

Overview of June 2013 Flood and Landslides with focus on Darchula Disaster



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Abstract: In mid June 2013 there was a cloud outburst in northern Uttarakhand, India and far western region of Nepal, due to simultaneous activation of monsoon arms one from Bay of Bengal in the east and other from the southwest. There was 322mm of rainfall in Uttarakhand during the week 13-19 of June 2013 (847% of the normal rainfall of Uttarakhand for this period). The extreme flood event caused thousands of human lives lost and several billions of property damages in India and extensive damages in Nepal. The Mahakali River a border river between India and Nepal caused very heavy damages in several places in Nepal's Darchula and also in Dodhara and Chandhani, the Nepali settlements in west side Mahakali River.

Contribution of Dhualiganga a tributary of the Mahakali River where a 280 MW hydro plant with 6.2 million cubic meters of storage reservoir capacity is constructed by India for the severity of flash flood in the region cannot be overlooked. The sudden spillway gate opening from this reservoir added the already very heavy floods in Mahakali that devastated Darchula the district HQ of Darchula. More than 100 houses in Darchula were washed away by the big flood event. However, India was quick to refute the charge of sluice-gate-opening of the Dam and stated that the disaster in Darchula was not caused by the dam opening. Detailed Investigation is yet to be done.

This paper analyses the events surrounding the 17-18 June catastrophic flood causing wide spread damages in Darchula District Head Quarter. Both the countries need to work honestly for mutual benefit especially for minimising the effects of any disasters in the future.

Key words: Extreme rainfall, flood damage in Darchula, Dhualiganga dam, Nepal

Introduction Background

All river systems in Nepal flow north to south and drain to the River Ganges. The rivers are lifeline for the people of Nepal. The rivers are utilized for domestic use, hydropower generation and many other uses.

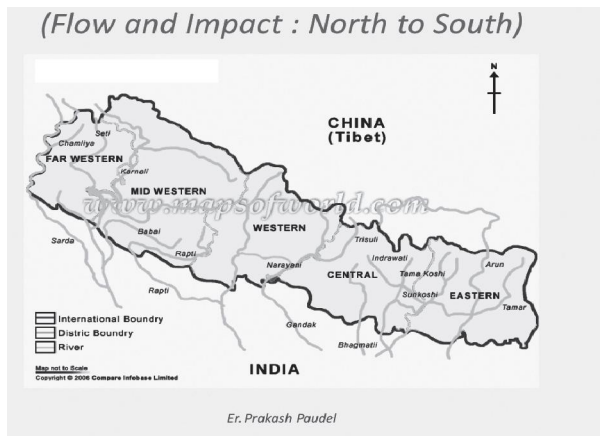


Figure1. Major Rivers of Nepal

However, in every rainy season, especially in monsoon period, these rivers are cited as the cause of devastation, disaster and havoc due to floods, inundation and mass waste (avalanche, soil erosion, landslides and river bank erosion)

Historical Extreme Events

About 26 major events of floods, cloudbursts, Glacial Lake Outburst Floods (GLOFs), Infrastructure Failure Outburst Flood (IFOF), landslides have been recorded between the year 1958-2013 (June). The major events of

floods were found in the rivers Kosi, Bagmati, Narayani (Sapta Gandaki) and Karnali. The moderate events were found in the rivers Kankai, Kamala, Seti Gandaki, Kali Gandaki, Trishuli, Tinau, West Rapti, and Mahakali. The flood Events were also recorded in the rivers SunKosi, Balephi, Budhigandaki, East Rapti, Babai, Andhikhola, etc.

Government of Nepal, Ministry of home affairs has the records of loss of lives due to various disaster events including flood, landslide, inundation, fire, thunderbolt, windstorm, etc. As per the data for the last ten years out of the total loss of lives of 3,691 person, 2,141 (58%) are due to water induced disasters (WID). Similarly, during recorded 8-years, loss of property is NRs 1,240 billion, out of which NRs 931 billion (75%) is due to WID.

