

Preliminary Note on the devastating flash flood in Kheer Gad, Dharali, Uttarkashi district, Uttarakhand

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At approximately 13:40 hrs., on August 5, 2025, a severe flash flood and debris flow occurred along the Kheer Gad stream, a left bank tributary of Bhagirathi River, on the Gangotri National Highway in Uttarkashi district, Uttarakhand (Fig.1) which has severely affected the habitation at Dharali, and caused extensive damage to properties and loss of lives (Fig.2). The affected area lies on the left bank of the Bhagirathi River in Bhatwari Tehsil. The Kheer Gad, a perennial stream, flows between the two settlements of Dharali and merges with the Bhagirathi River opposite Mukhwa village. The main settlement of Dharali village is located around 100 meters above National Highway-34. However, due to accessibility of the location along the Gangotri route, numerous hotels and residential structures have been constructed on both sides of the highway and within the first 100–150 meters along both banks of the Kheer Gad.

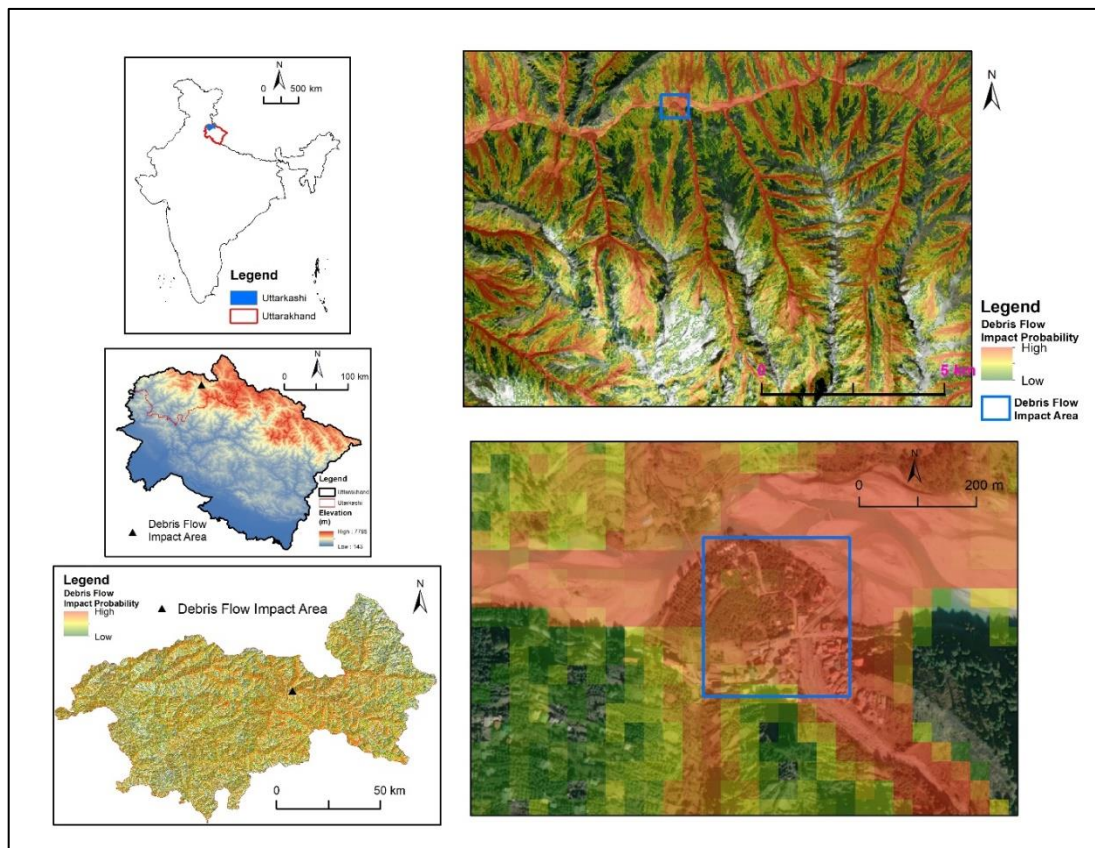


Figure-1 Location and Debris flow impact probability map of the affected area



Fig-2: Photographs of destruction caused by flash flood

Dharali-Harsil area lies in the Higher Himalayas, where rocks of Central Crystalline Group are exposed. The Kheer Gad stream flows northward but changes course about 250–300 meters before entering the inhabited area, turning northwest. Near the NH-34 bridge, it shifts direction again and flows northeast before joining the Bhagirathi. The stream has a steep gradient, which contributes to rapid flow during rainfall. The flash flood along Kheer Gad directly impacted the settlements on the left bank, which lie in the direct path of debris runout.

