault and seismic activity dates back to Late Pleistocene [15]. In the present area of investigation, a N-S lineament was observed along which river Sutlej flows for a considerable distance before getting deflected near Akpa. A number of neotectonic evidences which were gathered during the study testify to its active nature. Morphotectonic parameters such as Asymmetry Factor (AF) and Transverse topographic symmetry factor (T) as well as the field evidences suggest that the Sutlej river basin is tilted. DEM of the area also shows the difference in elevation of the two blocks. Drainage analysis clearly displays the effect of tectonic rejuvenation. Blocking of Khokpa nala, a small rivulet took place due to fault movement leading to the formation of Morang palaeolake on the eastern block. Several levels of deformation structures have been observed in the fluvio-lacustrine profile at Morang. Similar structures are seen near Kaurik Chango fault in Sumdo and Leo. Presence of deformation structures in the Morang fluvio-lacustrine profile indicate that the area lies in the tectonically and seismically active zone and has experienced several pulses of intense seismic activity. Neotectonic indicators such as the uplifted terrain, unpaired terraces, fluvio-lacustrine deposits, deformation structures, alignment of springs and landslides in the fault zone are strong evidences of the active nature of the N-S fault in the study area. Fluvial deposits are predominant along the course of Spiti river between Losar and Sumra, and Sumdo and Leo. Near Sumdo, the shifting of Spiti river course towards west indicates the upliftment of eastern block of Kaurik-Chango fault.

[26] *Journal of Geographic Information System*, 2010, 2, 169-176; doi:10.4236/jgis.2010.23024 Published Online July 2010 (http://www.SciRP.org/journal/jgis)
Neotectonic Evidences of Rejuvenation in Kaurik-Chango Fault Zone, Northwestern Himalaya, Authors: Moulishree Joshi1, Girish Chandra Kothyari2, Arun Ahluvalia3, Pitambar Datta Pant

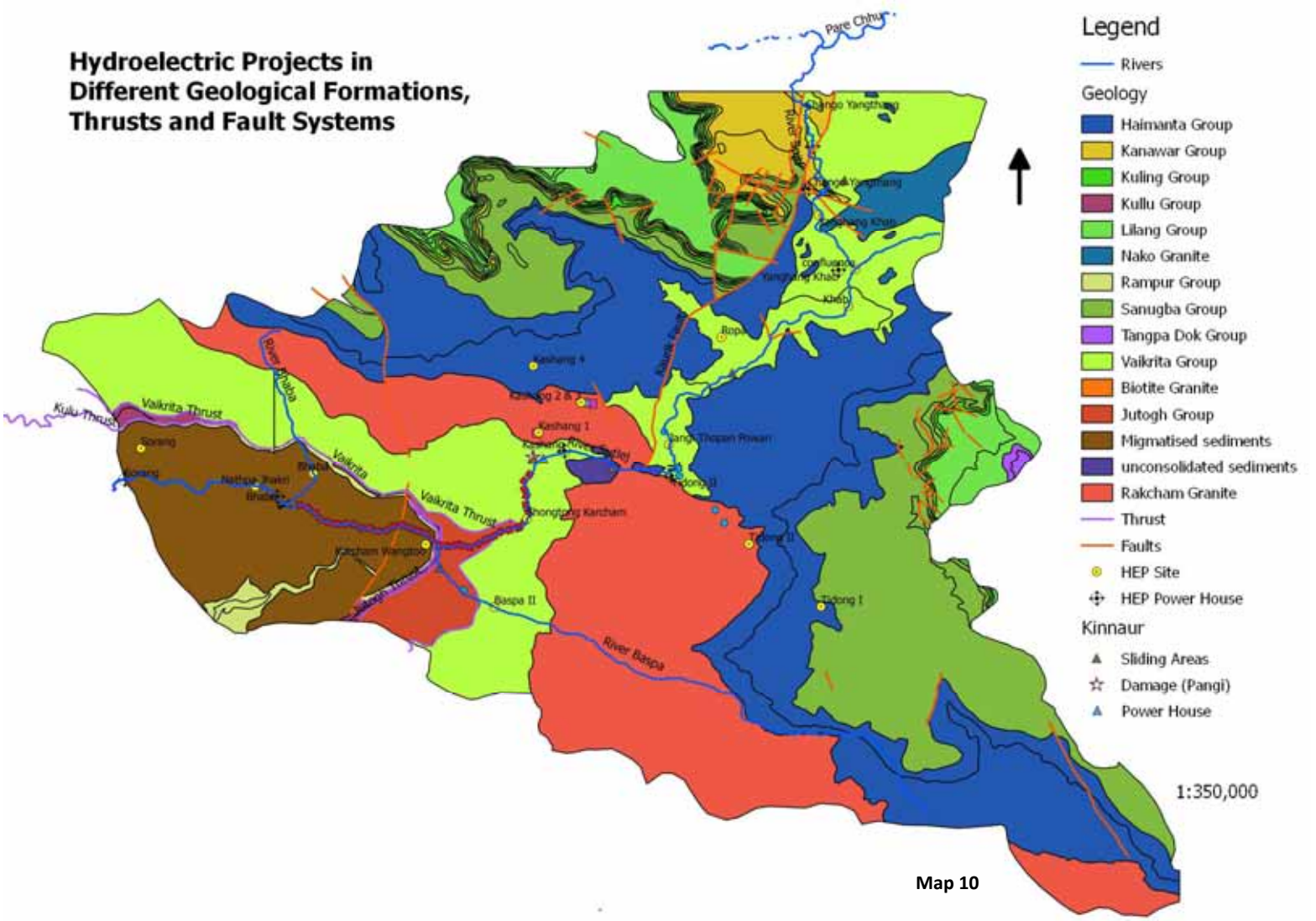


The results of micro-earthquake[27] (MEQ) monitoring indicated that the average seismicity (number of earthquakes per day) is 1-2 events at stations Tabo, Lalaung and Rangrik while it is 1 event per 2 days at Mikkim during the period of observation. The seismicity was comparatively higher in the north of Spiti river. The epicentral map prepared for common local events (S-P ≤ 8 sec. for the network) shows that most of the events are aligned along NW-SE trending Spiti fault. Cluster of earthquakes in the vicinity of Rangrik and Atargoo indicate that the Spiti fault in these portions is seismically more active. The seismic activity around these localities is manifested on the surface in the form of landslide. Distribution trend of epicentres of earthquakes also indicates that the Syarma and Guimal fault zones lying north of Spiti river are also seismically active. Near Sumdo, the shifting of Spiti river course towards west indicates the upliftment of eastern block of Kaurik-Chango fault. The seismic activity around these localities is manifested on the surface in the form of landslide.