June 2013 Flood Events

General

Mid June of 2013 saw unprecedented rainfall in Uttarakhand state of India and Far-western region of Nepal. The cloud outburst was due to simultaneous activation of monsoon arms from eastern and south western direction. Broad advancement and confluence of the monsoon winds is shown in Figure 2. Due to the flood generated by the rainfall, heavy loss of land and property in Darchula and Kanchanpur districts by Mahakali River were experienced. Also, the normal cases of bank cutting and inundations were reported in Narayani and Tinau rivers, besides events of inundation and bank cutting information came from some central and eastern parts of Nepal (Fig 3 and Fig 4). Huge losses of land and houses were caused by the floods of Karnali River in Bardia district.



Figure 2. Monsoon Winds

Hydro-meteorological Information of Western Nepal Rainfall

There was severe rainfall due to cloud outburst in the referred location. The rainfall in different parts of Uttarakhand is shown in Table 1. The excess heavy rainfall was observed in all the districts of Uttarakhand. It was more than eight times of normal rainfall in Dehradun and more than double in Pithauragarh district in that period.

The rainfall with hourly distribution in Dipayal station in Nepal is shown in figure 5. There was recorded daily rainfall of 80.4 mm in June 16 and 221.8 mm in June 17 at this station. Similarly, rainfall pattern in these areas of Nepal and India are depicted in the figures 6 and 7. All the records show that the rainfall far exceeded the normal and was main reason for the unprecedented flood in the region.

S. No.	State/Ut/Met Subdivision	Actual (mm)	Normal (mm)	%Dep	Cat.
Uttharakhand, India					
1	Almora	243.4	67.1	249%	E
2	Bageshwar	445.7	67.1	579%	E
3	Chamo; i	375.6	52.5	615%	E
4	Champawt	427	85.7	398%	E
5	Dehradun	644.5	75	759%	E
6	Garhwal Pauri	205.1	43.9	367%	E
7	Garhwal Tehrai	356.9	61	485%	E
8	Hardwar	342.7	47.9	615%	E
9	Nainital	586.2	89.8	553%	E
10	Pithoagart	320.3	154.2	208%	E
11	Rudraprayag	479.5	102.8	366%	E
12	Udham Singh Nagar	206.5	70.9	191%	E
13	Utharkashi	475.9	66.1	620%	E

Source: Indian Meteorological Department (IMD)

Table1. Rainfall Data of Uttarakhand Districts as per IMD up to June 19, 2013)

Note: IMD map showing 322 mm ,of rainfall over Uttharakhand during the week 13-06-2013 to 19-06-2013(847% of normal for Uttharakhand for this period)



Figure 3. Village building collapsed in Kanchanpur



Figure 4.Devastation of Darchula HQ

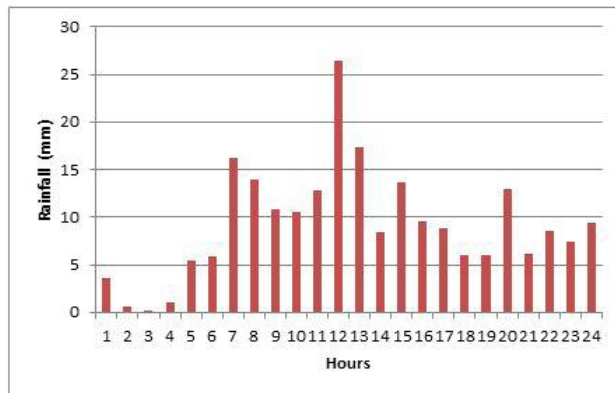
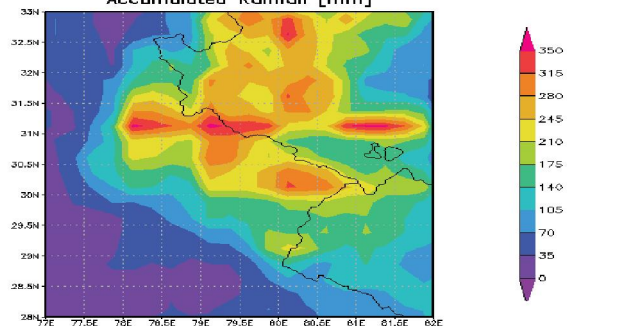