The macro-scale (1:50,000) landslide susceptibility map of the affected area classifies the settlement zone of Dharali, into low to moderate susceptibility zone, whereas, the headward slopes of Kheer Gad in the upstream fall within the high susceptibility category (Fig 3), indicating higher likelihood of susceptibility to landslide initiation from higher slopes (Gajbhiye *et al.*, 2015). However, in the district's debris flow impact map, prepared by GSI, the affected habitation area of Dharali comes within the ambit of high runout zone of Kheer Gad (Fig 1).

Rainfall data from the nearby available rainfall monitoring stations recorded interestingly low amount precipitation on 5th August, 2025.

- 6.2 mm at Harshil (approximately 3.5 km from Dharali) at 08.30 hrs.; between 08:30 and 11:30 hrs., it recorded 4.2 mm
- 10 mm at Bhatwari (approximately 49 km from Dharali), as of 08:40 hrs.

GSI had issued experimental landslide forecast bulletin on 4th August 2025 for Uttarkashi district at 14:30 hrs. for 24 hours, valid up to 5th August 14:30 hrs, and the forecast level for the district was moderate indicating moderate possibility for landslides. Notably, past

records also indicate that a similar flash flood had occurred along this particular stream during the June 2013 disaster too. Following 2013 event, the Geological Survey of India (Dangwal et.al. 2014) conducted preliminary assessments and recommended the following mitigation measures:

- Cleaning/dredging of the nala bed and proper channelization of the nala of its old course.
- Bank protection by constructing concrete wall/ crate walls all along the left and right bank.
- The bridge constructed at road level is not in a position to pass the discharge of nala therefore; it is advised to increase the span and height of the bridge.
- Encroachment along nala bed should be strictly prohibited.
- Construction of check dams/ cascades in the upstream side will also help to arrest the sediment load at higher level and will allow free flow near market.
- Few houses located below road on the left bank of Kheer Gad are in danger, therefore it requires shifting or needs adequate protection measures after further investigations.

