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Dam Rehabilitation & Improvement Project

Central Water Commission

A breach modeling of debris-dammed lake formed aftermath of the flash flood and debris flow on 07 February 2021 in the Rishiganga river valley

Presented by

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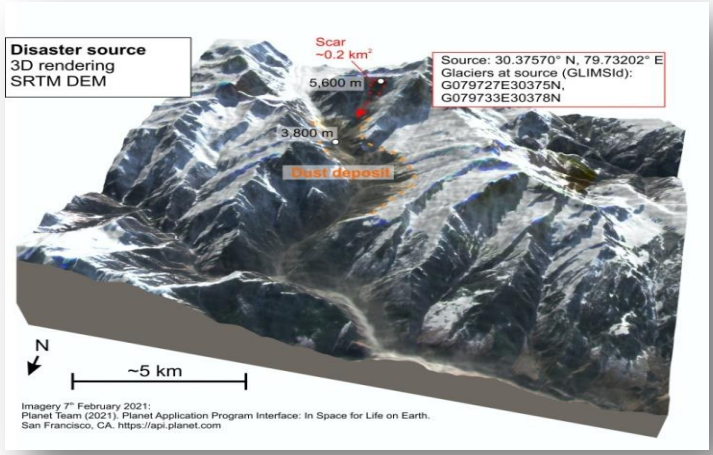
BACKGROUND

- What actually happened?
- Was it a GLOF? No.
- On 7th Feb 2021, at ~10:08 AM, a huge rock mass from Raunthi peak combined with a glacier avalanche detached.
- As per the NDMA report, the rock mass with ice descended from an altitude of about EL 5500 m to about 3700 m.
- The energy generated due to impact probably resulted into the melting of snow and ice along with crushing of rock mass into debris.
- It was followed by huge debris flow & flash flooding, which created catastrophe in the downstream areas of Rishiganga and Dhauliganga river valleys.

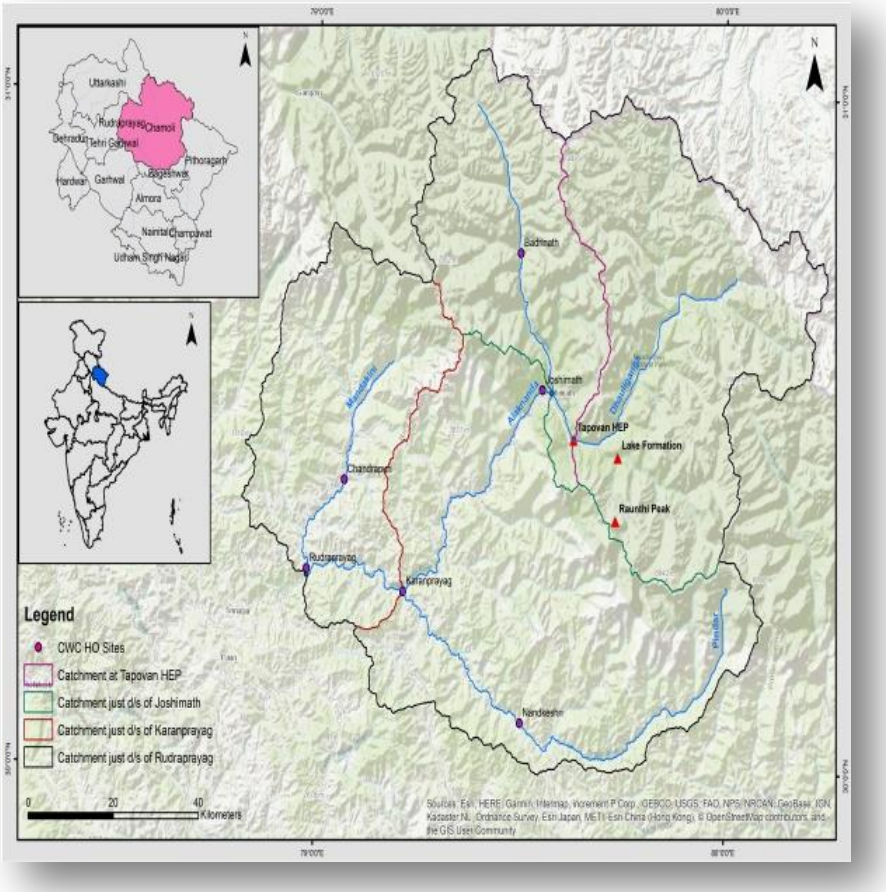


Source: PlanetLabs

Source: Unknown

THE AFFECTED REGION

- The devastated area covers latitude 30°16'14.14'' N to 30°32'8.86'' N and longitude 79°39'59.33'' E to 80°02'17.68'' E.
- The source of the debris flow was located in the Raunthi glacier and the impact was felt across Dhauliganga-Rishiganga catchments in Chamoli district of Uttarakhand.