Figure 5.Rainfall in Dipayal, Nepal (June 17, 2003)

3-hourly TMPA-RT 03Z15Jun2013-03Z18Jun2013
Accumulated Rainfall [mm]



Generated by NASA's Giovanni (giovanni.gsfc.nasa.gov)

Figure 6. Accumulated rainfall

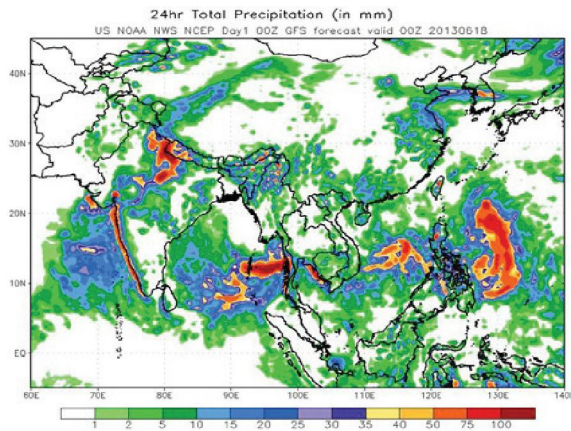


Figure 7. 24 hour total precipitation

It is reported that effective rainfall in the western Nepal started from June 17 and further increased on June 18. Table 2 shows the daily precipitation of Dipayal for consecutive 4 days (as per graph presented by ICIMOD after DHM). The measured flood records (PEP, FO-7) of Mahakali in Sarda barrage for Jun (17-18) are shown in the following hydrograph (Fig. 8).

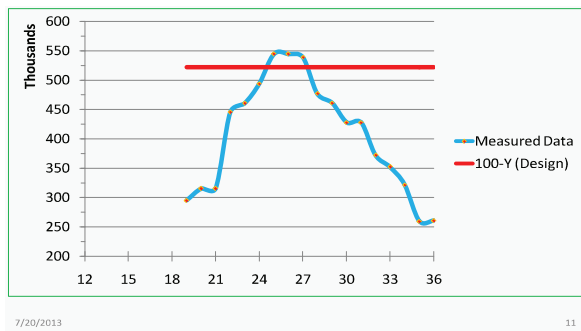


Figure 8. Flood Measurement (CUSECS) Hydrograph in Mahakali (River Discharge From Jun-17-Noon to Jun-18-Noon)

It is clear from above that the flood at 0100-0200 hrs on June 18 has exceeded all the past records as well as the design discharges of Banbasa and Tanakpur Barrages.

Date (Jun-2013)	16	17	18	19
Rainfall (mm)	3.7	67.8	186.3	5.7

Table 2. Rainfall records at Dipayal for 4 consecutive days. Measured date is next day at 8:45 AM. (DHM)

Floods and Landslides in India

We have heard, read and seen much in media about recent devastating effect of flood and landslides in Uttarakhand, the northern state of India. As per the report published by the Uttarakhand Space Application Centre (USAC), following possible actions or processes were derived under scientific examination of the events:

- Heavy rainfall exceeded the saturation limit on 16-17 June and caused heavy landslide.
- Flash Flood itself caused heavy loss of property.
- Level in Chaurabari Lake was raised to

overflow as a stream.

- The river upstream of Kedarnath Temple was flooded along with heavy debris flow.
- More channels were formed while entering the Kedarnath area and the debris loaded flood rolled over the houses around the Kedarnath Shrine.
- Most of the houses in the Kedarnath area were swept away, others were left damaged.
- Steep slope of river to Rambara and Gaurikund caused heavy losses in the area with debris deposition.

Besides the Kedarnath area, other high hill centers affected by the floods and landslides in the region are Uttarkashi, Gaumukh, Chamoli, Shrinagar, Pauri, Rudra prayag, Joshimath, Tehri, Dev prayag, Rishikesh, Haridwar, Dehradun and Yamunanagar.