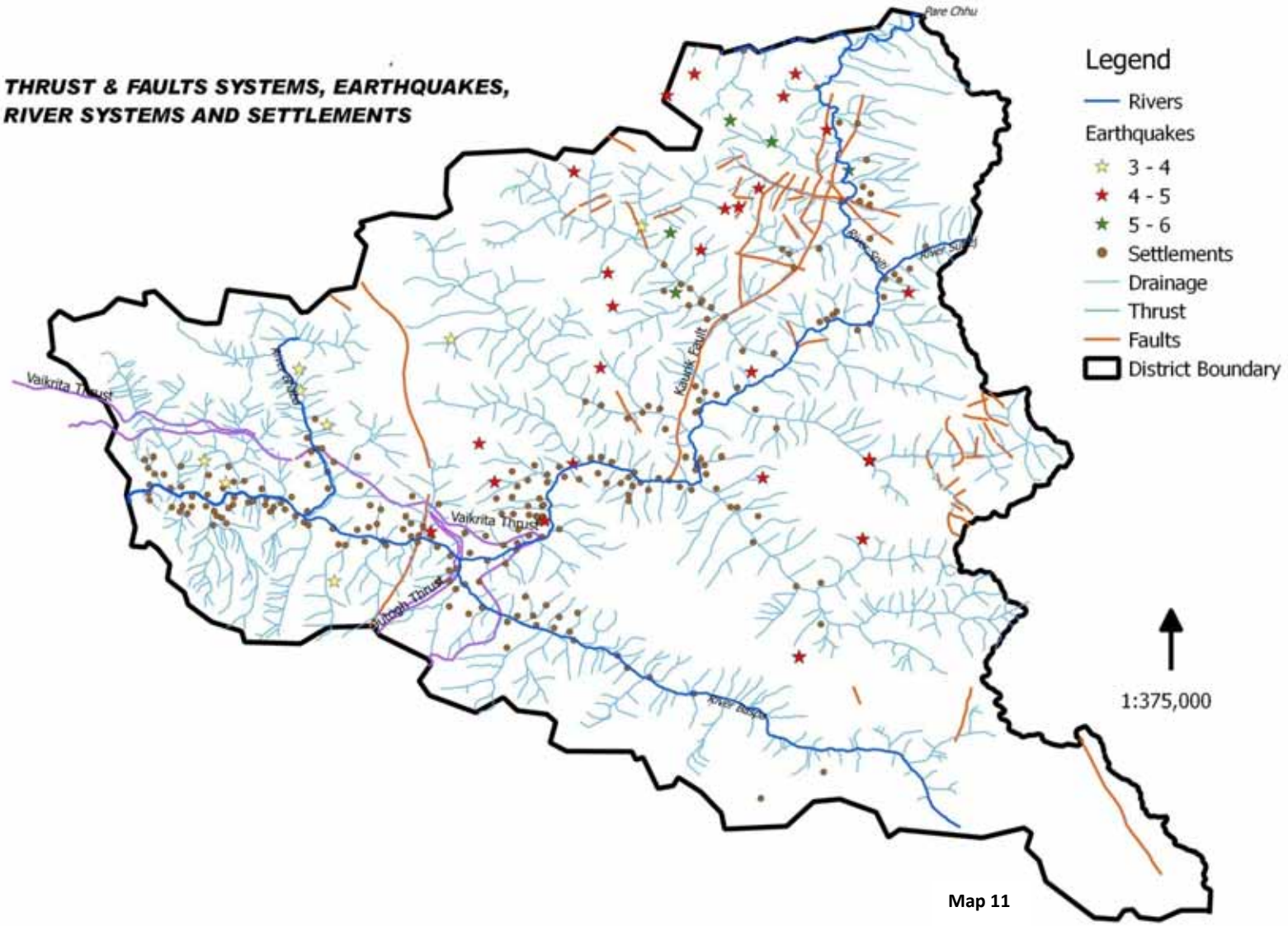


Histogram showing number of earthquake events per day by network in Spiti Valley area

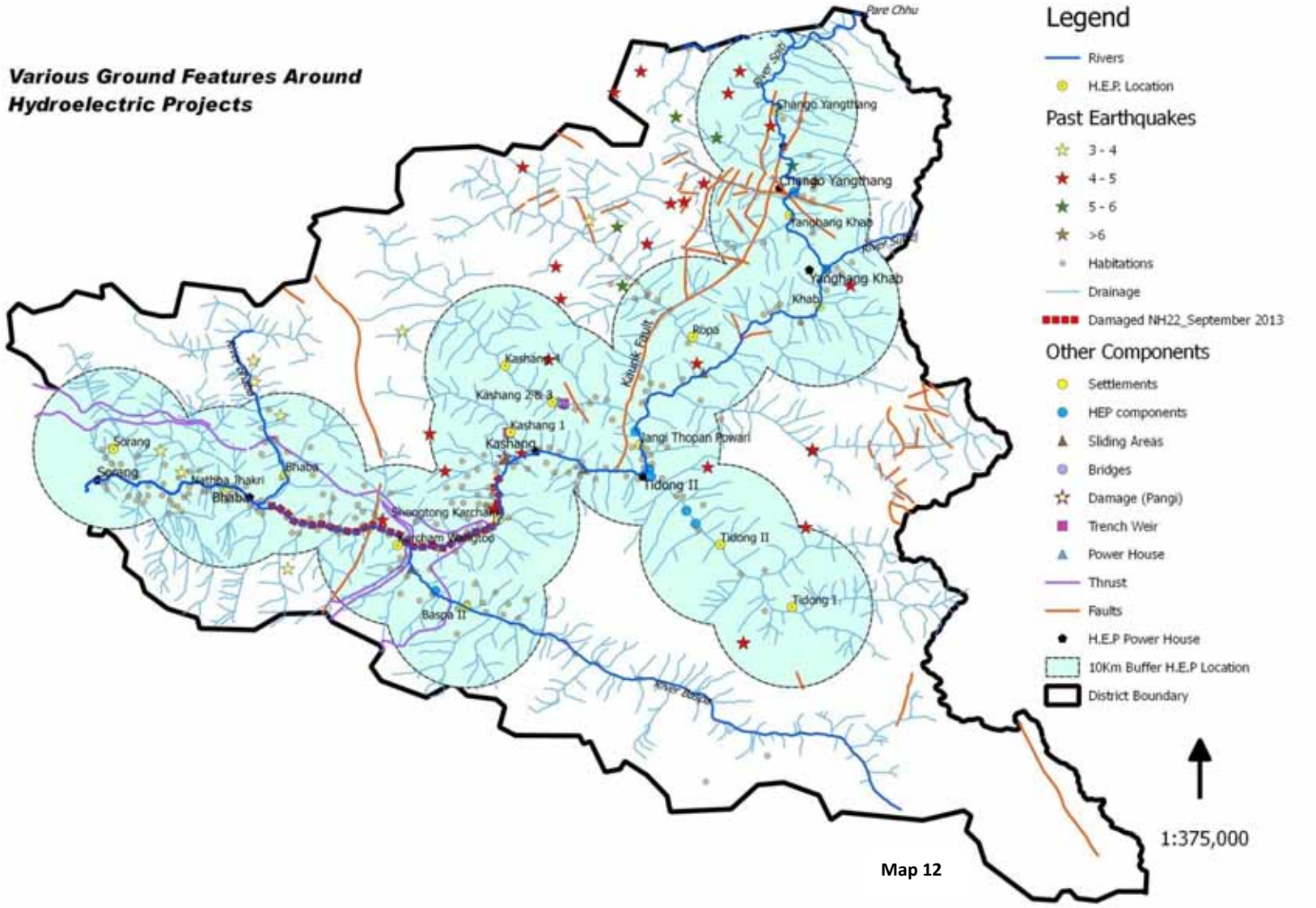
[27] Geological Survey of India: Active Fault Mapping of Spiti Valley Fault by Micro-earthquake Survey


Hydroelectric Projects in
Different Geological Formations,
Thrusts and Fault Systems
Legend
Rivers
Geology
Haimanta Group
Kanawar Group
Kuling Group
Kullu Group
Lilang Group
Nako Granite
Rampur Group
Sanugba Group
Tangpa Dok Group
Vaikrita Group
Biotite Granite
Jutogh Group
Migmatised sediments
unconsolidated sediments
Rakcham Granite
Thrust
Faults
HEP Site
HEP Power House
Kinnaur
Sliding Areas
Damage (Pangi)
Power House
Pare Chhu
Kashang 4
Kashang 2 & 3
Kashang 1
Vaikrita Thrust
Kulu Thrust
Vaikrita
River Baspa
Baspa II
Tidong I
1:350,000

Map 10


THRUST & FAULTS SYSTEMS, EARTHQUAKES,
RIVER SYSTEMS AND SETTLEMENTS
Legend
Rivers
Earthquakes
3 - 4
4 - 5
5 - 6
Settlements
Drainage
Thrust
Faults
District Boundary
Vaikrita Thrust
Vaikrita Thrust
Jutogh Thrust
Kaurik Fault
River Sutlej
1:375,000