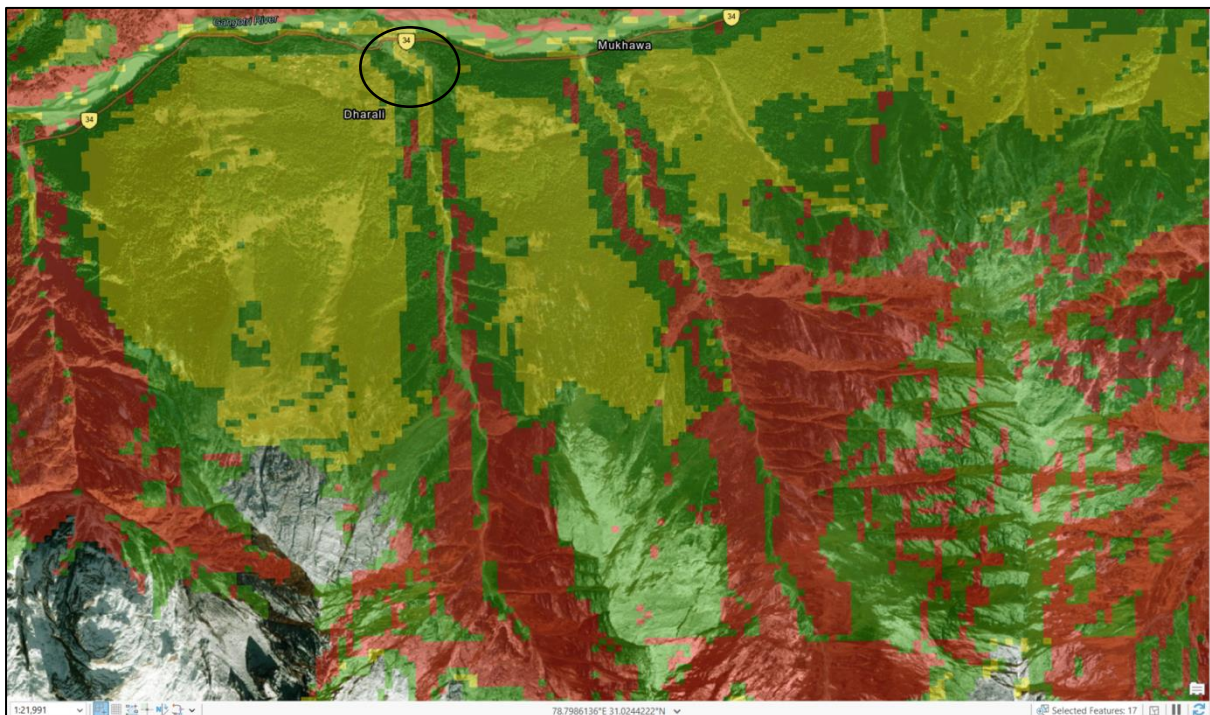


Figure -3 Landslide Susceptibility Map of Dharali Area

It is worth mentioning that GSI has completed Meso-scale (1:10,000) landslide susceptibility mapping of 22 sectors (Table-1), including the sectors along Char Dham yatra routes by 2024-2025, which has specific recommendations on mitigation of multiple vulnerable locations. Out of the 22 sectors, the reports for 14 sectors completed till 2023-2024, have already been shared with the Uttarakhand Government. Currently, the reports pertaining to the mesoscale landslide studies for rest of the 8 sectors, taken up during 2024-2025 (including the Sukki-Gangotri road sector, Uttarkashi district, which includes Dharali) are under finalisation, and will shortly be shared with the Uttarakhand Government.

Table-1 Reports on Mesoscale (1:10,000) Landslide Susceptibility Mapping in Uttarakhand

