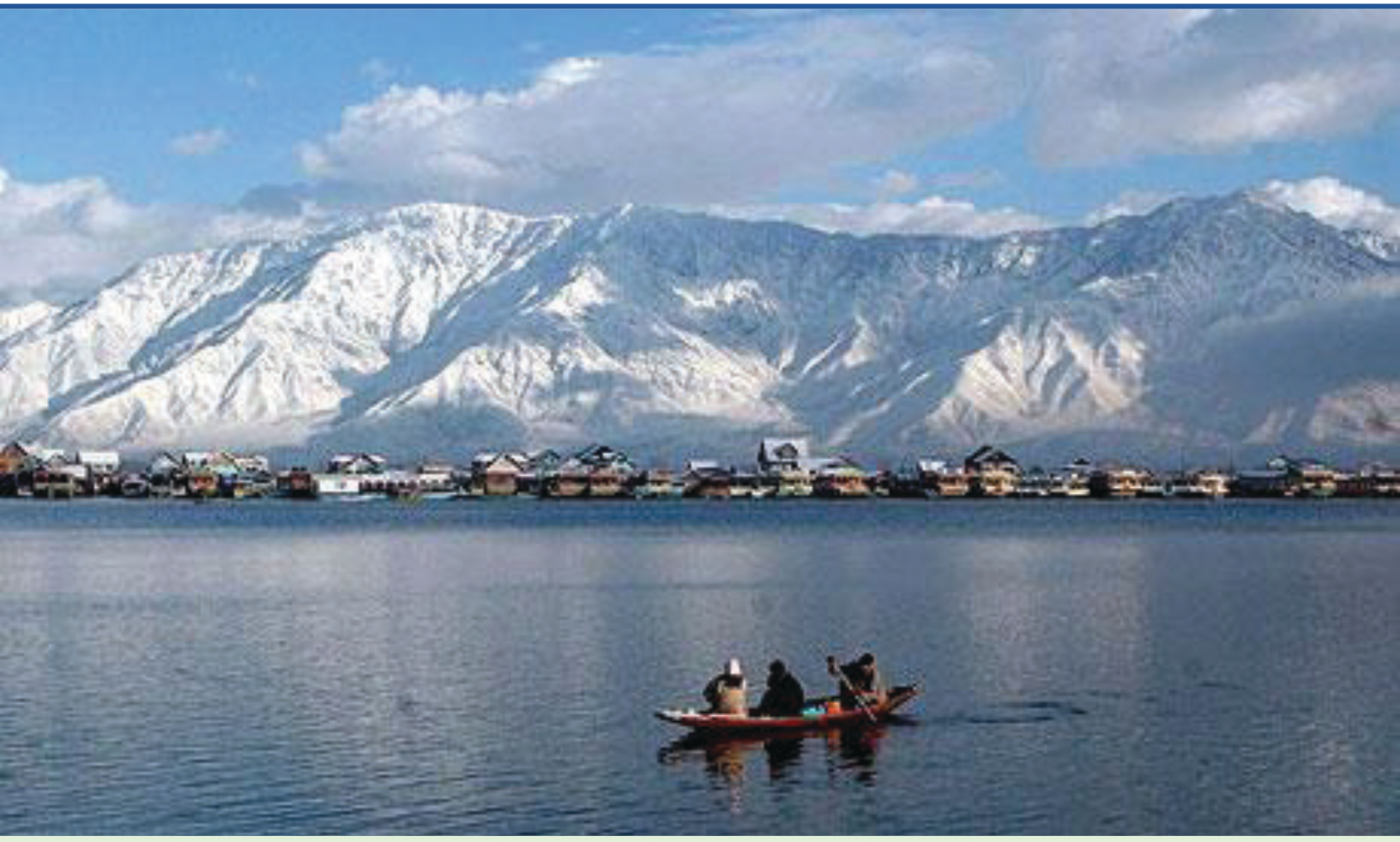
State of India's Rivers
for
India Rivers Week, 2016

JAMMU & KASHMIR



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JHELUM RIVER

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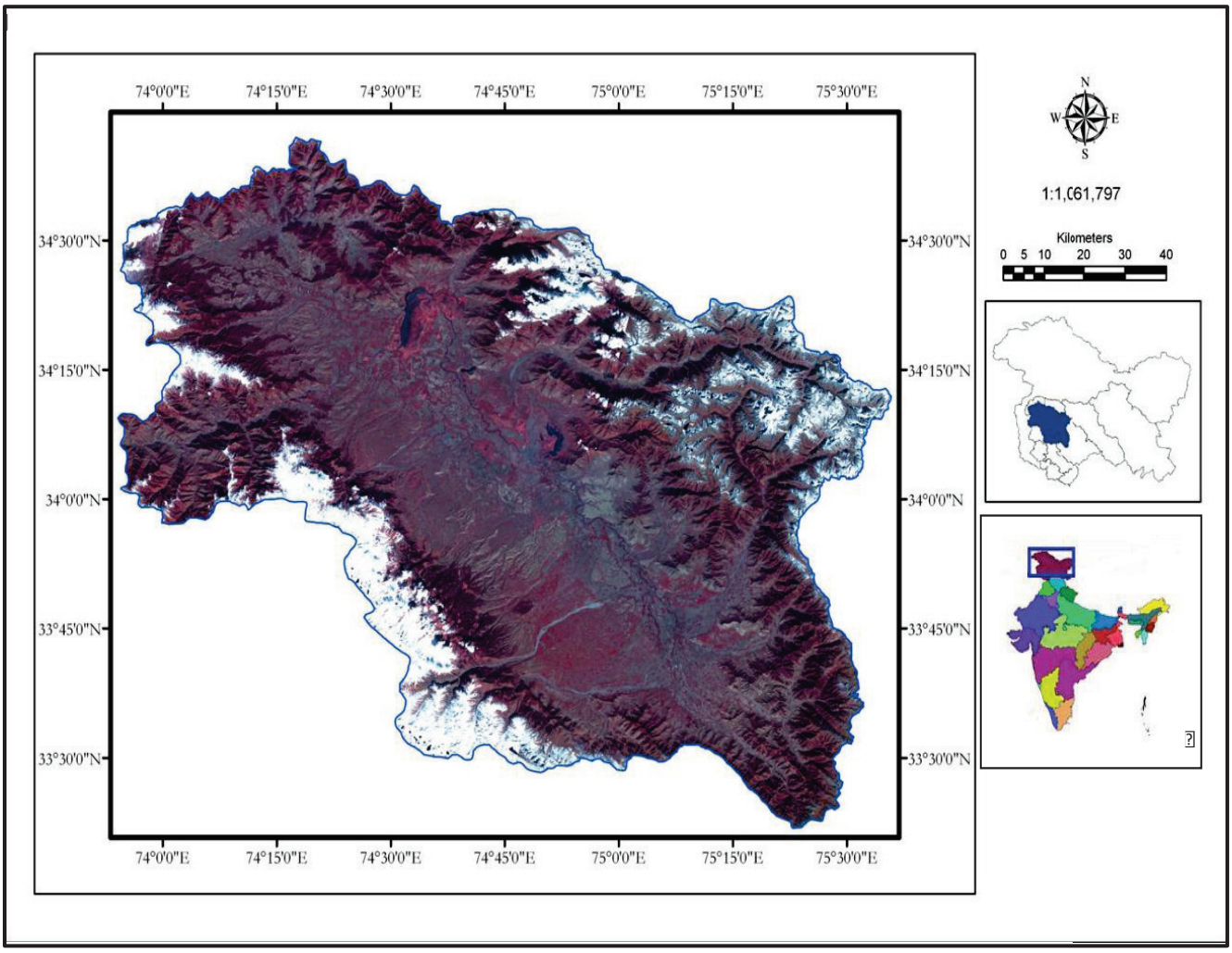
INTRODUCTION

Jhelum originates from Verinag spring in Anantnag and after passing through Srinagar it flows into Wular lake and then passing through Baramula and Uri, it enters into Pakistan. Figure 1 shows the geographical location of the Jhelum basin. From crest to crest, the transverse ridges on the southwest and northwest of the basin are about 190 km apart. From the crest of the Pir Panjal to that of the Great Himalayan range, the distance is about 100 kilometers. In altitude, it ranges from 1,549 m (Walur Lake) to a maximum of 5,432 m (Kolahoi Peak). The Jhelum basin draining the entire Kashmir valley is located in a longitudinal depression in the great northwestern complex of the Himalayan ranges. It constitutes an important hydrologic feature of tremendous geographic significance. The total catchment area up to the Line of Control when it enters into Pakistan is about 15,856 km^2, and has 24 watersheds, the details of which are shown in the table 1. Jhelum basin has a fairly well established drainage system headed by the Jhelum, the main channel of drainage as shown in the Figure 2. The encircling mountain ranges with ridges and supers and covered with snow almost throughout the year, provide a ground for the development of a number of streams which have more or less established their own entities within the basin. The figure shows the drainage pattern of the Kashmir valley with the distinct differences on the Pir Panjal and the Greater Himalayan sides. The Jhelum basin has 24 tributaries and some of them drain from the slope of the Pir Panjal range and join the river on the left bank and some others flowing from Himalayan range and join the river on the right bank.

The shape of the Pir Panjal and the Great Himalayan ranges have given the basin an oval shape with its long diagonal parallel to the general direction of the bordering mountain ranges. Geomorphologically, the Jhelum basin, has a unique position in the Himalayas so far as it possesses an extensive body of evidence on the evolution of its surface features. Nestled in the young folded mountains, still in the process of uplift, the geomorphic evolution of Kashmir valley has a striking recency (Raza *et al*, 1978). Having been the scene of operation of the complementary processes of deposition and erosion simultaneously, the surface features of the basin show an inextricable juxtaposition of both. It has undergone alternations of glacial and fluvial activity corresponding with glacial and interglacial periods during the Pleistocene epoch (Romshoo, 2015). These past processes have left indubitable imprints on the surface features of the basin. The surface features of the Jhelum basin can be properly described within the frame of the following three broad divisions. The northern and northeastern slopes and foothills of the Pir Panjal range, the slopes and foothills of the Greater Himalayan and the north Kashmir ranges and the valley floor as can be seen from the Figure 2.

The Jhelum basin is situated in subtropical latitudes, but owing to orographic features and snow-clad peaks, the climate over greater parts of the basin resembles to that of mountains and continental parts of the temperate latitudes. According to Bagnoulus and Meher-Homji (1959), the climate of Jhelum falls under Sub-

Mediterranean type with four seasons based on mean temperature and precipitation. There are, however, micro level variations in the general prevailing weather and climatic conditions of the basin (Romshoo, 2015).



Map No 1: Showing the Location and Extents of the Jhelum Basin

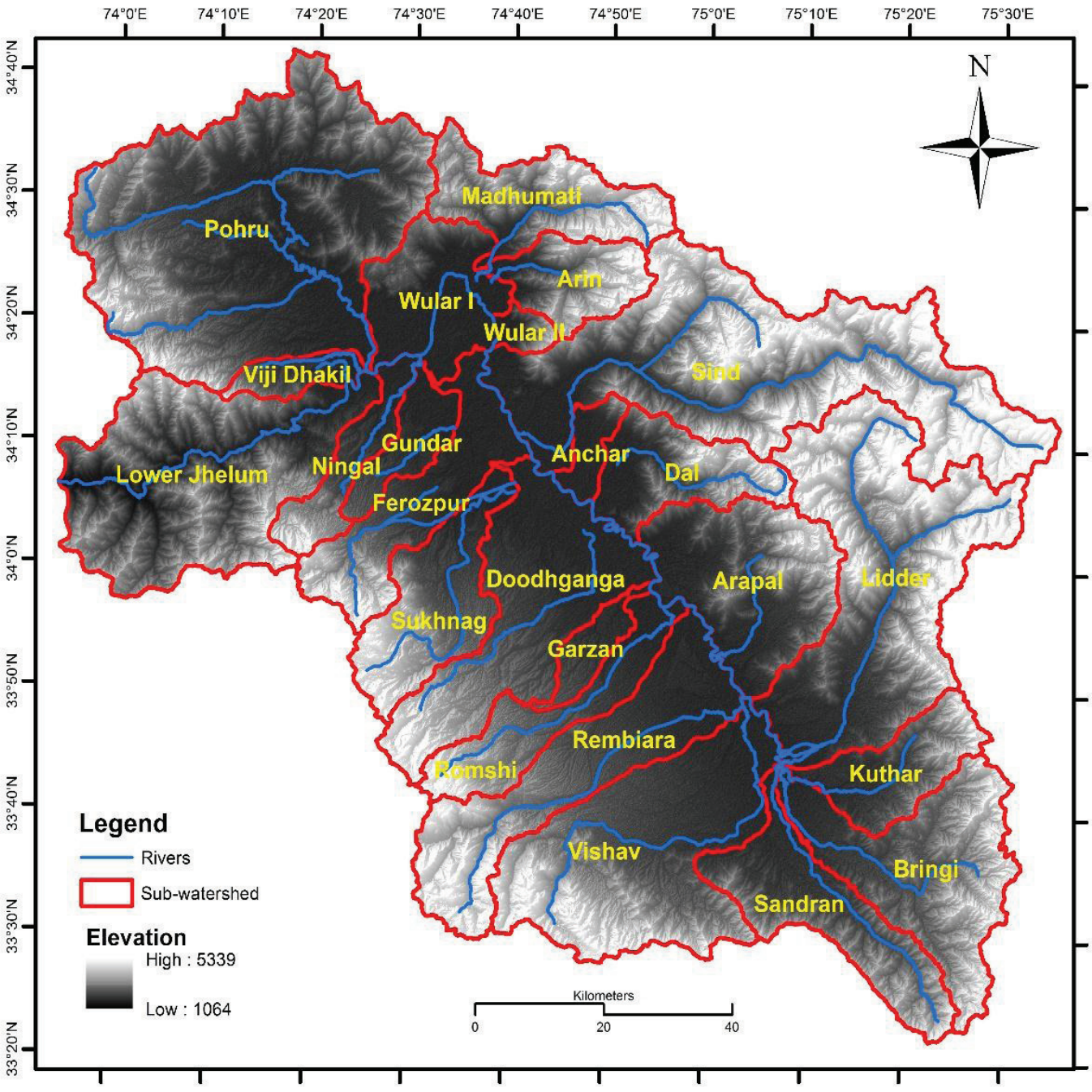
Many areas in the Jhelum basin are beginning to experience moderate to severe water shortages, compounded by the adverse effects of reckless urbanization and high population growth. In light of the clear and loud indications of climate change in the basin, an understanding of the changing hydrological set up in response to these changes is necessary for developing a robust strategy for sustainable development of the limited fresh water resources on short and long term basis (Romshoo et al., 2015)

This article discusses a few of the significant issues in the Jhelum- one of the main tributaries of the Indus and provides the readers a snapshot of the issues confronting the water resources development in the basin. On the basis of these factors, the health and status of the Jhelum basin was determined using an assessment matrix

providing qualitative weights to each of these indicators and influencing factors to arrive at the overall score of the river categorizing a riverscape as healthy, sick and dying.

Table 1: Showing the Tributaries of the Jhelum Basin

Sr.no	Sub-basin	Area in sq kms	Tributary	Length in kms	
1	Vishaw	994	Vishaw	72	**Left bank tributaries**
2	Romshi	338	Romshi	52	
3	Rembaira	702	Rembaira	66	
4	Sukhnag	433	Sukhnag	57	
5	Ferozpura	446	Ferozpura	52	
6	Dodhganga	756	Dodhganga	49	
7	Ningal Nallah	200	Ningal Nallah	31	
8	Vij-Dakil	103	Vij-Dakil nallah	30	
9	Gundar	164	Gundar	16	
10	Lower Jhelum	1061	Part of main Jhelum	60	
11	Lidder	1229	Lidder	110	**Right bank tributaries**
12	Bringi	676	Bringi	49	
13	Aripath	291	Aripath	30	
14	Sandran	473	Sandran	53	
15	Arpal	618	Arpal	24	
16	Sindh	1560	Sindh	138	
17	Dachigam	336	Dachigam	37	
18	Erin	251	Erin	13	
19	Mahumati	420	Mahumati	39	
20	Pohru	1837	Pohru	177	
21	Wular I	396	-	-	
22	Wular II	53	-	-	
23	Garzan	105	-	-	
24	Anchar	92	-	-	



Map No 2: Showing the sub-watershed map of Jhelum basin

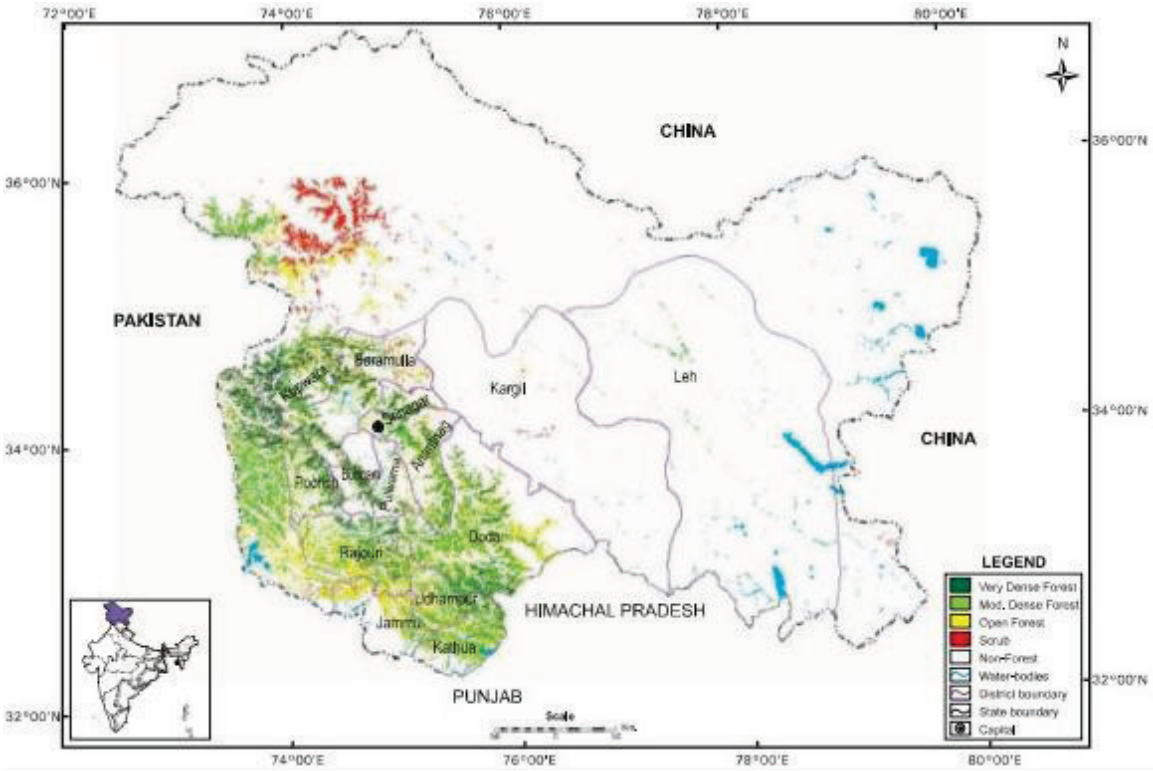
BACKGROUND INFORMATION FOR THE ENTIRE JHELUM BASIN

1. Forested / well vegetated tracts in the Jhelum river basin

Table 2: Showing Forest cover area in Jhelum Basin

District	Watersheds	Forest Area in sq. kms. (2011)	Forest Area in sq. kms (2015)	Change in area (sq.kms)
Anantnag	Lidder,Aripath,Sandran, Bringi,Vishaw	1438	1401	-37
Baramulla	Lower Jhelum, Ferozpora, Erin, Madhumati, Vij-Dakil, Ningal, Gundar	1157	1123	-34
Budgam	Sukhnag, Dodhganga	220	251	31
Kupwara	Pohru	1160	1150	-10
Pulwama	Romshi, Rembaira, Arpal	294	477	183
Srinagar	Dal,Sindh	752	627	-125
	Total	**5021**	**5029**	**8**

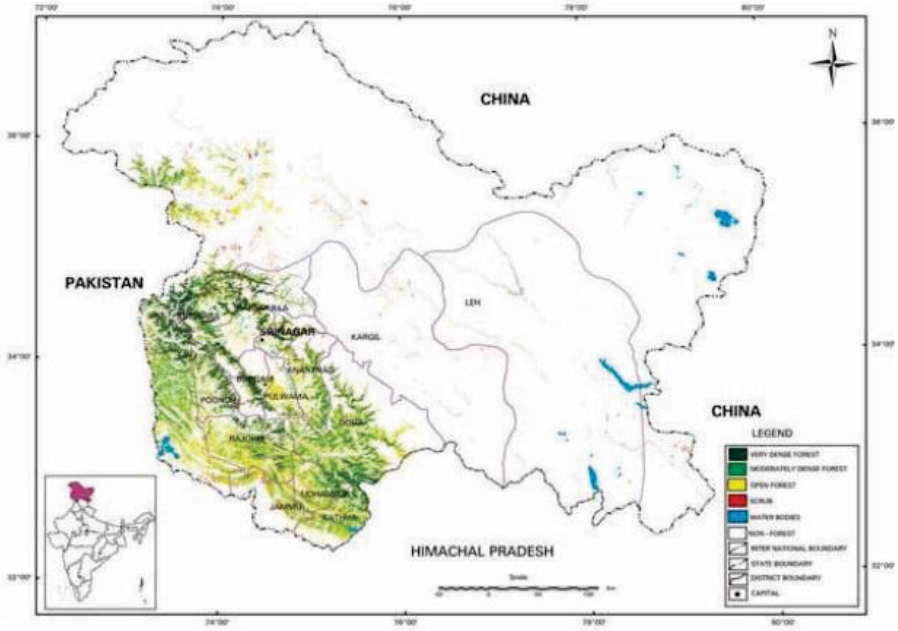
(Source: India State Forest Report, 2011 and India State Forest Report, 2015)



Map No 3: Forest Map of Jammu and Kashmir 2011

(Source: India State Forest Report, 2011)

As per the Forest survey of India, the total area of the forest cover from 2011-2015 has increased by about 8.00 sq. km as shown in the table 2 and Fig. 3 and Fig. 4. The net positive change is attributed to the conversion of the scrub areas to forest areas (ISFR, 2015). However, in reality there has been significant decrease in the forest cover since the last 5 decades (Rather et al., 2016).



Map No 4: Forest Map of Jammu and Kashmir 2015

(Source: India State Forest Report, 2015)

Figure 1: Reckless Logging of the Green Trees

As can be seen from the Plate-1, the scenes of the reckless logging of the green trees is a common site across the length and breadth of the basin. The magnitude of the deforestation could be judged from the print media reports shown in the box 2.1

2. National Park, Sanctuaries in the Jhelum river basin:

There are 3 national parks and 7 wildlife sanctuaries in the Jhelum basin as shown in the table 3. Figure 5 shows the location of these parks and sanctuaries.

Table 3: National parks and Wildlife Sanctuaries in Jhelum basin

National Parks/ Wildlife Sanctuaries	Watershed	Area in sq kms
Dachigam National Park	Dal	141
Salim Ali National Park	Dal	9.07
Kazinag National Park	Lower Jhelum	98
Gulmarg Wildlife Sanctuary	Lower Jhelum	180
Limber Wildlife Sanctuary	Lower Jhelum	26
Lachipora Wildlife Santuary	Lower Jhelum	80
Overa - Aru Wildlife Sanctuary	Lidder	425
Hirpora Wildlife Sanctuary	Pulwama	341
Rajparian(Daksum) Wildlife Sanctuary	Bringi	20
Thajiwas (Baltal) Wildlife Sanctuary	Sindh	203

(Source: J&K wildlife protection department.)

Map No 5: Showing Wildlife National parks and Sanctuaries of J &K

(Source: Maps of India)

The brief details the wildlife national parks and sanctuaries are given in the following sub-sections.

2.1 Dachigam National Park:

Dachigam National Park covers an area of 141km^2. It was set up as a sanctuary in the year 1910, under the management of the Maharaja of Jammu and Kashmir. The upgradation of the sanctuary to the status of a national park took place in the year 1981. The Dachigam National Park is famous for Hangul also called as Kashmiri Stag. The landscape of the park ranges from gently sloping grasslands to sharp rocky outcrops and cliffs. The mountainsides are covered with coniferous forests, dotted with alpine pastures, surging meadows, waterfalls and scrub vegetation. Marsar Lake, running through the Dachigam Wildlife Sanctuary of Kashmir, is the perfect place to catch trout fish. The wild trees found in the park comprise of Oak, Apricot, Poplar, Wild Cherry, Birch, Walnut, Pear, Elm, Plum, Apple, Chestnut, Willow, Chinar, Pine and Peach. In terms of

wildlife, park is habitat of Musk Deer, Langur, Himalayan Brown Bear, Himalayan Black Bear, Leopard, Himalayan Marmot, etc. Dachigam National Park provides home to as many as 150 species of birds. The most popular ones include Black Bulbul, Golden Eagle, Bearded Vulture, Griffon Vulture, Peregrine Falcon, Paradise Flycatcher, Western Yellow-Billed Blue Magpie, Golden Oriole, Grey Heron, Koklas, etc. Dachigam national park is gifted with numerous perennial streams, nallah, springs, glaciers, and the main Dachigam nallah coming from Marsar Lake is a perennial stream supplying adequate water in the area throughout the year and enters the Dal lake through Telbal.

2.2 Salim Ali National Park (City Forest):

This park has been named after the famous Indian Bird watcher and Naturalist named Salim Moizuddin Abdul Ali and was acknowledged as a national park in 1992. Salim Ali National Park is located in Srinagar and covers an area of 9.07 km^2. The Mangrove Shrubbery is what forms the flora of the Salim Ali National Park. The park features a number of wildlife species such as Hangul, Musk Deer, Himalayan Black Bear and Seventy species of birds including Paradise fly catcher, Himalayan Snow Cock. It was transformed into Royal Spring Golf Course during the period of 1998 to 2001 despite being a national park in violation of all the environmental laws.

2.3 Kazinag National Park:

Kazinag National Park is situated on north bank of Jhelum close to Line of Control in Baramulla district about 70 kms away from capital city Srinagar. This park was decided to be made out of the Limber and Lachipora wildlife sanctuaries and the Nagnari conservation reserve. The National Park is famous for Markhor (Capra falconeri), Himalayan Musk Deer (Maschus crysogater) besides home of 120 species of birds and 20 species of mammals. Vegetation in Kazinag is dominated by coniferous forests with deodar (Cedrus deodara) at lower altitudes, fir (Abies pindrow) and spruce (Picea smithiana) at middle to upper elevations and kail (Pinus Wallichiana) is widely distributed from lower to upper elevations. Around 20 species of mammals, including some rare, threatened, endangered are found in within the limits of kazinag National park. The key animal species sighted are Markhor (capra falconeri), Himaliyan Musk Deer (Moschus Crysogater), Himaliyan Brown Bear (Ursus artos), Himalayan black bear (Ursus thibetanus) and common leopard (Panthera pardus), Yellow Throated Martin (Martes flavigula), Himaliyan Marmot (Marmota caudate), Small Kashmir Flying Squirrel (Eoglaucomys fimbriatus) etc.The Kazinag National Park is home to about 120 Species of birds representing about 36 families which include Golden Eagle (Aquila chrysaetos), Impeyan or Monal Pheasant (Lophophorus impejanus), Koklas Pheasant (Catreus wallichii), Sparow Hawk (Accipiter nisus melaschistos), Snow Pigeon (Columba leuconota), The Cuckoo (Cuculus canorus) etc.

2.4 Gulmarg Wildlife Sanctuary:

The Gulmarg wildlife sanctuary is spread in an area of 180 km^2, the reserve is famous for retaining several rare and endangered species. It is located at a distance of 28 km from Srinagar.The area holds a rich cover of vegetation, the dominant forest consisting of conifers, which account for over 90%. The principal species are Cedrus Deodara, Pinus Griffithii, Abies Pindrow, Aesculus Indica, etc. The major shrubs are Indigofera Heterantha, Sorbaria Tomentosa, etc.Nature has gifted this wildlife sanctuary with multiple species of rare, endangered and protected species. The main species found over here are Hangul, Musk Deer, Serow, Brown Bear, Leopard, Black Bear and Red Fox, etc.

2.5 Limber Wildlife Sanctuary:

Limber wildlife sanctuary is situated in Lower Jhelum sub-watershed of Jhelum Basin.It is about 22 kms away from Baramulla. It is the part of Kazinag National Park was notified in 1987 and encompasses an area of about 44 km^2in Lower Jhelum sub-watershed. It is bounded to the north by Bhurji forest in Langet Forest Division to the south by the Jhelum River, east by Katha Forest. Along the west, it is connected with the Lachipora wildlife sanctuary and along the east with Naganari Conservation Reserve. Limber wildlife sanctuary is fed by two main nallahs, Mithwani and Gamalitter, which drain into theLimber nallah, which in turn drains into River Jhelum.The wildlife sanctuary is famous for Markhor (Capra falconeri).Vegetation in Limber wildlife sanctuary is dominated by coniferous forests with deodar (Cedrus deodara), fir (Abies pindrow), spruce (Picea smithiana) and kail (Pinus Wallichiana).

2.6 Lachipora Wildlife Santuary:

Lachipora Wildlife Sanctuary has been named after 'Lachipora' village which is present in the catchment area of the protected area, located over the northern banks of Jhelum River. It is surrounded by Maidan Forests towards its southern side, the lineo f control on its western end, Kakau Forest in Langet Forest Division on its northern portion and Limber and Bagna Forests in its eastern side. The landscape of this wildlife reserve varies greatly ranging from gentle to steep slopes which are interrupted by large, rocky cliffs. This sanctuary had been developed in order to safeguard Markhor, which is species of wild goat found in parts of Kashmir and neighboring countries. There exist various kinds of forests and trees inside the Sanctuary like Coniferous Forests, Broadleaf Forests and meadows of Alpine pastures. Birch, Horse Chestnut, West Himalayan Fir and Persian Lachipora Wildlife Sanctuary is home to several species of birds especially the Western Tragopan which has been categorized as a 'Vulnerable Species' by the International Union for Conservation of Nature or IUCN.

2.7 Overa - Aru Wildlife Sanctuary:

Overa-Aru Wildlife Sanctuary has derived its name from the two hutment areas of Overa and Aru falling in the lap of the sanctuary and along the two famous snow melt fresh water and perennial nallahs of Overa and Lidder meandering through the sanctuary. It is one of the biggest wildlife sanctuaries in Jammu Kashmir covered in the area of 457 km^2. Due to variation in altitude, aspect and soil, a diversity of vegetation is discernible in the protected area. The forest of Overa Aru comprises of riverian vegetation, coniferous forest, Alpine scrubs and green pastures. Fir (Abis pindrow) and Kail (Pinus griffithi) are the major variety of vegetation found here. Kashmiri Stag, Musk deer, Himalayan Mouse Hare, Kashmiri Flying Squirrel, Serow, Red fox, Jackel, Leopard, Langur, Himalayn Black Bear, brown bear, and other similar fauna are also found in Overa Aru wildlife sanctuary. There are more than 27 species of avifauna including Black eared kite, Monal, White backed vulture, Blue rock pigeon, Ring dove, Asiatic Cuckoo, and Rufus backed shrike, large spotted nutcracker that reside in the premises of Overa Aru wildlife sanctuary.