DISASTER AT A GLANCE

- The avalanche on 07 Feb 2021 in Rishiganga river valley led to the huge amount of mass consisting of rocks, mud, water, ice blocks, etc.
- This huge mass, flowing in the Rishiganga river valley, caused significant damage along its flow path.
- The debris flow damaged the operational **Rishiganga hydropower station** (13.2 MW), **under-construction Tapovan HEP** (520 MW), a road bridge and about 5 other pedestrian bridges.
- The devastation of road bridge, near Raini village, constructed and maintained by BRO, led to the disruption of physical connection of about 13 villages.
- This disaster also led to significant loss of life; about 204 human and many animals lost their life.

DISASTER AT A GLANCE

Pre and post disaster images of Rishiganga HEP

Source: NDMA Report

DISASTER AT A GLANCE

Pre and post disaster images of Tapovan HEP

Source: NDMA Report

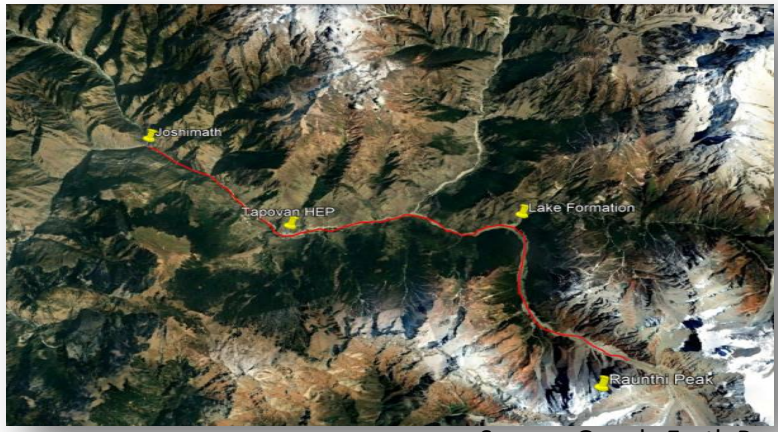
DISASTER AT A GLANCE

Damaged barrage of Tapovan HEP

Source: NDMA Report

DEBRIS DAMMED LAKE: A NEW THREAT

- The huge amount of debris flow blocked the valley by creating a landslide dam at confluence of Rishiganga and Raunthi river and resulted into formation of a debris dammed lake at an altitude of about EL 2400 m.
- This lake was growing in size and capacity due to continuous inflow of snow melt and might have breached in near future causing further catastrophe in the valley downstream.
- IMD forecasted precipitation in the region on 14th and 15th February 2021.



