

# Valley floor environmental changes and disasters associated with glacial collapse of mountain glaciers

## -A case study of the 2003, 04 and 2021 floods in the Himalayas -

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On the morning of February 7, 2021, the Rishi Ganga River (a tributary of the Burahi Ganga River in the Alaknanda system, which is the northeastern basin of the Ganges River basin) in the Chamoli district of Uttarakhand, India, flooded along Raini village and its downstream. As a result, more than 190 people were killed or missing (as of February 10), and major physical damage was caused to the Rishi Ganga hydroelectric power plant (13.2 MW; elevation of water intake: 2050 m; 12 km from the glacier-collapsed valley floor) and Tapovan Vishnugad hydroelectric power plant (520 MW; elevation of water intake: 1800 m; elevation of the valley floor) were washed away.

This event was initially suggested to be a glacial lake outburst flood, but the cause was attributed to glacier collapse from a 0.2 square kilometer of hanging glacier (Twitter, @Scott Watson <https://bit.ly/3rHIPWu>) and underlying slope bedrock collapse (Twitter, @Simon Gascoin <https://bit.ly/3s4R3qM>; Higaki et al, (2021) Disaster Response Committee Web site, Association of Japanese Geographers <https://bit.ly/3av8kTR>). At the bottom of the valley (N 30.401, E 79.738. EL. 3800 m) on the slope of collapsed glacier (distribution elevation: about 6000-5500 m), sediments covered with rock debris are distributed in long and thin strips, and the existence of an ice body is expected from the sinking and cracking. It is known that this snowdrift-like ice body existed continuously along the valley floor as late as 2003 and continued to disappear until October 2017, the latest satellite images from Google Earth were available (Komori, (2021) Disaster Response Committee Web site, Association of Japanese Geographers <https://bit.ly/3dmH23Q>). In particular, two periods, from 2013 to June 2014 and from May 2015 to October 2017, the distribution is more than 1 km longer than that of the earlier ice bodies. This indicates that there have been repeated collapses from the vicinity of the hanging glacier in the past, although on a smaller scale than the present collapse.

In this presentation, we will show an overview of this disaster and discuss the collapse history of the hanging glacier. In addition, we will compare glacier collapses and floods that occurred in 2003 and 2004 in the southeastern Annapurna massif, Nepal, and how similar glacier collapses (e.g., Kolka Glacier in the northern foothills of the Caucasus Mountains in 2002 and Gayari Glacier in the southern foothills of the Karakoram Range in Pakistan in 2012) have changed the valley floor.

Rescue work is continuing in the area. We sincerely pray for the safety of as many people as possible and the souls of the victims.

Keywords: hanging glacier, snow patch, Turkistan type glaciers, global warming, 2021 Uttarakhand flood, 2003 and 2004 Madi river flood