2.8 Hirpora Wildlife Sanctuary:

Hirpora Wildlife Sanctuary is located in Shopian district of Kashmir, 70 kilometers south of Srinagar. It spreads over an area of 341 km^2. It is bounded to the north by Gumsar Lake, northeast by Hirpora village, east by Rupri, south by Saransar and to the west by the Pir Panjal pass. The vegetation types present in the Hirpora Wildlife Sanctuary include western mixed coniferous forests, deciduous sub-alpine scrub forests and sub-alpine pastures. The Hirpora Wildlife Sanctuary is an abode to many species of animals including the Himalayan brown bear, Himalayan black bear, musk deer, leopard, Tibetan wolf, Himalayan palm civet and around 50 individuals the critically endangered Pir Panjal markhor. Besides, 130 species of birds including the spotted forktail, western tragopan, rock bunting, rufous-breasted accentor, Himalayan woodpecker, blue rock thrush, white-capped redstart, Himalayan griffon, common stonechat and grey wagtail are found in the sanctuary. The Mughal Road cuts through the Hirpora Wildlife Sanctuary and is believed to inhibit the movement of animals, especially the critically endangered Pir Panjal markhor. The Sanctuary has also been disturbed due to deforestation, excessive livestock grazing and construction of permanent huts by the Gujjars, Bakerwals and local shepherds.

2.9 Rajparian (Daksum) Wildlife Sanctuary:

Rajparian Wildlife Sanctuary is located 100 km from Srinagar city in Jammu Kashmir. The park is positioned in the extreme south western corner of state beside the catchment of Jhelum. This wildlife sanctuary has been protected since the time of Maharajas rule in valley. It got the status of National Park in 1981 under the Wildlife Protection Act. It has derived its name from Rajparian Nallah that drains this region in Bringi sub-

watershed. It is also called as Daksum Wildlife Reserve. Stretched in the area of 20 km^2, it is one of the most difficult wildlife sanctuaries to explore for travelers. It carries rich species of both flora and fauna. Kail pine, coniferous, spruce, juniper, deodar, Fir and Birch trees are found in this vegetation. Animal like musk deer, hangul, Himalayan black bear, etc. are also preserved here.

2.10 Thajiwas (Baltal) Wildlife Sanctuary:

Thajiwas wildlife sanctuary is situated in Sindh sub-watershed of Jhelum basin. Sindh River is the major source of water for the Jhelum river. The sanctuary is famous for the Thajwas glacier which is a favorite tourist spot in the Kashmir valley. The sanctuary has vast areas under meadows and is home to snow leopard, black bear and Hangul.

3. Notable geo-morphological, cultural, archeological, and biological sites along the Jhelum River:

Jhelum basin is home to a number of culturally and geologically important sites which has tremendous scientific and historical importance. In addition, there are several pilgrimage sites including sufi shrines in the basin that are being frequented by the people and tourists throughout the year. Table 4 provides information about the pilgrimage sites located in different watershed of the Jhelum basin.

Table 4: Pilgrimage sites in Jhelum Basin

Sr.no	Shrine\Mosque\ Temple Name	Location	Watershed
1	Baba Reshi Shrine	Tangmarg, Baramulla	Lower Jhelum
2	Dastgir Sahib	Khanyar Srinagar	Dal
3	Ziarati Hazrati Youza Asouph	Khanyar, Srinagar	Dal
4	Makhdoom Sahib Shrine	Hari Parbhat Hills, Srinagar	Dal
5	Khanqah-E-Molla	Srinagar	Dal
6	Aishmuqam Shrine	Aishmuqam, Anantnag	Lidder
7	Charar-e-Sharief	Budgam	Sukhnag
8	Jama Masjid	Srinagar	Dal
9	Martand Spring Temple	Mattan, Anantnag	Lidder
10	Avantiswami Temple	Awantipora, Pulwama	Arpal

11	Shankracharya Temple	Srinagar	Dal
12	Kheer Bhawani Temple	Tulmula, Ganderbal	Sindh
13	Baba Naseeb-u-ddin Shrine	Bijbehara Anantnag	Lidder
14	Mantaqi sahib Shrine	Awantipora	Arpal
15	Shiv Temple	Bijbehara	Lidder

(Source: Jammu and Kashmir Tourism Department)

Additionally, the Indus valley civilization is quite old and there are various archeologically important sites located in different watersheds of the basin as shown in the Tab. 5. Some of these sites pertain to pre-historical medieval times. Excavations at some of these sites by the Department of Archeology like burzohama and semthan karewa uplands have revealed a few important findings about the human life in the Jhelum basin during the Holocene. The graphic details of the later Stone Age (Neolithic) dating 2700 BC is available at Burzhama, north of Srinagar, where excavations offer details of a culture that inhabited the valley around 4,300 years ago. Geo-scientists have discovered a set of 57 basalt tools, believed to belong to the Palaeolithic Age at a place near pampore on the right bank of the Jhelum. Tools of the lower Palaeolithic period (2.5 million to 600,000 years ago) were never reported in Kashmir till this find, though they were found in Afghanistan and Baluchistan.

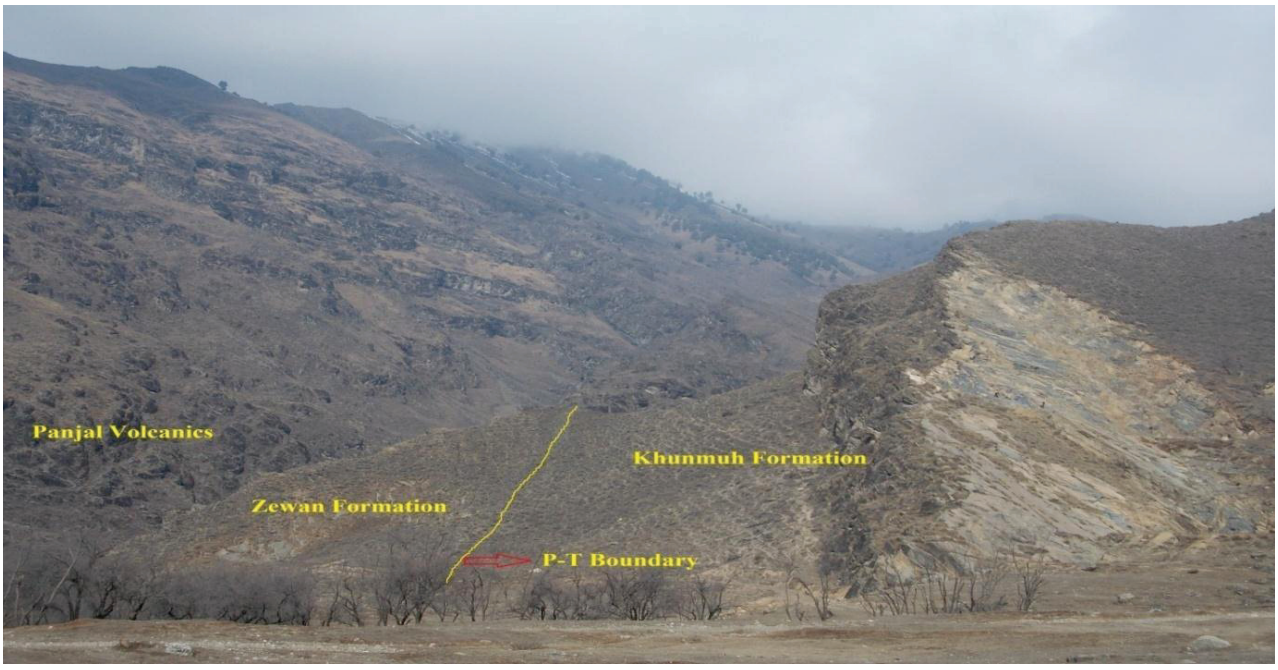


Figure 2: Field Photograph Showing Late Permian & Triassic Sequence at Guryul Ravine

Table 5: Showing Archeological sites in Jhelum Basin

Sr.No	Name	Location	Watershed name
1	Ancient site of Chakradhar / Semthan	Semthan	Lidder
2	Mughal Arcad and Spjring at Verinag	Verinag	Sandran
3	Martanda (Sun Temple)	Ranbirpura	Aripath
4	Bumzuva Cave and Temple	Bumzuva	Lidder
5	Detah Mandir	Bandi	Pohru
6	Ancient Temple	Buniyar	Lower Jhelum
7	Ancient Temple	Fatehgarh	Lower Jhelum
8	Ancient Stupa (Excavated Remains)	Ushkur	Lower Jhelum
9	Partapswami Temple	Tapparwaripor	Gundar
10	Sankaragaurisvara Temple	Pattan	Ferozpora
11	Sugandhesa Temple	Pattan	Ferozpora
12	Ancient Stupa, Chaitya & Monastery	Dever Yakhamanpjor / Parihaspjora	Ferozpora
13	Ancient Site	Sumbal	Ferozpora
14	Mosque and other ancient remains on the island	Nular Lake	Lower Jhelum
15	Khanpur Sarai	Khanpur	Sukhnag
16	Burzohama Karewa	Burzuhama	Dachigam
17	Semthan karewa	Bijbehara	Lidder
18	Guryul Ravines	Khunamoh	Arapal

(Source: Archeological Survey of India)

The Geological succession at Guryul ravine includes Panjal Volcanic rocks, the Gangamopteris beds, Zewan Formation and Khunamuh Formation The geological evidence at the Guryal ravine indicates that tsunami evidence is preserved in Kashmir rocks there, which is dated to 250 million years in the past. The Guryul section closely resembles the K-T boundary section in Texas, United States and may have been deposited in the same way from a waning tsunami.

4. Well known springs / perennial water sources in the Jhelum basin:

There are about 3650 wetlands and water bodies in the entire state of Jammu and Kashmir (NWIA, 2010) out of which 1143 are the high altitude wetlands and water bodies (NWIA, 2012). In the Jhelum basin, encompassing the Kashmir valley, there are 788 wetlands and water bodies out of which 69 are the high altitude lakes and wetlands. Table 6 provides the watershed- and district-wise distribution and areal coverage of the wetlands and water bodies in Jhelum basin. The details of some of the prominent lakes, springs and wetlands are given in the table 5. Figure 6 shows the watershed-wise distribution of the drainage, lakes, springs, and wetlands in the Jhelum basin.

Table 6: Lakes and springs in Jhelum basin

Sr.no	Lake/Spring	Description
1	Wular Lake	Wular Lake is one of the largest fresh water lakes of Asia. The lake is situated at a distance of about 50 kms from Srinagar at an average altitude of 1570 m amsl. The lake is balloon shaped with a maximum length of 16 kms and breadth of 7.6 kms with an average depth of 5.8m.
2	Dal Lake	It is a world famous lake lying north-east of Srinagar city with area of 11.20 sq kms at an altitude of 1584m amsl.
3	Ahansar Lake	It is a rural water body situated at a distance of about 30 kms from Srinagar city. It is an ox-bow type of water body and has probably originated by the meandering of the alluvial deposits.
4	Anchar Lake	It is a shallow water body which is located 10 kms north-west of Srinagar city at an altitude of 1585m amsl.
5	Nilnag Lake	It is a fresh water lake situated at a distance of about 41 Kms to the west of Srinagar city.
6	Sheikhsar Lake	It is a shallow fresh water closed type single basined valley lake located near Sumbal at a distance of 26 Kms North West of Srinagar. The lake covers an area of 28 ha with a maximum depth of 1.8 m.
7	Waskursar Lake	This is a small water body situated at a distance of 30 Kms from Srinagar city and is located in Ganderbal tehsil.
8	Mansbal Lake	It is situated about 30 kilometers north west of Srinagar in the direction of Wular Lake and is

		connected with Jhelum river by a canal.
9	Nilnag Lake	It is an oval shaped small lake and 19 meters in length and about 18 meters width on the southern side of Kashmir valley, about 6 Kms from Charari-Sharif
10	Nilsar Lake	A small lake in the Panjal range formed by Glacial action about one and a half Kms long and 1 Km broad.
11	Kounsarnag Lake	It is a mountain lake lies between the peaks of Panjal range in the extreme south west of Kashmir Valley.
12	Chandasar Lake	It is the small lake lying on the high mountains in between Kashmir valley and Sind River. The lake is circular in shape with 0.5 km in diameter.
13	Demansar Lake	A mountain lake in the south of Kashmir valley just east of Tosha Maidan pass at the upper end of Tsenimarag and area of the lake is 16.25 ha.
14	Didufnag Lake	This lake lies on the eastern side of the chain of mountains between Khompara, Merdwa Wardan.
15	Gaditar Lake	A mountain lake lying on the eastern side of Panjal Range about Tosh Maidan on the Poonch path.
16	Gadsar Lake	A small lake known as Yemsar lies in between lofty mountains of Sind valley and Tilail. It is a tarn oval shaped about 1 Km in length.
17	Gangabal Lake	It is a high altitude lake on the north- east slopes of Harmukh mountains at an elevation of 12000 ft. the lake is about 2 Kms long and about 300 meters wide.
18	Gogisar Lake	A mountain lake lying on the eastern side of the watershed between Kashmir and Mardwa Wardwan valley
19	Gumsar Lake	A small lake situated near Shipkour.
20	Marsar Lake	A high altitude lake situated on the southern side of high mountains forming a watershed between Kashmir and Sind Valley. This lake is about 2.5 Kms long and about 1 km wide. This lake is source of Dachigam Nallah.
21	Shishnag Lake	It is a small lake, situated at the north- eastern side of Dachnipora in a long valley enclosed by high mountains. The lake Shishnag is about 2 Kms long and 1 Km broad. It is connected

		with another lake called Zamtinag fed by a vast glacier.
22	Sonasar Nag Lake	A small lake situated amid of the mountains at the north eastern end of Dachnipora about 3.5 Kms south- west of Shishnag.
23	Ratansar Lake	It is a small lake lying in the plains at the southeast end from sopore
24	Tarsar Lake	It is a high mountain lake situated between Sindh valley and Kashmir.
25	Vethnar Lake	It is a shallow lake situated on the left bank of river Jhelum about 4.5 Kms south- east of Srinagar city. The lake is also called Nagat Nambal.
26	Vishansar Lake	This lake is situated between Tilail and Sindh valley amidst of high mountains. It is bear shaped lake with 1.5 Kms length and 0.5 Kms.
27	Zamtinag Lake	A small lake situated in lofty mountains at the north eastern end of Dachnipora village fed by glaciers.
28	Kounnag Lake	A small lake lying to the north-west of Schkach mountain close to the pass between Astan Marag and Panjtarni valleys.
29	Narkura Sar	The waterbody owes its name to the Narkura village, which lies to its south. The waterbody has its banks spread upto a number of villages viz; Nadur, Gurvaith, Omipora and Humhama.
30	Achabal Spring	It is the largest magnificent spring of Kashmir which rises at the foot of the Achabal Thung mountains
31	Anantnag Spring	The name of the spring has been derived from Anat Nag or Ananta Nag, the spring of Anant , the serpent of Vishnu, and the emblem of eternity, and is an esteemed sacred of the Hindus.
32	Kantar Nag	A small lake situated on the Pirpanjal range to the north of the Firozepur pass and is 6 kms from Gulmarg.
33	Kausar Nag	It is a high altitude lake lying between the basaltic peaks of the pirpanjal range at the south west of the Kashmir in Kulgam district. Its length is about 2 miles and its breadth is about one and a half mile.

34	Kukar Nag	The springs are located at the foothills on the south side of the Bringi valley. These springs gushes out at six or seven places at the foothills and forms a stream equal to that of Verinag in volume.
35	Hokersar	This wetland is located 16 kms from Srinagar on Srinagar-Baramulla road National Highway,. It is permanent and relatively a shallow waterbody. The main resources wetland is from Doodhanga flood channel.
36	Naraqnbagh	This lake is located about 25 km from Srinagar city. It is oxbow lake and the main source of this lake is springs within its basin.
37	Trigam Sar	This waterbody is located about 25 km to the west of Srinagar. This lake is very shallow and turbid due to heavy biotic interference due to the harvesting of fodder and plants and fishing.
38	Mirgund	It is a shallow a wetland and is locate4d about 20 kms south west of Srinagar city. The main resources of this wetland are from sukhnag nalla and the water channel irrigated surrounding agriculture areas.
39	Haigam Jhil	This lake is located 5 kms from sopore town and drains into Wullar Lake through tarozoo nalla.the main source of water to this lake is from ningli nalla and babakul .
40	Chatlam Wetland	This wetland is located in pampore area and about 30 kms from Srinagar city. The source of water to this wetland is springs within the basin.
41	Shalbugh Rakh	This wetland is temporary shallow and is located about 15kms from srinagar and is famous game reserve. The main resource to this wetland river Sindh River.
42	Khanpur Sar	This is a semi drainage water body and the main resources is from surrounding channels.
43	Narkura Sar (Nadir Sar)	This wetland is about 8kms from south west of Srinagar It is a perm anent and deep wetland and know for fishing and folder plants like nymphaea nymphoides.
44	Verinag	The Verinag spring rises in an octagonal stone reservoir situated at the foot of the spur. This spring is the main source of river Jhelum.
45	Vishan Sar	This lake is situated amid the mountains of the sindh valley and is fed by a huge glacier .It is the main source of Kishanganga river.

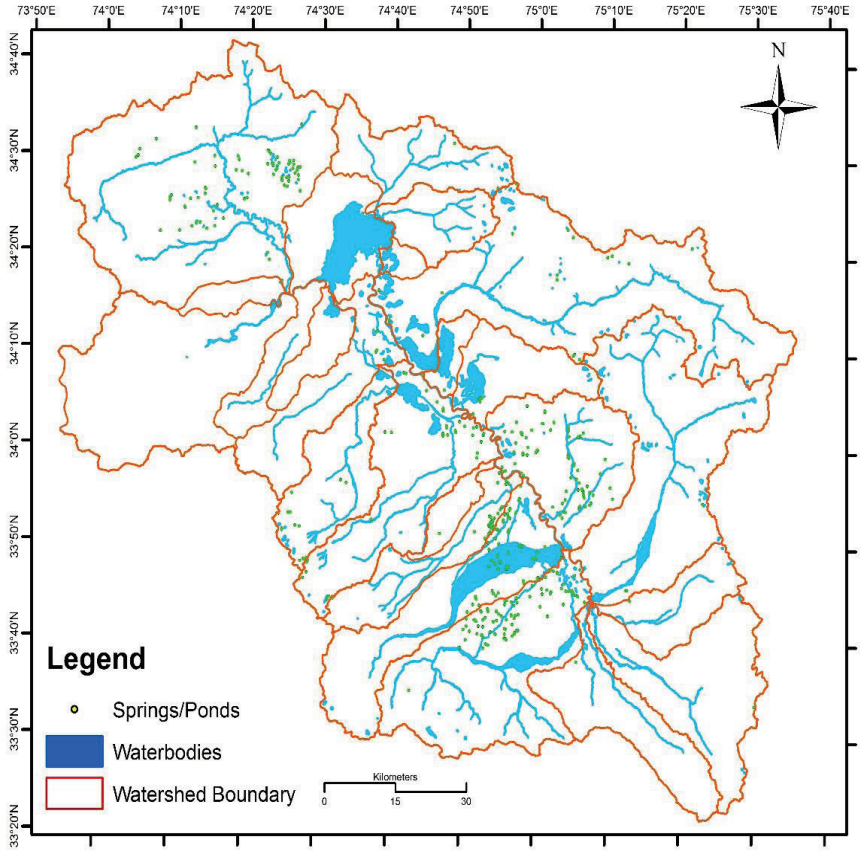
(Source: Directory of Lakes and Water Bodies of J&K State, 2011)

Table 7: Watershed wise distribution of water bodies in Jhelum basin

District	Watershed	Wetland Category	Number of Wetlands	Total Wetland Area sq kms
Kupwara	Pohru	Lakes/Ponds	18	96
		Riverine wetlands	2	6
		River/Stream	5	2212
		Wetlands (<2.25 ha)	70	70
Baramulla	Erin, Madhumati, Vij-Dakil, Ningal, Gundar Ferozpora, Lower Jhelum	Lakes/Ponds	2	11273
		High altitude wetlands	38	448
		Riverine wetlands	29	1478
		River/Stream	13	3146
		Wetlands (<2.25 ha)	15	15
Srinagar	Sindh, Dal	Lakes/Ponds	14	2194
		High altitude wetlands	29	392
		Riverine wetlands	25	5457
		River/Stream	7	2012
		Tanks/Ponds	1	3
		Wetlands (<2.25 ha)	23	23
Budgam	Dodhganga, Sukhnag	High altitude wetlands	11	150
		Riverine wetlands	9	1932
		River/Stream	12	1272
		Wetlands (<2.25 ha)	48	48
Pulwama	Romshi, Rembaira, Arpal	High altitude wetlands	2	4

		Riverine wetlands	7	347
		River/Stream	5	2956
		Wetlands (<2.25 ha)	251	251
Anantnag	Lidder,Aripath,Sandran, Bringi,Vishaw	High altitude wetlands	69	1026
		Riverine wetlands	15	273
		River/Stream	11	5553
		Wetlands (<2.25 ha)	23	23
	Total		788	42660

(Source: National Wetland Atlas: Jammu and Kashmir, 2010)



Map No 6: Map showing the main drainage, lakes, wetlands and Waterbodies in the Jhelum basin

(Source: National Wetland Atlas: Jammu and Kashmir, 2010)

There are a few famous and picturesque lakes in the Jhelum basin like Dal and Wular but most of these lakes and wetlands are facing brunt of anthropogenic pressure as is evident from the Plate-3 and Plate-4. The influx of the untreated domestic wastewater and the application of fertilizers are mainly responsible for the eutrophic conditions of the most of the lakes in the Jhelum basin.

Figure 3: Showing the Evidence Anthropogenic Pressures and Algal Bloom in the Dal Lake

Figure 4: Showing the Evidence of Siltation and Anthropogenic Pressures in the Wular lake

5. Ground Water:

Hydrogeologically, both porous and fissured formations occur in the Jhelum basin. Ground water occurs under water table and confined conditions in unconsolidated alluvial and Karewa formations in the valley. These formations form multi-layered aquifers and have prolific yields. The hard rock formations occurring in hilly and mountainous areas form the fissured formation and are in general low yielding with springs being the main ground water structures. A perusal of the data shows that in major part of the valley area the depth to water

levels are shallow, less than 10 m bgl with average depth to water level less than 5 m bgl. In valley areas, open wells and tube wells are the main ground water withdrawal structures.

The seasonal fluctuation varies between +0.24 to –2.38 m (Juneja, 2012). The reason for this abnormal behavior is that about 60 to 70% of the precipitation is received in the form of snow during December to February while March to April are the months of heavy rainfall. May to September months are relatively dry months. Hence recharge to the ground water takes place in the valley in the months of April to June with the melting of snow and with the onset of rainfall. Therefore, water level shows rising trend from April onwards and falling from August onwards.

Occurrence of the ground water is primarily confined to alluvial regions and fluvio-Lacustrine deposits in the Jhelum basin. Dug wells in Jhelum basin have limited yield. Ground water occurs in perched condition and gives rise to springs in phreatic zone water table. Occurrence and movement of ground water is mainly controlled by primary inter-granular porosity in the soft sedimentary quaternary alluvium and karewas formations. Depth to water level in the Jhelum basin is monitored through the network of 58 stations established in different parts of basin by Central Groundwater Board (CGWB) (CGWB, 2009). Table 8 provides information about the groundwater quality in different watershed of the Jhelum basin at watershed scale. As is evident from the perusal of the data given in the table 8, the chemical quality ground water in the basin is by and large suitable for domestic and irrigation purposes. Chemical analysis of water samples from various sources like dug wells, hand pumps, tube wells, springs, Jhelum River shows that the iron content (Fe) is slightly high at few places, which may be geogenic, or due to localized pollution, which requires proper treatment before use.

In presence of the plenty of surface water resources in the basin for irrigation and domestic consumption, the development of the groundwater in the Jhelum basin is sustainable and safe since stage of ground water development is low to moderate and depth to water levels in valley portions of the district within 10 m bgl.

Table 8: Showing watershed wise information on groundwater quality and GW resources.

	Ground Water Quality of Jhelum basin					
watersheds	**EC (µS/cm)**	**pH**	**Chloride (mg/l)**	**Fluoride (mg/l)**	**Iron (mg/l)**	**Major GW problems and Issues**
Lidder, Bringi, Kuthar and Vishaw	183-841	6.9	5.7-104	0.1-1.0	-	Presence of high Iron content are the main hazards

Sindh, Dal, Anchar	335-1380	7-7.69	7.1-92.00	0.01-0.42	0.03-0.16	No issues of GW quality
Pohru, Vij Dakil,	97-1580	7.1-8.2	05-199	0.01-0.57	-	Presence of Gas and Iron as main hazards
Dodhganga, Sukhnag	490-950	7.00-7.40	7.1-50	0.02-0.48	Tr-12.8	
Rembaira, Arpal, Romshi	175-2800	6.9-8.8	7.1-273	Trace-0.6	Trace-5.72	Fe is present more than permissible limits in pockets
	Dynamic Ground water resources of Jhelum					
Sub-watersheds	**Depth range (m)**	**Discharge(lps)**	**Annual Replenishable GW resources (Ham)**	**Net Annual GW Draft (Ham)**	**Projected Demand for Domestic and industrial uses up to 2025 (Ham)**	**Stage of Ground Water Development**
Lidder, Bringi, Kuthar and Vishaw	19.50-300.29	2.5-55	45646	4861	7062	10.64% Safe
Sindh, Dal, Anchar	42.65-357.20	10-40	14895	9277	12368	62.28
Pohru, Vij Dakil,	2-4 m bgl	10-20	18970	4472	7167	23.57%
Dodhganga, Sukhnag	12.00-390.00	2-50	25183	7532	10613	29.91%
Rembaira, Arpal, Romshi	3-4 m bgl	10-55	27994	10216	12368	27.42% Safe

(Source: Central Ground water board, 2013)

6. Point source(s) of pollution

In Jhelum basin, 3 sites at Rammunshibagh (Srinagar), Safapora (Ganderbal) and Sangam (Anantnag) were surveyed by the Central Water Commission for heavy metals presence (CWC, 2014). Results showed that the water at all the three sites falls within the permissible levels of heavy metal (Copper, Lead and Chromium) indicating that the Jhelum river water is free from any type of toxic and hazardous metal concentration. This is mainly due to the absence of heavy industries within the Jhelum basin. The Central Pollution Control Board (CPCB) is monitoring four locations in the Jhelum basin for Biological Oxygen Demand (BOD) as shown in the Table 9 (CPCB, 2015). The river is classified in two priority classes (Class IV and V).

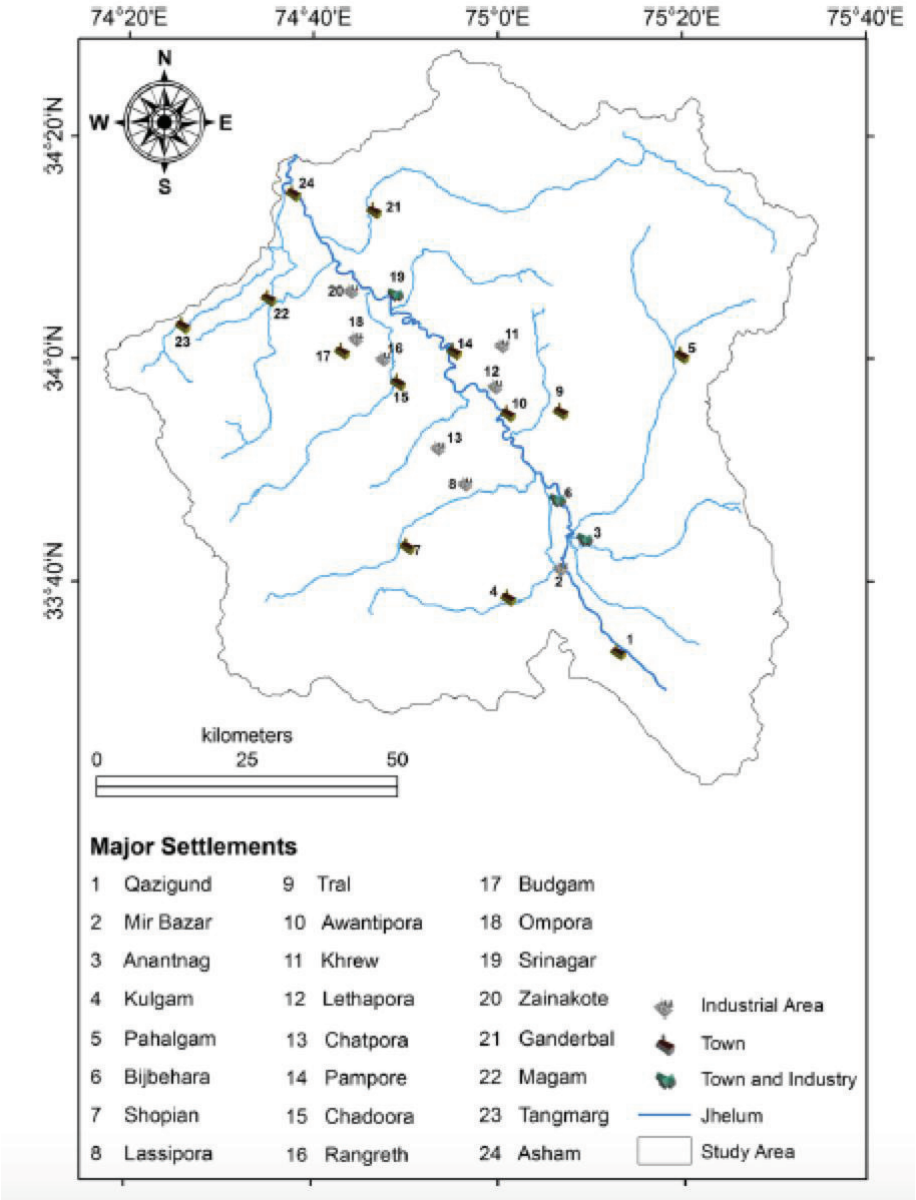
Table 9: Showing locations of monitoring river stretches in Jhelum basin.

Sr. No	River Name	Approx length of stretch (kms)	Towns Identified
1	Chut kul	5	Srinagar,Fatehkadal, Maharajganj
2	Gawkadal	2	Srinagar, Shaheed ganj
3	Jhelam	40	Srinagar, Karan nagar
4	Liddar Nalah	5	Anantnag

(Source: CPCB, 2015)

Rather et al., 2016 has reported the water quality of Jhelum river showing that Dissolved and suspended solids are present in higher concentration in Jhelum river especially near urban areas which is attributed to the anthropogenic influences and high erosion rates in the catchment (Zaz and Romshoo, 2012). Comparative analysis of water quality between 1983 (Sunder, 1983) and 2016 (Rather et al., 2016) reveals that the concentration of nitrate-nitrogen has increased from 185 to 672 μgL−1 in the Jhelum basin indicating an increase of 260 % over the years. TDS values during the same period showed an increase from 118 to 157 indicating an increase of 33 %. Besides, electrical conductivity values also showed an increase from 196 to 239 μScm−1, a 22 % increase over the years. Upstream areas of the Jhelum basin which are mostly rural are less polluted as compared to the downstream areas which are urbanized. The high values of the physicochemical parameters especially nitrate enrichment and increased sediment load indicate clear human footprint in the catchment of the Jhelum. The impact of large-scale urbanization especially along the banks of the river Jhelum is clearly evident from the water chemistry analysis. Figure 7 shows the location of the point and non-point sources of pollution in the Upper part of the Jhelum basin. There is a need for immediate remedial measures to

be taken up for improving the deteriorating water quality in the basin. In this context, the efforts should include blanket ban on expansion of settlements along river embankments and naturally vegetated areas, reforestation of degraded forest areas, afforestation of barren lands, construction of check dams, treatment of household sewage before its discharge into the rivers and water bodies, etc. The waters of the Jhelum are also polluted by the huge tourist influx into the Kashmir valley. It hence becomes imperative to scientifically assess the carrying capacity of the Kashmir valley in general and tourist places in the basin in particular to ensure sustainability of environmental goods and services that the river Jhelum provides for the region (Rashid and Romshoo, 2013).