List of Sectors Completed and Reports shared with Uttarakhand Government			
Sl. No.	District	FSP Year	Title
1.	Uttarkashi	2019-2020	Development of appropriate method for landslide susceptibility mapping on scale 1:10000 (mesoscale) along Bhatwari -Kunjan (Gangotri sector) road stretch of Uttarkashi, Uttarakhand.
2.	Pauri Garhwal, Tehri Garhwal	2019-2020	Generation of a Meso Level (1:10,000 scale) user friendly Landslide Hazard Zonation (LHZ) map and landslide inventory for Tapovan-Vyasi road corridor of Haridwar-Badrinath National Highway, Uttarakhand.
3.	Pauri Garhwal	2020-2021	Mesoscale landslide susceptibility mapping on scale 1:10000 along Byasi-Maletha road sector on Rishikesh-Badrinath Highway in parts of Pauri Garhwal, Uttarakhand.
4.	Chamoli, Pauri Garhwal	2020-2021	Mesoscale landslide susceptibility mapping on scale 1:10000 along Maletha-Gauchar road sector on Rishikesh-Badrinath Highway in parts of Pauri Garhwal and Chamoli s, Uttarakhand.
5.	Chamoli	2021-2022	Meso scale (1:10,000) landslide susceptibility mapping of Gauchar-Nandprayag road sector, Chamoli, Uttarakhand.
6.	Rudraprayag	2022-2023	Meso scale (1:10,000) landslide susceptibility mapping of Kund-Gaurikund road sector on Rishikesh-Kedarnath National Highway, Rudraprayag, Uttarakhand.
7.	Tehri Garhwal, Uttarkashi	2022-2023	Meso scale (1:10,000) landslide susceptibility mapping of Darwal Gaon-Nakuri road sector, Tehri Garhwal & Uttarkashi, Uttarakhand.
8.	Rudraprayag	2022-2023	Meso scale (1:10,000) landslide susceptibility mapping of Rudraprayag-Kund road sector, Rudraprayag, Uttarakhand.
9.	Chamoli	2022-2023	Meso scale (1:10,000) landslide susceptibility mapping of Tangnimal-Vishnuprayag Road sector, Chamoli, Uttarakhand
10.	Pauri Garhwal, Tehri Garhwal	2023-2024	Meso scale (1:10,000) landslide susceptibility mapping of Munikirethi-Agrakhal road sector, Tehri Garhwal & Pauri Garhwal, Uttarakhand.
11.	Tehri Garhwal	2023-2024	Meso scale (1:10,000) landslide susceptibility mapping of Chiriyali-Ram Gaon Road sector, Tehri Garhwal, Uttarakhand.
12.	Tehri Garhwal, Uttarkashi	2023-2024	Meso scale (1:10,000) landslide susceptibility mapping of Tiwar Gaon- Dharwal Gaon road sector, Tehri Garhwal & Uttarkashi, Uttarakhand
13.	Uttarkashi	2023-2024	Meso scale (1:10,000) landslide susceptibility mapping of Nakuri - Lata Road sector, Uttarkashi, Uttarakhand.
14.	Chamoli	2023-2024	Meso scale (1:5000) geotechnical investigation of Joshimath township, Chamoli, Uttarakhand.

List of sectors whose reports are under finalisation and to be shared with Uttarakhand Government			
Sl. No.	District	FSP Year	Title
15.	Pauri Garhwal & Tehri Garhwal	2024-2025	Meso scale (1:10,000) landslide susceptibility mapping of Byasi to Bharpur Gad Road sector, Pauri Garhwal & Tehri Garhwal, Uttarakhand
16.	Uttarkashi	2024-2025	Meso scale (1:10,000) landslide susceptibility mapping of Dharashu-Gewhoti road sector, Uttarkashi, Uttarakhand.
17.	Uttarkashi	2024-2025	Meso scale (1:10,000) landslide susceptibility mapping of Lata-Sukki Road sector, Uttarkashi, Uttarakhand.
18.	Pauri Garhwal	2024-2025	Meso scale (1:10,000) landslide susceptibility mapping of Maletha-Khakra road sector, Pauri Garhwal, Uttarakhand
19.	Uttarkashi	2024-2025	Meso scale (1:10,000) landslide susceptibility mapping of Nandgaon –Janki Chatti road sector, Uttarkashi, Uttarakhand.
20.	Uttarkashi	2024-2025	Meso scale (1:10,000) landslide susceptibility mapping of Naugaon-Nandgaon road sector, Uttarkashi, Uttarakhand.
21.	Uttarkashi	2024-2025	Meso scale (1:10,000) landslide susceptibility mapping of Sukki-Gangotri road sector, Uttarkashi, Uttarakhand.
22.	Chamoli	2024-2025	Meso scale (1:10,000) landslide susceptibility mapping of Vishnuprayag – Badrinath road sector, Chamoli , Uttarakhand

GSI team from SU Uttarakhand will soon take up the preliminary post disaster studies at site and will submit the note to the state government.

References

1. Dangwal DP, Chauhan N, Ghosh M, Ghosh T, (2014) Preliminary Slope stability assessment of the recent disaster affected areas of Uttarkashi district, Uttarakhand, unpublished report of Geological Survey of India.
2. Gajbhiye PK, Rajkumar, M (2015) A report on macro-scale (1:50,000) landslide susceptibility mapping in parts of toposheet nos.53J/6, 53J/9, 53J/12 and 53 I/16, Tehri Garhwal and Uttarkashi districts, Uttarakhand, unpublished report of Geological Survey of India.