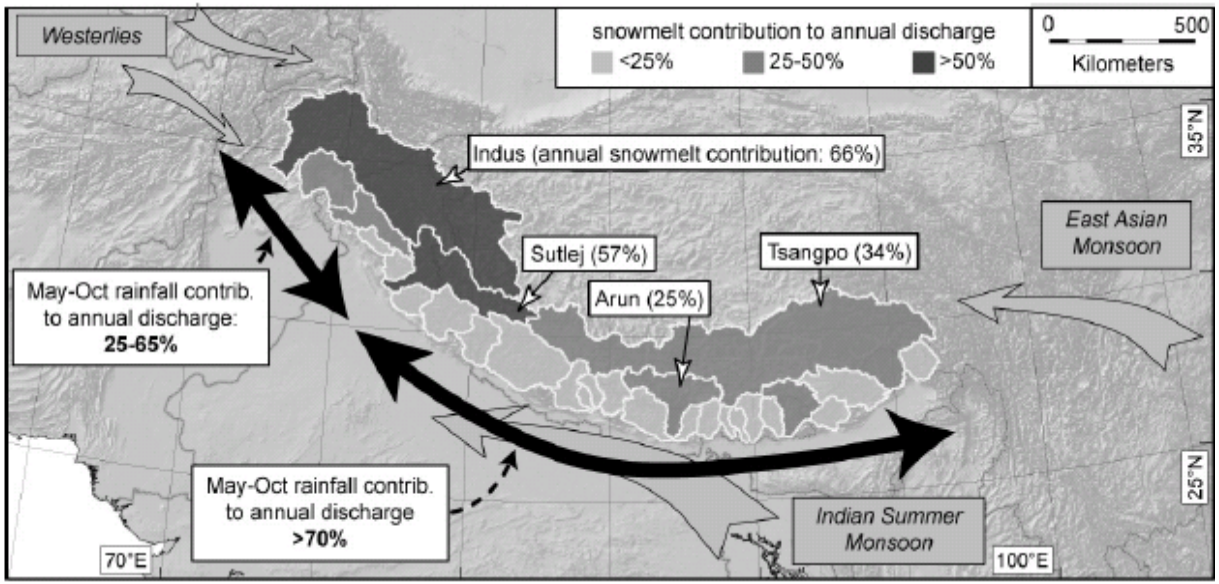
Map 11


Various Ground Features Around
Hydroelectric Projects
Pare Chhu
River Spiti
Changgo Yangtthang
Changgo Yangthang
Yangkang Khab
River Sutlej
Yangkang Khab
Khab
Ropa
Kashang 4
Kashang 2 & 3
Kashang 1
Kashang
Kaurik Fault
Jangi Thopan Powari
Tidong II
Tidong II
Tidong I
Sorang
Sorang
Nathpa Jhakri
Bhaba
Bhaba
Shaogotong Karchham
Karcham Wangtoo
Basga II
River Baspa
Legend
Rivers
H.E.P. Location
Past Earthquakes
3 - 4
4 - 5
5 - 6
>6
Habitations
Drainage
Damaged NH22_September 2013
Other Components
Settlements
HEP components
Sliding Areas
Bridges
Damage (Pangi)
Trench Weir
Power House
Thrust
Faults
H.E.P Power House
10Km Buffer H.E.P Location
District Boundary
1:375,000

Map 12

8.3 Snow and Rainfall

The catchment-average altitude is 4400 m.a.s.l and more than 80% of the catchment area is located at >4000m.a.s.l with virtually no vegetation cover (Fig. 1a). The lower part of the catchment area (<4000ma.s.l.) is located at the monsoon-impacted southern front of the Himalaya, where vegetation is lush and dense. Therefore, the primary land cover in the Sutlej Valley is bare ground (81.2%), followed by trees and shrubs (7.2%), cultivated areas (6.8%), glaciers (3.7%), and lakes (1.1%). Developed soils cover only a small fraction (<15%), mostly in the lower part of the Sutlej Valley. Glacial cover is particularly dense at the Himalayan Crest, where snowfall is highest. As a result, river runoff is dominated by snow- and glacial-melt from the high, orographically shielded Himalayan Crest and is comparable in magnitude to the Himalayan Front, where it is dominated by monsoonal rainfall.



The Sutlej River forms an important divide along the tilted EW axis comprising of snow cover and rocky portions and makes a distinguishing mark to regulate climate, river flows and agro climatic zones. To the North West the rainfall contribution to the discharge is significantly lower than to the East along the Himalayan Arc. Whereas the Westerlies are prominent in the North West, Indian and East Asian Monsoons bring water to the eastern regions.

Figure 9 - Regional Climate Control depiction

The rainfall pattern in the Himalayan Crest and the Tibetan Plateau is marked no rainfall and is a typical cold-desert. Nichar, South of Recongpeo, the District Headquarters was considered the northern limit of rain. However, in the recent decade rain has transgressed and has been noticed immediately north. The sub-division of Nichar *(Table 11)* receives rain spread over the year but receives its monsoon rains averaging 81.71 mm from June-September.

Table 11 Rainfall pattern in Nichar Sub-division

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Total	SD	Mean
1999	10.2	19	36.8	12	52	42.4	106	91.4	66.2	23.4	2.4	5.2	467.4	34.24	38.95
2000	38	184	102	Nil	94	NA	86.6	86.2	14.4	Nil	15.4	8.6	629.4	57.02	69.93
2001	3.4	35.6	168	35.2	105	108	117	176	34.4	4.8	18.2	36.8	841.3	61.59	70.11
2002	46	32	83.7	191	27.8	65.9	23.8	135	117.4	9.5	3.2	4	739.7	59.52	61.64
2003	26.8	92.1	89.6	133	33.8	59	205	122	62.2	Nil	7	6	835.3	60.50	69.61
2004	8.4	60.6	NA	63.6	94.7	29.2	47	97.8	17.6	65.2	Nil	19.4	503.5	31.57	41.96
2005	47	26.2	141	24.6	20.2	61.4	282	23	71	4.06	Nil	Nil	701.1	84.20	58.42
2006	Nil	43.8	31	61.9	8.2	46.4	104	47.4	50	2	9.8	37.4	441.6	28.64	36.80
2007	Nil	95.4	75.2	17.6	25.2	35	89.9	59.4	27.8	11.6	Nil	Nil	437.1	32.05	36.43
2008	Nil	Nil	4.2	44.4	46.8	92.7	87.2	112	173.2	Nil	1.6	42	604.2	54.94	50.35
2009	7.6	20.3	22	34.6	54.4	9.3	109	25.2	128.8	NA	NA	NA	410.9	43.98	34.24
Average (11 yrs)	17	55.4	75.4	56.2	51.1	54.9	114	88.6	69.36	12.1	5.76	15.9	616	33.52	51.33

Source: http://hprural.nic.in/IWMP_V_Nichar_Kinnaur_hp.pdf (Data sourced from Forest Range Officer, Nichar)

The five year monthly average rainfall indicates high standard deviation over a year and among the months over different years barring few winter months. The median values derived for each year and similar periods over various years indicate negative departure from the normals. In 2010, the median value for % departure from normal was 26 (or excess) and whereas it is negative in rest of the four years. High variation of rainfall is seen in the monsoon months i.e. July-September.