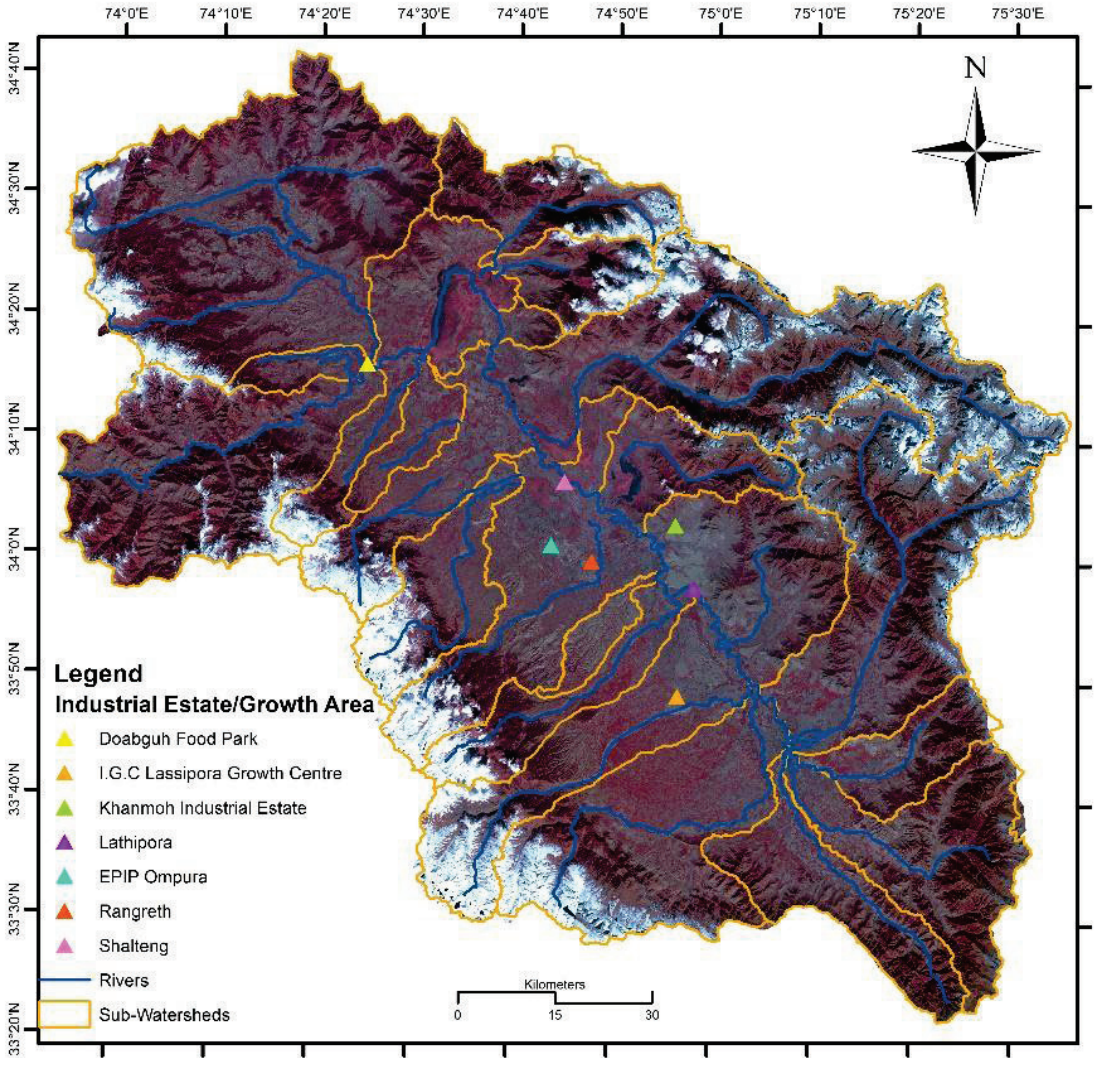
Map No 7: Major point and non-point sources of pollution in upper Jhelum (Source: Rather et al., 2016)

7. Industry / Industrial area / Developmental project:

Table 10: Showing Industrial Estates in Jhelum Basin (

District	Watershed	Name of Industrial Estate Area	Total Land (In Kanals)	No of Units
Srinagar	Arpal	Khanmoh - Industrial Estate	1878	564
	Arpal	Khanmoh - Food park	160	43
	Dodhganga	Shalteng	94	42
Budgam	Dodhganga	Rangreth	1147	193
	Dodhganga	EPIP Ompora	1000	Under Development
Pulwama	Rembaira	Lathipora	-	-
	Rembaira	IGC Lassipora - Growth Centre	6193	117
Baramula	Lower Jhelum	Doabgah - Food Park		

Source: Jammu & Kashmir State Industrial Development Corporation)



Map No 8: Map showing Industrial Estates in Jhelum Basin

In general, there are no heavy industries in the Jhelum basin that is the primary reason for overall good water quality of the Jhelum. However, there are a number of Industrial Estates established all across the basin hosting smaller industries of every kind, the details of which are given in the Table 10. Figure 8 shows the location of these Industrial Estates in different watersheds of the Jhelum basin. Most of these Industrial Estates have poor pollution control measures in place. The majority of the industrial units in these estates can be categorized into food processing, cold storages, diaries and milk processing plants, steel industries, packaging industries and a few tanneries as well.

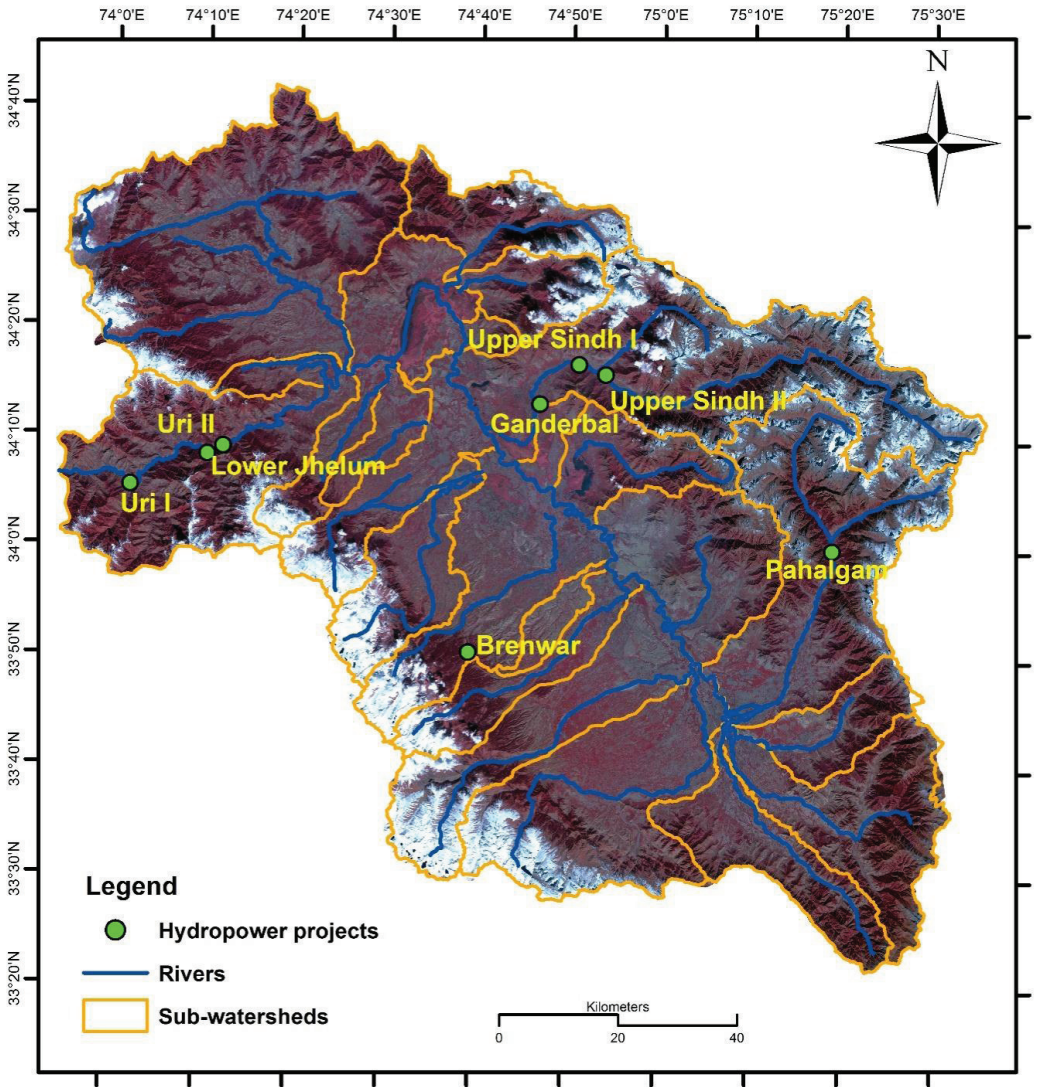
Table 11: Showing Hydroelectric Power plants in Jhelum Basin.

S.no	Project Name	River	Capacity MW
1	Lower Jhelum Hydroelectric Project	Jhelum river	105
2	Upper Sindh Hydroelectric Project-I	Sindh Nallah tributary of Jhelum	22.6
3	Upper Sindh-II Hydroelectric Project	Sindh Nallah tributary of Jhelum	105
4	Uri-I Hydroelectric Project	Jhelumriver	480
5	Uri-II Hydroelectric Project	Jhelumriver	240
6	Ganderbal	Sindh river	15
7	Phalagam	Lidder river	4.5
8	Brenwar	Dodhganga river	8
9	Kishenganga HE project	Nelum	330

Source: Jammu and Kashmir State Power Development Corporation Limited)

Given its special geographical position, Jhelum basin has enormous potential for development of hydropower energy. The estimated runoff the river Hydropower potential of the state is reported to be 20000 MW out of which the identified hydropower potential of the Jhelum basin is about 4500 MW. The existing and pipeline hydropower development of the Jhelum basin is about 1311 MW (Table 11). Figure 9 shows the location of the ongoing hydropower projects in the Jhelum basin. The hydropower is harnessed by National Hydropower Corporation (NHPC) and the State Power Development Corporation (SPDC).

Though the hydropower development in the basin is just 30% of the identified potential but the way the hydropower development is promoted in the state, it has tremendous environment costs for this mountainous Jhelum basin. It has been very well accepted that the growing human interference in the global environment has increased so much so that if left unattended, it may endanger survival of the organisms on this blue planet in the coming near future. Therefore, it is important that the hydropower development is promoted in a way that envisages minimum environmental costs in the basin. The hydropower development has become a contentious issue between India and Pakistan sharing the Indus waters. The two countries failed to resolve their differences over the Kishanganga HE project and the matter was taken to the Court of Arbitration.



Map No 9: Map showing Hydropower projects in Jhelum Basin

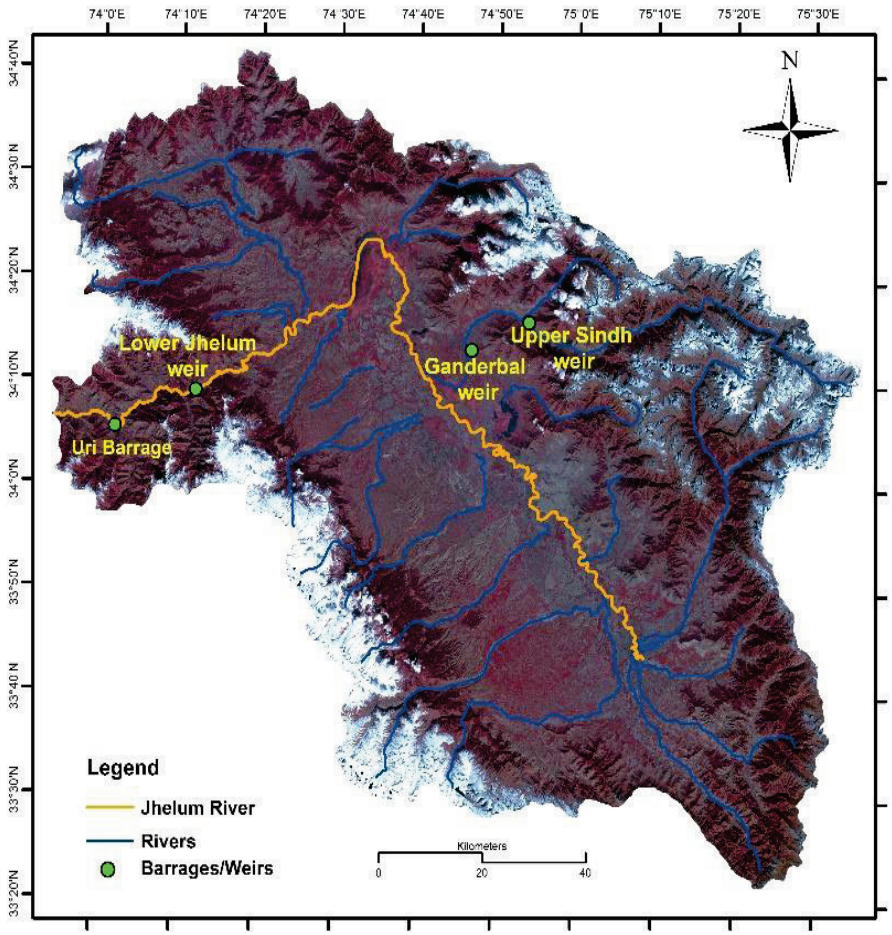
7.1 Barrages and Weirs in Jhelum Basin

Table 12: Showing Barrages and Weirs in Jhelum Basin

Barrage/Weir name	Tributary name	Location	Length(m)
Ganderbal Weir	Sindh nallah Tributary of Jhelum	Kangan	-
Lower Jhelum Weir	River Jhelum	Baramula	113.11
Sumbal /Upper Sindh - II Weir	Sindh nallah tributary of Jhelum	Kangan	73
Uri Barrage	Jhelum	Uri	95

(Source: WRIS Database)

In addition to the runoff the river hydropower projects detailed in the Table 11, there are a few barrages and weirs in the Jhelum basin. The details and location of these barrages and weirs are given in the Table 12 and Fig. 10



Map No 10: Showing Barrages/Weirs in Jhelum Basin

7.2 Airfields, Railways, Highways:

- Sheikh-ul-Alam International airport Srinagar, Kashmir
- Four lane National Highway- NH1A
- Railway line from Qazigund to Baramulla (119 Km)
- Airfield at Koil, Pulwama
- A few firing ranges and cantonments

In the Jhelum basin, we have a few mega development projects as listed above. Specifically, the four lane national highway and the railway line in the midst of the Jhelum basin has potential to interfere with the hydrology of the Jhelum basin. These two mega transport lines hindered with the movement of flood waters during the 2014 extreme floods. The exact role of these two development projects in influencing the river hydrology especially during flooding is unclear and needs to be investigated for taking any corrective measures.

8. River stretch submerged under reservoir, if any (state of siltation in the reservoir)

All the hydropower projects in the Jhelum basin are runoff the river project with small ponding or storage as provided under the Indus Water Treaty (IWT) governing the sharing of the Indus waters of which Jhelum is one of the six major tributaries. There are as such no dams in the Jhelum basin and therefore no stretch of the river is sub-merged due to the setting up of the hydropower projects in the. The pondage of these projects is small and have not submerged any stretch of the river or tributary.

9. Downstream dried stretch of the river if any, from water diverted / abstracted into tunnel or canals

The Uri Hydro-electric project which is runoff of the river project on the Jhelum main has resulted in significant reduction in the flow of the Jhelum along the main stretch from the intake (pondage) downstream of the powerhouse, particularly during the lean winter period.

Further, the controversial Kishenganga project which is coming up on the Nelum tributary which joins Jhelum downstream in Pakistan controlled Kashmir envisages diversion of the waters through a tunnel into the Wular lake located on the main stretch of the Jhelum river leaving the Nelum river dry after the project site. Pakistan objected to the diversion of the waters and approached the Court of Arbitration for the dispute resolution a provided under the IWT. The Court of Arbitration as provided opined for the release of 9 Cumecs of water from the reservoir downstream into the Nelum tributary in order to maintain the required environmental flows in the Nelum.

10. Riverfront development, floodplain conversion (other than traditional and seasonal farming)

The Jhelum river front in the Srinagar city has been recently developed to attract tourists and the tourist infrastructure in terms of the parks, viewsheds and footpaths have been laid on the banks of the river, particularly on the right bank. However, the experiment has not worked well at places as one could see the adverse impact of this development on gigantic chinars along the Jhelum river bank that have dried down due to the earthworks along the river fronts. In addition, there has been unregulated conversion of the Jhelum floodplains to the built-up and other land uses in the entire basin. The conversion of the floodplains has an adverse impact on the floodwater storage as was evident during the 2014 floods.

11. Sand/boulder mining etc

Sand and boulder mining is a common practice in the Jhelum main and tributaries all across the basin. The mining of the sand and gravel from the riverbed is being done haphazardly with adverse impacts on flood control and mitigation as can be seen from the Plate-5. The haphazard mining of the gravel have made the channel to change course in some of the high gradient tributaries of the Jhelum. There is need for zoning the river for mining purposes based on the sole criteria for improving the flood mitigation through the mining of the riverbed material in the Vishav. Once allotted, the mining leases/licenses for a particular stretch of river course need to enforced strictly on the ground as per the zoning scheme. Any violation of the mining contract needs to be dealt severely by the concerned agencies. The uncontrolled mining of the river Jhelum has had adve4rse impact on the fish spawning in the river. Certain indigenous species of fish have become rare and endangered in the basin like schizothorax species.

Figure 5: Showing the Haphazard Riverbed Mining and the Consequent River Shifting of the Vishav Tributary of Jhelum

There are also a number of stone quarries along the foothills of the mountain in various tributaries of the Jhelum basin where rampant quarrying on daily basis is a routine with serious implications for the environment and the geological setting of the region, Panthachowk, Athwajan, Zewan, Khunmoh, Wuyan, Mandak pa, Donpai and Dever and Liser are some of the major stone quarrying sites in the basin.

12.Mineral Mining.

There is mineral mining of limestone, gypsum, marble, granite, lignite, slates, quartzite, and graphite in the Jhelum. The location, reserves and other information about various mineral mining sites in the Jhelum basin is given in the table 13. The Department of Geology and Mining of the state government regulate the mining and extraction of the minerals.

Table 13: Showing Mineral Mining sites and their location in Jhelum basin.

Mineral	Occurrence	Reserves	Uses	Watershed
Limestone	All districts of the Valley	6081 Million tons	Manufacture of Cement, Calcium Carbide, Quicklime, Bleaching- Powder, Glass, Paper, paints	All Watersheds
Gypsum	Baramulla	150 Million tons	Cement, fertilizer, Filler in Paper, Paints, Rubber, Textile industry, Plaster of Paris & sanitary ware.	Lower Jhelum
Marble	Kupwara	400 Million Cubic mtrs	Decorative building stone.	Pohru
Granite	Ganderbal ,Baramulla	5.2 Million Cubic mtrs.	Decorative building stone.	Sindh, Lower Jhelum
Lignite	Handwara	8 Million tons	Thermal power and low grade fuel	Pohru,
Slates	Baramulla	9.6 Million cubic mtrs	Building Material	Lower Jhelum
Quartzite	Anantnag, Baramulla	2 Million tons	Glass & IT industry	Lower Jhelum,Lidder

	and Kupwara			
Graphite	Baramulla	62 Million tons	Crucibles, foundary, refractory, paints	Lower Jhelum

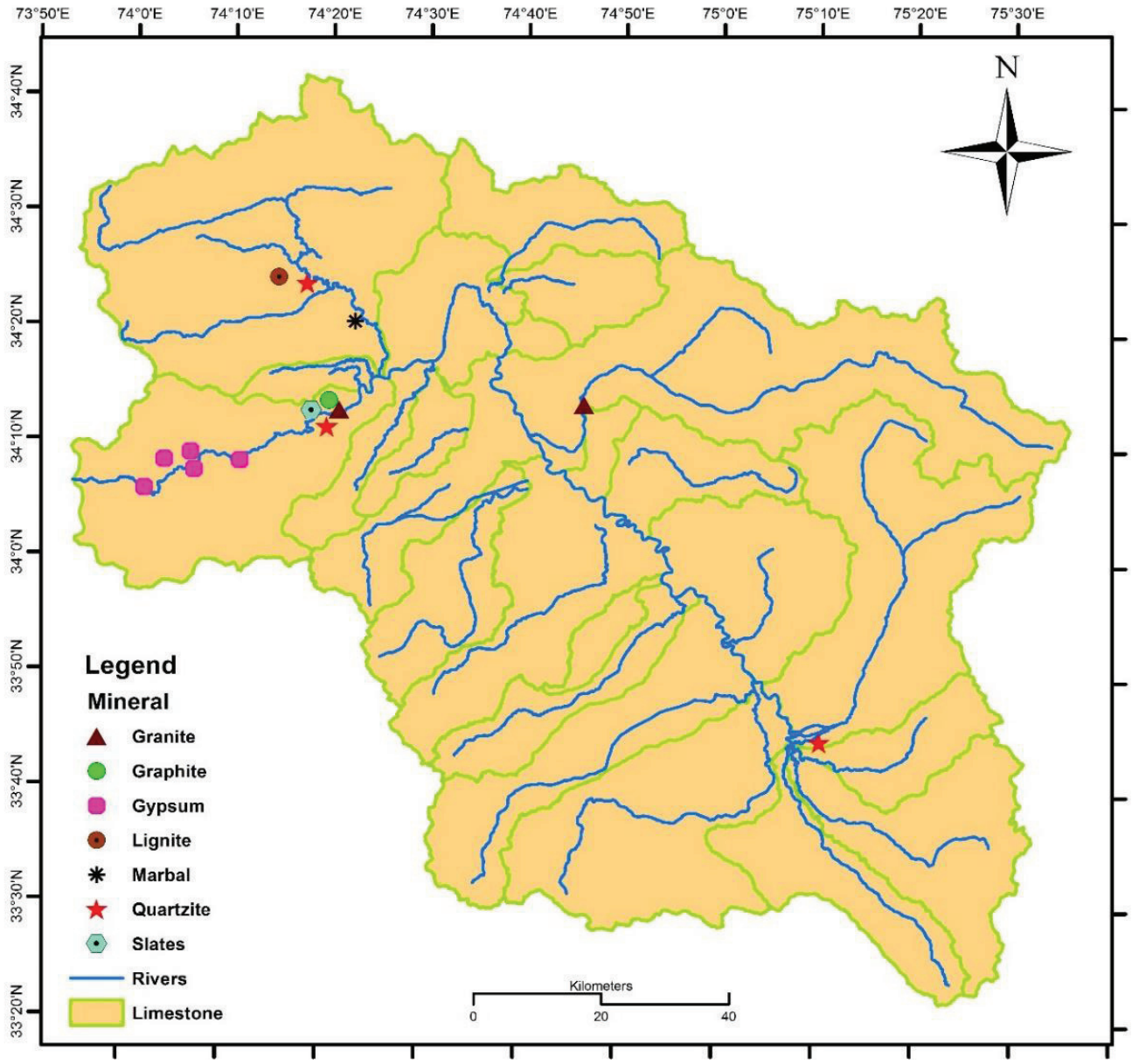
(Source: Department of Geology and Mining, Jammu and Kashmir Government)

Table 14: Showing mineral based units in Jhelum Basin.

Sr. No	**Name of District**	**Watershed**	**Portland Cement**	**Plaster of Paris**	**Lime Kiln**	**Marble Processing**	**Total**
1	Srinagar	Dal	5	6	-	-	11
2	Budgam	Dodhganga	-	-	-	-	-
3	Pulwama	Rembaira	5	2	2	-	9
4	Anantnag	Lidder	1	-	7	-	8
5	Baramullah	Lower Jhelum	-	2	-	-	2
6	Kupwara	Pohru	-	-	-	6	6
		Total	11	10	9	6	

(Source: Department of Geology and Mining, Jammu and Kashmir)

Table 14 provides the information about mineral based industries in the Jhelum basin. Cement production is one of the main mineral-based industries in the basin. Figure 11 shows the location of the mineral mining sites in the basin.



Map No 11: Showing the location of Mineral mining sites in Jhelum Basin

EXISTING OR SIMMERING CONFLICTS OVER THE RIVER

Though not based on any international water law but governed by political compromise with a focus on engineering solutions, the waters of the Jhelum and other Indus river are shared between the two countries; India and Pakistan under the Indus Water Treaty (IWT) signed in 1960 and is often widely cited as a success story for transboundary sharing of river waters. It has survived despite three wars, several skirmishes, cold relations and frequent military mobilizations during the last 56 years of

hostility between the two countries. The treaty involved the division of the Indus River system comprising of three eastern rivers - the Sutlej, the Beas and the Ravi, and three western rivers - the Indus, the Jhelum and the Chenab. The treaty gave India exclusive rights to the three eastern rivers up to the point where they enter Pakistan. At the same time, Pakistan was given exclusive rights to the western rivers.

The key aspect of the treaty is the mechanism to adjudicate future disputes over the allocation of water through structured negotiations which has worked very well till date. Recently, diverge national views have emerged about the interpretation of different clauses of the treaty and a minority in both the countries is even asking revisiting the treaty on political considerations and perceived injustice. However, majority of the experts in both the countries acknowledge that there are good reasons to supplement and expand the treaty using scientific knowledge to address issues that have emerged post-IWT like climate change, environmental flows, watershed management, groundwater etc. so that the implementation of the treaty and dispute resolution mechanism is modernized for promoting peaceful relations between the two countries (Romshoo, 2016).

PEOPLES CONNECT WITH WATER

Jhelum provides services and goods to a number of people in the basin. People in the basin are therefore connected with river through activities which they perform for their livelihood mainly fishing, vegetable gardens in and around the lakes, boating, tourism etc. Jhelum is lifeline of the city of Srinagar and some other major town along its course from Verinag to Uri. Over the years, some water bodies and even the main river have emerged as an important tourist destination for amusement, accommodation and sightseeing purposes. The nine bridges over the river, which were built long years ago, also serve as hot spots of tourism and public gathering in Srinagar. Embankment areas of the river also served as perfect sites for a stroll and leisure. Recently, Water Taxi service has been introduced to provide amusement of cruising in Jhelum for locals and tourists.

Recently, there have some cases of Non-Governmental Organization coming up in the basin with an interest the solid waste disposal and creating awareness among the people about the need for cleanliness of water courses and water bodies. The upper reaches of all the tributaries of the Jhelum are home to the cold-water fish like trout. In past few years, there has been decrease in the trout fish population as well as the local varieties of fishes which are now rarely found in Jhelum basin. Few reports have been written on the loss of trout and local fishes in the Jhelum basin (Box 2 and Box 3).

13.BOX 1

India water Portal

Title: Kashmir's lake fisheries are dying a slow death

Authored By : Neha W Qureshi M Krishnan, Posted Date : Fri, 2015-03-06 22:33

The decline of local species, aggressive promotion of species such as carp, and emphasis on tourism have led to a decline in fish production in Kashmir's Dal and Wular lakes. Fisheries form an important component of the economy of Jammu and Kashmir, which along with agriculture, contributes a significant 23% to its Gross State Domestic Product (GSDP). Besides being an important allied activity to agriculture, it contributes significantly to the agricultural economy and also generates self-employment. The paper titled 'Lake fisheries in Kashmir: A case more undone than done' published in the Economic and Political Weekly, informs that the two important lakes Dal and Wular, contribute as high as 70% of the total fish production in the state. They were noted for having a flourishing fisheries production over the years but recent data on fish production shows a decline in fish catch in both these lakes.

Reasons for decline in fish production

- **The introduction of the carp species of fish** in Dal lake and heavy siltation in Wular lake have led to a consistent decline in the production of schizothorax, a local fish species.
- Besides this, **negative externalities of tourism** such as excessive growing of vegetable crops on floating gardens leading to algal blooms, have all led to a decline and destruction of the breeding grounds of the local fish species.
- The problem of fisheries in Kashmir lakes is a double-edged sword and has arisen due to the **dilemma created due to differential objectives by the Department of Fisheries and the Department of Tourism**. While on the one hand the fisherfolk who derive primary income from lake fishery are in favour of schizothorax fishery, they also want to increase total fish production from the lakes to meet the ever-increasing demand of the local consumers irrespective of the species.

14.BOX 2

thethirdpole.net
UNDERSTANDING ASIA'S WATER CRISIS

The troubled trout of Kashmir
The Third Pole, April 18, 2016

Brought to Kashmir from Europe a century ago, the trout is imperilled by pollution, human intervention, and climate change

Trout caught in Pahalgam Valley, Kashmir [image by Matthew Laird Acred]

According to a recent study conducted by Farooz Ahmad Bhat, senior assistant professor at the faculty of fisheries of the Sher-i-Kashmir Institute of Agriculture Sciences (SKUAST), "in most of the water bodies of Kashmir valley the fish catch per unit effort has decreased over the years". As this is an index of abundance, the survey shows that the fish populations have decreased over the years. "The ecological degradation in their habitats mostly due to lifting of sand, boulders, pebbles and stones from the river beds illegally has affected their population over the years," the report says. There are multiple causes for this problems, the study states, that, "The use of biocides (pesticides, insecticides, herbicides, fungicides, etc) and other chemicals in the horticulture and agriculture activities have contaminated our water resources. Consequently the aquatic biota, particularly fishes are getting affected." It goes on to state, that, "hydroelectric power projects (HEPP), barrages, weirs are also responsible for the decline in fish population in Kashmir waters." A third reason is the heavy deforestation. According to the Indian State of Forest Report, the encroachment of the forest land in the state had grown 88% between 2003 and 2012. The period witnessed 6,281 hectares of forest land diverted for other uses and there was no "alternative arrangements for afforestation". "This has caused sedimentation in the trout streams, damaging the habitat of the trout," says a senior fisheries officer, not wishing to be named as he was not authorized to speak to press. "Trout need cobble and boulders and crystal clear water. Sedimentation changes this and turns water muddy". A fourth reason is that many people have constructed houses close to the banks. Such violations are common along Sindh, Lidder and Ferozpora streams. "The sewage from the houses goes directly into the streams, contaminating the water," said the fisheries officer. In the past two decades, a large number of farmers have converted their rice paddies into apple orchards due to the reduction in irrigation, resulting from the declining discharge in snow-fed water bodies.

