FLOOD DAMAGES IN KEDARNATH AND ITS IMPACT ON HYDRO-POWER DEVELOPMENT

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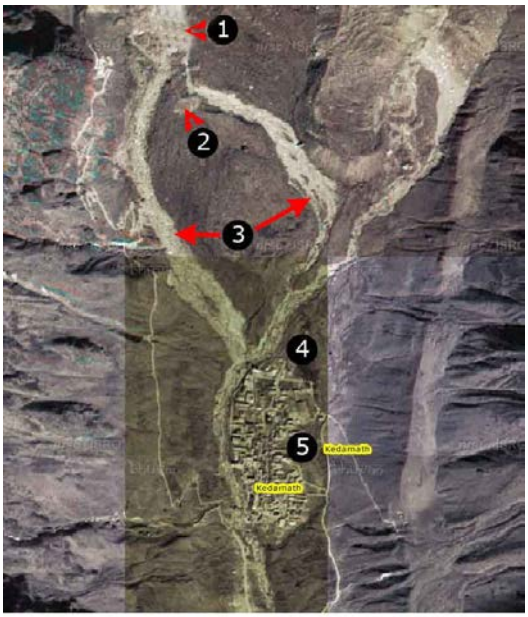
THE KEDARNATH TEMPLE AND CHAR DHAM

Thousands of people from all over India and abroad visit every year the Kedarnath Temple, one of the Char Dhams, namely, Yamunotri, Gangotri, Kedarnath and Badrinath located on the banks of rivers Yamuna, Ganga, Mandakini and Alkananda respectively (photo-1). The state of Uttarakhand has large revenue income from the tourists visiting all Hindu holy shrines like Chardhams, Gourikund, Hemkund sahib, Vadrinath, Rudraprayag, Uttarkashi, Devaprayag, Vishnu prayag, Hrishikesh, Hardwar etc. located on the banks of rivers Ganga and Yamuna and their tributaries as shown in photo-1. Photo-2(a) shows Kedarnath valley and settlements (5) on the bank of river Mandakini (1&3). Photograph-2(b) depicts the devastated Kedarnath town with the kedarnath temple (in circle) after the disastrous flood on 16-17 June, 2013. The Kedarnath temple was built by the Pandavas and rebuilt in the ninth century by Adi Shankaracharya who saved the Hindu religion from the spread of Buddhism in India. Although the temple is safe, the Sacred Samadhi of Shri Adi Shankaracharya has been washed out in the flash flood.(DDF,2013)

Photo-1 Showing Char Dhams (Yamunotri, Gangotri, Kedarnath &Badrinath in Uttarakhand) on the Four Rivers-Yamuna,Ganga, Mandakini &Alkananda originating in N-W Himalayas.



(1) Water comes from glacier is a single stream
(2) Large amount of debris lies on the path of this water
(3) Water moves down in two streams
(4) Water moves along in thin channels
(5) Kedarnath settlement

Photo-2(a) Showing Kedarnath Valley and Mandakini River(before Flood)

Photo-2(b) Devastation in Kedarnath Valley after Flash Flood on 16-17 June.2013 (Kedarnath Temple can be seen in Circle)

RIVER MANDAKINI

A tributary of river Ganga, Mandakini river (photo-1) originates in the western Himalayas at an elevation of about 4,800m. It joins river Saraswati just downstream of Kedarnath valley, river Alkananda near Rudraprayag and river Bhagirathi (name of Ganga. upstream) near Devaprayag. Mandakini river has a catchment area of about 45 sq. km up to Kedarnath valley at an elevation of about 2500m. The catcment area is mostly covered with snow and glaciers without any vegetation. Run-off occurs principally from snowmelt due to higher temperature and heavy precipitation in the catchment in the month of June. The river has very high longitudinal bed slope upstream of Kedarnath valley where it falls through a height of about 2300m (4800m-2500m) in a length of about 10km only, i.e.with an average bed slope varying from 1 in 4 to 1in 5. As shown in photograph-2(a), Mandakini river used to flow on the west side of Kedarnath valley before the flash flood. River Saraswati flowing on the east side of Kedarnath joined Mandakini immediately after Kedarnath Valley. After the flash flood during 16-17 June, 2013, Mandakini suddenly changed its old course and started flowing eastward in an old abandoned channel and joined Saraswati river just upstream of the Kedarnath valley. The old course of the river Mandakini west of Kedarnath is completely choked with debris and stones with little conveying capacity of the river in the valley region.(Mazumder,2013)