Figure 9. Road to Gaurikund collapsed



Figure 10. Kedarnath city washed away

Severe Mahakali Flood at Darchula Headquarter Similarity to India

Mahakali River has the sources of glaciers in Himalayas on both sides of Nepal and India. It was analyzed with the help of satellite images in the area and was found that there is no case of glacier slides or avalanche or GLOF. Hence following logical reasons are drawn regarding process of flooding in Mahakali:

- Heavy rainfall and cloud outburst in the area (extreme event).
- Rapid melting of glaciers to add to the run-off due to climate change and increase in the temperature.
- Heavy land erosion, slides and mass-movement in the saturated fragile geology.
- Heavily debris loaded water flow (flood) triggering further devastation.

Difference from India

There is no evidence of failures or openings of natural water bodies adding to more flooding and landslides from the upper catchment. However, local people and the people’s representatives from the area firmly believe that devastation in Darchula was mainly due to sudden opening of sluice gates of the Dhauliganga dam constructed in one of the major tributaries of the Mahakali upstream of Darchula headquarter. The debris flood flushing from the reservoir, with 6.2 million cubic meters of stored water and sediment content, within a short timeframe has exacerbated the situation with the main stream of Kali River already at the critical level simultaneous action has devastated substantial stretch of the River. However, without any verification, the Indian embassy in Kathmandu has denied the possibility of such incident.

Dhauliganga Dam

Dhauliganga is a tributary of Mahakali River. It is a glacier fed river. Dhauliganga dam is constructed to divert and regulate water for the power generation of 280 MW. The project brochure explains the provision of the sluice spillway and power intake as follows: “The gated spillway and power intake structures are located adjacent to the dam and are designed to minimize the inflow of sediments into the pressure waterways, whilst allowing their efficient flushing from the reservoir during periods of flood.” The spillway section and general dimensions are shown below.

Following impressions can be drawn from the data available:

- Crest of Sluices are 46.5 m. below Pond Level and 28.0 m. below the power operating level
- Spillway has full capacity to discharge the design flood (3,210 Cu. m./sec) of the river
- The sluice gates are opened when the reservoir is having sediment or excess water

Further government of India made it clear that there was much debris and sediment in the reservoir due to heavy rainfall and resulting debris flow. Hence it is clear that sluice spillway was fully opened on that day.

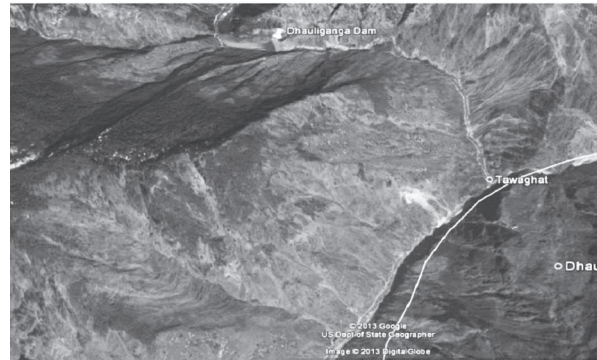
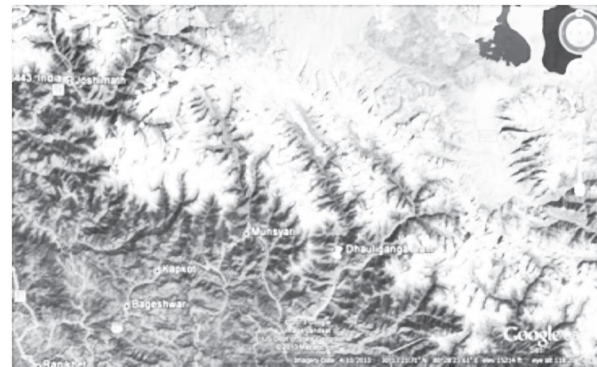


Figure 12. Dhauli Ganga meets mahakali d/s of site



Item	Dimension
Catchment Area	1360 sq.km
Design Flood Discharge	3210 cum/s
Total Power (4x70)	280 MW
Dam Height	56 m
Total Reservoir Capacity	6.20 M.cum
Active Reservoir Capacity	1.54 M.cum
Reservoir Pond Level	1348.50 m
Power Canal FSL	1345.00 m
Min. Operating Level	1330.00 m
Sluice Crest Level	1302.00 m
Sluice Opening (3x6x10)	180 sq. m
Sluice Capacity	3210 cum/s