Table 12 KINNAUR DISTRICT RAINFALL (MM.) FOR LAST FIVE YEARS (the figures represent % Departures of rainfall from the long period averages of rainfall for the district)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SD	Median (yr)
2008	127	-49	-83	-20	-64	14	-40	55	199	-97	-83	-18	90.79	-30
2009	-70	-65	-88	-21	11	-10	3	-61	263	-42	39	-58	93.55	-31.5
2010	-63	3	-42	49	101	168	173	170	259	-22	-24	-15	107.03	26
2011	-55	7	-32	-17	-50	1	-17	42	-69	-96	-100	-90	44.86	-41
2012	-3	27	-37	-17	-86	-82	-70	-30	-50	-97	-90	-65	38.79	-57.5
SD (month over years) [high values indicate more variation in a given set)	82.48	39.46	26.86	30.35	75.44	91.64	95.19	89.60	166.31	36.12	58.68	32.15		
Median (month over years)	-55	3	-42	-17	-50	1	-17	42	199	-96	-83	-58		

Source: www.imd.gov.in

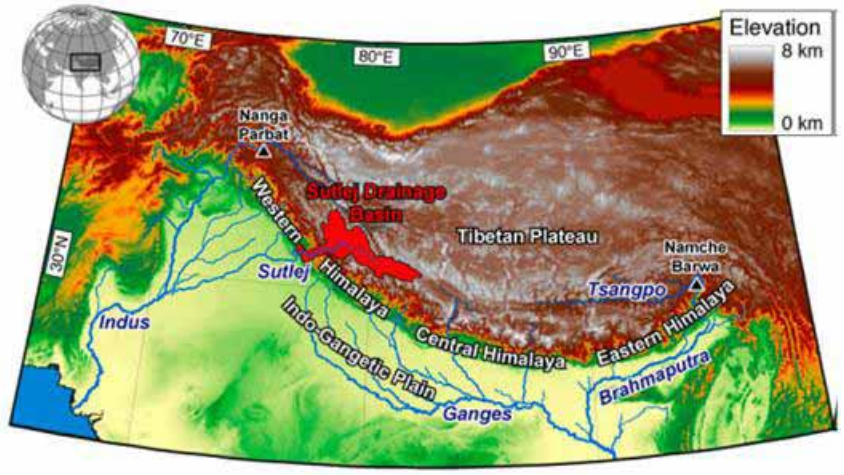
8.4 Extreme Weather, Transient Environments and Climatic Controls

Climate change is a dynamic phenomenon and interplays with a variety of factors as causes and results in its spatial variance. The transient NW Himalayas are witness to massive earthquakes in the region and the region remains tectonically active, the climatic parameters **have a bearing in adding to the vulnerability of the geophysical form, the point here to argue is (which is more exemplified by the 2013 disaster in the Western Himalayas) that climatic parameters become one of the risks these transient environments collectively face and further delineates the boundary of risks**, Rivers valley's therefore become natural vulnerable zones. Broadly, the Himalayan Frontal region, Himalayan Crest and the Tibetan Plateau define the orogenic front and interior of the Himalayan Systems, the presence of major thrust and fault systems has always brought challenges to physical development and coping capacities are not addressed in this changed regime of development when there are consistent changes in the transient environment. Hydropower development and its integrated components demand heavy machinery, construction, drilling, excavation, blasting and control riverine flows for generating power. The research done by Wulf et. al provides a holistic insight into (although acceptance of limited data availability due to sparse climatic meteorology and consistent long term monitoring and studies remain a concern) the interrelations among these three regions and how peak event days trigger the river behaviour or so more to say river morphology in response to the events occurring in its upper reaches. Most importantly the author talks about the sediment budget and uncertainties in case of events triggered by climate change or regional micro climatic interrelations.

Physiography and Climate Controls

The present topography of the high, laterally extensive Tibetan Plateau and surrounding orogens exerts strong influence on atmospheric processes. On a continental scale, the high topography poses a physical obstacle to atmospheric circulations and acts as an elevated heating surface, which intensifies the South Asian monsoon [Boos and Kuang, 2010; Flohn, 1957; Hahn and Manabe, 1975]. At regional scale, orographic barriers influence precipitation patterns and air temperatures, which directly control runoff and surface erosion processes.

Especially extreme weather events, like rainstorms, can have a profound impact on the character and



Topographic overview of Central Asia and Major Himalayan River Systems. Elevation and river routing is based on the SRTM30 dataset.

Physiographically, the Himalayan arc forms a 150-400 km long transition between the low-elevated (<0.5 km) Indo-Gangetic Plain to the south and the high-elevated (~5 km) Tibetan Plateau to the north [Fielding et al., 1994].

rates of surface erosion processes [Baker and Kale, 1998; Bookhagen et al., 2005a; Coppus and Imeson, 2002; Hartshorn et al., 2002]. Heavy rainstorms in the Himalaya repeatedly cause devastating floods and landslides, which result in loss of life and property, and mobilize large sediment volumes that damaged hydropower infrastructures [Houze et al., 2011; Webster et al., 2011]. For the next century, it is projected that more intense and increasingly direct rainfall runoff will lead to more flooding and landsliding [Chalise and Khanal, 2001; Immerzeel, 2008; Kumar et al., 2011]

In the Baspa Valley, based on the magnitude-frequency relation of maximum summer rainstorms in the orogenic interior, such daily rainstorms re-occur at intervals of three to five years. Additional analyses of all 80 weather stations in Himachal Pradesh reveal that these two storms were characterized by a large spatial extent (>100 km), lasted 2-3 days in most records, and migrated from the orogenic front across the main orographic barrier into the orogenic interior. Rainfall has been witnessed as a trigger for slope failure along 500m reach and resulted in a landslide (sparse vegetation) which cut-off the Sangla valley and access to the Baspa Valley was inhibited for three months *Sharma* [2006].

The study estimated 17 peak Suspended Sediment concentration (SSC) events (>99th SSC percentile) over 33 peak SSC days spread along the main stem of River Sutlej at Namgia (7|4|3|75), Jangi (3|1|1|100), Karcham (3|2|1|50) and Wangtoo (20|8|5|63), the figures indicate Peak SSC[28] days, Peak SSC events, events caused by rainstorms and percentage contribution of rainstorm events respectively. Concluding the case study of Baspa, the author concludes that 40% of the summer precipitation falls during 4-6 rainstorm events in both regions (Orogen Interior and Exterior), rainstorm intensity in orogenic interior varies considerably more than at the orogenic front.

When rainstorm events in the orogenic interior contribute majorly to the precipitation threshold, the risks associated with such phenomenon cannot be left alone to nature and should draw out a policy framework for long term analytical observations before opening it up for tapping water for energy generation.

[28] Suspended sediment concentration

Table 13 Topographic, climatic and hydrological characteristics of the studied watersheds by Wulf et al.

	Catchments	Topography				Climate				Hydrology				
		Area	Elevation		Relief	Ice	Snow	Rain	Vege-tation	Runoff		Sediment Concentration		Sediment yield
			min	max	(km/	area	area	TRMM	NDVI		summer		summer	(t km^{-2}
		(km^2)	(km)	(km)	5 km)	(%)	(%)	(m/yr)		(m/yr)	(%)	(g/l)	(%)	yr^{-1})
Tributaries	Ganvi	117	1.6	5.6	2.58	3.7	25.8	1.12	0.39	1.27	78.3	0.93	-	1507
	Wanger	264	2.5	5.7	2.24	17.2	54.1	0.74	0.11	1.67	85.4	0.29	-	614
	Baspa	989	2.5	6.4	2.21	24.0	54.0	0.93	0.09	1.14	89.5	0.80	96.5	1717
	Spiti	12,477	2.6	6.7	1.58	6.7	37.4	0.36	0.03	0.26	86.9	1.45	-	499
Watersheds	Sutlej at Namgia	30,950	2.6	7.2	0.93	1.8	19.8	0.38	0.08	0.06	85.1	2.59	-	223
	Sutlej at Jangi	44,738	2.2	7.2	1.21	3.6	25.6	0.39	0.07	0.13	81.5	1.85	-	302
	Sutlej at Karchham	46,291	1.9	7.2	1.22	3.6	25.7	0.39	0.07	0.16	85.3	2.37	-	556
	Sutlej at Wangtoo	48,316	1.5	7.2	1.27	4.1	26.5	0.41	0.07	0.20	85.9	2.20	91.6	615

The trigger in the upper reaches of Sutlej valley is low Normalised Differentiated Vegetation Index (NDVI) which is 0.07, Ganvi which is in the Western part of Sutlej River axis has much higher NDVI. The rainfall range is 380 mm – 410 mm from Namgia to Wangtoo and contributes 37 and 17% respectively to the flows, majority of flow discharge source is snow followed by rainfall and ice. High runoff is interpreted at Jangi (33%), Karchham (41%) and Wangtoo (50%) in the summer period. The sediment yield in Baspa is the highest at 1717 t km^{-2} yr^{-1} and it gradually increases from Namgia towards Wangtoo from 223 to 615 t km^{-2} yr^{-1} indicating the highly glaciated Baspa Valley and contribution of sediments despite have a low concentration of sediments at 0.80 gl^{-1}. The sediment concentration remains in excess of 2.20 at Namgia, Karchham and Wangtoo, the yield increases as the cumulative catchment area increases towards the downstream site. The orogenic interior has steep slopes with less NDVI and exposed alluvial fans which are readily erodible and rainstorms trigger their mobilization, the riverbed which already has transiently stored sediments could also be mobilized due to increase discharge of snow and glacial melts and may increase the contribution of riverbed load in the overall sediment load contribution.