FLASH FLOOD AT KEADARNATH DURING 16-17 JUNE,2013

The State of Uttarakhand experienced an unprecedented meteorological condition during the mid June 2013. The onset of monsoon in the state was relatively early resulting in heavy to very heavy rainfall/cloud burst throughout the state during 16th to 18th June 2013. Various factors, namely, high melting rate of glaciers, prolonged heavy rains, (320-340 mm/day), steep and bare

catchment, landslides etc. resulted in very high run-off/flash flood in all the rivers in the state. Moreover, a glacial lake outburst flood (GLOF) occurred during 16-17 June night due to sudden breaching of Chorabari Tal - an artificial lake made of loose moraine - from where Mandakini river originates about 10 km upstream of Kedarnath. A wall of water about 3m high mixed with huge quantity of stones and debris descended the valley during the night with very high velocity. Due to choking of its old course (west of valley), river Mandakini anabranched and started flowing in an old abandoned course and joined river Saraswati (flowing earlier east of Kedarnath) upstream of Kedarnath capturing all the minor streams in between Mandakini and Saraswati rivers resulting in devastation of the valley during 16-17 June,2013 .

DAMAGES IN FLASH FLOOD IN UTTARAKHAND & KEDARNATH

Out of thirteen districts in Uttarakhand, the four districts (Rudraprayag, Chamoli, Pithoragarh & Uttarkashi) suffered maximum damages. Kedarnath and Badrinath in Rudraprayag district were the worst affected places. The heavy rain and landslides caused devastation all around Uttarakhand State. The flood waters ravaged the town of Kedarnath as Mandakini river flowed downhill towards flat land. The flash flood in the Kedar valley, where thousands of people gathered during the peak tourist season, caused instantaneous death of more than 500 people during 16-17 night. About 5,700 people and 9,000 cattles/livestocks lost their lives in the state of Uttarakhand and almost equal numbers of people were missing. Besides loss of lives, 600 villages in the four most affected districts were either washed out or submerged whereas 760 villages got cut off with no connectivity. 3,000 houses 1,520 roads. Photo-3 depicts a typical damaged road in Srinagar. 154 bridges, 35 small, mini and micro hydro- electric projects, water supply lines, telephone lines etc. were damaged. Apart from loss in tourism, 14,000 micro industries in the state were badly affected. More than 1,00,000 stranded people had to be evacuated by helicopters. The state is reported to have suffered a financial loss of about Rs.3,000 crores in infrastructures, excluding tourism sector loss of about 12,000 crores. It was the country's worst natural disaster after the 2004 tsunami. (Misra et al,2013)

HYDRO-POWER DEVELOPMENT IN INDIA

The hydro-power potential of India has been estimated as 84,000 MW at 60% load factor equivalent to about 1,50,000 MW installed capacity. Total hydro-power potential of India including pump storage, tidal, river linking, mini and micro hydel schemes is about 3,00,000 MW (Mishra,2013) of which about 60% lies in Arunachal, Himachal and Uttarakhand states. Out of a total of 2,23,626MW Installed capacity of India (including thermal, hydro, nuclear and wind as on 30.4.2013), the share of hydro-power is 39,624 MW i.e 17.7% only against an ideal share of about 40%. Hydel power has several advantages over thermal and nuclear power. It is renewable and pollution free. It is essential for peaking purpose due to its flexibility of operation. China, Brazil, USA and Canada have developed 210GW, 84GW, 79GW and 74 GW hydro-power respectively, compared to only 39.6 GW by India on 30.4.2013 (Madan,2013).

Against 83 feasible major projects with the potential of 20,402 MW in Ganga and Yamuna basins (table-1), the present status of hydro development in Alakananda and Bhagirathi basins is that only four major projects — Tehri, Maneri-Bhali-I & II and Vishnuprayag of 3164MW capacity — have been commissioned. Another five projects are in different stages of implementation. Less than 40 km of riverine stretch has been impacted by these projects out of 800 km of main river and tributaries. No project component or its vicinity has suffered from

Photo-3 Typical road damage by landslip in Srinagar, Uttarakhand.