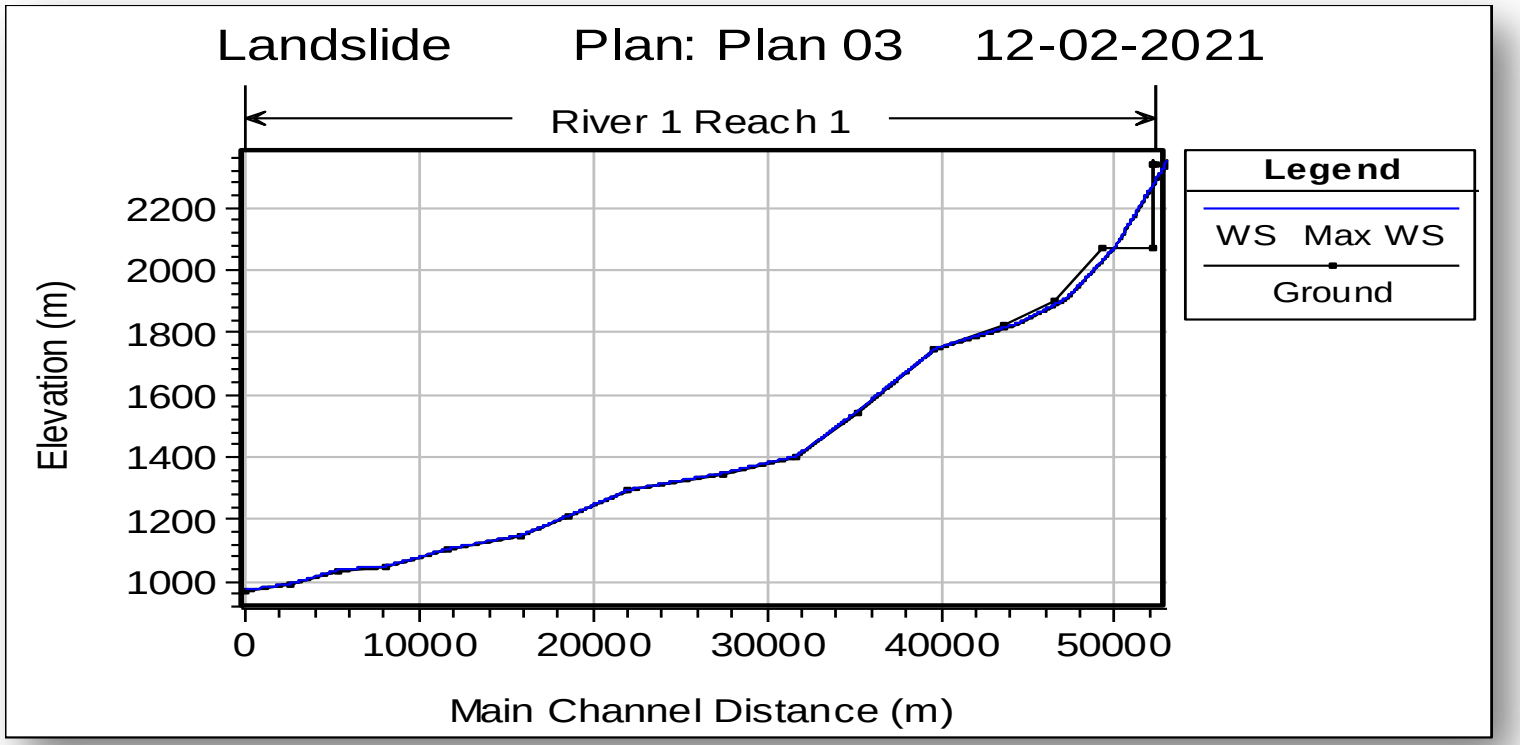
Source: Google Earth Pro


Source: NDMA Report

INPUT DATA & BREACH PARAMETERS

- The volume of the lake was estimated to be 0.7 MCM using the cross-section extracted from SRTM DEM of 30 m in HEC-RAS 1D software.
- The length of the obstruction and width of the lake was estimated to be about 500 m and 120 m respectively as per the available photographs and information provided by various disaster management agencies.
- Breach width and breach formation time are very crucial in any breach modeling and the landslide dam was having loosely deposited debris with boulders, silt and snow/ice.
- Hence, the breach parameters was assumed in line with the moraine dam.
- **Breach Formation Time : 60 minutes**
- **Average Breach Width : 75 m**
- **The height of Breach : 12 m**