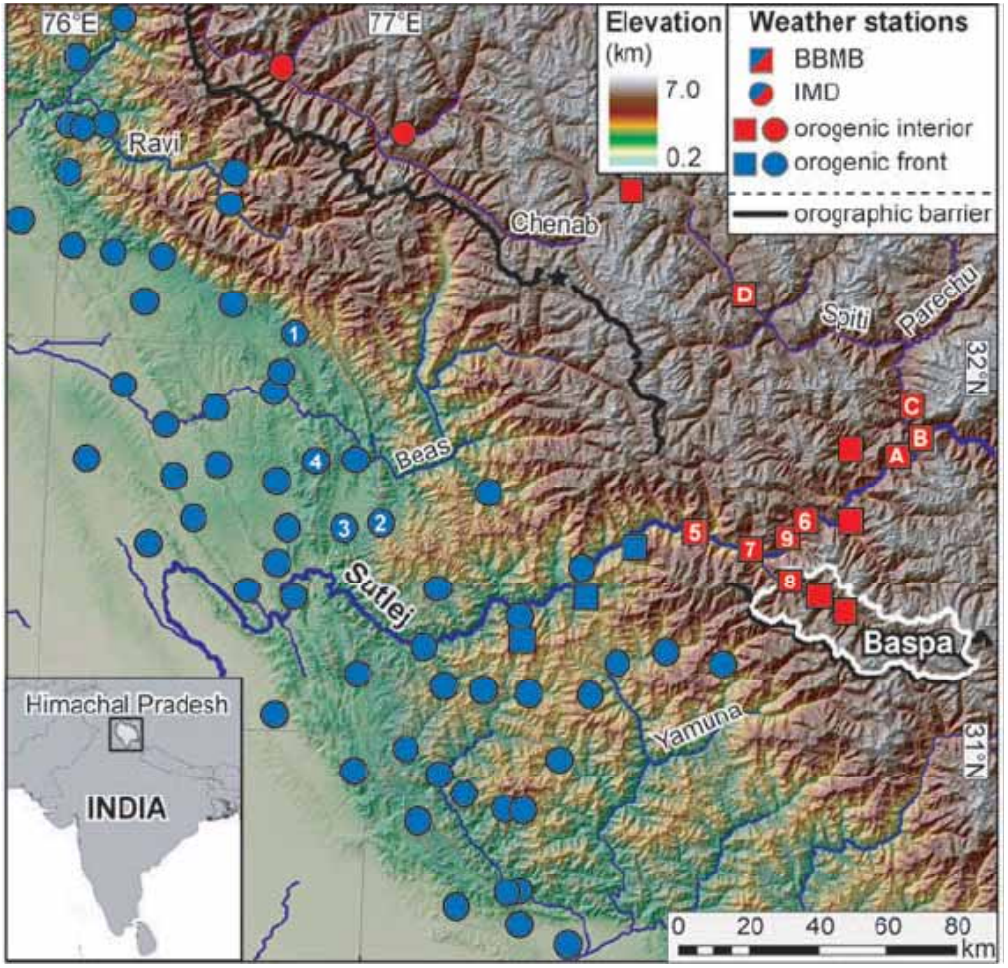
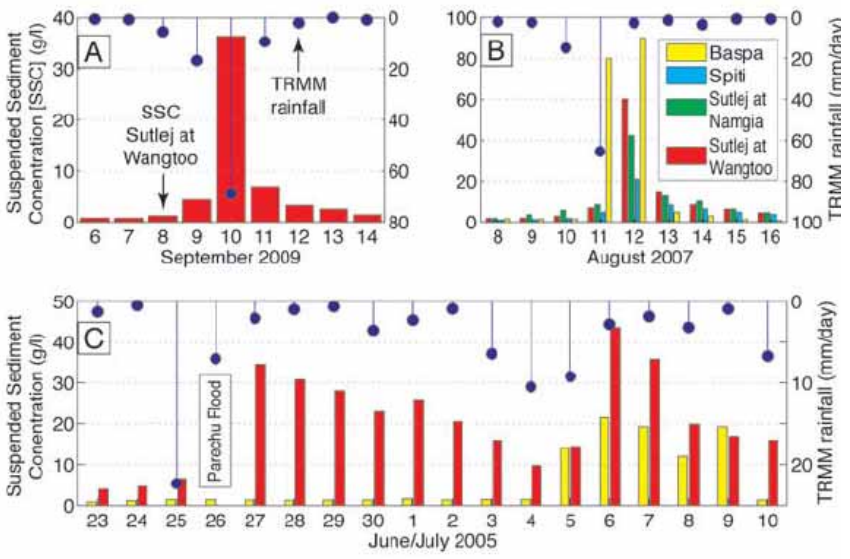


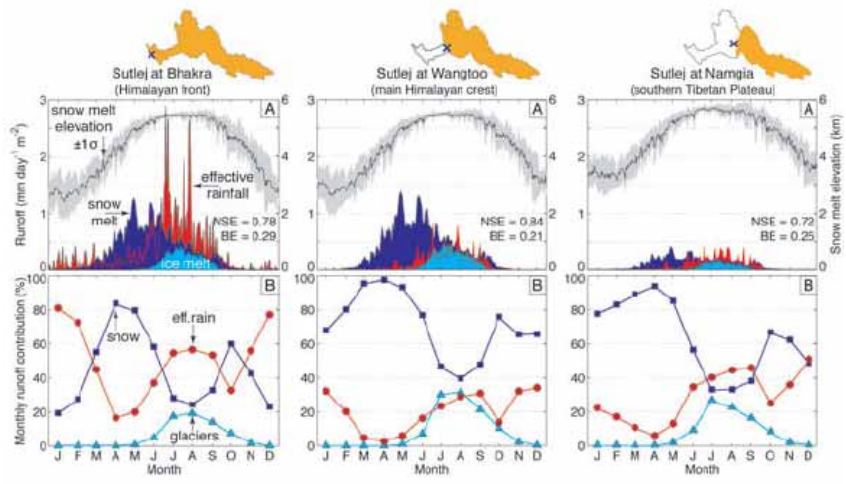
Figure 10 (3.1) We point out that the Sutlej River slices through the main orographic barrier and forms a potential conduit for transport of moist air into the orogenic interior. However, the mean summer rainfall recorded by weather stations in this corridor (label 5, 6, 7 and 9) is typically low (0.4-0.2 m), as substantial amounts of the monsoonal moisture are drained at previous orographic barriers.

Circle and square-shaped symbols indicate the Indian Meteorological Department (IMD) and the Bhakra Beas Management Board (BBMB), respectively, as operators of these stations

Figure in bracket indicates original reference in the research paper. The figures in the next page present relation between rainfall and peak SSC event, spatial and temporal variation of hydrological components. These are self explanatory and corresponding notes are written alongwith.