15.BOX 3

GREATER KASHMIR
After power, water scarcity hits Valley

MUKEET AKMALI and SYED IMRAN ALI HAMDANI
Publish Date: Aug 4 2012 12:00PM

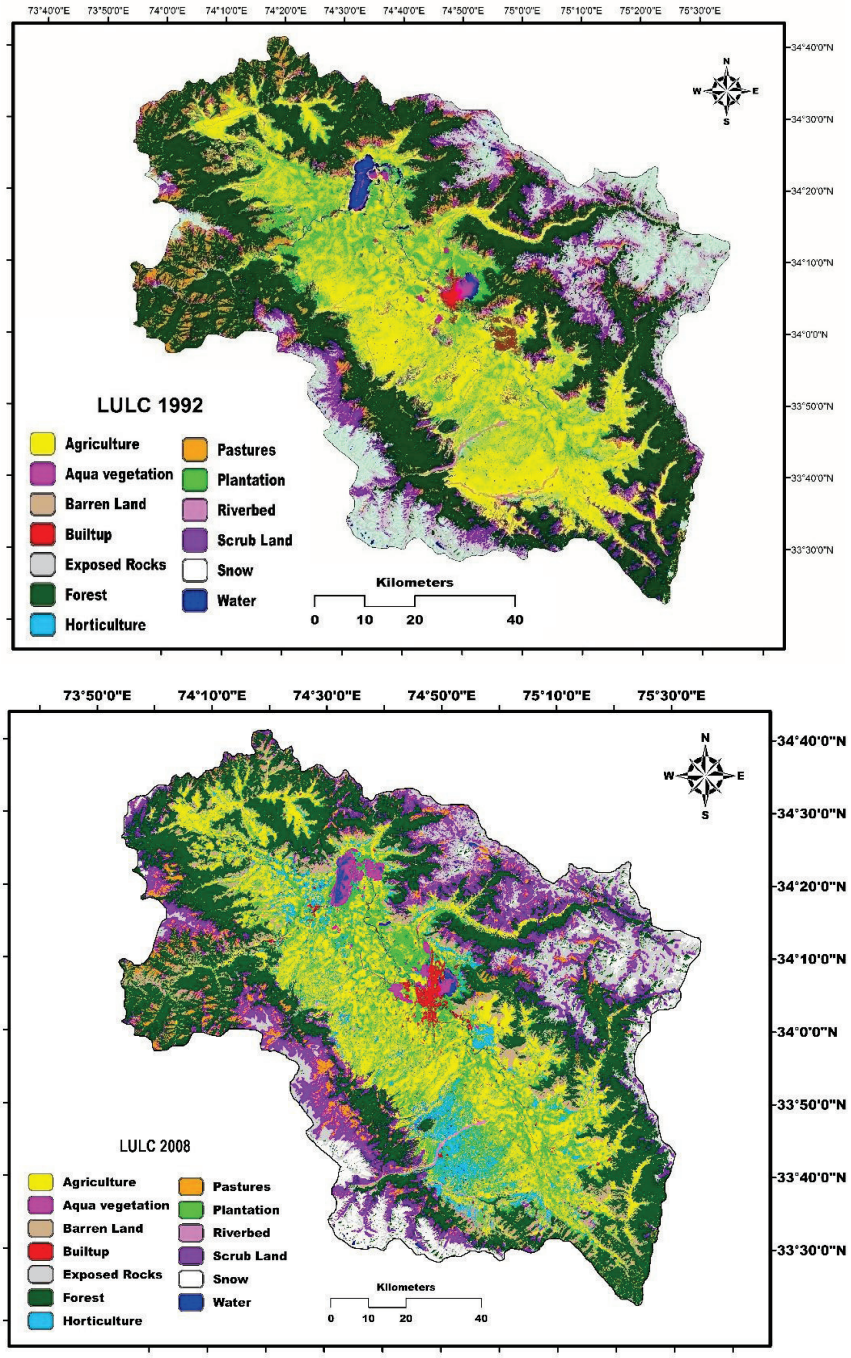
Srinagar, Aug 3: With rise in mercury during the ongoing month of Ramadhan, the Kashmir valley is reeling under unprecedented shortage of potable water, resulting in protests in different areas. The residents of Soura, Khanyar, Nowpora, Bagh-i-Ali Mardan Khan, Fateh Kadal, Nawab Bazar, Malla Bagh, Rangerstop, Khayam and many other areas complained of non- availability of water. Total potable water requirement of Kashmir is around 12 crore gallons per day, which includes 7 crore gallons in urban areas and 5 crore in rural areas. For the past few days taps are often running dry in most parts of Srinagar city. From Shivpora to Natipora to Nishat many residential colonies are running short of the supply. Ghulam Muhammad of Firdousabad Batamaloo said his family has to fetch water from nearby colony as water supply was very poor."We don't even have water for Sehri and Iftaar," Ghulam Muhammad said while carrying two buckets towards a nearby area to fetch water.The Batamaloo welfare committee president Abdul Kabir Bhat said the government was forcing people to take to streets. "PHE has already played a joke with us by not resuming work on 150 MM pipeline augmentation plan, pending for two years," he said adding the locals would soon stage protests.The residents of Shivpora have been staging roadside protests against the water scarcity in the area. They even blocked the main road. "We are facing acute shortage of drinking water for past two months and the government is acting a mute spectator," said a protester Khaleel-u-Rehman. The residents of Gupkar housing colony, in the neighbourhood of villas of government top brass including Chief Minister Omar Abdullah, have similar tales to narrate. Yasir Shah, a local said: "We are craving for drinking water supply while our MLA is least bothered about his constituency."

Group of Kashmiri women carrying vessels filled with drinking water on the outskirts of Srinagar

Zargar said that people should use water judiciously. "People are using potable water for watering lawns, flowers and for construction. We request them to install hand pumps and use ground water for these purposes. Portable water should be used only for domestic purposes," he appealed. "There's no deficit between the supply and demand of water. City is getting around 70 MGD of water. But the problem is of misuse including use of boosters," PHE Executive Engineer Shafaat Hussain Qadeemi told Greater Kashmir. He said despite repeated appeals the people were not giving up the water misuse.

ANY OTHER NOTABLE ACTIVITY WITH POTENTIAL OF IMPACT ON THE RIVER

16.Massive Land system Changes



Map No 12: Land systm changes in the Jhelum Basin

(Source: Khalid et al. 2014)

Table 15: Showing Landuse/Landcover area statistics in Jhelum Basin

Sr. No	Class Name	Area 1992 (Km^2)	Area 2008 (Km^2)	Change 1992-2008 (Km^2)
1	Agriculture	3010.94	2691.39	-319.55
2	Aquatic vegetation	75.04	117.29	42.26
3	Built up	59.15	214.33	155.18
4	Barren	478.73	508.88	30.15
5	Exposed rock	1033.20	1183.82	150.63
6	Forest (including pastures)	5053.65	4469.01	-584.64
7	Horticulture	345.23	755.33	410.09
8	Plantation	894.43	858.77	-35.67
9	River bed	98.12	75.13	-22.99
10	Scrubs	1495.48	1826.73	331.25
11	Snow	562.31	447.58	-114.73
12	Water	110.24	68.27	-41.97

(Source: Khalid et al. 2014)

Over these decades, landscape in the Jhelum basin has been largely transformed and land is being converted to other uses without any regard to its congenital land use suitability. Increased population has also put pressure on the arable agricultural land for settlements. With changing hydrological patterns, a change in the cultivation patterns is being observed with a shift from agricultural to horticultural land use. Large scale deforestation, dwindling grasslands, depleting water bodies and denuded landscapes have transformed the land surface processes linked to hydrology, erosion and weather patterns in the Jhelum basin that are manifest by decreasing stream flows, increasing sediment and nutrient load (Romshoo, 2015; Badar et al., 2013, Romshoo and Muslim, 2011, Romshoo and Rashid, 2012), shrinking fish habitat and degrading water quality (Rashid and Romshoo, 2012). The land system changes in the Jhelum basin between 1972-2008 as detailed above in the table15 and shown in the Figure 12 have serious implications for the catchment scale hydrological processes, not in the basin alone but also in the downstream part of the Indus. Extensive deforestation of natural forests in the upland catchment area for timber and fuel wood reduces the water-retention capacity of the forest eco-systems. The rapid expansion of human settlements together with the construction of hydroelectric dams, barrages and an extensive system of roads, railways, bridges, flood protection embankments and drainage channels all serve to divert or constrain the natural pathways of the river and its tributaries. These land system changes and accompanying degradation of the natural environment in the Jhelum since last few decades has affected the streamflow, surface runoff, sediment yields and water quality of

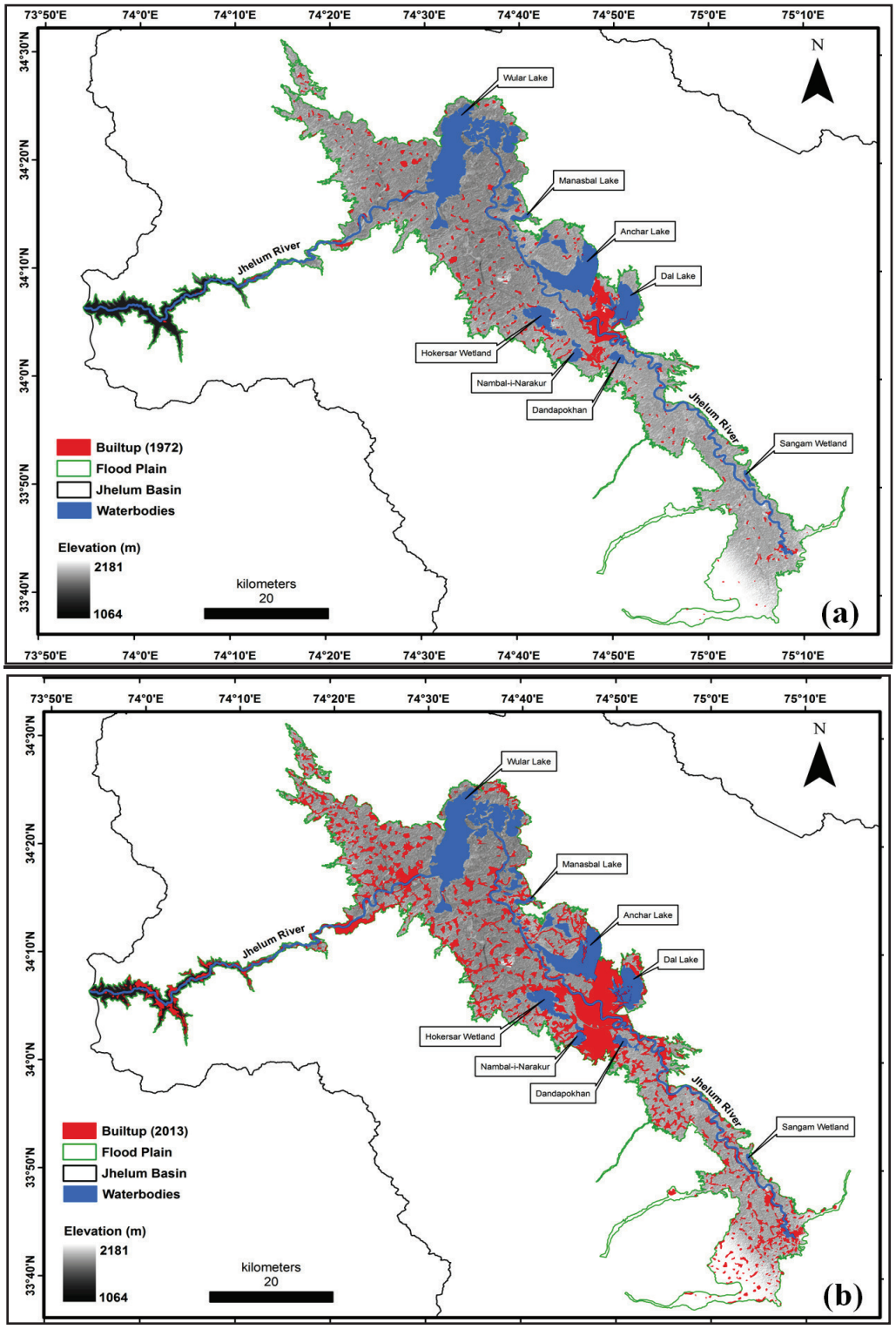
the Jhelum river system. As could be noticed from the table, the area under water intensive paddy cultivation has decreased substantially by about 700 sq.km during the last about 40 years only and the same has been either transformed into horticulture or built up land. This has significantly reduced the demand for irrigation of the agriculture lands in the Jhelum.

17.Reckless use of Pesticides and Insecticides:

Agriculture as a nonpoint pollution source greatly affects water quality of streams due to use of pesticides and fertilizers which after degradation find their way into the streams directly causing enrichment in the concentration of nitrogen and phosphorus compounds, thereby affecting the biota of stream. The increased use of fertilizers over the years in the Jhelum basin has led to the deterioration in the water quality of Jhelum river especially in the lower plains of the catchment (Rashid and Romshoo, 2013). During the period from 1980 to 1981, 24.14 kg/ha of fertilizers were used in the Jhelum basin (Anonymous 2008). Over the course of time, people in the Jhelum basin have restored to extensive use of fertilizers to increase the crop productivity, and the application of fertilizers increased from 44.21 kg/ha in 2002–2003. An all-time high rate of fertilizer application of 97.03 kg/ha was used for 2007–2008 (Anonymous, 2008). The excessive use of fertilizers has a significant impact on the deteriorating water quality of the Jehlum river waters in the low lying areas of the catchment especially around the places where land use is dominated by agriculture. The main reasons for the deterioration of the water quality of Jhelum are increase in the nutrient and silt load from the catchment due to reckless use of pesticides and fertilizers, encroachment, and unplanned urbanization in the vicinity of the river (Rashid and Romshoo, 2013). The physicochemical analysis shows an increase of most of the water quality parameters particularly nitrate nitrogen, ammonia nitrogen, total phosphorus, orthophosphate phosphorus, and BOD from April to August. Due to the increase of these nutrients, the ecology of the river is changing and adversely affecting the distribution of aquatic flora and fauna therein. The direct discharge of the effluents and sewage from the surrounding areas into the River has increased the nutrient loading. As a result of nutrient enrichment, a drop in the oxygen content has been observed which has direct bearing on abundance of aquatic fauna.

The agricultural activities are at maximum between June and August month releasing tremendous quantities of nitrogen and phosphorus into the tributaries of Jhelum, thereby synergizing the deterioration in quality of water caused by tourist activities in the same period. In addition, heavy sewage ingress into Lidder waters, from hotels in Pahalgam, commercial places, and residential areas, is also responsible for the deteriorating water quality of Lidder River (Rashid and Romshoo, 2013). Hence, there should be proper management and disposal of wastes from agricultural, domestic, and commercial sectors. It is suggested that an appropriate mechanism be established for continuous monitoring of the Jhelum River for its land cover, hydrochemistry, biodiversity, and hydrology so that a robust strategy and action plan is developed for the conservation and restoration of this important river.

18.Urbanization and encroachment of the food plains



Map No 13: Showing Urbanization in the floodplain in 1972 and 2013 in Jhelum Basin

Table 16: Showing area under urbanization in flood plain

Class name	Area 1972 (km²)	Area 2013 (km²)
Urbanization	95.00	382.00

There have been significant changes in the land system particularly built-up in the floodplains of the Jhelum river. The Fig. 13 and Table 16 show the changes in the built up areas within the floodplains of the Jhelum basin that have occurred between 1972 and 2013. The large-scale urbanization of the Jhelum floodplains since the last 4-5 decades has adversely affected the hydrological functionality of the floodplains and increased the vulnerability of the people and infrastructure to floods.

19. Climate Change scenario in Jhelum Basin

The indicators of climate change are quite loud and clear in the Himalayas (Romshoo and Rashid 2014; Immerzeel et al. 2012). The Jhelum basin, like the rest of the Himalaya, is experiencing a temperature increase that is higher than the global mean of about 0.7 °C in the last century (Bhutiyani et al. 2007). In particular, a strong increase in the mean temperature of about 1.7 °C was recorded in the Himalayas potentially inducing strong impact on the high-altitude ecosystems especially changes in the vegetation structure and biodiversity (Aryal et al. 2014).

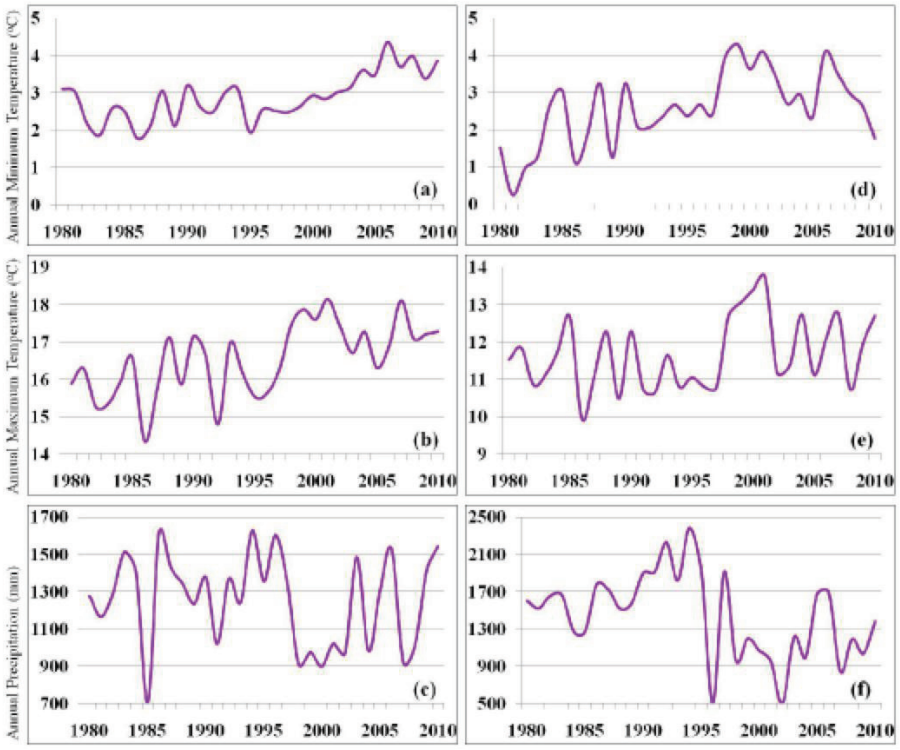


Figure 6: Showing the observed changes in minimum temp, maximum temp. and precipitation at Pahalgam (a, b, c) and Gulmarg (d, e, f) Source: Rashid et al., 2015

In the Jhelum basin, minimum, maximum and average temperatures are showing a significant increasing trend in all the four seasons as shown in the Fig. 14 (Rashid et al., 2015). Precipitation is showing insignificant decrease over time in the basin. However, the proportion of snow is decreasing and correspondingly, the proportion of rains is increasing (Romshoo et al., 2015). The temperature projections also show increasing trends for the end of this century, however, there are insignificant changes predicted in the precipitation by the end of this century as shown in the Fig. 15 (Rashid et al., 2015). The climate change is going to bring about significant changes in various land surface and atmospheric processes in the basin and might therefore adversely affect the services and products available from various land and water resources that currently support a number of livelihoods in the Jhelum basin.

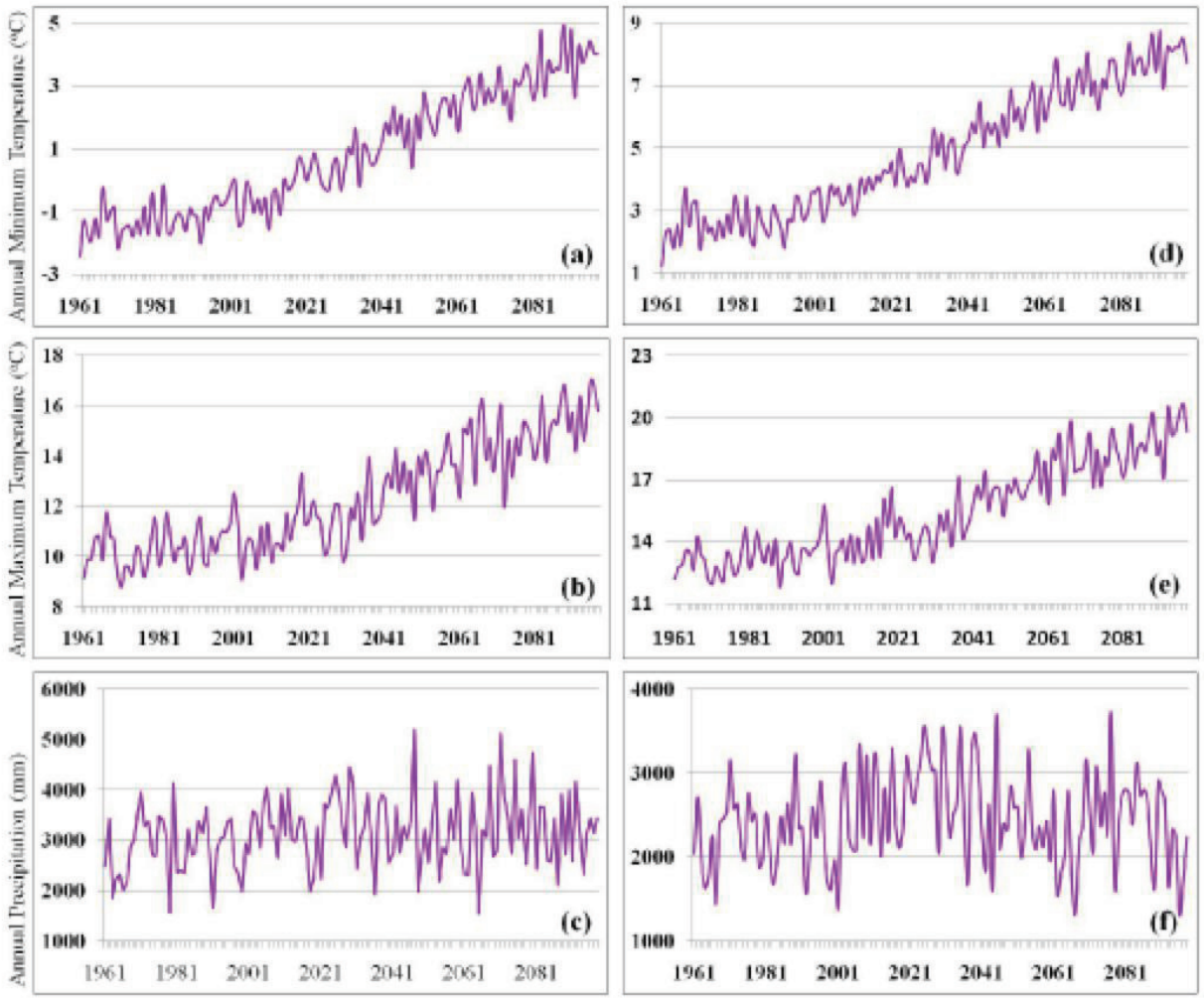
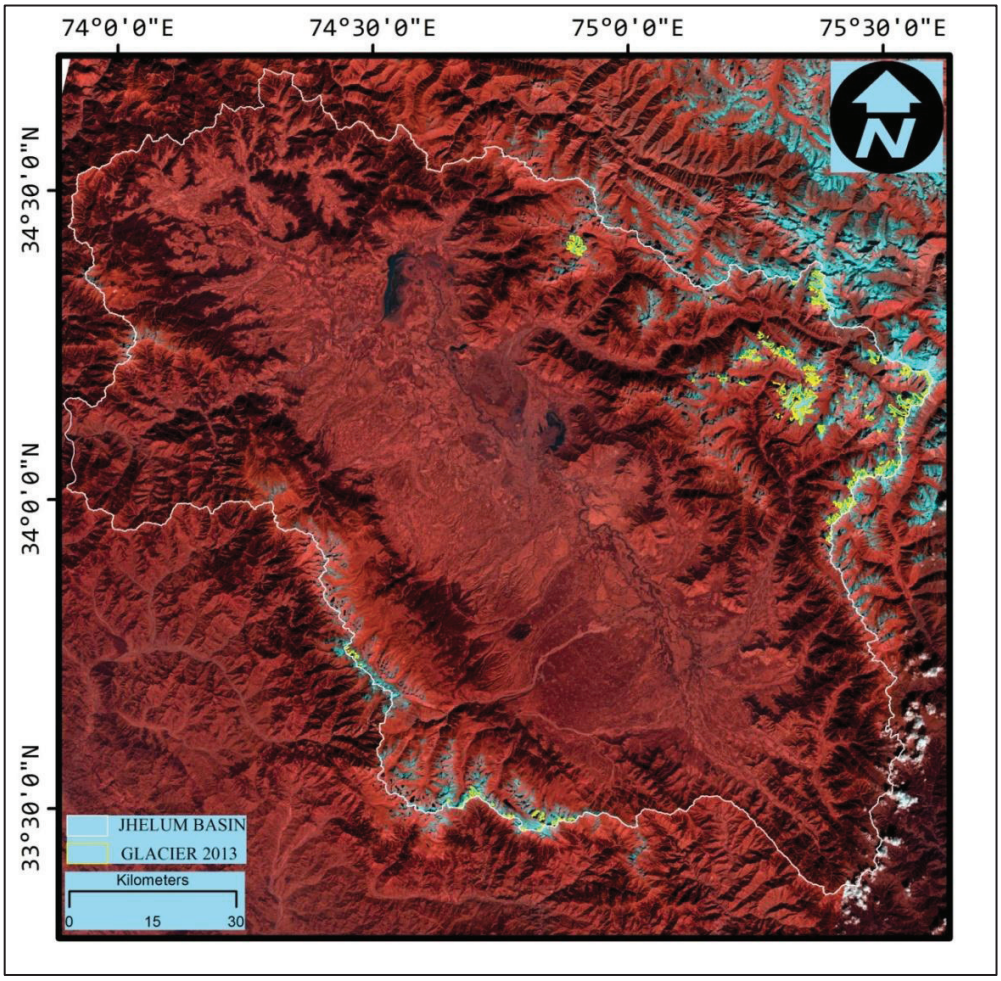


Figure 7: Showing the projected changes in minimum temp, maximum temp. and precipitation at Pahalgam (a, b, c) and Gulmarg (d, e, f) Source: Rashid et al., 2015

20.Depletion of snow and glacier resources:

The climate change signals are quite loud and clear in the region and the higher rates of recession could be due to the significant increase in the minimum winter temperatures observed in the region. During the last 51 years, the glacier area in the Jhelum basin has decreased from 46.09 km^2 in 1962 to 33.43 km^2 in 2013, a depletion of 27.47%. As a result of glacier recession in the basin, the streamflow fed predominantly by snow- and glacier-melt, is showing a statistically significant decline since the mid-nineties (Romshoo et al., 2015). The declining streamflow has potential to adversely affect agriculture, energy production, tourism and even domestic water supplies. (Romshoo et al., 2015). The time series analysis of the Normalized Difference Snow Index (NDSI) shows a depletion of the snow-cover in the region (Dar et al., 2010). precipitation falling more as rain rather than snow due to the warming in winter is observed in the Kashmir valley. Further, the concentration of black carbon in the valley is highest compared to the other high altitude station in the Himalaya (5.9 μgm^{-2}) was found in the plains of the Kashmir. All of these factors act in the same direction to decrease the volume and extent of the glaciers in the Himalayas.



Map No 14: Satellite based Glacier inventory of the Jhelum basin (2013)

Table 17: Watershed-wise Glacier area loss from 1980 to 2013 in Jhelum basin

		Total Glaciered area in sq.kms			
Sub-watershed	**No. of Glaciers**	**1980**	**1992**	**2000**	**2013**
Liddar	59	45.05	42.42	38.98	34.59
Sind	65	46.28	42.69	38.86	34.68
Vishav	18	8.78	7.93	6.73	4.77
Doodganga	6	1.61	1.53	1.33	0.78
Total	147	101.73	94.58	85.90	74.81

Figure 16 shows the location of the glaciers in the Jhelum basin in 2013. There are about 147 glaciers in the Jhelum basin covering an area of about 75 sq. km. Precipitation falls predominantly as snow during the winter. On the basis of 10-year snow cover data, the snow cover in the Jhelum basin is highly and varies from 3%-75% as can be seen from the Table 18 (SAC, 2016).

Table 18: Minimum and maximum snow cover in Jhelum during 2004-14 (SAC, 2016)

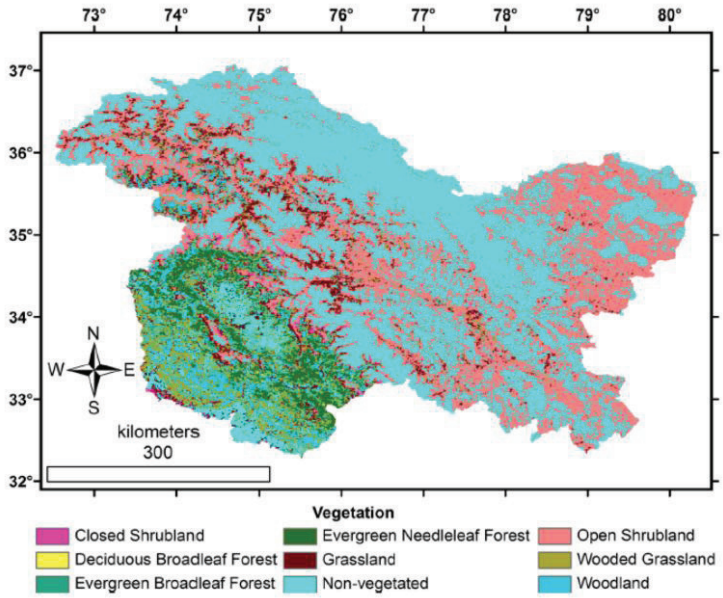
Jhelum sub-basin (14472 sq. km)				
Year	Minimum snow cover		Maximum snow cover	
	Sq. km	%	Sq. km	%
2004-05	579	4	10275	71
2005-06	289	2	6223	43
2006-07	724	5	11867	82
2007-08	145	1	10420	72
2008-09	434	3	6512	45
2009-10	434	3	11433	79
2010-11	145	1	13748	95
2011-12	1158	8	14038	97
2012-13	289	2	13314	92
2013-14	145	1	9407	65
Mean	434	3	10724	74
SD	320	2	2762	19

21.Keystone biodiversity:

The state of J&K is also called the biomass of state of India. The biodiversity of the area of J&K happens to be one of the 26 hotspots in India with high endemicity. The whole Himalayan belt is one hotspot mega center having 8 critical areas which includes two regions from the state viz Ladakh and Kashmir encompassing the

Jhelum basin. The valley of Kashmir has both deciduous and evergreen vegetation. The Chinar, Poplar, Deodar, Fir, Pine, Kail, Partal, Mulbery, Walnut and other fruit trees grow throughout the valley. Baramulla and Anantnag districts in the Jhelum basin have respectively 71% and 60% of their areas under forests. . The state of J&K has fairly rich diversity of plant life and includes angiosperms, gymnosperms and pteridophytes. Kashmir valley encompassing the Jhelum basin is well known for their medicinal properties. (Fig. 17). This area is storehouse of medicinal and aromatic plants which are used in pharmaceutical and perfume industries. The list includes 55 species of important medicinal and aromatic plants. There are 11 medicinal plants in temperate, cold arid regions of J&K. Several medicinal plants grow wild in temperate and alpine habitats. Some medicinal plants have been taken up for cultivation e.g Dioscorea deltoidea is now cultivated for its tubers rich in Diosgenin and yield cortisone, a steroid hormone. The people in the basin depend on biodiversity for their daily needs of food, medicine, fuel, fiber etc. The varied plant life also contributes to food and habitat needs of wild and domesticated life in the basin.

The faunal component of biodiversity of the state is rich with interesting and unique forms both in the forest zone and above forest line. The variety of animal forms ranges from higher groups like vertebrates, including mammals, birds, reptiles, amphibians and lower groups like invertebrates including insects and even unicellular micro-organisms. The faunal diversity of Kashmir is diverse due to its unique location and climatic condition. 16% of Indian mammals are present in state of Jammu and Kashmir including birds, reptiles, amphibians and butterflies. 75 species of mammals belonging to 54 genera, 21 families and 8 orders. Carnivores represents 32% of the total mammalian faun of the state. The total of 19 species of ungulates are reported from the state, 13 have been listed as globally threatened.