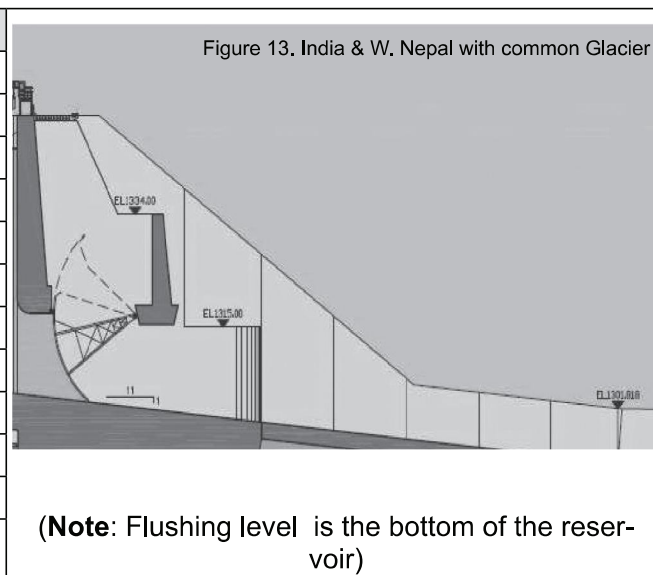


Figure 11. Under sluice Spillway Section

Figure 13. India & W. Nepal with common Glacier

Impression on Flood Event of Darchula

Main cause for the flood in Mahakali River is the unprecedented rainfall in the basin area. Besides, the opening of gates and flushing of debris of Dhauliganga Dam has exacerbated the flood situation further. The 6.2 million cubic meter capacity reservoir with about 3,200 cubic meter per second design discharge could not be operated properly in such extreme situation without the downstream damages. With the sudden opening of gates of Dhauliganga reservoir, it has created surge in the river aggravating situation in Mahakali river already in the critical state. Encroachment in the low land, mining of river bed materials, inferior river protection works with-in Nepal, etc. are other minor reasons. Preparedness and coordination between the countries and agencies was clearly lacking in the area. There was no reporting of glacial lake outburst. Effects of each component contributing for the disaster can be obtained only after detailed investigation of the basin area.

Basic information gathered for the occurrence of these events is:

- On the day of heavy rainfall, the soil of the area which was fully saturated already abruptly failed in the upper catchment slopes with the fragile geology, and heavy debris flow was observed.
- Like other rivers in the vicinity, Dhauliganga carries larger amount of heavy sediment and debris which enters into the reservoir.



Figure 14. Deposition in India, Scouring in Nepal

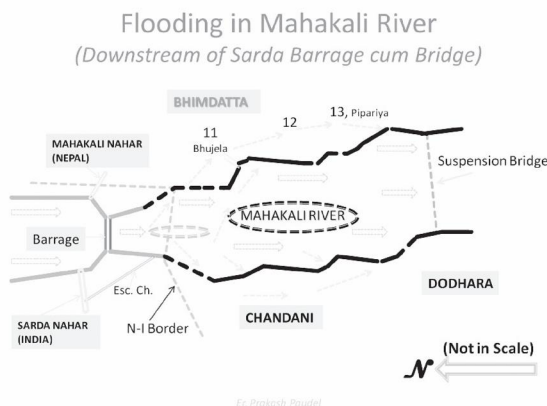


Figure 15. Mahakali River in Banbasa-Kanchanpur

- In Dhauliganga Dam, power channel was closed and sluices were fully opened on the day to flush out the sediment (both incoming and collected earlier).
- The Dhauliganga operation combined with swelling of main Mahakali River in Tawaghat has created unusual flood which ultimately triggered disaster in Darchula Khalanga area.
- Embankment protection work on other side in Indiawas robust and, sowas intact after the event while in Nepalese side it was scattered and weak and easily eroded and washed away.