Read Figure 11 [5.3] (above), Figure 12 [4.11](right) and Figure 13 [4.13] (below).with explanatory notes for respective figures



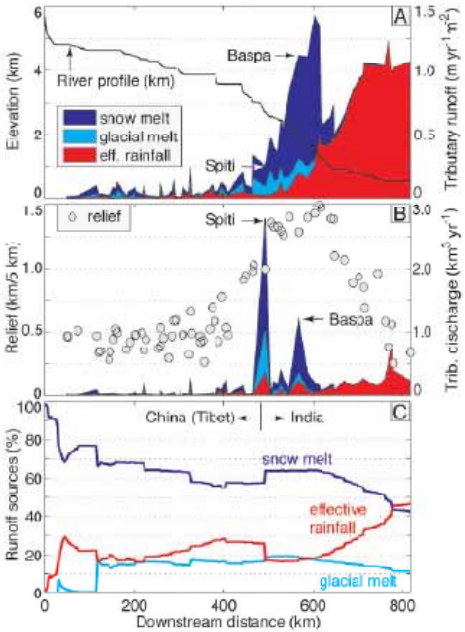


Figure 5.3 – Relation between rainfall and peak SSC events. Rainfall indicate TRMM 3B42 derived daily rainfall rates of the Sutlej Valley at Wangtoo. SSC color-coding is indicated in panel B. (A) Peak SSC event triggered by a 3-day rainstorm. (B) Peak SSC event caused by a synoptic rainstorm affecting several catchments in the Sutlej Valley. Larger catchments show longer response time. (C) SSC response of the Sutlej River at Wangtoo to the Parechu flood and a successive rainstorm, which especially affected SSC levels in the Baspa River.

Figure 4.11: Spatial variation of hydrological components. (A) Distance and elevation of the Sutlej longitudinal river profile along with mean annual (2000-2008) runoff of tributaries > 100 Km2. (B) Local relief within a 5-km radius and mean annual (2000-2008) river discharge of Sutlej River tributaries > 100 km2. Color coding is given in A. (C) Runoff sources of the mean annual Sutlej river discharge along its river profile

Figure 4.13: Temporal variation of hydrological components. (A) Mean daily runoff of hydrologic components for the Sutlej River (2001-07) at Bhakra, Wangtoo and Namgia gauging stations (cf. Figure 4.1). Mean catchment-wide snow melt elevation (+-1 sigma) increases to above 5 km asl during summer months. (B) Monthly percentages to total runoff as shown in A. During the pre-monsoon season (April to June) snow melt dominates river discharge regardless of geographic location. During the monsoon (July to September) rain, snow and glacial melting have an approximately similar runoff impact at and upstream of the mean Himalayan crest.

8.5 Flash Floods, Heavy Downpour, Glacial and Landslide Lake Outburst

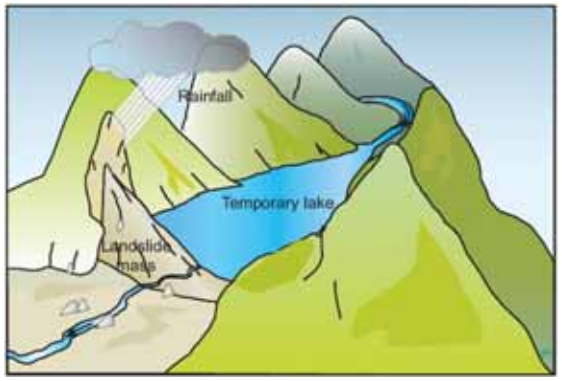


Illustration credits: ICIMOD, USAID – Resource Manual on Flash Flood Risk Management

The Parecchu landslide lake outburst in June 2005, produced an estimated discharge at Sutlej-Spiti confluence of 2000 cumec, 20 times higher than the average discharge over 4 years. This post event depicted ratio itself is a huge risk factor, although the direct damages were public infrastructure like roads, bridges but such and even severe events may speed up the weathering of slopes with lack of vegetation. This was a rain-on-snow event which eventually reduced the snow cover by 52% and assisted accumulation of water into this lake and by the estimates of volume suggested by Wulf i.e. 64 million cu.m. or over 64 million tonnes equivalent considering the turbidity, the hydrostatic pressure was enough to break away the barrier. (refer illustration of landslide induced temporary lake)

But this has not stopped development of projects in the upper reaches or in the orogenic interior where rain-storm events occur and coincide with peak suspended sediment concentration, even the Chango Yangthang project which is in close vicinity to the Parechhu-Spiti arc is under investigation. Such events (like Parechhu Landslide lake outburst floods) have even propelled further storage dams like in Khab and Jangi to safeguard the already established projects like Nathpa Jhakri and a greater need for catchment area treatment is realized but the matter of fact is whether there are robust weather and spatial monitoring tools available and even if available can the answer be creating more voids to contain the geological, weather and disintegration challenges.

A total of 38 lakes could be mapped[29] in the entire Sutlej basin, out of which 14 lakes falls in the Himachal Himalayas whereas the remaining lakes fall in the Tibet Himalayas. The area of 14 moraine dammed lakes is 1.175 Km^2 whereas of those in Tibetan Plateau is 1.15 Km^2

[29] State Centre on Climate Change, Himachal Pradesh

9. Conclusions

The fragile Himalayan region being a storehouse of natural resources has also thrown challenges in the form of natural fury like floods, earthquakes and now its most abundant resource i.e. water is being tapped to generate power by building hydroelectric projects. The recent climatic phenomenon in July 2013 reflected upon the unprecedented risks that loom large over the NW Himalayan system, virtually the road alignment was lost to heavy rain and many parts of roads were washed away from Nathpa to Recongpeo and region was accessible till Kalpa. The Sangla valley was also inaccessible for more than a month.

1. 198 census villages are located in the 1-4 km buffer (population 74,529 persons) from Rivers and considering 10km radius from project location there would be additional 22 villages, thereby totalling to 220 villages in the project buffer and they are prone to risks of earthquakes, micro-seismic activities, flash floods from numerous streams, fault and thrust systems prominent within this area. Lack of incorporating the impacts on socio-economic and cultural practices and immense dependence on resources has to be remedied without denying these facts.

2. The villages in immediate buffer of the river, upto 2 kms (145 villages, 66,507 persons; 32,699 hectares village area) would be prone to greater risks from construction works, blasting and dumping for diversion and dam site, power house site, HRT alignment, road construction; loss to community resources and forest diversion add to the risks as the process of settlement of forest rights has not been initiated. Almost 46% (2952 Km^2) of the district area (and even more if projects in Lahaul & Spiti District are included) is under 10km influence of these power projects which are supposed to carry out impact assessments. The denial of forest rights has been clearly held untenable by the Ministry of Tribal Affairs.

3. The majority of projects proposed, under investigation, construction and consideration are between the Main Central Thrust which passes through Shongtong Bridge and the Himalayan crest, the region which has several active faults like Kaurik Fault, Spiti Valley Fault, Guimal Fault, Syarma Fault and micro seismic events are taking place. Many landslides are induced due to this tectonic activity and also induced by construction activities as noticed in the illustrations. Similarly GLOF (Glacial Lake Outburst Flood) and LLOF (Landslide Lake Outburst Flood) could also be triggered by seismic activities or increasing hydraulic weight leading to sudden flash floods (Parechu 2005); there are 38 identified moraine dammed lakes in Sutlej basin in Himachal and Tibet region over an area of 2.325 km^2

4. Loss of rare and endemic species which form community resource in the region is an irreversible impact. For the sake of comparison, consider 1000MW Karcham Wangtoo project where 1287 trees were allowed to fell (additional 3924 for transmission lines as a separate component) but in

100MW Tidong - I, 1261 trees were allowed to fell (751 Chilgoza trees) – almost equivalent to Karcham Wangtoo but for 1/10th of anticipated power - this indicates indiscriminate decision making and lack of intra-ecological evaluation with no conservative approach in sight. The economy of such resources is never calculated and socio-economic assessments are weak.