Map No 15: Major vegetation types in the J&K State (Rashid et al., 2015)

22.Stream flow Changes:

Himalayan mountainous river systems like Jhelum have complex and diverse hydrological rules. The river Jhelum that forms an important tributary of the Indus basin is mainly fed by the snow resources with quite a few glaciers. Various studies have been carried out in different watersheds of Jhelum basin that revealed decreasing trends in discharge (Romshoo and Muslim 2011; Badar et al., 2013; Romshoo, et al., 2015). The analysis of time series of the discharge data at all the stations of River Jhelum (Khanbal, Sangam, Ram-munshibagh, Sopore and Baramullah) showed significant to insignificant decrease in the annual and seasonal discharge from 1960-2010 with significant decrease in spring discharge. This observation is in agreement to the projections of the impacts of the climate change in the Himalayas carried out by various researchers. Romshoo et al., (2015) which suggest temporary and short term increases in river flows followed by a sharp decrease as the glacial area diminishes. Fig. 18 shows the depleting streamflow of Jhelum at various stations along its course from Khanabal to Srinagar

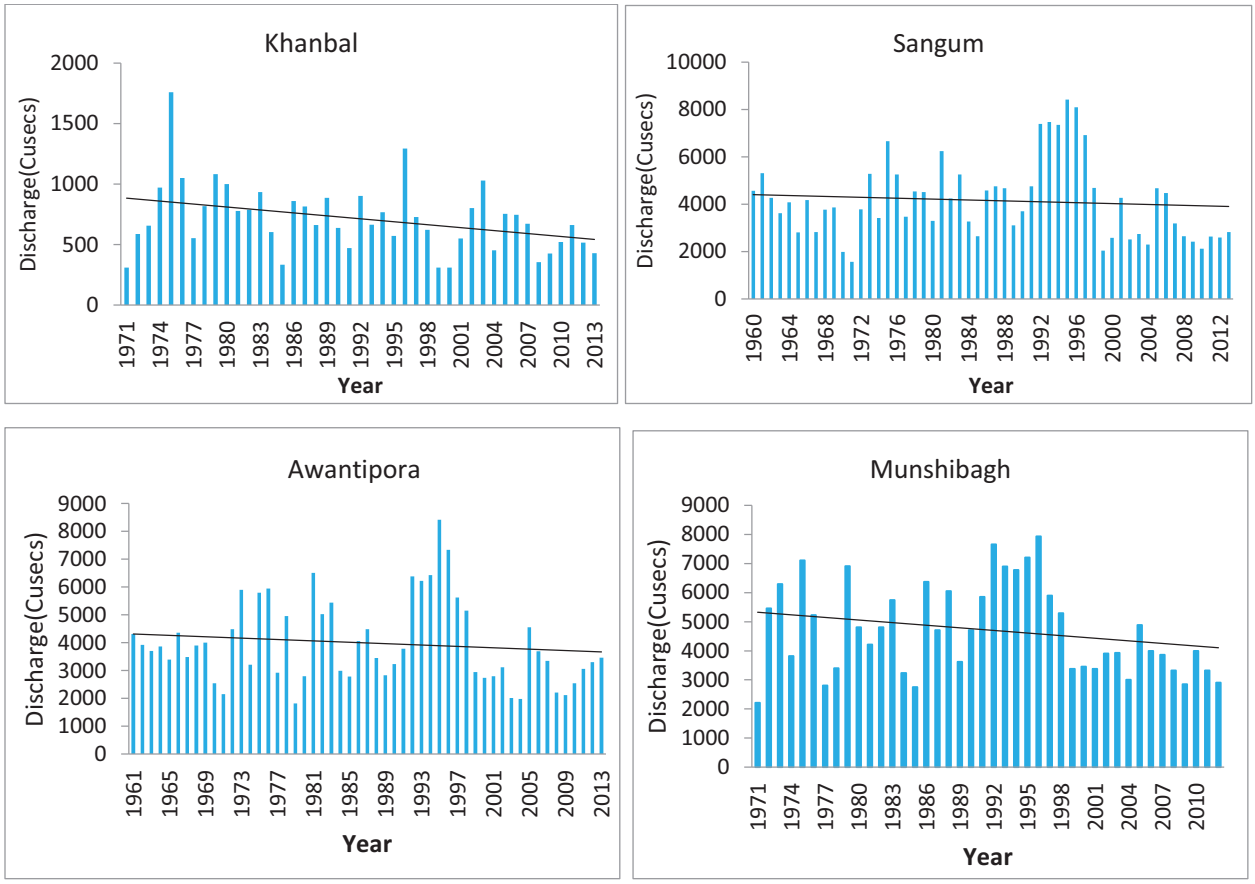


Figure 8: Historical stream flow at different station along the Jhelum River

Since most of the runoff in Jhelum is derived from the melting of seasonally accumulated snow that is reported to have declined considerably during the last few decades (Negi et al., 2009, Romshoo et al., 2015), resulting

in decreased river discharge. Sharif et al., (2012) also noted that flow magnitude and timing in the Indus are vulnerable to changes due to the climate change.

STATUS OF JHELUM RIVER USING ASSESSMENT MATRIX:

Using different indicators and contributory factors of the riverscape at the basin level, the status and health of the Jhelum river was determined using the Assessment Matrix shown in the Table 19. There are various factors related to land, water, climate, culture and demography that shape the riverscapes. Accordingly, we used all the relevant factors and indicators numbering 19 for determining the condition of the Jhelum riverscape. Most of these indicators and parameters have been briefly described in the preceding sections of the report. However, there is variation in these parameters and indicators across 24 watersheds of Jhelum. The observed transformations in the biophysical, hydrological, climatic, socio-economic and other related aspects in the basin have transformed the structure and functionality of the Jhelum river, adversely affecting the services and products emanating from a living river system. According to the assessment outlined in the table 19, the Jhelum river can be categorized as a **Sick and Threatened Riverscape** with 12 pinks 4 blues and three Reds categories for various indicators and contributory factors. The riverscape is a dynamic system and there is ample scope to reverse some of these transformations witnessed in the basin since the last 4-5 decades to restore the heathy nature of the river.

Table 19: Assessment Matrix for the determining the Health of Jhelum River

Name of River	Unit of Assessment	Indicators/Contributing Factors	Assessment
Jhelum River	**Jhelum Basin**	Catchment Vegetal Cover	B
		Protected Areas	B
		Lakes, springs and Wetlands	P
		Status of Surface waters	P
		Condition of Groundwater	B
		Status of pollution	P
		Polluting Influences (Industrialization)	B
		Dams	P
		Barrages	P
		Conflicts over the River	P
		People's Connect With The River	P
		Floodplain Condition	R

		Urbanization (cities)	P
		Climate change Scenario	R
		Depletion of Cryosphere	R
		Keystone biodiversity	P
		Historical Streamflow trends	P
		River Side Embankment	P
		People's action and awareness	P
		Total	**12P, 4B, 3R**

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CHENAB RIVER

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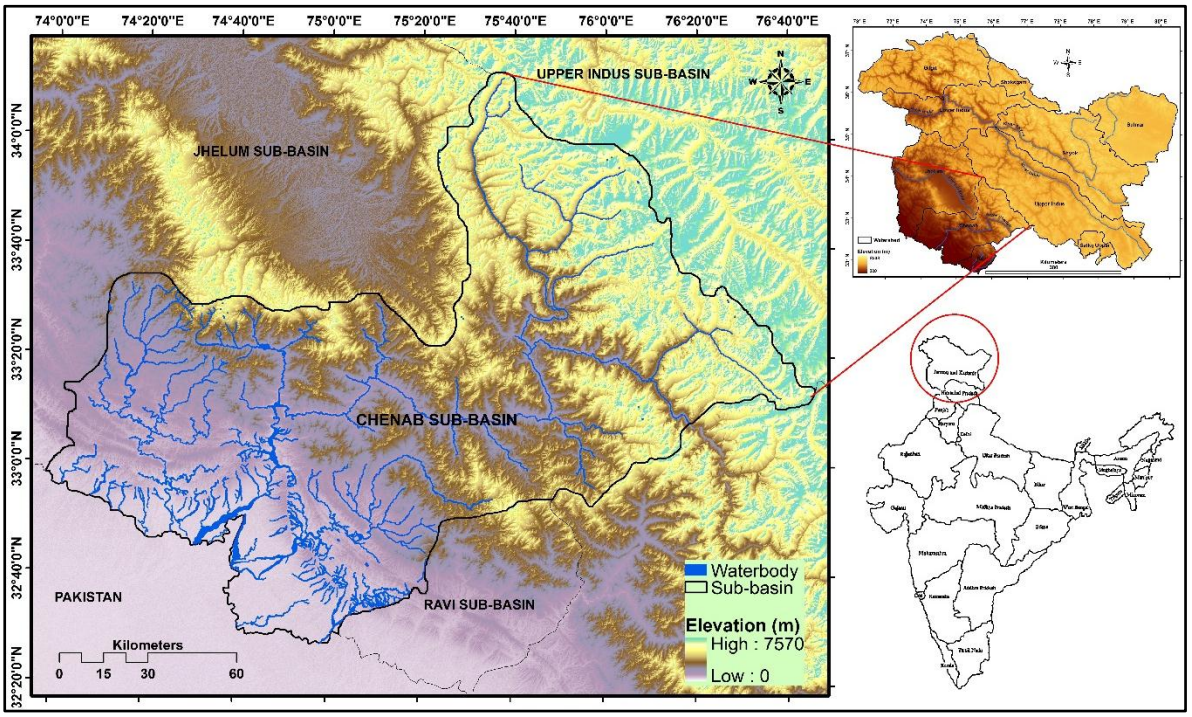
ASSESSING STATE OF HEALTH OF CHENAB RIVER

1. INTRODUCTION:

River Chenab originates from near the Bara Lacha Pass in the Lahaul- Spiti part of the Zaskar range of Himachal Pradesh snow-bound mountains. The geographical extent of the Chenab sub-basin lies between 74°2' to 77°46’ East longitudes and 32°0’ to 34°15’ North latitudes of the country (Figure 1).



Map No 1: Showing the location and extents of the Chenab Sub-basin

The river Chenab (or Chandra Bhaga) is formed after the two streams- the Chandra and the Bhaga merging with each other at an altitude of 4900 m. The Chandra and the Bhaga originate from the south-west and north-west faces of Barelacha pass respectively in the Himalayan canton of Lahul and Spiti valley in Himachal Pradesh. The Chandra initially flowing southeast for about 88 km sweeps round the base of the mid-Himalayas and joins the Bhaga at Tandi, after traversing a total length of about 125 km. The course of Bhaga up to the confluence is 80 km only having a steep slope with an average fall of about 24 m/ km. Thereafter the united stream, known as the Chenab or Chandra Bhaga, flows in a north-westerly course for about 46 km where it receives its first major tributary the Miyar Nalla on the right bank. Then it flows for another 90 km generally in a northerly direction in Himachal Pradesh when it crosses the Pangi valley before entering to Padder area of Doda district of Jammu province in Jammu & Kashmir State. The river flows in a northwest direction in this reach for a distance of 56 km. when it is joined on the right by its biggest tributary, the Marusudar at Bhandalkot. The main tributaries in its passage up to Kishtwar are the Thirot, the Sohal, the Bhut nallah, the Liddrari and the Marusudar. The Marusudar is the biggest tributary of the Chenab and meets the Chenab at Bhandalkot. Further Downstream, the river flows in a southerly

direction for a distance of 34 km up to Thathri and then takes a west ward course. In this reach about 17 km downstream of Thathri, Niru Nallah joins the Chenab on its left bank. The river Chenab thereafter flows generally in a northwest direction for another 41 km till it receives a tributary Bichleri on the right bank. Afterwards, the river traverses in a westerly direction for a distance of about 50 km. In this reach a number of small streams join in, namely Chaini, Talsuen and Ans on the right bank, Yabu Nallah, Mandial and Painthal Khad on the left bank. Downstream of Ans river confluence, the river changes its direction and flows in southerly course for about 45 km up to Akhnoor where-after it enters into Sialkot district of Pakistan. Between Kishtwar and Akhnoor, it receives the waters of the Kalnai, the Neeru, the Raghi, the Bichleri and the Ans. The Tawi and Manawar Tawi join Chenab in Pakistan. Total length of the river from confluence of Chandra and Bhaga to Akhnoor is about 504 km.

In India, the 49 watersheds of the Chenab sub-basin cover parts of two states viz. Jammu and Kashmir and Himachal Pradesh (Figure 2) (CGWB, 2013). In J&K State, the Chenab basin covers the districts of Kishtwar, Doda, Ramban, Udhampur Jammu and Rajouri. The catchment of the Chenab is elongated and narrow. The catchment area of the Chenab in J&K state is 22014 km². Table 1 provides information about the Chenab River and its all 49 tributaries. The part of Chenab falling in J&K state is covered by brown hill (on sand stones and shales) and sub-montane soils in Doda district. Adnsub-mountain and mountain meadows in Udhampur district while in Jammu district, brown hill (on sand stones and shales) and alluvial soils. The soils of the high Himalayas in the north are subject to continuous erosion and a thick silt sediment layers are deposited to form a wide valley plain.

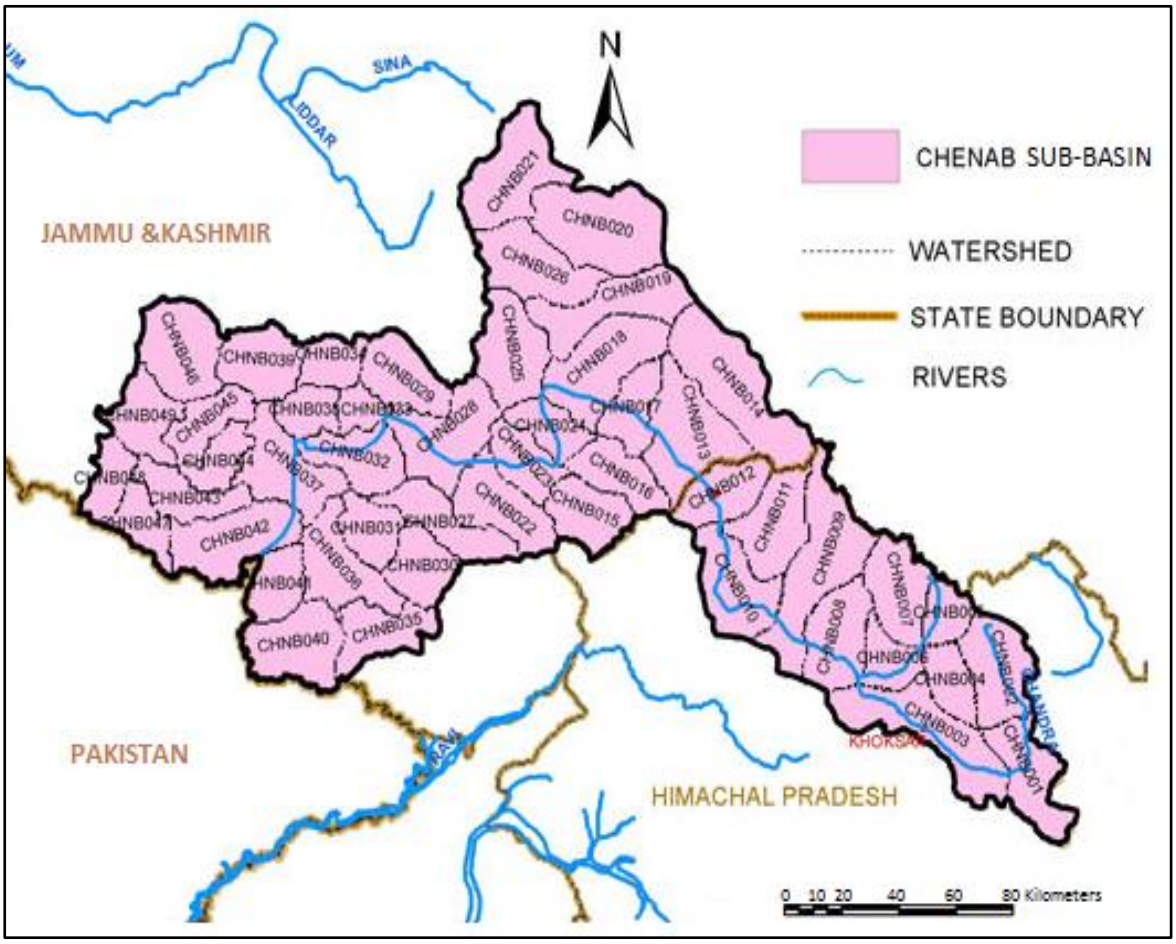
This article discusses a few of the significant issues in the Chenab river basin- one of the main tributaries of the Indus and provides the readers a snapshot of the issues confronting the water resources development in the basin. On the basis of these factors, the health and status of the Chenab basin in J&K state was determined using an assessment matrix providing qualitative weights to each of these indicators and influencing factors to arrive at the overall score of the river categorizing a riverscape as healthy, sick and dying.

Table 1: Showing the tributaries and watersheds of the Chenab basin

S.No.	WATERSHED CODE	NAME OF STREAM/ TRIBUTARY	SHARING STATE	AREA (km²)
1	CHNB001	CHANDRA RIVER	HIMACHAL PRADESH	659
2	CHNB002	CHANDRA RIVER	HIMACHAL PRADESH	700
3	CHNB003	CHANDRA RIVER	HIMACHAL PRADESH	1051
4	CHNB004	MILANG RIVER	HIMACHAL PRADESH	356
5	CHNB005	BHAGA RIVER	HIMACHAL	291

			PRADESH	
6	CHNB006	BHAGA RIVER	HIMACHAL PRADESH	342
7	CHNB007	JANKAR NADI	HIMACHAL PRADESH	623
8	CHNB008	CHENAB RIVER	HIMACHAL PRADESH	667
9	CHNB009	CHENAB RIVER, MIYAR NADI	HIMACHAL PRADESH	1154
10	CHNB010	CHENAB RIVER	HIMACHAL PRADESH	727
11	CHNB011	SAICHU NADI	HIMACHAL PRADESH	670
12	CHNB012	CHENAB RIVER	HIMACHAL PRADESH	523
13	CHNB013	CHANDRA BHAGA	JAMMU & KASHMIR	947
14	CHNB014	BHARIANG	JAMMU & KASHMIR	1160
15	CHNB015	KENTHA	JAMMU & KASHMIR	538
16	CHNB016	KALNAI	JAMMU & KASHMIR	501
17	CHNB017	CHADRA BHAGA	JAMMU & KASHMIR	416
18	CHNB018	CHENAB	JAMMU & KASHMIR	909
19	CHNB019	KIAR	JAMMU & KASHMIR	771
20	CHNB020	LOKUT ZAZ	JAMMU & KASHMIR	1099
21	CHNB021	GUMBAR	JAMMU & KASHMIR	855
22	CHNB022	NIRU	JAMMU & KASHMIR	671
23	CHNB023	NAIL	JAMMU & KASHMIR	421
24	CHNB024	GEN	JAMMU & KASHMIR	362
25	CHNB025	TSINGAN	JAMMU & KASHMIR	720
26	CHNB026	DUN	JAMMU & KASHMIR	778
27	CHNB027	TAWI	JAMMU & KASHMIR	580
28	CHNB028	LIDDAR	JAMMU & KASHMIR	817
29	CHNB029	MOHU, MAMGAT	JAMMU & KASHMIR	585
30	CHNB030	SALOH	JAMMU & KASHMIR	480
31	CHNB031	DUDAHAR	JAMMU & KASHMIR	397
32	CHNB032	CHENAB	JAMMU & KASHMIR	575
33	CHNB033	CHAINJ	JAMMU & KASHMIR	217
34	CHNB034	CHAINI	JAMMU & KASHMIR	321
35	CHNB035	BASANTAR	JAMMU & KASHMIR	568
36	CHNB036	CHAINJ	JAMMU & KASHMIR	686
37	CHNB037	RAD KHAD	JAMMU & KASHMIR	748
38	CHNB038	ANS	JAMMU & KASHMIR	317

39	CHNB039	ANS	JAMMU & KASHMIR	572
40	CHNB040	RANBIR SINGH PURA	JAMMU & KASHMIR	753
41	CHNB041	WADI TAWI	JAMMU & KASHMIR	400
42	CHNB042	MANWAR TAWI	JAMMU & KASHMIR	838
43	CHNB043	QARAQASH R.	JAMMU & KASHMIR	461
44	CHNB044	THANNA TAWI	JAMMU & KASHMIR	321
45	CHNB045	DHALER WALI NADI	JAMMU & KASHMIR	435
46	CHNB046	TOANA	JAMMU & KASHMIR	763
47	CHNB047	HALSI	JAMMU & KASHMIR	358
48	CHNB048	CHAUKIWALA	JAMMU & KASHMIR	323
49	CHNB049	TAWI	JAMMU & KASHMIR	511



Map No 2: Showing watersheds of Chenab basin

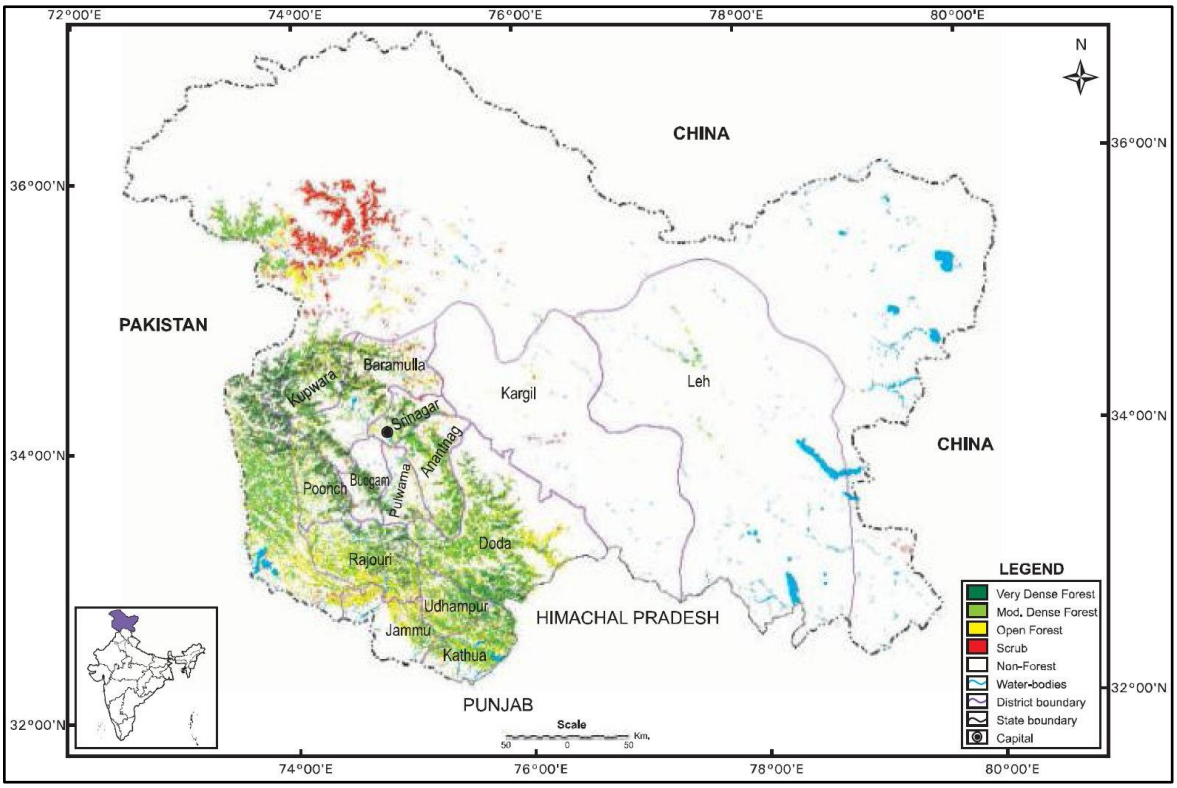
2. BACKGROUND INFORMATION FOR THE CHENAB BASIN

2.1 Forested / well vegetated tracts in the Chenab basin:

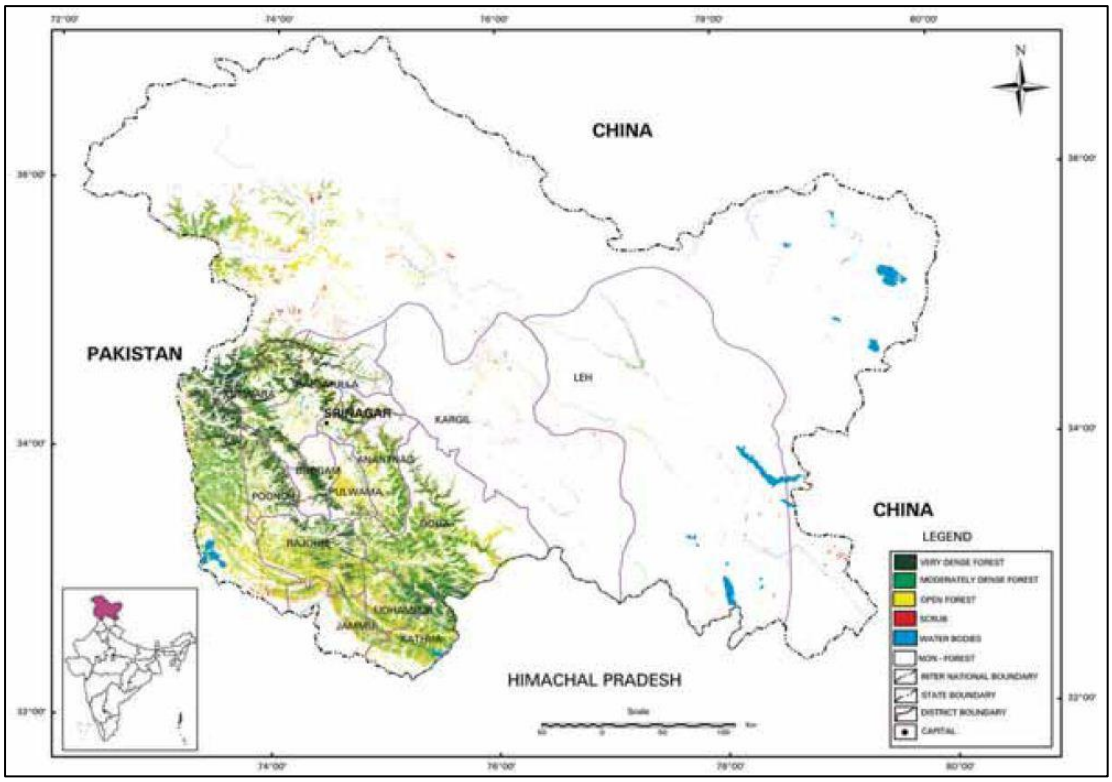
As per the Forest survey of India, the total area of the forest cover from 2011-2015 has decreased by about 61 km² as shown in the table 2 and Figure 3 and Figure 4. The positive change in the forest cover in the basin is attributed to the conversion of the scrub areas to forest areas (ISFR, 2015).

Table 2: Showing forest cover in Chenab basin (Source: ISFR, 2011 and ISFR, 2015)

S.No.	District	Geographical Area (km²)	Forest area- 2011 (km²)	%age of Forest area- 2011	Forest area- 2015 (km²)	%age of Forest area- 2015	Change
1	Doda	11691	3967	33.93	3797	32.48	-170
2	Jammu	3097	882	28.48	895	28.90	13
3	Poonch	1674	729	43.55	728	43.49	-1
4	Rajouri	2630	1240	47.15	1240	47.15	0
5	Udhampur	4550	2689	59.10	2783	61.16	97
	Total	**23642**	**9507**	**212.21**	**9443**	**213.18**	**-61**



Map No 3: Showing Forest map dated 2011 of J&K state (Chenab sub-basin)



Map No 4: Showing Forest map dated 2015 of J&K state (Chenab basin)

2.2 National Park, Sanctuaries in the Chenab river basin:

There is one national park and 5 wildlife sanctuaries in the Chenab basin as shown in the table 3. The brief details about the wildlife national park and sanctuaries are given in the following sub-sections.

Table 3: Showing National Park and Sanctuaries in the Chenab sub-basin (Source: J&K wildlife protection department)

S.No.	National Parks/ Wildlife Sanctuaries	
1	Kishtwar High Altitude National Park	National park
2	Ramnagar Wildlife Sanctuary	Sanctuary
3	Jasrota Wildlife Sanctuary	
4	Surinsar Mansar Sanctuary	
5	Nandini Wildlife Sanctuary	
6	Trikuta Wildlife Sanctuary	

Kishtwar High Altitude National Park: Kishtwar high altitude National Park is located in the Kishtawar district and covers an area of about 400 km^2 with altitude ranging between 1700 – 4800m. It is bounded to the north by Rinnay River, south by Kibar Nala catchment, east by main divide of Great Himalaya and west by Marwa River. Mean maximum and minimum temperatures recorded at Sirshi are 13°C and -7°C in January and 35°C and 11°C in July respectively. Mean annual rainfall at Palmar and Sirshi (1,761 m), located near the periphery of the national park, is 827 mm and 741 mm, respectively, precipitation is maximal and in excess of 100 mm per month in March and April, and again in July and August. The vegetation in the park include: silver fir, spruce, cedar, blue pine, chilgoza pine, horse chestnut, walnut maple, poplar, hazel, bird cherry, ash yew and birch. The park is famous for Himalayan Snow Cock and brown bear.

Ramnagar Wildlife Sanctuary: Ramnagar Wildlife Sanctuary is situated only 6 km away from Jammu city occupying an area of 31.50 km^2. The sanctuary area sustains 8 mammal species including Nilgai and Barking Deer, Wild Boar, Rhesus Monkey, etc. The sanctuary supports 15 species of birds including Indian Mynah, Blue Rock Pigeon, Peafowl, Red Jungle Fowl, Jungle Crow, Golden Oriole, and White Cheeked Bulbul.

Jasrota Wildlife Sanctuary: The Jasrota Wildlife Sanctuary is flanked by the River Ujh occupying 10.04 km² area. The vegetal cover of the sanctuary is dominated by bamboo plantations. The species that can be traced here are *Dalbergia Sissoo, Acacia Catechu A. Arabica* and *Lannea Grandis*. The flora includes shrubs like *Carisa spinarum*, *Lantana camara* and *Dodonea Visacosa*. The animals that can be sighted here include a large variety of mammals and significant among them are Cheetal, Barking deer, wild boar, rhesus monkey. The feathered creatures that are to be sighted in the Jasrota Wildlife Sanctuary include a rich variety of pheasants, peafowl, red jungle fowl, jungle bush quail, green pigeon and blue rock pigeon.

Surinsar Mansar Sanctuary: Surinsar Mansar Sanctuary is situated at a distance of 42 km from Jammu and covers an area of 97.82 km². It stands on an altitude that ranges from 430 to 611 meters above the sea level. The favorable climatic conditions of the state lead to the growth of various types of vegetation in the Surisar Mansar wildlife sanctuary. Mixed scrub forest with broad leaved species mixed with stands of *Pinus gerardiana* is the main vegetation. Other leaved species include *Acacia spp.*, *Mallotus phillipensis*, *Dalbergia sissii*, *Ficus religiosa*, *Bahunia variegate*, etc. The mammal species include leopard, barking deer, goral, wild boar, etc. The avifauna species include blue rock pigeon, peafowl, green pigeon, black partridge, grey partridge, red jungle fowl and rufus turtle dove.