TABLE-1:Distribution of Total Hydro-Power Potential (MW) In Ganga &YamunaBasin

Basin	Large Hydro projects (above 25 MW)		Small Hydro projects (1-25 MW)		Mini-micro Hydro projects (below 1 MW)		Total Hydro projects	
	No of projects	Capacity,	No of Projects	Capacity,	No of Projects	Capacity,	No of Projects	Capacity,
Alaknanda	29	4823	43	375.6	2	0.65	74	5199.25
Bhagirathi	5	675	13	125.5	4	1.4	22	801.9
Ramganga	6	314	12	93.5	2	1	20	408.5
Sharda	26	11920	16	101.95	6	0.33	48	12022.28
Yamuna	17	2670	13	110.3	3	0.55	33	2780.85
TOTAL	83	20402	97	806.85	17	3.93	197	21212.78

landslip-induced failure, except flooding of debris into partially completed components (Das 2013). State of Arunachal Pradesh with a major potential of about 55,000MW has so far developed only around 4-5% of hydro-power so far and a large numbers of projects are in the pipeline. Apart from hydro-power, the project proponents offer drinking water, recreation, tourism , infrastructures, education , employment opportunities of poor people living in hilly areas in India.

The Himalayan region is attractive for hydro-power generation because all the rivers in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh descend from around 3,500m to 500m in a short 200-km stretch. This water wealth is nature's gift and a bounty for these relatively underdeveloped states and for the country as a whole. This is not to say that abstraction of fresh water by blocking of rivers for power generation is being indiscriminately allowed disregarding either the geotechnical/seismic safety of the terrain or the riparian need of the river to support the needs of humans as well as terrestrial and aquatic ecosystem down the river.

IMPACT OF FLASH FLOOD ON HYDRO-POWER DEVELOPMENT

The environmentalist lobby are up in arms against hydro-power development in India. Dams/ barrages/ tunnels needed in all hydel projects have been blamed unequivocally for all the ills that have currently befallen in the region after the flash flood in Uttarakhand. They are trying to correlate the damages suffered with hydel construction with a view to stop further development. It is very unfortunate that. many of the environmentalists are ignorant about the real causes of the recent flash flood and consequent damages. Flash floods have occurred in India and abroad at many places even where there is no hydel projects.

Flash flood that occured on 16-17 june,2013 is a natural disaster due to accidental coincidence of extreme events like cloud burst, prolonged and heavy rainfall, high rate of snowmelt , landslides etc. All these combined with GLOF from sudden failure of Chorabari Tal-an artificial lake made of loose glacial moraines- resulted in wash out of Kedarnath town, Rambara, Gourikund and other villages lying downstream of Kedarnath on the bank of Mandakini river. Such intense rainfall of prolonged duration as observed during June 16 to 18, 2013, has a statistical recurrence interval exceeding 500 years .

It is alleged that building dams and reservoirs in the frazile Himalayas is responsible for flash floods and landslips. On the contrary, the Tehri reservoir on the Bhagirathi held back the incoming devastating flood which attained a peak of 7000 cumec due to very heavy rainfall in its catchment. The incoming peak was routed and flood release was restricted to a mere 400 cumec — causing the reservoir to rise by 25 metre a day thereby eliminating the flood damage below the Tehri dam. Without the Tehri dam the combined flood of the Mandakini, Alakananda and the Bhagirathi would have exceeded 25,000 cumec at Rishikesh, possibly wiping out the prosperous urban river stretch at Rishikesh, Haridwar and Saharanpur (Das, 2013).

The human intervention in the region over the last 10 years also played a major role in intensifying the disaster. To cater to the unprecedented growth of religious tourism, a large network of new highways and road-widening schemes are cutting into the toes of delicate,

fragile and marginally stable slopes that hug the highways on river edges (p0hoto-3). Highways — around 500 km long — on the banks of the Alakananda and the Bhagirathi are constantly being widened at narrow stretches, leaving extremely steep conglomerates of rock and soil exposed to the vagaries of the weather. The recent spurt of construction of hotels on river edges, particularly on low over-banks prone to flooding, is one of the major cause of the recent disaster.

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