5. Risks from disaster prone area (Seismic zone IV) and failure to capture cumulative loss of resources and risks from water storage behind diversion sites, dams is thus unable to provide a scenario, preparedness and response given large number of cascade projects. River ecology and climatic factors add to the aspects which require long term investigation but the constraint exists in spite of so much investment – the lack of institutional infrastructure or policy on micro climate monitoring leaves a big gap in understanding spatial and temporal extents and quality of climatic controls in prescribing projects, for instance the study (refer footnote 14) took 5 years to arrive at some limited conclusions. The June 2005 and 2013 events in the Upper and trans Himalayan ranges depict transient environments which are changing forms and the disintegration occurring on account of development activities make it a close call for 'disasters'.

6. Damages to structures, land and other resources of the community described in the previous section are also due to lack of primacy given during scoping of the projects which is more or less on the preliminary information of straightforward issues but risks arising during and post construction reflect gross failure to capture or provide space to these 'possible risks' to be reported in the EIA based on which people can take informed decision during public hearing process. Post facto project wise measures or policy again reflects ad-hoc approach leading to poor monitoring of projects in the absence of clear mandates by State Government / District Authorities to competent agencies like Geological Survey of India for such high risk prone regions.

7. As a result, no one has evaluated the risks that these numerous settlements face and imposing abrupt cost-benefits promoting their dependency over the State and making them devoid of their self-reliance is a huge debt which has kept the process of 'excluded impacts' still functional. The provisions like CAT plan (2.5% of project cost), CA fund & NPV (area & type of forest based), Local Area Development Fund or LADF (1.5% of project cost) indicate alleged promulgation of benefits under the projects but as clearly pointed out by the Shukla Committee appointed by Hon'ble High Court of Himachal Pradesh that various activities of hydro project development are detrimental and there cannot be an environment friendly hydel project in the Himalayas. The report points to the fact that 90% of the damages are due to road construction and dumping sites whereas CAT and CA which meant to achieve restoration have not taken shape due to various reasons.

8. The raw estimate of CAT and LADF amount for 4834 MW *(see table 1)* amounts to Rs. 1160 Crore (assuming @ Rs. 6 Crore per MW as capital cost) excluding CA and NPV. When such a large public finance is involved as a proclaimed benefit for the affected and the environment, it has to be proactively brought into the public domain for rightful decisions before spending. This cannot be held back and decisions regarding its implementation should have a greater role of people who are affected.

9. Central Water Commission has brought out guidelines to develop River Morphology studies for different River basins but hardly one finds any mention of these in the Environment Impact Assessment reports which neglect this very important component of probable impacts and impacts over the river system. It has much more relevance for the allocation of dumping sites for the muck generated during the process and also to address the issue of free riverine stretches between the series of projects from the Spiti Valley into the Sutlej Valley.

10. The District Disaster Management Authority of Kinnaur has identified vulnerability more realistically and has indicated the following

Elements at Risk	Degree of Vulnerability to Various Hazard District Kinnaur (H.P.)								
	Earthquake	Landslide	Flash Floods//GLOF	Snow Avalanche	Drought	Forest Fires	Domestic Fires	Dam Failure	Road Accidents
Community	Very High	High	Very High	High	High	High	Very High	High	High
Infrastructure	Very High	Very High	Very High	High	Moderate	Moderate	Low	High	Low
Houses	Very High	Very High	High	Moderate	Low	Low	Very High	High	Nil
Social Sector	Very High	High	Moderate	Low	Moderate	Low	Very High	Low	High
Livelihood Sector	Very High	High	Moderate	Low	Very High	High	High	High	High
Environment	Very High	Very High	Very High	High	Very High	Very High	Very High	Very High	Low
Source: http://hp.gov.in/ddma-kinnaur/page/Vulnerability-Analysis.aspx									

10. Recommendations

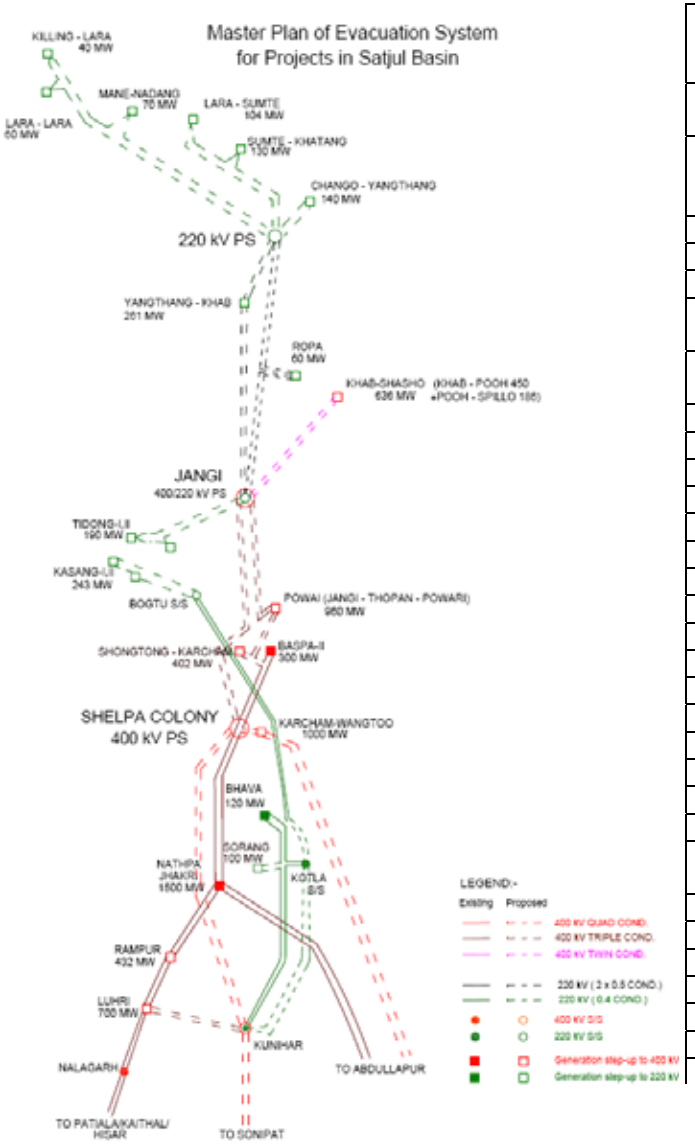
1) As has been pointed out in the study and indicated by the Disaster Management Authority, the risk of an earthquake and dam failure is very high to all aspects considered. Therefore a detailed study on the implications of earthquake and dam failures must be undertaken that has been grossly neglected in all the EIAs by various agencies. Scenario building exercises, such as the worst case scenario of Earthquake – GLOF/LLOF – Flash Floods and specific disasters have to be evolved. Further project development and clearances should be subject to the establishment of adequate infrastructure and mechanisms for dealing with the current range of projects. The ability of the institutions to protect and mitigate was shown in poor light in the last two flood incidents. Ironically institutions which need to protect have themselves claimed damages.
2) The assessments should not be at the behest of those who want to promote hydropower. While the Cumulative Assessment was supposed to be independent, but it has been clearly influenced by the Department and the Group of Hydropower Developers. Such assessments tend to obfuscate the facts and crucial aspects are relegated to some sweeping conclusions bereft of the basis for the same. It will be a difficult proposition but in order to reduce the potential conflicts between local communities and the State and Potential developers, the process of assessment has to be laid threadbare in front of the communities and they should be involved in all stages of assessment, from data collection, synthesis and analysis. In the light of the fact that many of the studies are "desk-top", the High Court has recommended that any assessment should be preceded by a notice to the local communities much in advance, very much like that mandated for a public hearing.
3) These projects and the observations of the court clearly indicates that current methodologies adopted for assessment, evaluation of impacts, efficacy of the mitigation measures and decision-making on the project through EIA, EMP and even a broad based CEA are ineffective and are only partial. Issues of equity, endogenity or self-reliance of communities and the state are not at all addressed in these methodologies.
4) The next phase of our project will address the development of a comprehensive framework based on sustainability, incorporating indicators which can be consistently used at various levels so as to lead to more rational decision making based on the four pillars of economic efficiency, equity, endogenity and environmental soundness.
5) The subsequent section of the river from Karcham-Wangtoo to Kol Dam should be studied in detail and the information generated during this phase of study should be recast to look at the overall picture. Communities in the region would need continued support in presenting their concerns in different forum and should be supported while groups in the subsequent segment should be incorporated in the assessment.