Nandini Wildlife Sanctuary: The sanctuary is located 28 km from Jammu and spreads over an area of 34 km². The region play hosts to a large number of rare and endangered species of mammals and birds. The main species are leopard, wild boar, rhesus monkey, bharal, grey langur, goral, Indian fox, barking deer, two species of civet cats, jungle cat, hare, common leopard, rhesus monkey, mongoose, five-striped squirrel and porcupine. Some of the members of the bird kingdom may include babblers, great jungle fowl, barbets, bee-eaters, bulbul, Indian mynah, blue rock pigeon, peafowl, red jungle fowl, chir pheasants, chakor etc.

Trikuta Wildlife Sanctuary: Trikuta Wildlife Sanctuary covers an area of 31.77 km² and is recognized as the area adjacent to Mata Vaishno Devi Shrine.

2.3 Notable geo-morphological, cultural, archeological, biological sites along the Chenab River:

Chenab basin is home to a number of culturally and geologically important sites which have tremendous scientific and historical importance. In addition, there are several pilgrimage sites including sufi shrines, temples, etc. that are being frequented by the people and tourists throughout the year. Table 4 provides information about the religious and pilgrimage sites located in different districts of the Chenab basin.

Table 4: Pilgrimage sites in Chenab basin

S. No.	Shrine/ Mosque/ Temple Name	Location
1	Ziarat of Baba Budhan Shah	Jammu
2	Ziarat Peer Mitha	Jammu
3	Dargah Garib Shah	Samba
4	Shahdara Sharief	Rajauri
5	Baba Sakhi Sultan	Rajauri
7	Nao Gazi Ziarat	Rajauri
8	Budha Amarnath temple	Poonch
9	Nangali Sahib Gurudwara	Poonch
10	Sain Mira Sahib	Poonch
11	Chhotey Shah	Poonch
12	Ziarat Asrar-ud-Din Sahib	Doda
13	Zain Shah Sahib	Doda
14	Farid-ud-Din Sahib	Doda
15	Athara Bhuja Devi temple	Doda
16	Chandi Mata temple	Doda

Additionally, there are quite a few sites in the basin that are archeologically important as listed in the Table 5. Some of these sites pertain to pre-historical medieval times.

Table 5: Archaeological sites in Chenab basin (Source: Archeological Survey of India)

S. No.	Name of Monument / Site	Location
1	Fort at Akhnoor	Akhnoor
2	Remains of Ancient sites (Pambaran)	Ambaran

3	Ancient Temple (Harihara)	Billawar
4	Rock carving of Devi riding a lion	Basohli
5	Rock carving of Sitala, Narada, Brahma & Radha Krishna.	Basohli
6	Vishesvara and other cave Temple	Basohli
7	Trilochannanath Temple	Mahadera
8	Ancient Site, Babour	Thalora
9	Devi Bhagwati Temple, Babour	Thalora
10	Ancient Temple Dera, Babour	Thalora
11	Ancient Temples Kala Dera I & II	Manwal
12	Ancient Temple, Babour	Manwal
13	Group of Temles	Kirmachi
14	Ancient Fort attributed to Raja Suchet Singh and Samadhi of Queen of Raja Suchet Singh	Ramnagar
15	Ancient Palaces attributed to Raja Suceht Singh	Ramnagar

2.4 Well known springs / perennial water sources in the Chenab basin:

There are about 3650 wetlands and water bodies in the entire state of Jammu and Kashmir (NWIA, 2010) out of which 1143 are the high altitude wetlands and water bodies (NWIA, 2012). In the Chenab basin, there are 453 wetlands and water bodies out of which 30 are located at the high altitudes. Table 6 provides the watershed and district-wise distribution and areal coverage of the wetlands and water bodies in Chenab sub-basin. The details of some of the prominent lakes, springs and wetlands in the Chenab basin are given in the table 7. Figure 5 shows the watershed-wise distribution of the drainage, lakes, springs, and wetlands in the Chenab sub-basin.

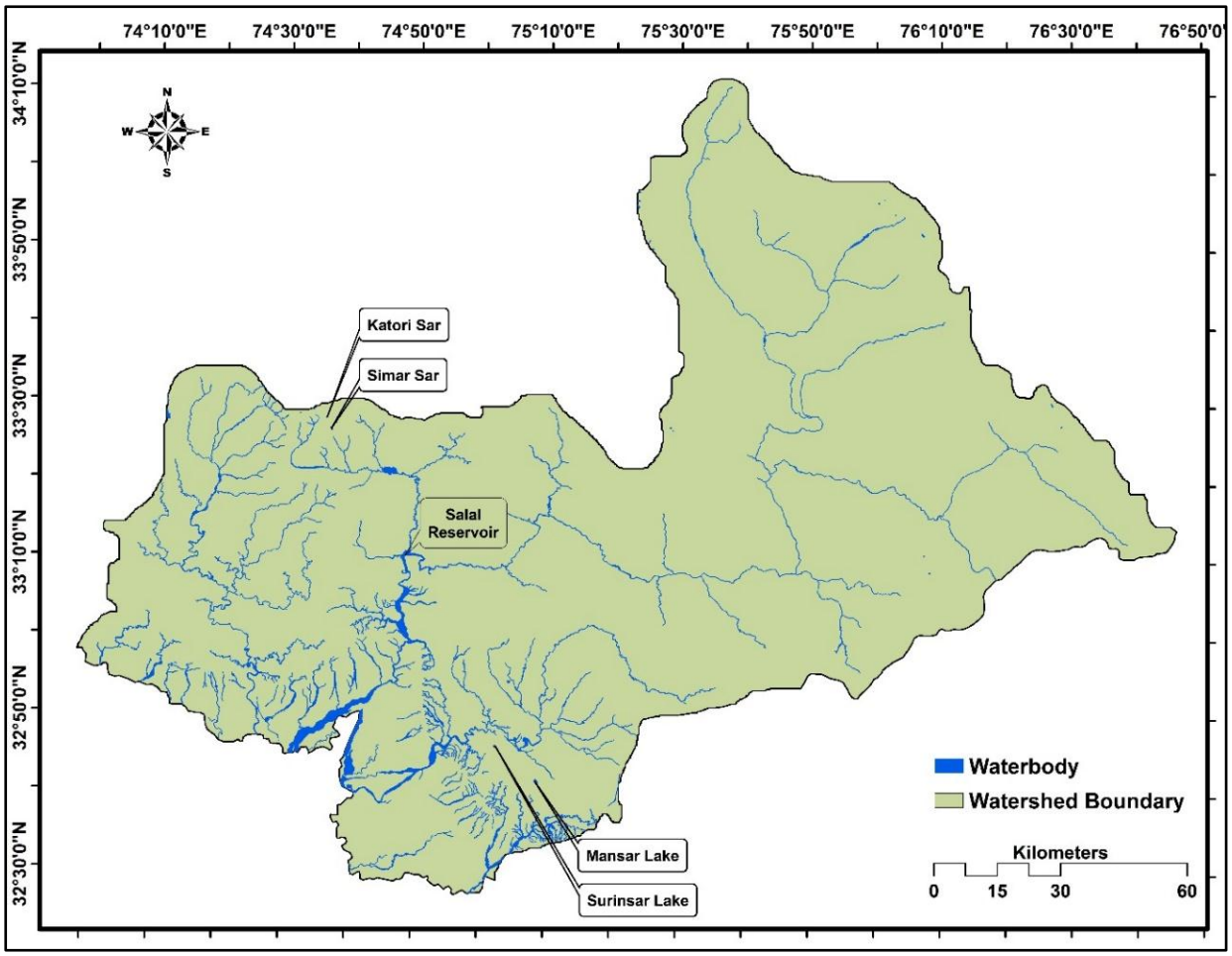
Table 6: District-wise distribution of water bodies in the Chenab basin (Source: NWIA, 2010)

S.No.	District	Wetland Category	Number of Wetlands	Total Wetland Area
1	Doda	High altitude wetlands	11	79
		River/Stream	2	5567
2	Udhampur	Lakes/Ponds	1	58
		High altitude wetlands	3	13
		Riverine wetlands	3	45
		River/Stream	22	7591
		Reservoirs/ Barrages	1	576

		Wetlands (<2.25 ha)	43	43
3	Poonch	High altitude wetlands	10	59
		River/Stream	6	6932
		Wetlands (<2.25 ha)	22	22
4	Rajauri	High altitude wetlands	6	37
		River/Stream	9	4835
		Wetlands (<2.25 ha)	38	38
5	Jammu	Lakes/ Ponds	1	31
		River/Stream	40	19372
		Wetlands (<2.25 ha)	235	235
		Total	**453**	

Table 7: Important lakes in the Chenab basin

S.No.	Lake/Spring	Description
1	Mansar Lake	Mansar lake is a very small and lies amid low hills and is about a mile in length and less than a half a mile in width but is very deep. This lake is considered a very holy place and a best tourist destination of Jammu region.
2	Surinsar Lake	It is situated to the north east of Jammu city at a distance of 40 km. It is a fresh water warm monomictic lake with a river damming origin.
3	Sanasar Lake	It is located in a picturesque setting 25 Km from the famous tourist spot-Batote in Ramban district.



Map No 5: Main drainage, lakes, wetlands and water bodies in the Chenab basin

Ground Water:

Hydrogeologically, both porous and fissured formations occur in the Chenab sub-basin. The ground water conditions vary from place to place within Chenab sub-basin. The depth of the borehole drilled in Sirowal range between 59.60 m bgl at Garar to as deep as 350.81 m at Chamlial. The yield of the wells constructed in this formation range between 500 lpm for a drawdown of 27.16 m at Pounechak and 3785 lpm for a drawdown of 11.17 m at Budhwar site. However in most of the wells, the discharge obtained is more than 1500 lpm for moderate drawdown. Transmissivity values vary from 272 m^2/day at Deolichak to maximum of 1197 m^2/day at Phinder site. Confined conditions are substantiated by the Storativity values remaining within 9.6 x 10^{-4} and 9.8x 10^{-6}.

The hardness of strata comprising of big boulders along with clay restrict the drilling depth in Kandi area. The drilling depth in this formation ranges from 70.30 m at Khour site to 302.67 m bgl at Rayapatti site. Depth to water level ranges from 5.24 m at Supwal site to 65.0 m bgl at Pangiari site. Majority of EW have depth to water level standing at more than 15.0 m bgl. The yields are generally more than 700 lpm for moderate drawdowns. Transmissivity values range between 367 m^2/day at Supwal to 928 m^2/day at Raya Patti.

The overall stage of ground water development in the State is 21.97 %. Total ground water resources (in Hectares Meters) as on March 2009 is 7298664 ham or 72.99 bcm for Jammu and Kashmir State. The total ground water draft for domestic & industrial use for all districts of Jammu & Kashmir State is of the order 57987.60 ham whereas for irrigation use is 15455 ham (IFC & CGWB, 2009 (a)). The valley wise Total Ground Water Resource Availability in ham (Chenab basin) is given in the Table 8.

Table 8: Total Ground Water Resource Availability in Chenab basin

S.No.	Name of assessment unit	Total geographical area (ha)	Total Annual Replenishable Ground Water Resources (ham)	Total In - storage Ground Water Resources (ham)	Total Annual Ground Water Resource (ham)
1	Jammu	309700	83819.29	1704338	1788157.2
2	Udhampur	455000	5487.20	3001	8488.2
3	Rajauri	263000	10625.09	10503.5	21128.59
4	Poonch	167400	7025.92	2408	9433.92
5	Doda	1169100	5338.17	1000.05	6338.22

The assessment of dynamic ground water resources in Chenab basin is given in the Table 9.

Table 9: Dynamic ground water resources of J&K (2008-2009)

S.No.	Name of assessment unit	Stage of Ground Water Development (%)	Pre-monsoon		Post-monsoon		Category (Safe/ Semi-critical/ Critical/ Over-exploited)
			Water level Trend	Is there a significant decline (Yes/ No)	Water level Trend	Is there a signifi-can t decline (Yes/ No)	
1	Jammu	22.83	Rise	No	Rise	No	Safe
2	Udhampur	37.61	Rise	No	Rise	No	Safe
3	Rajauri	34.18	Rise	No	Rise	No	Safe
4	Poonch	32.94	-	-	-	-	Safe
5	Doda	18.90	-	-	-	-	Safe

The groundwater development is highest in Udhampur (37.61 %) in Chenab basin. Assessment units have been categorized for Jammu and Kathua districts based on both the stage of ground water development and long term trends of water levels as shown in Table 9. All the areas in the Chenab basin fall under safe category. Also, no area in the basin is of poor ground water quality. The chemical quality of ground water (shallow aquifers) has been determined by analyzing 85 water samples collected from the National Hydrograph Network Stations during May, 2002 falling in Jammu province comprising Jammu, Udhampur and Rajouri districts of the Chenab basin (Table 10) (IFC & CGWB, 2009 (b)).

Table 10: Range (Max and Min) of various chemical parameters in Chenab basin

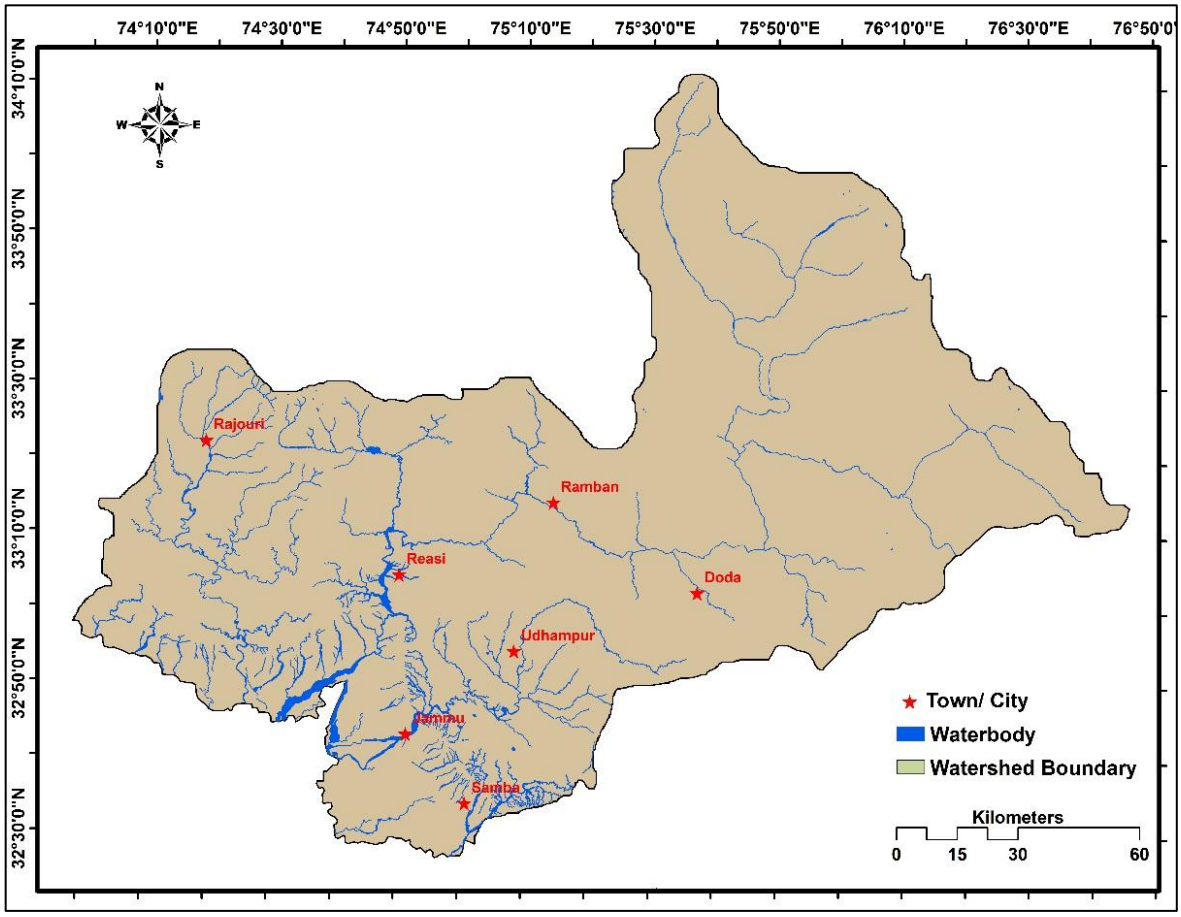
S. No.	Dis-trict	pH	EC	HCO_3	Cl	NO_3	F	Ca	Mg	Na	K	TH	Fe
			mi-cros/ cm	mg/l									
1	Jam-mu	7.02-8.4	282 - 3420	122-1379	7.1-279	1.60-310	Tr--1.76	14-152	3.7-117	1.8-310	0.9-320	135-840	0.12-3.38
2	Ud-ham-pur	7.0 - 8.44	215-1150	84-549	7.1-128	Tr-46	Tr-1.9	0.4-108	4.9-63	1.2-164	0.5-60	30-455	Tr-11
3	Doda	7.05-8.60	150-1980	67-1037	3.5-220	0.10-139	Tr-4.9	04-166	2.4-90	3.7-490	0.6-15	20-700	0.37-6.5
4	Ra-jouri	7.2-9.3	217-1470	92-525	3.5-184	0.72-60	0.02-2.45	01-144	1.7-45	0.5-225	0.30 -8.5	20-545	0.19-10

2.5 Point source(s) of pollution

Urban settlements are the main sources of pollution for any river. The rapid urbanization and industrialization have had huge impact on the water quality of Chenab along the urbanized stretches of the river. The main cities and towns which discharge pollutants into the Chenab and act as point and non-point sources of pollution due to large urban areas in Chenab basin are shown in Table 11 and the location of these cities and towns is given in the Figure 6. Jammu city which is the winter capital of the State of Jammu and Kashmir is very congested city with very high urban sprawl rates and discharges huge volumes of untreated sewage and domestic wastewater directly into the Chenab River through Tawi tributary.

Table 11: Main cities in Chenab basin (Source: Census 2011)

S.No.	City/ Town name	Population (Census 2011)
1	Rajauri	642415
2	Doda	409936
3	Ramban	283713
4	Udhampur	554985
5	Reasi	314667
6	Jammu	1529958
7	Samba	318898



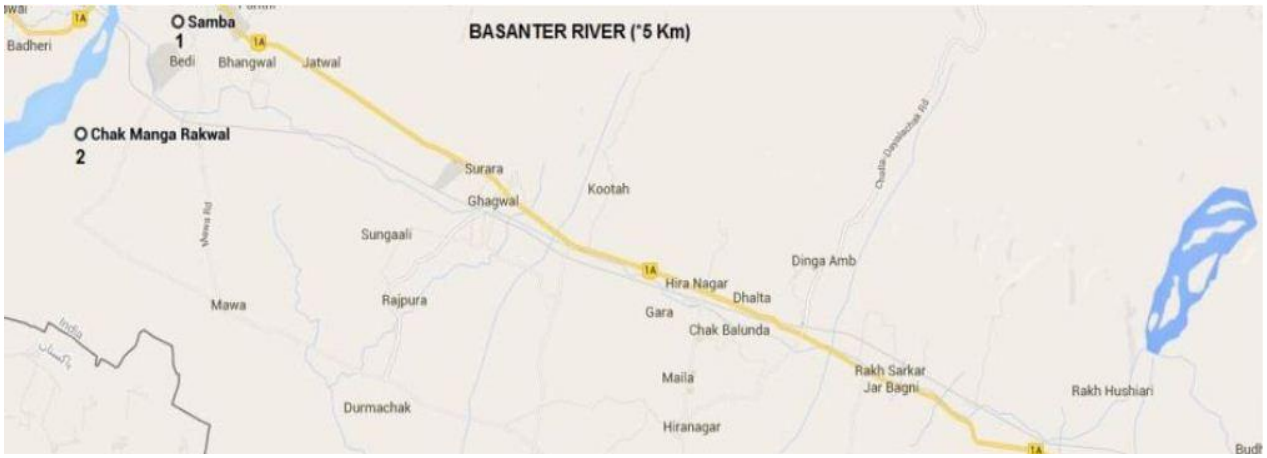
Map No 6: Location of major towns and cities in Chenab basin which act as sources of pollution to the River

Urban waste-water is particularly threatening the health of rivers when combined with untreated industrial waste. Central Water Commission periodically checks the metal toxicity of Indian rivers in order to maintain the standard water quality as per the Bureau of Indian Standards (BIS). In Chenab basin, 8 sites at Benzwar, Jammu L/B, Jammu R/B, Akhnoor, Tandi, Udaipur, Dhamkund and Prem nagar are sampled and investigated by the Central Water Commission for status of trace and toxic metals in Chenab River. Tests

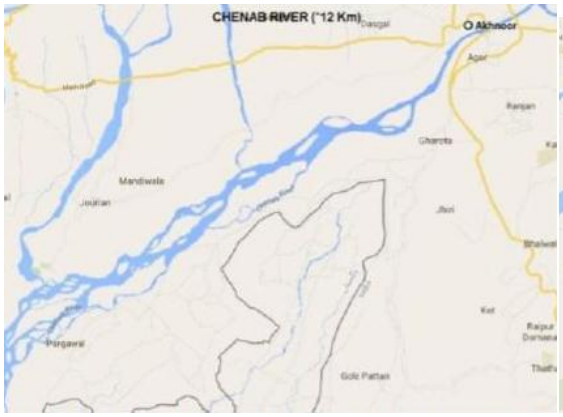
for detecting the concentration of nine metals: arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc and iron have been carried out. Since the Chenab basin is less industrious, the results depict that all the eight sites show concentrations of the given metals under acceptable limits except at the Akhnoor site where the Copper concentrations was found above the acceptable limits of 50µg/L (CWC, 2014). In order to check the pollution levels in Chenab waters, the CPCB is monitoring 5 locations in the sub-basin for Biological Oxygen Demand (BOD) as shown in Table 12 (Figure 7). Out of these locations, Banganga is classified in priority class V while as Basanter, Chenab, Dewak and Tawi fall in priority class IV (CPCB, 2015).

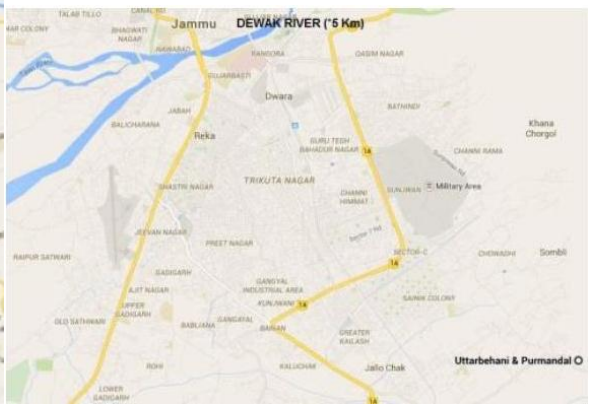
Table 12: Locations of the monitoring river stretches and their BOD range/ maximum value in Chenab basin

S.No.	River Name	Approx. length of stretch (km)	Towns Identified	BOD Range/ Max value	Priority
1	Banganga	3	Katra	4.4 – 4.8	V
2	Basanter	5	Mananun, Balour, Parei, Bedi, Palth	3.6 – 8.0	IV
3	Chenab	12	Akhnoor, Muthi, Pargawal	8.0	IV
4	Dewak	5	Jammu, Trikuta nagar, Chak Rakwalan	6.3	IV
5	Tawi	5	Jammu, Chak Rakwalan	3.4 – 6.5	IV



a) Basantar River From Samba to Chakmangarakwal





b) **Chenab River from Jal Patan to Pargawal** c) **Dewak River from Garigarh to** Uttarbehani

c)

d) **Banganga River from Ponyshed to Bathing Ghat** e) **Tawi River from Suraj Nagar to Belicharana**

Map No 7: Polluted river stretches (a-e) along various tributaries of the Chenab River Polluted river stretches (a-e) along various tributaries of the Chenab River

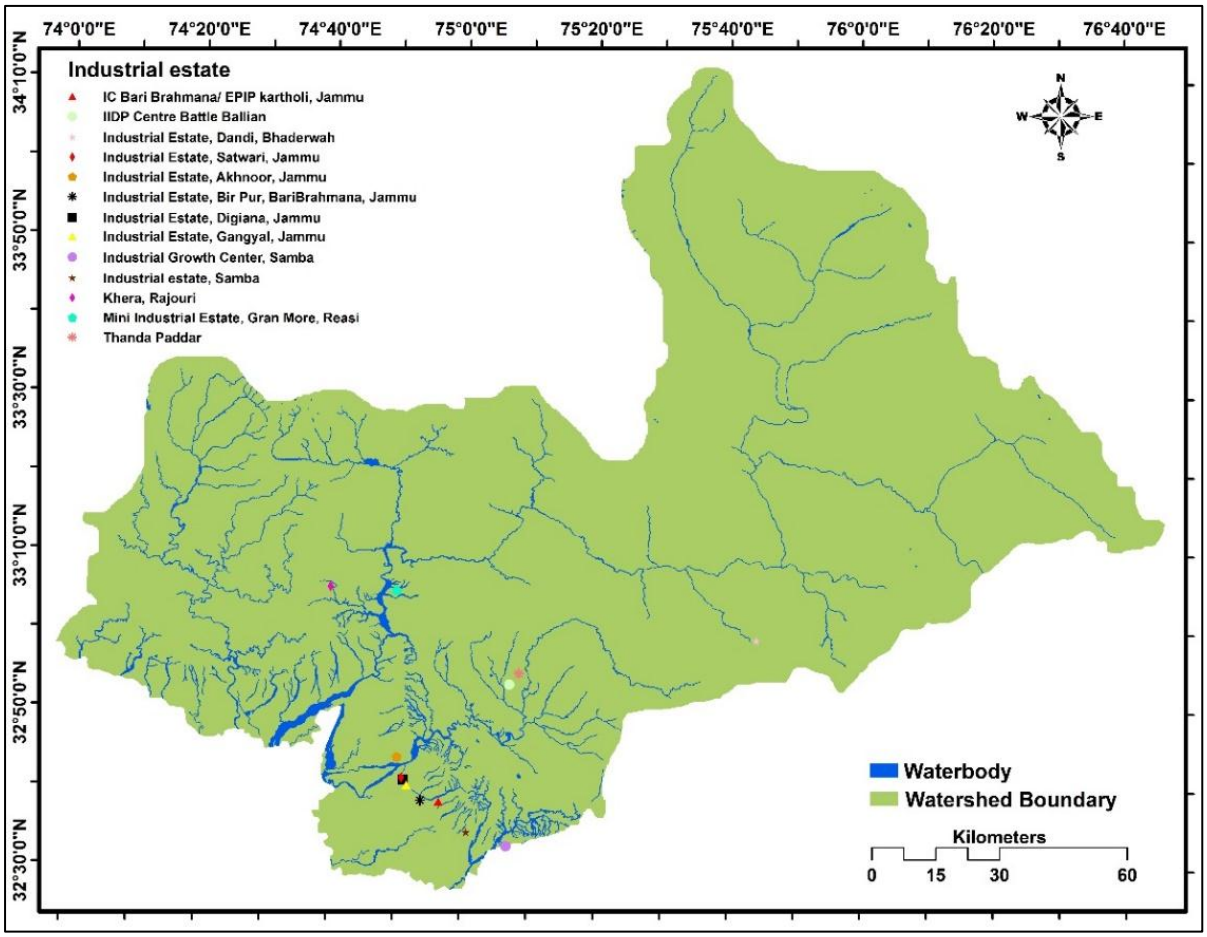
3. INDUSTRY / INDUSTRIAL AREA / DEVELOPMENTAL PROJECTS:

In general, there are no heavy industries in the Chenab basin, except in the vicinity of the Jammu city, and that is the primary reason for overall good water quality of the Chenab and its tributaries. However, there are a number of Industrial Estates established all across the basin hosting smaller industries of every kind, the details of which are given in the Table 13. Figure 8 shows the location of these Industrial Estates in different watersheds of the Chenab sub-basin. Most of these Industrial Estates have poor pollution control measures in place.

Table 13: Industrial estates in the Chenab basin

S. No.	Name of Industrial Area	Land acquired (In Kanals)	District
1	Industrial Estate, Dandi, Bhaderwah	54.61	Doda
2	Kheara	51.17	Rajouri
3	Mini Industrial Estate Gran More, Reasi	70	Reasi
4	Industrial estate, Samba	1	Samba
5	Industrial Growth Center	3494	
6	Thanda Paddar	49.4	Udhampur
7	IIDP (Industrial Infrastructure Development Project), Centre Battle Ballian	1051	
8	Industrial Estate, Digiana, Jammu	137	Jammu
9	Industrial Estate, Akhnoor, Jammu	29.05	
10	Industrial complex , Bari Brahmana /EPIP kartholi, Jammu	7152	
11	Industrial Estate, Gangyal, Jammu	988	
12	Industrial Estate, Bir Pur, BariBrahmana, Jammu	306.035	
13	Industrial Estate Jammu cantt, Satwari	96	

(Source: Ministry of Micro, Small & Medium Enterprises)



Map No 8: Location of Industrial Estates in Chenab Basin

3.1 Hydropower Development Projects

In the Indus basin, Chenab River has the highest and enormous potential for development of hydropower energy. The existing and pipeline hydropower development of the Chenab basin is about 8667.8 MW (Table 14) in the State of Jammu and Kashmir. Additionally, 3173 MW of hydropower from 17 projects out of the 49 projects (in pipeline) are already developed or under implementation in the Himachal Pradesh state (Dandekar et al., 2012). Figure 9 shows the location of the ongoing and pipeline hydropower projects in the Chenab basin. The hydropower is harnessed by National Hydropower Corporation (NHPC), Jammu and Kashmir State Power Development Corporation (SPDC), the Chenab Valley Hydropower Development Corporation which is a joint venture between the JKSPDC and NHPC, HP government and a very small proportion by the private producers.

Chenab flows for 130 km in Himachal Pradesh, which holds a tiny proportion of the basins catchment area. In this tiny area, Himachal Pradesh is constructing, implementing and planning 49 hydroelectric projects on Chenab. As things stand now, if all these projects are implemented, less than 10% of the river can be seen flowing at all. Dams are being constructed bumper to bumper in a very tight sequence, where water from one hydro project meets not the river, but reservoir of the next hydro project in line. This conversion of a living river into a series of puddles, alternating with dry stretches, bypassed by the tunnels has a profound impact on ecology, biodiversity, hydrology, sociology and water availability of the region (Dandekar et al., 2012).

The hydropower development in the Chenab basin is already a source of concern for the people in the basin and beyond. Keeping in view the mountainous topography, fragile slopes and high tectonic activity, the hydropower development, even if they are the runoff river projects, has serious environmental costs. The Environmental Impact Assessment (EIA) which is a mandatory exercise before initiating any hydropower activity, has come under the scanner of the citizenry because of its inadequacy or even in some cases shoddy analysis. The concern of the citizenry expressed in a petition to the authority arranging public hearing of the one of the pipeline hydropower project is highlighted in the Box 1 below. Therefore, it is important that the hydropower development in the basin is promoted in a way that envisages minimum environmental costs in the basin. Some of the hydropower development projects in the basin like Baglihar Hydropower project and now the Rattle Hydropower project have become a bone of contention between India and Pakistan who share the waters of the Chenab and other five rivers under the Indus Water Treaty (IWT). The Baglihar Hydro-electric project become a dispute and was decided by the Neutral Expert (Box 2). Though the hydropower projects in the basin are runoff the river projects, as provided under the IWT, but on the ground most of them have quite a significant ponding with significant environmental costs (Plate 1)

The Kisthwar-Doda-Bhadarwah belt in the Chenab basin is vulnerable to earthquakes due its geological and tectonic setting and being close to the MCT and some area within the belt are falling within

the Kishtwar window, which has seismically been active since ages. The recent earthquakes in 2012- 2013 caused widespread damage and destruction not only to residential buildings but also to government buildings, especially to hospitals and schools which should be a cause for concern as these public places normally should have served as emergency shelters in the eventuality of any of the disaster (Romshoo et al., 2013).