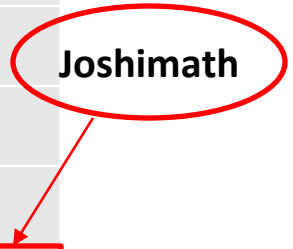
BREACH MODELING



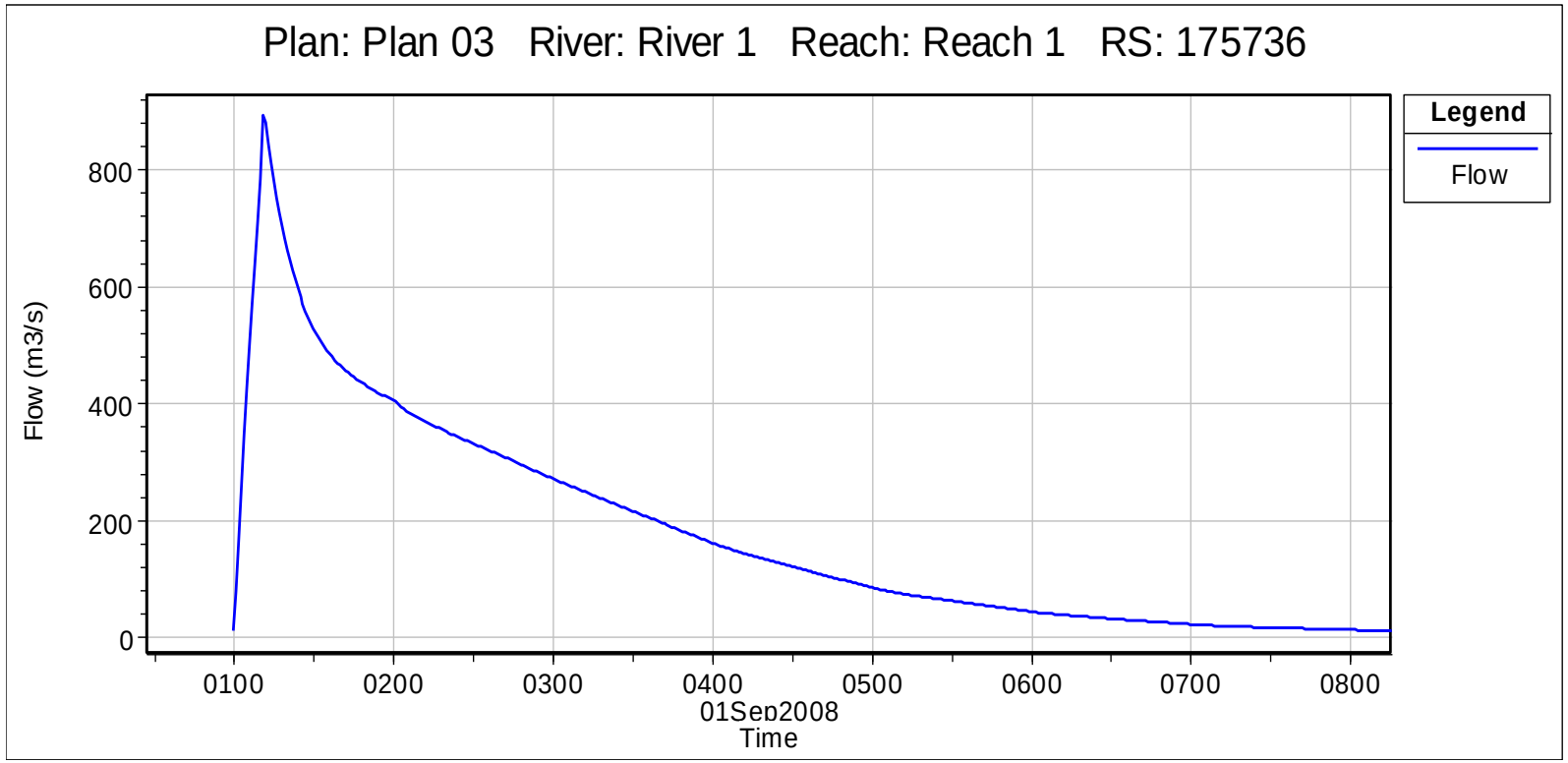
Longitudinal river profile developed using SRTM DEM of 30 m from the lake site up to 53 km downstream

MODEL RESULTS

S. No.	Chainage (km)	Maximum Discharge (cumec)	Increase in Maximum Water Depth (m)	Flood Arrival Time (min)
1	Lake Site	891	-	0
2	2.5	836	4.75	9
3	5	823	4.24	13
4	10	753	5.38	24
5	18	659	3.66	43
6	**23**	**608**	**4.71**	**53**
7	35	508	2.9	98
8	45	440	4.52	139
9	53	418	4.3	173