In Nepal the disaster caused by the flood of the river was extreme. The flood started after midnight of 17 June and people started to evacuate Mainbazaar, Topavan, Bangabazaar, Gholphai, Namaskar and nearby areas. In the morning of June 18, there was mud flow in the river which devastated settlements in Nepalese side.

Effect of Mahakali Flood on Kanchanpur

As explained earlier, Mahakali River received more than



Figure 16. Nepal- India suspension bridge over Mahakali



Figure 17. River Mahakali in fury



Figure 18. Rescue and rehabilitation work



Figure 19. Attack by the flood on settlement

the historical as well as design flood discharge. The gate of under sluices and barrages of both Tanakpur and Banbasa were opened and heavy flood laden with the sediment was discharged downstream of the Banbasa barrage. On right bank, scouring started from Indo-Nepal border and part of the flow diverted to left after striking to strong embankment structure constructed in the Indian territory. The accumulated flow on the left entered Bhujela village through the unprotected gap portion between Nepal and adjoining India border. In Bhujela village, settlements and school building were swept away by the flood. The land was either cut down to Mahakali or buried under the sediment carried out by the intruding flood before coming out to Mahakali near Piparia Village. The effect was substantial in the ward nos. 11, 12 & 13 of Bhimdutta Municipality. The situation is depicted in the sketched figure 15 with the photographic evidence in figure 16-19. On the right side, the flood damaged the previously constructed embankment and entered into the villages in Nepal. The effect of flooding, inundation and destruction was observed in various areas under Dodhara and Chandani VDCs. .

Public reaction

There are many public reactions posted in internet sites from the peoples of both countries. Representative public opinion is shown in figure 20.

नेपाल	भारत
<ul style="list-style-type: none"> दाचुलाको अस्तीत्व खतरामा परेको छ । दाचुला सदरमुकाम खलंगा हराएको छ । २०७०।३।२ गते सम्म कति राम्रो रहेको दाचुला सदरमुकाम खलंगा आज गायब भएको छ । सबै महाकाली नदिको वगरमा परिणत भएको छ । हाम्रो अगुवा स्रोत केन्द्र, र शिक्षाको लागि खाद्य कार्यक्रमको कार्यालय पनि बगाएको छ । अब खलंगाको एक तिहाइ भाग मात्रै बाँकी रहेको छ । अब बस्ने कहाँ त ? अब सदरमुकाम सार्नु पर्ने अवस्था पनि देखिएको छ । किनकी बाँकी भाग पनि एक चोटी वगरमा परिणत हुने पक्का छ । यस्तो हुनुमा विभिन्न कारण रहे पनि भारतले बनाएको बाँध पनि रहेको स्थानिय जनताहरूको भनाइ छ । 	<ul style="list-style-type: none"> नदियों में उनके ऊपर बनाये अनेक बांधों से अचानक बहुत सारा पानी छोडा गया था .. कयाँ छोडा गया था .. किसने आदेश दिया .. इसकी जाँच होनी चाहिए ये बाँध कयाँ बने थे .. इसकी जाँच होनी चाहिए जब इतना सारा पानी अचानक छूटेगा तो नदियाँ सडकों को बहा ही ले जायेंगी और अपने किनारों को तोडकर उस शहर में भी घुस जाएगी जो सदियों से इन्हीं नदियों के किनारे पर बसा है और हर वर्ष ऐसी बाढ देखता रहा है जो नदियाँ सदियों से एक निश्चित सीमा से ऊपर नहीं चर्टी ये अचानक नगर में घुस जाएँ तो पश्च उठता है कि अखिर नया काम क्या हुआ है कि इन नदियों ने अपनी सीमा तोड दी !!!!! <p style="text-align: right;">• (साभार: फेसबुक)</p>

Figure 20. Public opinion

A legalistic view on the flooding at Darchula and Mahakli River

Mahakali is basically a border river which forms boundary between Nepal and India at major stretches. In 1996 both the governments entered into a treaty concerning its integrated development. One of the objectives of this treaty is to define the obligations and corresponding rights and duties thereto of the parties in regard to the waters of the Mahakali River and its utilization. The treaty has been ratified by both the parties and is in operation.