Figure 1: Ponding of Dul-Hasti (a) and Baghliar (b) Hydropower projects in the Chenab basin

Box 1

Sub: Violations in public hearing for 1856 MW Sawalkote HEP in Ramban, Udhampur and Reasi districts in J&K

Respected Chairman, Member Secretary and Regional Director, J&K State Pollution Control Board.

We understand from J&K SPCB website that the pubic hearings for the proposed 1856 MW Sawalkote Hydropower project is to be held in Udhampur (Village Panchari), Reasi (Village Mahore) and Ramban (Village Tanger) districts at 10 am on January 18, 21 and 28, 2016 respectively. However, we notice a number of problems in this context, some of the key ones include:

1. **JKSPCB website does not have full EIA-EMP**: The JKSPCB website contains (see: http://jkspcb.nic.in/ModuleDesc.aspx?Mod_ID=2&ID=136) only the executive summary of the EIA-EMP of the project in English, Hindi and Urdu. It does not contain the full EIA-EMP as is the norm.

2. **Flawed, incomplete translation of EIA-EMP Executive Summary** A perusal of the Hindi translation of the Executive Summary shows that it is totally incomplete and inadequate from a number of aspects, including: It does not contain the certificates from EIA consultants, no index, the cover page comes at the end, the table and maps are not translated, most key words are not translated, including common words like dam, monsoon and reservoir and even the translation done is flawed and there are so many mistakes in just first two pages, it is clear there has been no proof reading of the text. This is clearly not acceptable and does not reflect the contents of the English executive summary. Most importantly, it says, ";JKSPDC is executing the project as state sector project and was initially planned with installed capacity of 1200 MW. Scoping clearance of Sawalkote HEP of 1200 MW project was accorded by Ministry of Environment Forests and Climate Change (MoEF&CC), Government of India vide letter no. J-12011/19/2011-IA.I dated October 13, 2011. During DPR preparation, based upon approved Hydrology, the installed capacity of the project was revised to 1856 MW and same has been approved by CEA in April 2012 - 1406 MW as stage 1 and 450 MW as stage 2. Subsequently, scoping clearance was revalidated by MoEF&CC for Installation capacity of 1856 MW vide letter no. J-12011/19/2011-IA.I dated June 12, 2013" This sentence on the first page of the Executive Summary gives an impression that the project has already been given clearance by MoEF, when what the MoEF according was only scoping clearance, which has not been translated. This public hearing is in fact part of the process to get environment clearance. With such completely wrong executive summary of the EIA-EMP, this is clearly not an acceptable document and will not stand legal scrutiny.

3. **Invalid Scoping clearance** The scoping clearance to the project given by MoEF on June 12, 2013 clearly stated in para 10 that "In case of any change in the scope of the project, such as capacity enhancement, shifting of dam site/ power house and change in submergence etc, fresh scoping clearance has to be obtained by the project proponent." The scoping clearance letter said in para 2 that submergence area is 900 ha including forest land of 600 ha. However, the EIA executive summary now on JKSPCB website says (para 1.4.1.7) that the project submergence area is 1158.75 ha (add the figures of three districts given in the table) including 684.15 ha of forest land. This huge 28.75% increase in submergence area makes the scoping clearance for the project already invalid and project will need to apply afresh for the scoping clearance as per point 10 of the clearance letter. There are many other changes: Total land requirement has gone up from 1099 ha given in scoping clearance to 1401.35 ha and number of project affected families have more than doubled from 629 given in scoping clearance to 1477 now mentioned in EIA summary. Even the minutes of the EAC meeting dated July 20, 2015, which considered the request for extension of the TOR Clearance noted that this is being considered "keeping in view no significant change in project parameters" and all these key parameters were mentioned there. All this makes the current scoping clearance invalid according to the clearance letter. Hence holding public hearing for a project that does not have valid scoping clearance is clearly legally invalid.

4. **TORs not fulfilled** A quick perusal of the executive summary of EIA-EMP shows that the EIA-EMP has not fulfilled number of terms of reference of the scoping clearance, including the following:

- ⇒ TOR required Social Impact Assessment, which does not even find mention in the EIA summary.
- ⇒ There is no R&R plan, it does not give any details except financial allocation.
- ⇒ TOR required the details of land use of what is called state land, but no details are provided.
- ⇒ TOR required valuation of biodiversity and ecosystem services of the forest to be cut down, but this is not even mentioned.

- ⇒ TOR required GPS readings of the RET species
- ⇒ TOR said that at least 30% flow in monsoon should be released, but there is no mention of this in the EIA executive summary. TOR also said that the capacity of the 56 MW station for release of environment flows may need change keeping in mind higher environment flows requirement, but again there is no mention of this.
- ⇒ TOR mentioned that the river has high silt load and full details of desanding mechanism should be given, but this has not been given.

5. **Invalid QCI-NABET certificate** The QCI-NABET certificate for the EIA consultants that is attached with the EIA executive summary is valid only upto Aug 13, 2013, so this is no longer valid now and hence this EIA cannot be acceptable.

6. **No Cumulative Impact Assessment** The Chenab river in Kashmir has already existing hydropower projects including 690 MW downstream from proposed Sawalkote project, 900 MW Baglihar I and II and 390 MW Dulhasti HEPs in the upstream, in addition to large number of other projects under consideration. However, in spite of this bumper to bumper hydropower situation, there is no cumulative impact assessment or carrying capacity study of the Chenab basin. This is not only imprudent, but it is also in violation of the MoEF orders of May 28, 2012, where MoEF had cleared required such study before more projects can be considered in any basin.

7. **No mention of climate change** The EIA executive summary does not even mention the word climate change, how climate change will change Chenab river flows and monsoon rainfall, how the project will be impacted by such changes, how the project construction and related changes in landscape will affect the adaptation capacity of the people and area in changing climate. Such an EIA cannot be acceptable in current situation when climate change is already impacting all the Himalayan areas including J&K, as was also clear from the Sept 2014 floods.

8. **No mention of upstream downstream projects** The FRL of the Sawalkote project is proposed as 695 m and the Tail race level of upstream Baglihar project just above at 702 m. In immediate downstream there is Salal project. How the water flow, silt flow and disaster situations of these collective projects will affect the river, people and the area is not even mentioned.

9. **Is Sawalkote Run of River Scheme?** The EIA executive summary claims that Sawalkote is a run of the river schemes, but this claim is totally wrong and misleading considering that in involves 192.5 m high dam, 1159 ha reservoir with 530 million cubic meters of storage capacity and a massive power house close to the toe of the dam. How can such a project be called run of the river project? This is clearly wrong and misleading claim.

Respected Sirs, it may noted that Sawalkote is Kashmir's biggest capacity hydropower project. For such a project, to accept such a shoddy EIA and accept so many violations will not only be imprudent, but also legally questionable. Under the circumstance, we urge you to cancel the public hearings now slated on January 18 to 28, till all these concerns are addressed in a satisfactory way.

We will look forward to your response on each of these points and also necessary action,

Yours Sincerely,

Prof Shakil Ahmad Romshoo, Head, Department of Earth Sciences, University of Kashmir, Srinagar Kashmir, shakilrom@yahoo.com

Prof. M. Sultan Bhat, Head-Department of Geography & Regional Development, University of Kashmir, Srinagar, msbhatgeog@yahoo.com

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Box 2

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Baglihar project: Pak may go to Court of Arbitration

PTI, Islamabad |

After initial claims of victory and promise to accept the World Bank neutral expert's verdict on Baglihar power project, Pakistan is reportedly considering the option of going for Court of Arbitration over Raymond Lafitte's decision to approve the spillway gates of the dam, which Islamabad claims would help India regulate the flow of water.

"Pakistan is considering moving the Court of Arbitration on the design of spillways of Baglihar hydropower project as Lafitte didn't buy Islamabad's point of view on the issue," an unnamed senior government official was quoted as saying by The News.

<b1>"A team of legal experts has started working out a case on the design of spillway gates keeping in view the verdict of neutral expert," the official said.

The neutral expert in his final determination upheld India's point of view on the design of spillway gates.

"As India can still regulate water of Chenab River through spillway gates, therefore legal experts have started examining the decision in which neutral expert has held that spillway gates are in conformity with international practice and state-of-the-art," the official said.

Soon after the verdict was announced on February 12 Pakistan's power and water minister Liaqat Jatoi has said it was a victory for Pakistan.

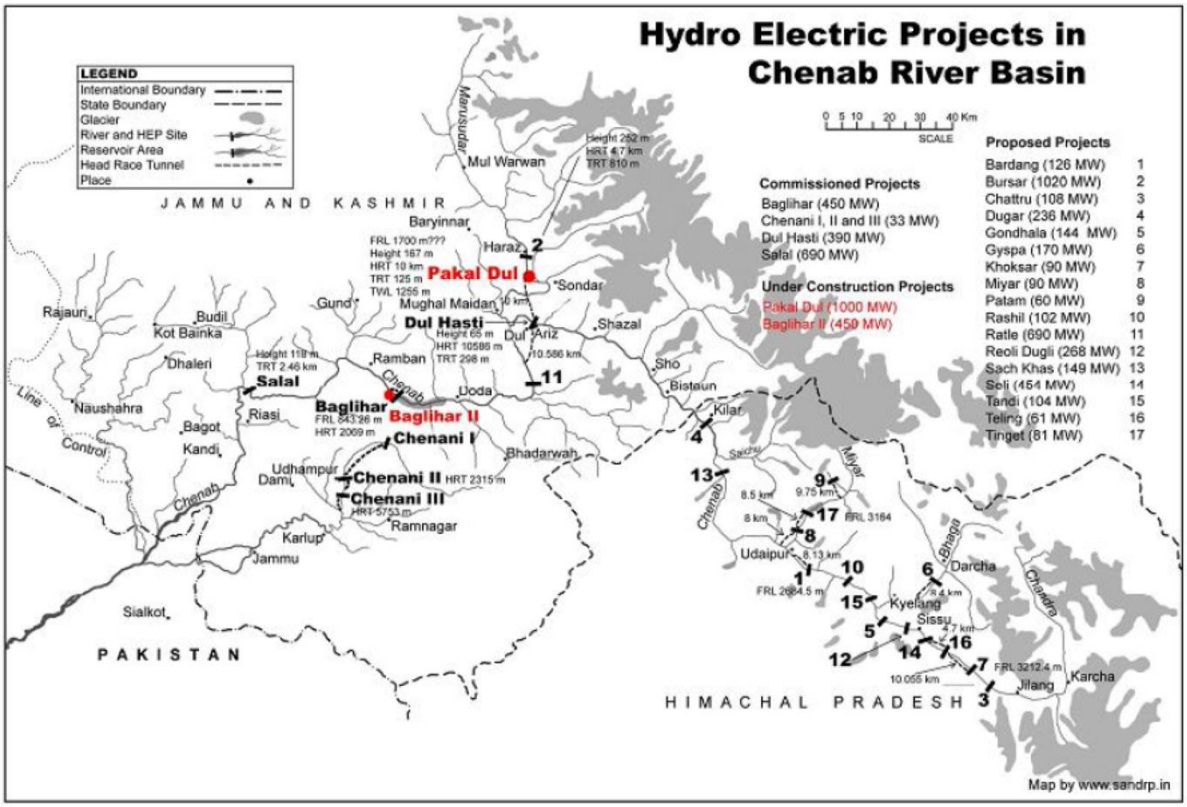
He said the verdict was binding on both sides and hoped India would implement it.

Jatoi has said "we will not ask the neutral expert again to review its decision on spillways, but under the treaty, the Court of Arbitration is the next forum wherein the

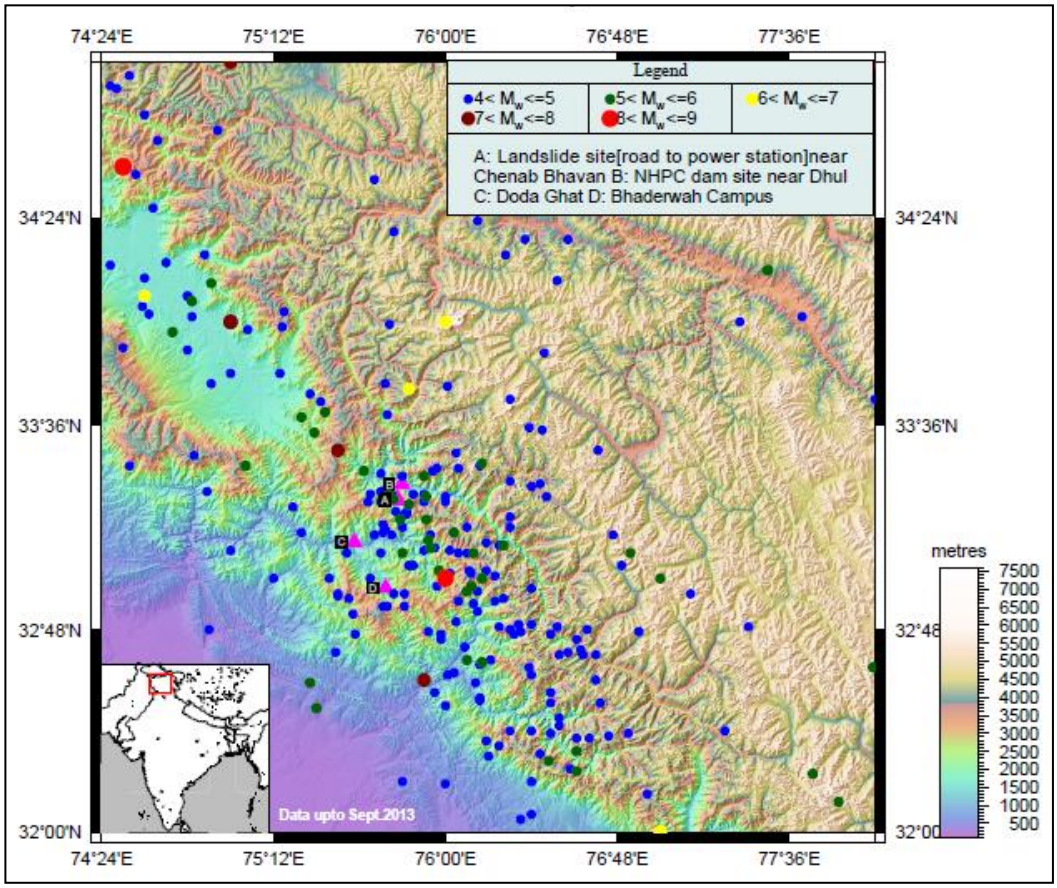
The swarm of earthquakes observed in the basin during 2012-13 created scare among the people and there were concern that the hydropower dam activity might have triggered the seismicity in the basin which were however ruled out by the team of experts drawn from various institutes who visited the areas (Romshoo et al., 2013). However, the team observed that none of the hydropower projects in the basin is designed to withstand an earthquake of magnitude 8.0 and above. The recent series of earthquakes (2012-2013) that hit Kishtwar and Doda regions (Figure 10 and 11) of the Chenab basin, though of very low magnitude, have proved that earthquakes can wreak havoc any time and can cause large damage to the people and property.

Table 14: Hydro-power projects in the Chenab basin

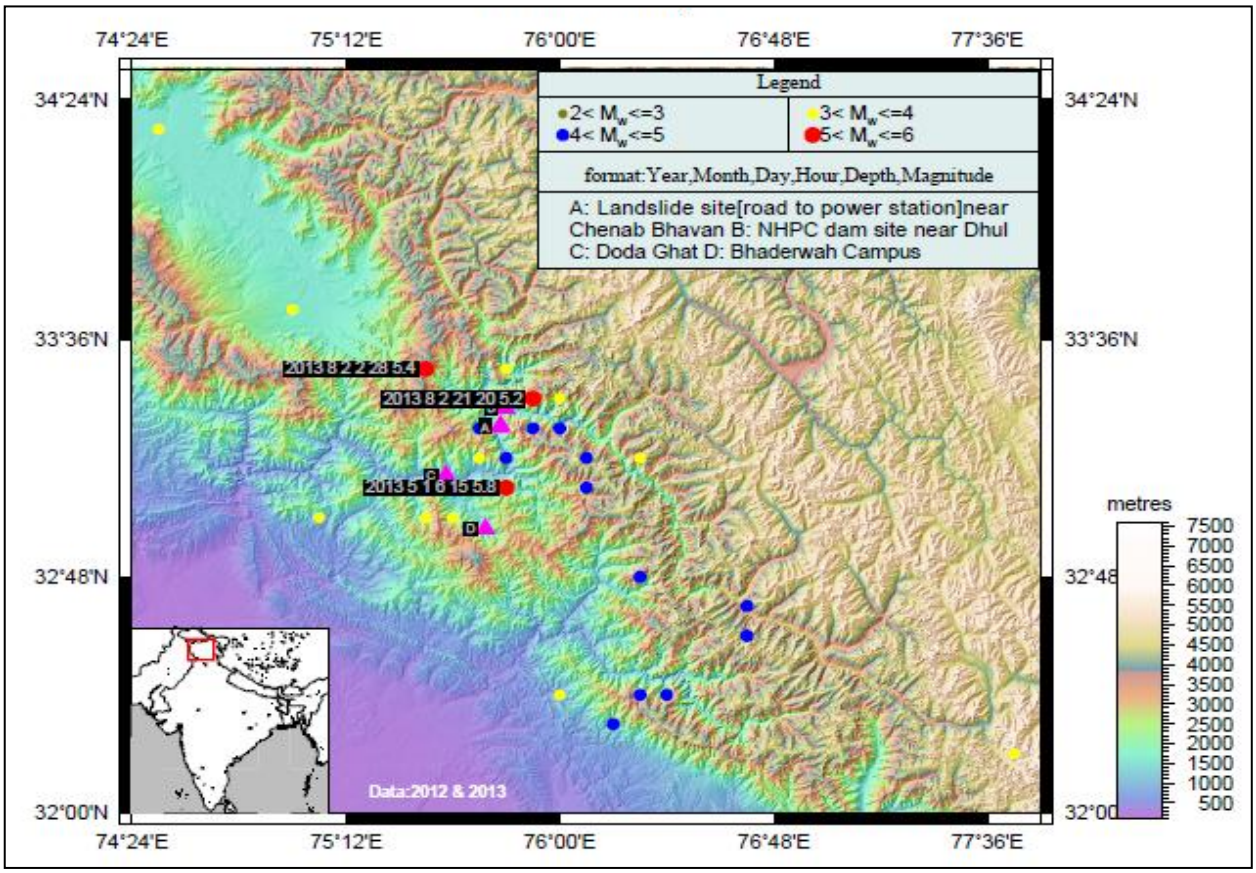
S. No.	Project Name	River	Capacity MW
1	Chenani-I	Tawi river	23.3
2	Chenani-II	Tawi river	2
3	Chenani-III	Tawi river	7.5
4	Bhaderwah	Chenab	1
5	Baglihar	Chenab	900
6	Salal	Chenab	690
7	Dul-Hasti	Chenab	390
8	Kiru	Chenab	624
9	Kwar	Chenab	540
10	Pakal Dul	Marusadar	1000
11	Bursar	Marusadar	1200
12	Kirthai 1	Chenab	250
13	Kirthai II	Chenab	990
14	Rattle	Chenab	850
15	Sawalkote	Chenab	1200
		Total	8667.8



Map No 9: Showing Hydropower projects in Chenab basin (source: SANDRP)



Map No 10: Distribution of recent earthquakes of various magnitude in Chenab basin



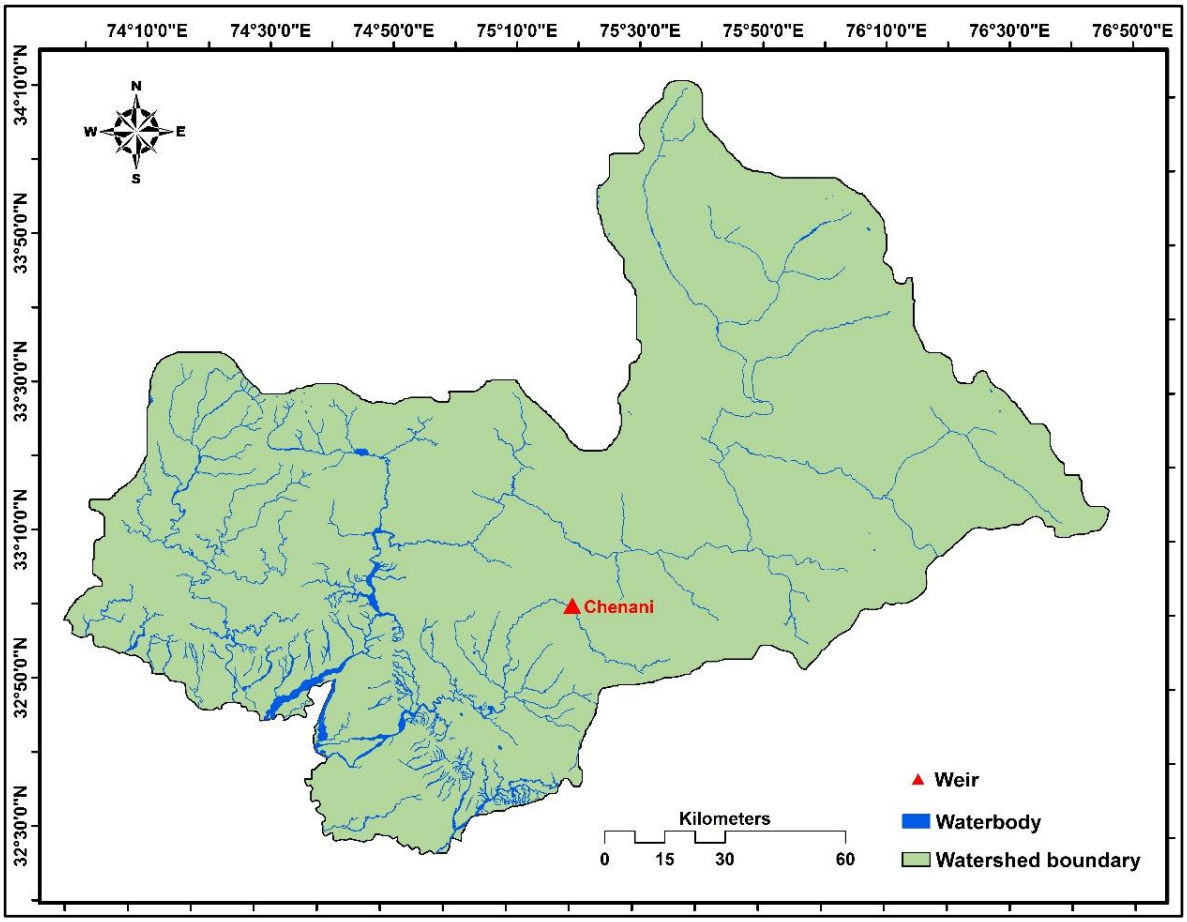
Map No 11: Map showing the distribution of earthquakes of various magnitude from 2012 to 2013 in the Kishtwar and adjoining areas

In addition to the runoff the river hydropower projects detailed in the Table 14, there are a few barrages and weirs in the Chenab basin. The location and other details of these barrages and weirs are given in the Table 15 and Figure 12.

Table 15: Barrages/ weirs in the Chenab sub-basin

S.No.	Barrage/Weir name	Tributary name	Length(m)
1	Chenani weir	Tawi	-

(Source: India-WRIS)



Map No 12: Location of the Chenani weir in Chenab basin

3.2 Airfields, highways

- Jammu Airport (also known as Satwari Airport)
- Highway- NH1A
- Railway line from Jammu to Banihal (136 km)

The National highway from Banihal to Jammu is passing through the mountainous terrain and road construction has highly 31 destabilized the fragile ecology of the mountainous catchment affecting the hydrological functionality of the Chenab basin. The road closure especially during the winter season is very frequent due to the recurrent landslides and even sometimes blocks the Chenab water course.

Most of the stretch of the railway line from Jammu to Banihal is under construction and it is mostly likely that the railway line construction, even if through tunnels for a large stretch, will have significant impact on the waters in the basin particularly during the construction phase.

3.3 River stretch submerged under reservoir, if any (state of siltation in the reservoir)

Three major dams are present on the Chenab River affecting the river stretches by ponding and submergence. The siltation of the dams and upstrem portions of the river just above the project site (Wirsing and Jasparro, 2006; Nair, 2010). The dams include Baglihar (Plates 2-3), Salal HEP (Plate 4) and Dul-Hasti (Plate 5-6).

Dams hold back the sediment load normally found in a river flow, depriving the downstream portion of the lake water and nutrient rich minerals. Thus, the water downstream the projects have increased capacity to scour the river banks and river bed of as shown in Plate 3 and 6 for Baglihar and Dul-Hasti dam.

Figure 2: Ponding of the Run-of-the-Riuver Baglihar project

Figure 3: Chenab River bank erosion and siltation near Baglihar HE Project

Figure 4: Ponding and dam structure of the Salal HE project

Figure 5: Ponding and dam structure of the Dul-Hasti HE project

Figure 6: Degradation and Siltation in Chenab River near Dul-Hasti HE Project

3.4 Downstream dried stretch of the river if any, from water diverted / abstracted into tunnel or canals

The three major hydropower projects on the Chenab river; Baglihar, Salal and Dul Hasti have obstructed the natural flow of the Chenab along the main stretch from the intake (pondage) downstream of the powerhouse. Downstream of each of these projects, there is a stretch of river with low flows for most of the time affecting the aquatic life in these stretches.

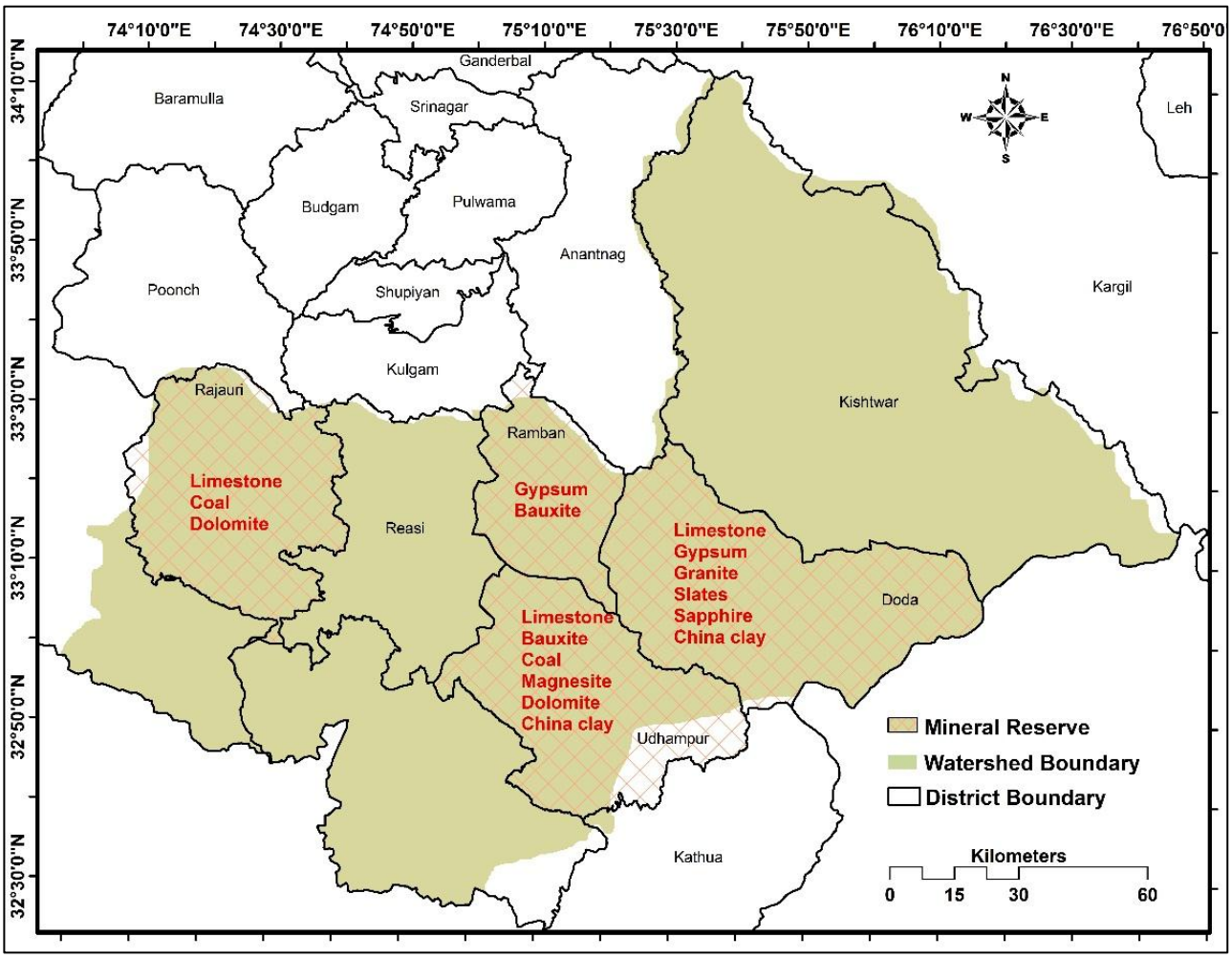
3.5 Mineral mining (coal, bauxite, iron, copper etc)

There is mineral mining of limestone, gypsum, granite, bauxite, coal, magnesite, slates, sapphire, dolomite and china clay in the Chenab basin. The location, reserves and other information about various mineral mining sites is given in the table 16. The mining and extraction of the minerals is regulated by the Department of Geology and Mining of the state government.

Table 16: Information about the minerals in Chenab basin

S.No.	Mineral	Occurrence	Reserves	Uses
1	**Limestone**	All districts of Valley, Kathua, Udhampur, Rajouri, Poonch, Kargil and Leh	6081 Million tonnes	Manufacture of Cement, Calcium Carbide, Quicklime, Bleaching-Powder, Glass, Paper, paints
2	**Gypsum**	Baramulla, Kathua, Ramban and Doda Distt.	150 Million tonnes	Cement, fertilizer, Filler in Paper, Paints, Rubber, Textile industry, Plaster of Paris & sanitary ware,
3	**Granite**	Kargil, Leh, Ganderbal , Baramulla, Poonch and Doda	5.2 Million Cubic mtrs. However, stretched over an area of 800 sq kms	Decorative building stone.

4	**Bauxite**	Udhampur and Ramban	8.6 Million tonnes	Manufacture of aluminum, aluminum products, and aircraft industry
5	**Coal**	Udhampur, Rajouri (Kalakot)	9.5 Million tonnes	As fuel
6	**Magnesite**	Udhampur	7 Million tonnes	Refractory Bricks for furnaces. Pharmaceuticals
7	**Slates**	Poonch, Kathua, Doda and Baramulla	9.6 Million cubic mtrs	Building Material
8	**Sapphire**	Doda (Paddar)	2 kms mineralized zone	Precious Stone
9	**Dolomite**	Rajouri, Udhampur and Reasi	12.37 Million tonnes	Refractory bricks
10	**China clay**	Doda, Udhampur	28 Million tonnes	Ceramics, pottery



Map No 13 : Location and Type of minerals in the Chenab basin

Cement production is one of the main mineral-based industries in the Chenab basin followed by Plaster of Paris. Figure 13 shows the location of the minerals in the basin and Table 17 shows information about various industrial units related to the mineral mining in the Chenab basin.