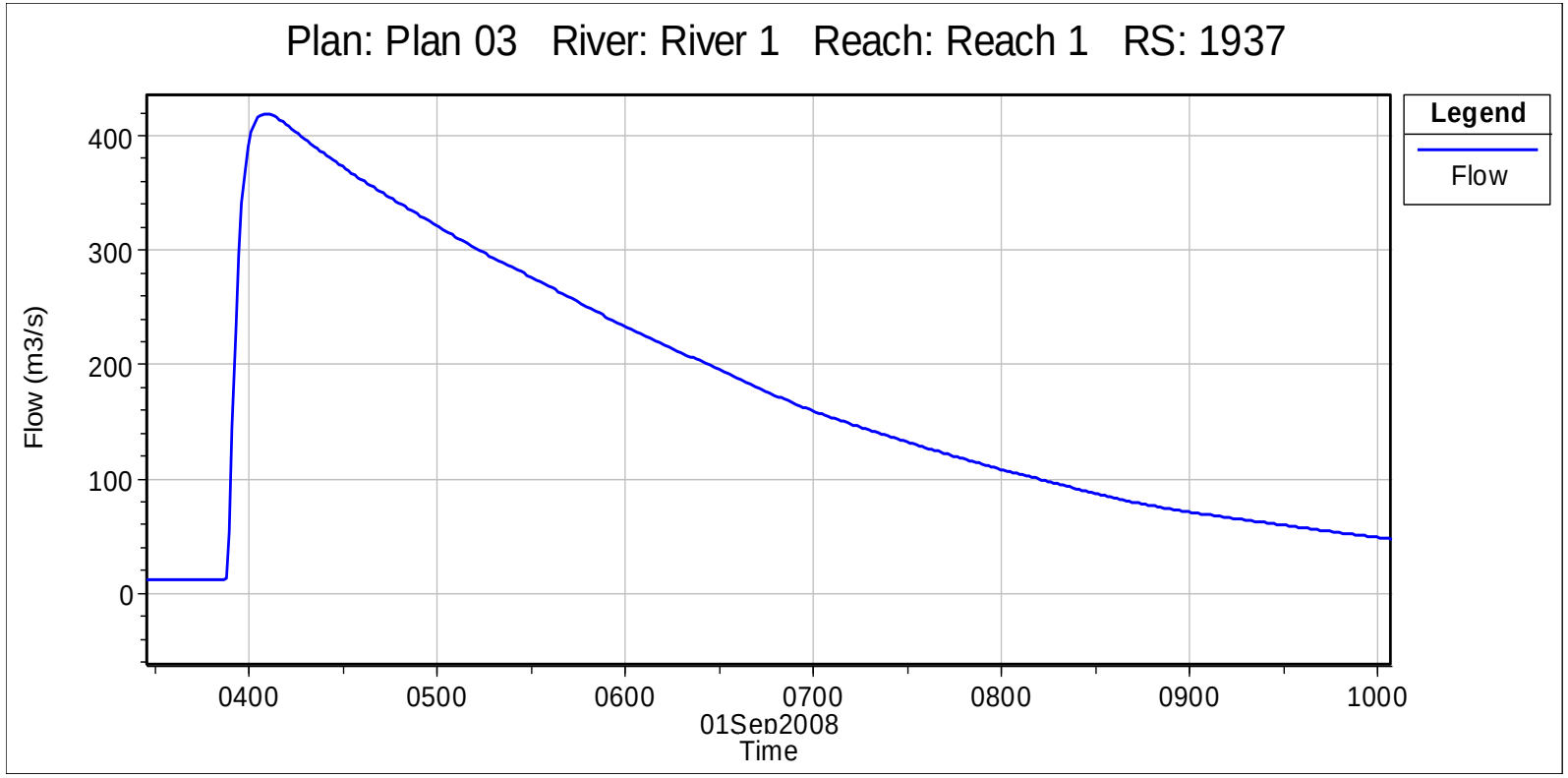


MODEL RESULTS



Breach flood hydrograph just downstream of lake site

MODEL RESULTS



Breach flood hydrograph at 53 km downstream of lake site

RISK AVERTED

Expert team widens mouth of Rishiganga lake by 15ft to prevent repeat tragedy

India News

Published on Feb 23, 2021 07:43 AM IST

Scientists, Indian military personnel, Indo Tibetan Border Police (ITBP) and disaster management personnel and experts analysed the lake including its depth before widening its mouth.

Source: The Hindustan Times

CONCLUSION

- When a dam/lake, located close to the population, is at risk, it is important to predict the breach outflow hydrograph.
- In the present case, the damming material was loosely deposited debris, and the debris-dammed lake could have breached, probably during any precipitation events.
- Hence, the breach modeling was carried out to know the timing relative to event in the failure process to start the evacuation efforts.
- The outcome of the modeling study and model simulation of the lake was shared with the Ministry of Jal Shakti, Ministry of Home Affairs and NDMA.
- The appropriate precaution measures like widening the mouth of the lake, close monitoring of any precipitation event in the catchment of the lake were suggested to minimise the risk of disaster.

CONCLUSION

- Since the Chamoli district of Uttarakhand lies in Seismic Zone V, the most seismically active zone, as per IS:1893 and Climate change has also increased the vulnerability of this hilly region.
- Hence, the Chamoli district has seen many natural disasters in the past like landslide, rock fall, glacier avalanche and stream blocking.
- The lessons learned from the previous disasters as well as from this model study may be used as a case study to prepare for any such futuristic unfortunate event.

Thank You
For Your Attention