No agreement could be reached between the two parties on finalizing the Detailed Project Report of the proposed Pancheshwar Project to be built for mutual benefits under the treaty. Similarly, Mahakali River

Commission which was to be formed between the parties under the treaty could not be constituted. The objectives of the commission enter alia was to make recommendation to both the Parties for the conservation and utilization of the Mahakali River as envisaged and provided for in the treaty.

Although some of the above provisions under the treaty have not been implemented several other provisions are in operation. The water under the treaty is being diverted by the Indian side for its use in the Tanakpur Power Station and Banabasa Barrage. Nepal is being supplied with the agreed amount of power from the Tanakpur Power Station; agreement has been reached on the location of the sluice gate for the delivery of water to Nepal from the Tanakpur Barrage, etc.

Under the treaty (Article 7, and 8 read together) each Party has undertaken the obligation of not to use or obstruct or divert the water of the Mahakali River adversely affecting its natural flow and level except by an agreement. This provision of the obligation is applicable in relation to the tributaries of the Mahakali River also.

Dhauliganga is a tributary to the Mahakali River. From the above facts and the reasoning it is clear that the construction and operation of the Dhauliganga Power Project does affect the natural level and flow of the Mahakali River. Government of India constructed the

project without even caring for informing the Nepalese side on the details of the project let alone entering into some prior understanding to ensure that its operation would not affect the natural flow of Mahakali River including adverse affect downstream on either side. This is clearly a violation of the treaty obligation on the part of India. Such a behavior is not new to India though, when it comes to dealing with Nepal. Nepal should point out this to the Indian side and impress upon them that they should desist from such behavior in the future. One may even argue for a case of reparation of damages.

This incident of washing away of the establishments at Darchula Khalanga and similarly the flooding in the Mahakali River and the devastation that was caused to Nepal and India does signify the imperative of working

together by Nepal and India on the use and conservation of Mahakali River and its tributaries. Therefore, Mahakali River Commission must be established as early as possible to save the loss of life and property on either side in the future.

Conclusions

There was lack of preparedness, sharing of information and resources and coordination on both sides of the river. It is a general case for both Nepal and India. Lesson should be learnt from such events and improvements in preparedness, rescue and relief activities planned properly and if possible jointly.

- Though Flooding, landslide and debris flow are triggered as natural process, human activities and response also play important role to change their effects.
- The flood defence structures in Nepalese side were of inferior quality. In future sturdy defence structures should be constructed to protect Nepalese side.
- Mahakali river course has been shifted towards Nepal due to deposition in Indian side and bank erosion in Nepalese side.
- Response and Preparedness of Government of Nepal was insufficient to address the water induced disaster in the region.
- Information sharing and mutually agreed action plan did not exist between Nepal and India for the water induced disaster.

Recommendations

- Long term master plan for all the rivers with potential incidents of flooding, bank cutting and inundation are necessary.
- Potential hazards due to heavy landslides and debris flow in higher hills should be studied and protection activities planned accordingly.
- Strong legal provision should be made and wider public are to be educated for controlling unwanted activities in rivers, hills and high mountains.
- Commonly approved mutual benefit program between Nepal and India for boundary rivers should be implemented.
- River protection work in both sides of the river should be done simultaneously and the quality of work should also be similar.
- Implementation of water induced disaster prevention program with strong commitment, stakeholders' participation and sufficient resources should be encouraged.
- Works should be done immediately to protect international boundary between Nepal and India.
- Mahakali Treaty between the two countries must be abided by both the countries and a regular exchange of data and other information on the possible change of regime of the river be exchanged between the two countries.
- To ensure the better utilization and conservation of the Mahakali River the Mahakali River Commission as provided by in the Mahakali Treaty must be estab-

lished.

Water induced disasters like flood and landslides will occur in future also. We cannot eliminate it. More collection and sharing of information and installation of warning systems are necessary. As the river is international boundary river structural intervention like rigid bank protection is also necessary. Rescue and rehabilitation should be fast and adequate. Time has come for introduction of Insurance of life and property of disaster prone areas. Government could subsidize insurance premium for poor and needy people.

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This paper was prepared under the banner of JVS and GWP Nepal.

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