Annexure I Projects envisaged under the 50,000 MW initiative in 2003

Himachal Pradesh		Agency	Units	Size (MW)	Total (MW)	Head (m)	Live Storage (MCM)	Dam Height (m) & Type	FRL (m)	MDDL (m)	Tail WL (m)	Head Race WCS Length & Size(m)	Tail Race WCS Length & size (m)	PH Type	S.A. (ha)	Annual Energy (GWh)	Tariff Rs./Kwh
1	Yangthang (Kinnaur)	HPSEB	3	87	261	186.45	1.1	57, C	2805	2775	2600	9050, 7	100, 7	UG	57	938.02	2.08
2	Jangi Thopan (Kinnaur)	HPSEB	3	160	480	174.14	8	64, C	2320	2276	2130	7050, 9.45	100, 9.45	UG	100	1779.45	2.00
3	Tidong-II (Kinnaur)	HPSEB	2	35	70	575.00		W	-	-	-	8250, 2.6	100, 2.6	UG	-	256.18	2.02
4	Thopan Powari (Kinnaur)	HPSEB	3	160	480	161.14	0.8	53,C	2130	2120	1954.75	5840, 9.85	100, 9.85	UG	70	1786.26	1.81
5	Tidong-I (Kinnaur)	HPSEB	2	30	60	511.50		65, C	3435	3390	-	5036, 2.6	100, 2.6	UG	100	211.65	2.71
6	Khab-I (Kinnaur)	SJVNL	3	150	450	170.00	36.4	69, C	2592	2568	2403	8400, 9	318, 9	UG	-	1551.00	2.24
7	Khab-II (Kinnaur)	SJVNL	3	62	186	70.00			2403	2399	2320	11950, 9	128, 9	UG	-	640.00	3.04
Kinnaur					**1987**												
8	Bardang (L&S)	*HPSEB*	*3*	*38*	114	55.00	2.17	23, B	2684.5	2675.5	2614.5	8130, 8.6	220, 45	Surface	32.5	424.46	2.91
9	Gharopa (Kullu)	HPSEB	3	38	114	169.00	0.6784	26, B	1653.5	1638.5	1467	5700, 5.25	1150, 6	UG	11.98	534.25	2.09
10	Gondhala (L&S)	HPSEB	3	48	144	134.00	1.43	16, B	3007.7	3007	2854	10870, 6.5	190, 35	Surface	200	570.19	1.92
11	Khoksar (L&S)	HPSEB	3	30	90	99.00	0.9531	21,B	3212	3206	3097.9	10055, 6.3	193, 6.3	UG	18.51	351.91	2.46
12	Chhatru (L&S)	HPSEB	3	36	108	160.00	0.88	19, B	3421	3413.5	3240	6500, 5.1	1150, 6	UG	16.75	455.72	2.89
13	Chamba (chamba)	HPSEB	3	42	126	110.00			-	-	765	10320, 6.5	230	Surface		646.82	1.48
14	Bajoli Holi (Chamba)	HPSEB	3	60	180	278.00	0.8	33, B	2015	1994	1700	14600, 5	450, 5	UG	11.79	762.98	2.03
15	Luhri (Shimla)	HPSEB	3	155	465	88.00	12.45	80, C	770	728	642	15500, 11	150, 11	UG	200	1825.13	2.41
Total			**43**		**3328**												

Source: http://www.cea.nic.in/reports/hydro/feasibility_report_50kmw_he.pdf

Note: MW – Capacity in Mega Watts, MCM – million m^3, FRL – Full Reservoir Level, MDDL – Minimum Draw Down Level, WCS – Water Channel Size, PH – Power House, GWh – Gigga Watt Hour, KWh – Kilowatt hour



S.No.	Project	Forest Diversion (Hectares) Proposal	Brief Description
1	Transmission line	34.2867	From Akpa to Pooh in favour of HPSEB (Kinnaur Forest Division)
2	Sorang Karcham Abdullapur T/L	13.345	T/L from switchyard of Sorang to connect to 400 KV Karcham Wangtoo of JP Grid in favour of Himachal Sorang Pvt. Ltd., Kinnaur FD
3	Karcham-Jhakri 400 KV DC T/L	165.36	Nachan Forest Division, Kinnaur
4	Pooling Station, Wangtoo	7.9108	HPPTCL
5	Brua & Shaung 66KV T/L	4.7823	Darjeeling Power Ltd., Kinnaur FD (Joint mode)
6	400 KV DC T/L Karcham-Wangtoo-Abdullapur to JP	322.6538	Kinnaur, Rampur, Theog, Rajgarh and Nahan Forest Divisions
7	66 KV Pooh to Samdhu 22KV T/L	42.9083	HPSEB, Kinnaur FD
8	Rakchad (5MW)	4.423	WL division Sarahan & F.D. Kinnaur
9	Tangling (3 MW)	2.754	Sai Engg. Foundation, Kinnaur FD
10	Panvi Mini (4MW)	4.2381	Kinnaur FD
11	Melan Mini (4.5MW)	4.4119	Kinnaur FD
12	Brua Mini (5MW)	3.7836	Contransys Pvt. Ltd., Kinnaur FD
13	Shaung (3MW)	3.3094	Darjeeling Power Ltd., Kinnaur FD
14	Rukti – II (5MW)	2.281	Door Sanchar Hydro Power Ltd.,
15	Pangi (3MW)	1.789	Sai Engg. Foundation, Kinnaur FD
16	Raura (8MW)	4.2017	DLI Power Ltd., Kinnaur FD
17	Roura – II (20MW)	4.8951	Roura Non-Conventional Energy Pvt. Ltd. , Kinnaur FD
18	Rala (9MW)	2.8602	Taranda Hydropower Ltd. Kinnaur FD
19	Thang Mini (800 Kw)	0.22	Kinnaur FD
20	Rampur	70.3036	
21	Natpha	169.94	
22	Kol Dam	954.69	Additional diversion expected
23	Baspa – II	44.1795	
24	Crusher, Quarry and Dumping stones	48.1304	M/s NJPC (Shimla, Kinnaur)
25	Khab Namgia Road	26.4006	0/00 – 23/150 in Pooh Range
26	NH-22	3.4062	Realigned portion between Karcham-Ralli, Kinnaur FD
27	NH-22	5.49	Km 356 – 361, Double Laning
28	NH-22	7.2209	Km 361 – 373 Widening, Improvement
29	NH-22	21.7094	Km 373/00 – 395/00 Upgradation
30	NH-22	62.36	Km 395/200 – 436/000 (Pooh) Upgradation,
	Total	**2044.2445**	

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Himalaya Niti Abhiyan (HNA) is in the forefront of social and environmental action in Himachal Pradesh and has significant influence on other peoples movements in the Himalayas and outside. Over the years, HNA has active members across the state, and every major struggle around hydropower, mining, SEZ, Mega Tourism has had inputs and action from HNA. HNA aims at bringing long term policy and legal changes while in the short run addressing concerns of displacement, loss of ecological resources and livelihoods.

Himalaya Lok Jagriti Manch (HLJM) is a local group focusing on environmental awareness and challenging the destructive development activities in Kinnaur. The Manch is comprised of members from the community, retired government officials and other professionals in the region. It has successfully challenged the Karcham-Wangtoo and other projects and brought about significant changes in the operations. On the Shontong project the Manch approached the UNFCCC not to grant CDM to the proposed project. HLJM consolidates its annual programme at a large gathering on the World Environment Day each year.