Table 17: Minerals based units in Chenab sub-basin

S.No.	Name of District	Cement	Plaster of Paris	Lime Kiln	Marble Processing	Calcium carbide	Total
1	Jammu	13	15	4	1	6	39
2	Kathua	15	1	1	-	-	17
3	Udhampur	9	5	1	-	-	15
4	Poonch	-	1	-	-	-	1
	Total	37	22	6	1	6	72

(Source: Department of Geology and Mining, Jammu and Kashmir Government)

3.6 Existing or simmering conflicts over the river

Since 1960 when the Indus Water Treaty (IWT) was signed, the waters of the Chenab and other Indus river are shared between the two countries; India and Pakistan. The treaty involved the division of the Indus River system comprising of three eastern rivers - the Sutlej, the Beas and the Ravi, and three western rivers - the Indus, the Jhelum and the Chenab. The treaty gave India exclusive rights to the three eastern rivers up to the point where they enter Pakistan. At the same time, Pakistan was given exclusive rights to the western rivers.

The key aspect of the treaty is the mechanism to adjudicate future disputes over the allocation of water through structured negotiations which has worked very well till date. Recently, diverge national views have emerged about the interpretation of different clauses of the treaty and a minority in both the countries is even asking revisiting the treaty on political considerations and perceived injustice. However, majority of the experts in both the countries acknowledge that there are good reasons to supplement and expand the treaty using scientific knowledge to address issues that have emerged post-IWT like climate change, environmental flows, watershed management, groundwater over-exploitation etc. so that the implementation of the treaty and dispute resolution mechanism is modernized for promoting peaceful relations between the two countries.

4. PEOPLE'S CONNECT WITH THE RIVER

Water resources in the Chenab basin face a host of threats, all of which are caused primarily by the anthropogenic activities in the basin. The most significant of these threats from the existing and pipeline cascade of hydropower projects in the basin. It is important to note that a number of civil society groups in the basin had raised their voices blaming these hydropower projects for the swarm of earthquakes

witnessed in the region in 2013. Further, there are reports of a few Non-governmental organization working in the basin for protection and conservation of environment.

4.1 Fish diversity

As reported by Sehgal (1999), fish production in mountain streams is low and therefore commercial fishery is on a low scale. Sport and recreational fishery targets the native mahseers, Tor tor, Tor putitora, and brown trout. If a better management of river fisheries is to be achieved, a better knowledge of fish stocks is needed. Protection and rehabilitation of some fish habitats is also needed. However, the future improvement in fish stocks will depend on regular stocking, as the presence of dams on many rivers and streams has stopped the migrations of mahseers and schizothoracines. There are reports of 35 fish species habituating the Chenab as compared with the earlier report of 59 fish species (Sharma and Dutta, 2012) which reveals a decline in fish diversity due to the advrerse environmental factors and anthropogenic pressure.

4.2 Water quality of Chenab tributaries:

The water quality of the Chenab tributaries is deteriorating along the stretches where there are settlements or major towns like Jammu, Udhampur, Doda, Kishtwar, Bhadarwah, Samba, Kathua and a number of other smaller towns. Though there is quite ufficient wter available for domestic and irrigation purposes as provided under the IWT, but the towns and cities are facing shortage of drinking water supplies, primarily because of the lack of the water infrastructure in the basin. Following are some of the stories on the Chenab Basin River highlighting declining water quantify and quality as a serious concern.

BOX 3

DAILY EXCELSIOR

Posted: 28/04/2013

Sahil Mahajan: Tawi flows polluted

Tawi River of Jammu and Kashmir has great religious and historical importance attached to it. River Tawi is also known as River Suryaputari i.e Daughter of Sun God.

Through the city of Jammu, the Tawi River flows along the left bank of the Chenab River. It is in fact, one of the major tributaries of the River Indus and one of the important rivers & lakes of Jammu and Kashmir.

It originates in the Himalayas, below Seoj Dhar peak at Kali Kund, near Bhaderwah, in Doda district. The total catchment area of the River Tawi is more than two thousand and one hundred square Kilometers. The total stretch of the river adds up to 141 Kilometers and it falls within the following districts: Jammu, Doda, Udhampur

The Tawi River is the main river, which flows through Jammu city and has its name attached to the inception of the city. Although the Tawi enhances the beauty of Jammu, the river itself has been polluted by ill usage. The main concern now is to clean up the river and give back to it its original crystal clear look.

On March 08, 2011, Jammu and Kashmir Cabinet approved the Artificial Lake project on Tawi river in Jammu. The cabinet under the chairmanship of Chief Minister Omar Abdullah approved the design and construction of auto-mechanically operated Gated Barrage having an approximate length of 370 meters and height 4 meters with sluice gates across the river with Reinforcement Cement Concrete (RCC) base for creation of poundage at Belicharana area of Jammu city.

A view of proposed lake

This is an initiative from the Govt to boost the tourists attraction and beauty of proposed lake.

At the present the work is going on the said project but the authorities fail to prevent the river from being polluted through different means, especially the nallas, liquid disposals, dumping polythene bags waste, chemical wastages from nearby service centers etc. Thus causing the water pollution which affects plants and organisms living in it.

The Tawi River was famous for Trout Fish but with passage of time they have got extinct and the quality of water has been so much degraded that it is not suitable for bathing. In earlier days, the river was the sole source of potable water supply to the town. In the rainy seasons, the water took sometime to settle. The tiny particles used to settle down before the water was used for drinking. Now-a-days there are very few people, who could think of taking a dip in once holy and sacred Jammu Tawi. All the sewage and storm water of Jammu city pours into the river directly without treating the sewage etc.

BOX 4

EARLY TIMES REPORT

Posted: July 28

Tawi Andolan and Yuva Shakti Team organized an awareness programme

Jammu: Tawi Andolan and Yuva Shakti Team of Tawi Andolan organized an awareness programme on keeping River Tawi, also known as "Suryaputri"neat and clean organized by Shakuntla.

Speaking on the occasion, Sushpal Singh President, Yuva Shakti team said that we should pledge to make the cleaning of river Tawi a regular activity, which is the main source of water to Jammu city and is now being degraded day by day due to garbage disposal.He said that due to pollution the aquatic flora and fauna especially the number of species of fishes have declined to a large extant in the river.

Expressing serious concern over pollution in River Tawi Yuva Shakti Vice President, Rekha Mahajan, said that at least 18 big nullahs and several small tributaries flow into the Tawi and add to the pollution level in the river. Besides, over 100 metric tonnes of solid waste and sewage is being dumped on the river bed daily basis.

Nearly 25 trucks and loaders collect the solid waste and sewage from various parts of the city and dump it on the river bed. She appealed to the people of Jammu to cooperate with the government to keep river Tawi and other water bodies clean and pollution free by stopping throwing domestic and other wastes into the river.Giving details of the plight of the River Tawi, she demanded that state government should constitute Tawi Development Board for comprehensive development of the Suryaputri, Tawi. She said that it will help in conservation and protection of the holy river.

BOX 5

TRIBUNE NEWS SERVICE

Posted at: Jan 21, 2016, 12:05 AM; last updated: Jan 20, 2016, 11:56 PM (IST)

Sumit Hakhoo: Jammu city's water crisis to worsen; Demand may double by 2024, but no back-up plan in place; PHE Dept expresses inability to fulfil need

If your tap has been running dry lately, brace yourself for worse times ahead. The Public Health Engineering (PHE) Department has expressed its inability to meet the drinking water demand of a projected population of 20 lakh by 2024.

With no alternative source and Tawi, the only natural source flowing through the winter capital being exploited ruthlessly, the city is heading for terrifying times. Its population is expected to reach 20 lakh by 2024 and 30 lakh by 2030.

A total of 15 lakh people reside in the city at present. They face scarcity of drinking water everyday despite nearly 250 heavy duty tubewells dug since 2005 to meet the rising demand.

Official sources say the PHE Department has asked the government to speed up the Chenab diversion project lest there is public disorder. It says there will not be enough water to meet future requirements and infrastructure is already under great strain.

The Chenab diversion project was abandoned after the Asian Development Bank rejected the plan submitted by the National Conference-Congress government in 2014 as it had not conducted an environmental impact study.

Announced in 2007, 450 million litres per day of water was to be lifted from the Chenab near Ranjan lift station at Akhnoor, around 30 km from the city, at a cost of Rs 1,000 crore.

The daily potable water requirement of Jammu is 47 million gallons per day (MGD) while supply is close to 45 MGD. The city faces 2 MGD of water shortage. The gap is likely to widen as the population is growing at a fast pace.

"We do not have any back-up plan for now. About 25 MGD water is lifted from the Tawi everyday, but pollution is making things difficult. Underground resources are under great strain. The Chenab is the only source to save future generations," said a senior official in the PHE Department.

"The city is already facing water scarcity, but no long-term plan has been made to meet future demands. Water diversion is the only solution, but successive governments have ignored the project," said Capt Anil Gour, chairman of ASHA, an NGO. (Cntd.)

Cntd.) Jammu city got organised water supply in 1934 when Maharaja Hari Singh got the first water treatment plant built at Panjtirthi. The first tubewell to augment supply was drilled at Partap Bagh near the Tawi in 1956. Expansion of the city had led to over-exploitation of both underground and overground resources.

Accepting that the Tawi would not be able to meet the demands of the city in coming years, RK Gandotra, Chief Engineer, PHE, said, "The Chenab project is being reviewed and a new detailed report will be sent to the Centre. It is a big project and needs a detailed study, but we are facing some problem at the moment."

The consultants who conducted the geo-technical feasibility study for the Chenab diversion project had expressed their concern over the landscape of the area through which water pipes were to be laid to lift water from the Ranjan lift station and over its transportation in pipes and an open channel till Muthi.

The first phase of the project was expected to be made operational by 2015, but due to the delays, the Tawi continued as the only source to quench the thirst of Jammu residents.

Acute shortage ahead

The demand is expected to double by 2024 and cross the 100 MGD (million gallons per day) mark by 2030. Areas like Roop Nagar, Janipur, Indira Colony, Buta Nagar, Naseeb Nagar, Ploura, Durga Nagar, Muthi, Ban Talab, New Plots, Sainik Colony, Bathindi, Sunjwan, Narwal and Greater Kailash are reeling under severe water shortage. Even the old city has been feeling the pinch in recent years. Many areas have been getting water supply for only one hour on alternate days.

BOX 6

TRIBUNE NEWS SERVICE

Posted at: Jul 16, 2016, 12:33 AM; last updated: Jul 16, 2016, 12:33 AM (IST)

Deepanker Gupta: Udhampur residents protest water scarcity, power cuts

Up in arms over perpetual power cuts and water scarcity, locals have been holding protest demonstrations in the district for the past few days.

Irate residents of Barta and Sarota areas staged a protest in front of the Deputy Commissioner's office here today. They raised slogans against the Power Development Department (PDD) and the Public Health Engineering (PHE) Department and alleged that the authorities have failed to solve their problems, forcing them to come on roads.

Although PHE and PDD officials claim that sufficient water and power was being supplied, residents in many parts of the city have been complaining about erratic and inadequate supply.

Similar protests have been seen in various parts of the region. Residents of Sallian Talab, Rathian, Tikri, Mand, Jib, Thathi, Ossu, Darsoo, Kaisherah, Barta, Jaganoo, Mansar, Garnai, Battal, Malhar, Barmeen, Thanoa and other adjoining areas had come out on streets in large numbers and taken out a protest march from Slathia Chowk to the office of Executive Engineer, PDD, and Executive Engineer, PHE, Udhampur.

Sham Lal of Rathian had alleged that people were being forced to drink water from pond and nullahs, owing to acute water shortage. "We have apprised the authorities of our miseries but they are not paying heed to our demands," another protester said. Protesters had threatened to block the national highway if their demands were not met

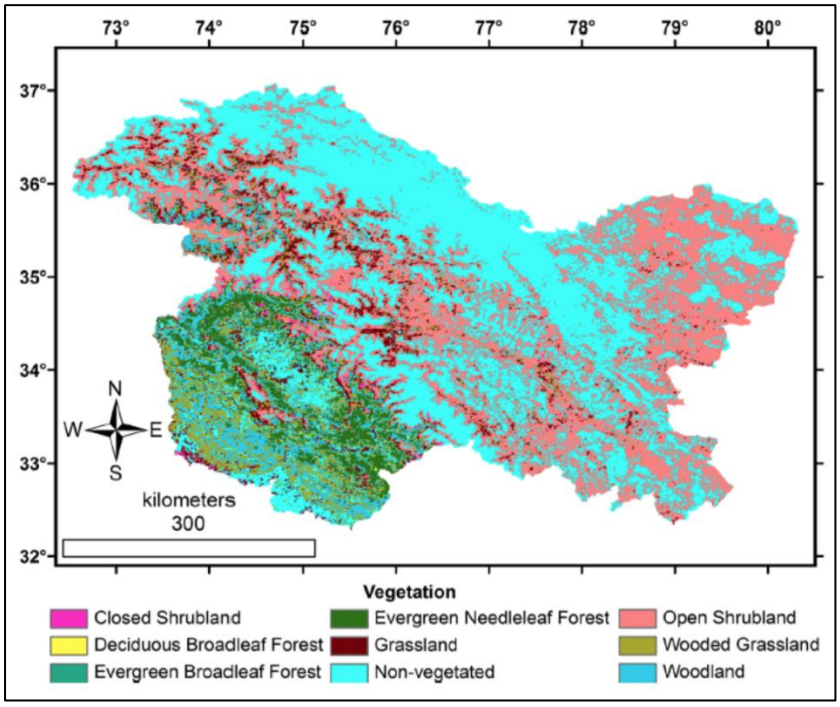
5. ANY OTHER NOTABLE ACTIVITY WITH POTENTIAL OF IMPACT ON THE RIVER

5.1 Keystone biodiversity:

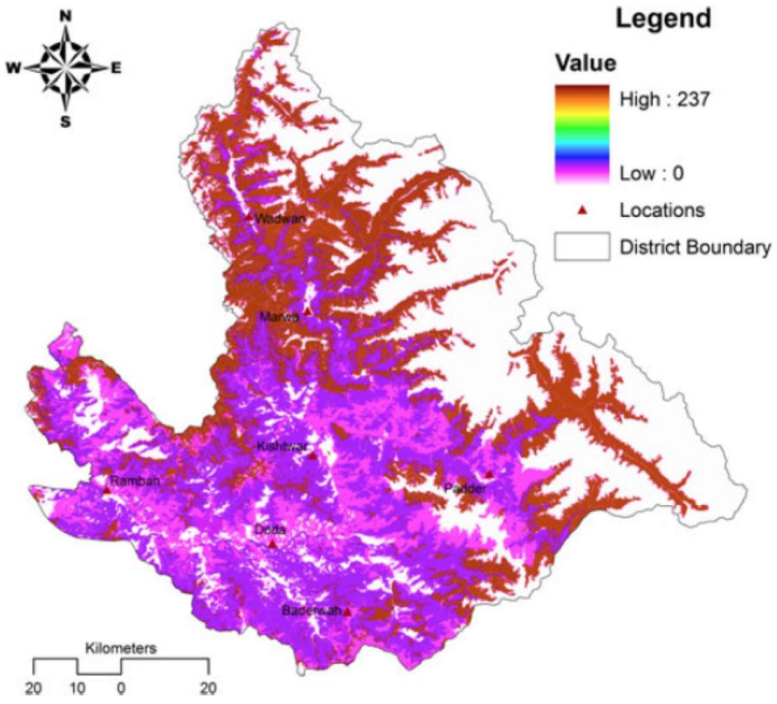
The Chenab basin has both deciduous and evergreen vegetation. The region has fairly rich diversity of plant life and includes angiosperms, gymnosperms and pteridophytes (Figure 14). Mosses and ferns cover the ground with alpine scrubs and flowering herbs. Alpine scrub is dominated by *Rhododendron companulatum* and *Juniperus squamata.* Open Scrub occurs at elevations less than 3,000 m and is dominated by *Indigofera heterantha, Parrotiopsis jacquemontiana, Viburnum grandiflorum* and *Cotoneaster nummularioides* (Rashid et al., 2013). The common tree species (Sub-Tropical Dry Deciduous Forests) in the basin are *Acacia catachu, Dalbergia sissoo, Acacia modesta, Albizzia sp., Salmlia malabarica, Eucalyptus Sp., Dendrocalamus strictus*. *Pinus roxburghii, Olea cuspidata* and other broad leaved associates in Sub-Tropical Pine Forests. *Cedrus deodara, Pinus wallichiana, Picea smithiana, Pinus gerardiana, Abies pindrow* (low level), *Abies spectables, Juglans regia, Acer sp., Populus ciliata, Aesculus indicia, Fraxinus floribunda, Quercus leucotricophora, Punica granatum, Robinia pseudoacacia,* etc. in Himalayan Moist Temperate Forests. *Prunus padus* and the typical under wood of *Parrotia jacquamentiana* etc in Himalayan Dry Temperate Forests. Fir, Kail, Junipers, *Quercus semicarpifolia, Populus ciliata, Betual utilis, Salix sp*., *Rhododendron,* and a variety of wild flowers and grasses in Alpine Forest. Udhampur and Rajouri districts in the Chenab basin have respectively 61% and 47% of their areas under forests. The basin is also a store house of medicinal and aromatic plants which are used in pharmaceutical and perfume industries. The list includes 55 species of important medicinal and aromatic plants. Several medicinal plants grow wild in temperate and alpine habitats. But over the past few decades, reckless exploitation of medicinal plants has rendered them vulnerable to extinction as is the case with *Saussurea costus, Gentiana kurroo, Podophyllum hexandrum* and many other plant species (Rashid et al., 2013). So the government has started cultivation of some medicinal plants like *Dioscorea deltoidea and* is now cultivated for its tubers rich in Diosgenin and yield cortisone, a steroid hormone. The people in the basin depend on biodiversity for their daily needs of food, medicine, fuel, fiber etc. The varied plant life also contributes to food and habitat needs of wild and domesticated life in the basin.

Almost 60 %of the area in Doda district of the Chenab basin falls under Medium and highly biologically rich landscapes (Fig. 15). High biological richness is observed in Marwah forest division comprising most of the Northern part of Doda district (Fig. 9). Besides, Ramban and Kishtwar areas in th basin also show high biological richness which can be attributed to low pressures (both anthropogenic as well as natural) on landscapes located in these areas. A relatively low biological richness was found around Banihal, Baderwah and Doda towns of the basin.

The faunal component of biodiversity of the basin is rich with interesting and unique forms both in the forest zone and above forest line. The variety of animal forms ranges from higher groups like vertebrates, including mammals, birds, reptiles, amphibians and lower groups like invertebrates including insects and even unicellular micro-organisms. The faunal diversity of basin is diverse due to its unique location and climatic condition.



Map No 14: Major vegetation types in the J&K State (Rashid et al., 2015)



Map No 15: Biological richness map of a part of the Chenab basin in J&K State

5.2 Climate Change Scenario in Chenab:

Climate change has emerged as a global environmental issue that has engaged the world attention as it relates to global common atmosphere. Mountains are early indicators of climate change (Singh et al., 2010). Studies indicate that the Himalaya seems to be warming more than the global average rate (Liu & Chen 2000; Shrestha et al. 1999), temperature increases are greater during the winter and autumn than during the summer; and the increases are larger at higher altitudes (Liu & Chen 2000). The Indian Institute of Tropical Meteorology, Pune has reported a decrease in precipitation over 68 % of India's area over the last century (Kumar et al., 2006). However, significant increase in rainfall was noticed in Jammu and Kashmir and some parts of Indian peninsula (Agarwal, 2009). The average temperature of Kashmir valley has gone up by 1.45 ºC over the last two decades (Sinha 2007). Impact of changing climate is perceptible on snow, glacier and vegetation. In some parts of the high altitude, the biodiversity is being lost or endangered because of land degradation and the over use of resources, e.g., in 1995, about 10 % of the known species in the Himalaya were listed as `threatened' (IPCC, 2002). However, impact of CC on biodiversity and vegetation in the region is yet to be carefully studied to establish such a relationship.

5.3 Depletion of snow and glacier resources:

Himalayan glaciers are a focus of public and scientific debate. Prevailing uncertainties are of major concern because some projections of their future have serious implications for water resources. Most Himalayan glaciers are losing mass at rates similar to glaciers elsewhere, except for emerging indications of stability or mass gain in the Karakoram. A poor understanding of the processes affecting them, combined with the diversity of climatic conditions and the extremes of topographical relief within the region, makes projections speculative. Nevertheless, it is unlikely that dramatic changes in total runoff will occur soon, although continuing shrinkage outside the Karakoram will increase the seasonality of runoff, affect irrigation and hydropower, and alter hazards (Bolch et al, 2012). As glaciers recede and snowlines move upwards, river flows are likely to change, and alteration in water flow regime may lead to a plethora of social issues and affect hydropower generation, endanger biodiversity, forestry and agriculture-based livelihoods and overall wellbeing of the people.

From Miyar, Bhaga, Chandra, Warwan and Bhut and Ravi watershed of the Chenab basin, the minimum and maximum snow cover in each hydrological year from 2004-05 to 2013-14 was calculated (SAC, 2016). Overall the minimum snow cover was lowest in Chenab basin in the 2013-14 year. The quantity of minimum snow cover varies in each year for different sub-basins and is not uniformly same. This suggests that within Chenab basin also the different sub-basins experience different amount of precipitation in different years. Also, the pattern of snowfall and subsequent melting of snow up to middle of January is common in all the sub-basins. There is quite similarity in melting of snow cover from early march

onwards. In Indus basin of which Chenab River is a major tributary, there is large unevenness in the accumulation pattern of snow cover in the Chenab basin.

Changes in snow cover for the duration 2004-2014 in sub-basins of the Chenab basin are shown in Table 18 to Table 23. It is observed that Ravi sub-basin shows minimum snow cover (5 to 70%), while remaining sub-basins show snow cover changes ranging 20 to 100% annually. All the sub-basins are showing a marginal increasing trend of snow cover during 2004-2014 time frame.

Table 18: Min and max snow cover in Warwan sub-basin during 2004-14 (SAC, 2016)

Warwan sub-basin (4670 sq. km)				
Year	Minimum snow cover		Maximum snow cover	
	Sq. km	%	Sq. km	%
2004-05	1868	40	4670	100
2005-06	747	16	4110	88
2006-07	1401	30	4203	90
2007-08	887	19	4483	96
2008-09	1074	23	4063	87
2009-10	1354	29	4670	100
2010-11	701	15	4483	96
2011-12	747	16	4623	99
2012-13	1261	27	4530	97
2013-14	607	13	4483	96
Mean	1065	23	4432	95
S D	402	9	226	5

Table 19: Min and max snow cover in Bhut sub-basin during 2004-14 (SAC, 2016)

Bhut sub-basin (2218 sq km)				
Year	Minimum snow cover		Maximum snow cover	
	Sq km	%	Sq km	%
2004-05	976	44	2218	100
2005-06	488	22	1952	88
2006-07	399	18	2018	91
2007-08	555	25	2174	98
2008-09	466	21	1930	87
2009-10	421	19	2218	100
2010-11	444	20	2107	95
2011-12	444	20	2196	99
2012-13	665	30	2151	97
2013-14	421	19	2151	97
Mean	528	24	2112	95
S D	176	8	107	5

Table 20: Min and max snow cover in Miyar sub-basin during 2004-14 (SAC, 2016)

Miyar sub-basin (4449 sq km)				
Year	Minimum snow cover		Maximum snow cover	
	Sq km	%	Sq km	%
2004-05	1913	43	4449	100
2005-06	845	19	4405	99
2006-07	578	13	4360	98
2007-08	890	20	4449	100
2008-09	1335	30	4360	98
2009-10	756	17	4449	100
2010-11	667	15	4449	100
2011-12	756	17	4449	100
2012-13	1290	29	4449	100
2013-14	534	12	4449	100
Mean	956	22	4427	100
S D	431	10	38	1

Table 21: Min and max snow cover in Bhaga during 2004-14 (SAC, 2016)

Bhaga sub-basin (1680 sq km)				
Year	Minimum snow cover		Maximum snow cover	
	Sq km	%	Sq. km	%
2004-05	1159	69	1680	100
2005-06	638	38	1663	99
2006-07	420	25	1680	100
2007-08	504	30	1680	100
2008-09	840	50	1680	100
2009-10	672	40	1680	100
2010-11	622	37	1680	100
2011-12	470	28	1680	100
2012-13	907	54	1680	100
2013-14	353	21	1680	100
Mean	659	39	1678	100
S D	249	15	5	0

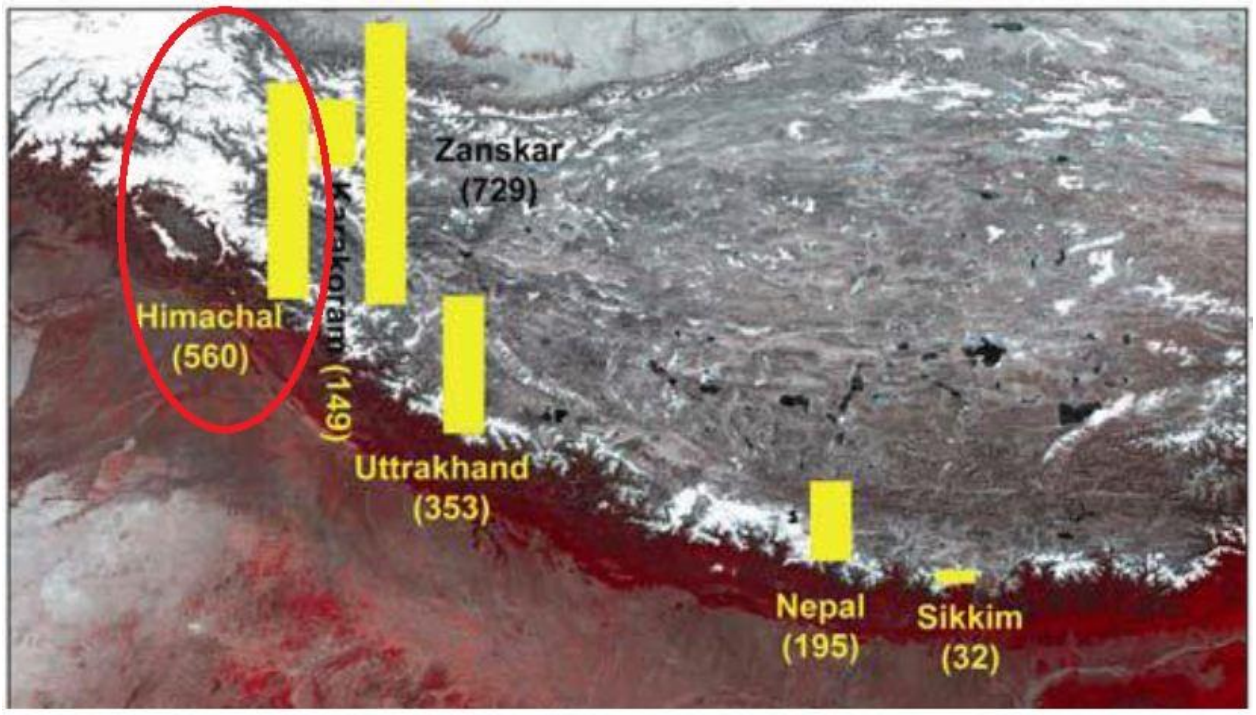
Table 22: Min and max snow cover in Chandra sub-basin during 2004-4 (SAC, 2016)

Chandra sub-basin (2433 sq km)				
Year	Minimum snow cover		Maximum snow cover	
	Sq. km	%	Sq. km	%
2004-05	1825	75	2433	100
2005-06	925	38	2433	100
2006-07	706	29	2433	100
2007-08	1362	56	2433	100
2008-09	1484	61	2433	100
2009-10	1435	59	2433	100
2010-11	1241	51	2433	100
2011-12	754	31	2433	100
2012-13	1314	54	2433	100
2013-14	633	26	2433	100
Mean	1168	48	2433	100
S D	394	16	0	0

Table 23: Min and max snow cover in Ravi sub-basin during 2004-14 (SAC, 2016)

Ravi sub-basin (4907 sq. km)				
Year	Minimum snow cover		Maximum snow cover	
	Sq. km	%	Sq. km	%
2004-05	785	16	4465	91
2005-06	294	6	3091	63
2006-07	196	4	3827	78
2007-08	245	5	3827	78
2008-09	491	10	3190	65
2009-10	442	9	4220	86
2010-11	245	5	4760	97
2011-12	147	3	4564	93
2012-13	196	4	4024	82
2013-14	294	6	4171	85
Mean	334	7	4014	82
S D	192	4	551	11

Glaciers were monitored using IRS LISS III images of 2001 and 20111/12 (Bahuguna et al., 2014). Figure 16 shows the location of glaciers monitored in different climatic zones of Himalayas. Table 24 summarizes the findings of change in glaciers in 6 sub-basins of the Chenab basin. Maximum glacier retreat was observed in Bhaga and Warwan of the Chenab basin.



Map No 16: Showing Chenab glaciers (encircled) (Source: Bahuguna et al., 2014)

Table 24: Changes in glacier extent in Chenab basin during 2000-11

S. No.	Sub-basin	No. of glaciers	Stable	Retreat	Advance	Glaciated Area (km^2)		Area change (km^2)
						2000/2001	2010/2011	
1	Chandra	140	121	19	0	173.83	172.89	-0.94
2	Bhaga	69	53	16	0	100.58	97.35	-3.23
3	Warwan	77	56	21	0	170.68	167.4	-3.28
4	Bhut	167	158	9	0	64.5	63.54	-0.96
5	Miyar	59	52	7	0	111.77	111.61	-0.16
6	Ravi	36	33	3	0	11.61	11.47	-0.14

6. DETERMINING THE HEALTH STATUS OF CHENAB RIVER USING ASSESSMENT MATRIX:

Using different indicators and contributory factors of the riverscape at the basin level, the status and health of the Chenab River was determined using the Assessment Matrix shown in the Table 25. There are various factors related to land, water, climate, culture and demography that shape the riverscapes. Accordingly, we used all the relevant factors and indicators numbering 15 for determining the condition of the Chenab riverscape. Most of these indicators and parameters have been briefly described in the preceding sections of the report. However, there is variation in these parameters and indicators across all the watersheds of Chenab sub-basin. The observed transformations in the biophysical, hydrological, climatic, socio-economic and other related aspects in the basin have transformed the structure and functionality of the Chenab River, adversely affecting the services and products emanating from a living river system. According to the river health assessment outlined in the table 25, the Chenab River can be categorized as a Sick and Threatened Riverscape with 8 Pink, 5 Blue and 3 Red categories for various indicators and contributory factors. The riverscape is a dynamic system and there is ample scope to reverse some of these transformations witnessed in the basin since the last 4-5 decades to restore the heathy nature of the river.

6.1 Red (Critical), Pink (Threatened) and Blue (healthy)

Table 25: Assessment Matrix for determining the Health of Jhelum River

Name of River	Unit of Assessment	Indicators	Contributing Factors
Chenab	Chenab sub-basin	Catchment vegetal cover	B
		Protected areas	B
		Lakes, springs and Wetlands	P
		Status of Surface waters	P

		Condition of Groundwater	B
		Status of pollution	P
		Polluting Influences (Industrialization)	B
		Dams	R
		Barrages	P
		River side embankment	B
		Conflicts over the River	P
		People's Connect with the River	P
		People's action and awareness	P
		Keystone biodiversity	P
		Climate change	R
		Depletion of snow and glacier resources	R
		Total	**8P, 5B, 3R**

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