

**Progress Report**

**Long-Term Monitoring of Gangotri Glacier, Garhwal Himalaya**

*(July – September 2025)*

by

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## Background

The Himalayan Mountain Range hosts one of the largest concentrations of glaciers outside the polar regions, comprising several thousand glaciers that vary widely in size, morphology, and dynamic behavior. These glaciers play a crucial role in regional hydrology and serve as sensitive indicators of climate variability and change. Recent glaciological observations across the Himalaya reveal a pronounced reduction in snow accumulation rates accompanied by enhanced ablation, reflecting a sustained negative mass balance and accelerated glacier retreat. Despite their scientific and societal importance, systematic ground-based glaciological investigations in the Himalaya remain sparse due to the region's challenging terrain, harsh climatic conditions, and logistical constraints. Recognizing the need to strengthen long-term glacier monitoring, the Department of Science and Technology (DST), Government of India, has mandated the Wadia Institute of Himalayan Geology (WIHG), Dehra Dun, to undertake comprehensive monitoring of selected Himalayan glaciers. In this context, the **Uttarakhand State Disaster Management Authority (USDMA)** has sponsored a research project entitled “**Long-term Monitoring of Gangotri Glacier, Garhwal Himalaya,**” which was awarded to WIHG in December 2021, with financial support formally released in March 2022.

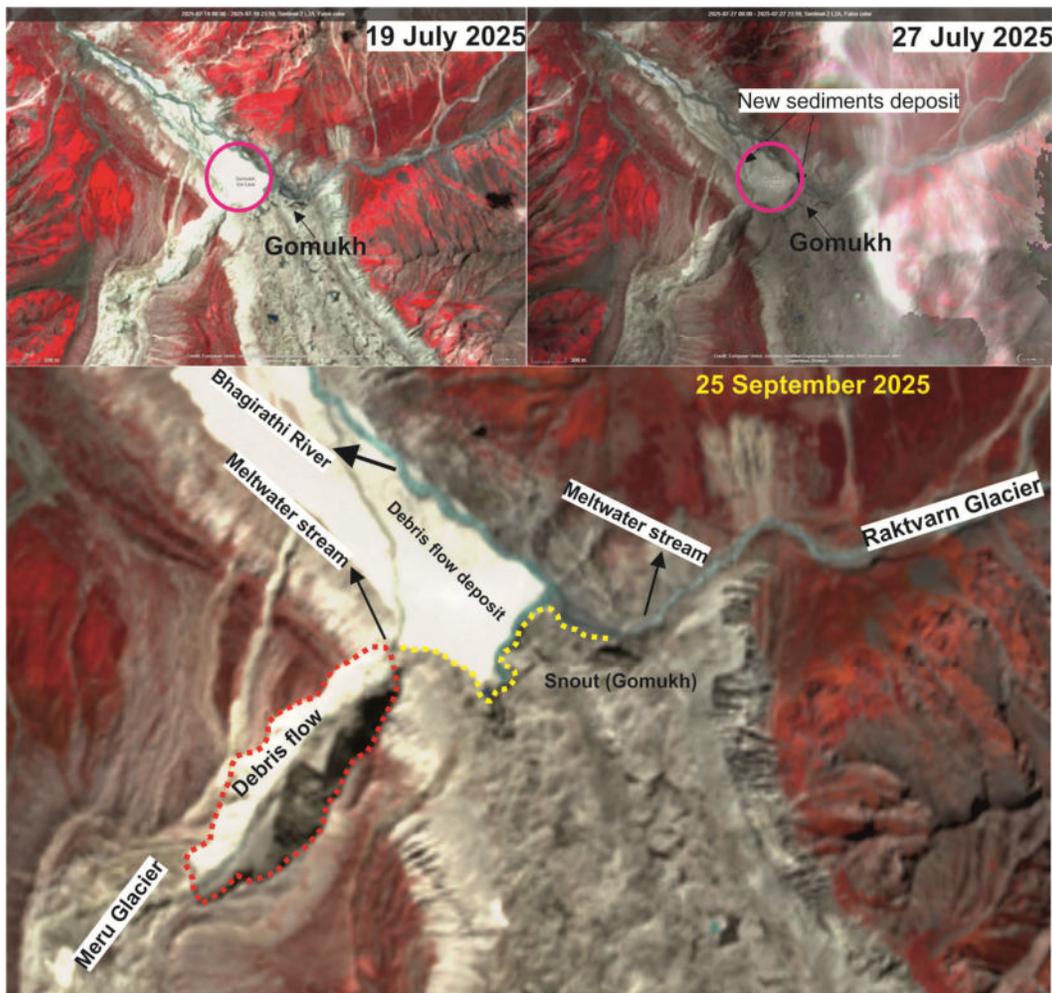
### The approved objectives of the project are the following:

- Mapping and monitoring of the Gangotri group of glaciers.
- Mapping and monitoring of glacial lakes in the Gangotri group of glaciers.
- Monitoring of meteorological (temperature, rainfall and snowfall) and hydrological (water level/discharge and sediment transfer) parameters throughout the year and identification of extreme events.
- Risk assessment of glacial hazards (GLOF, debris flow, flash floods, etc.) using an integrated approach i.e. meteorological, hydrological, seismological and satellite data.
- Dissemination of information to the local administration with regard to any emanating threat from the glacial hazards.

### The following outputs were produced from July to September 2025 to meet the objectives of the mentioned project.

- During the visit, the glacier snout (Gomukh) and the emerging Bhagirathi River were clearly visible, with sediment-laden meltwater actively flowing downstream. To verify the source of sediment in the meltwater, two cloud-free Sentinel-2 images acquired on 19<sup>th</sup> and 27<sup>th</sup> July were analyzed, revealing the deposition of unconsolidated sediments in front of the Gomukh region. The most probable source of this sediment input is the meltwater channel originating from the Meru Glacier, where the debris-flow event occurred and continues to supply sediment into the main stream, although no significant direct impact on the snout itself was observed (**Figure 1**).
- Contrasts between the two dates indicated short-term surface reorganization driven by meltwater flow, while the absence of pronounced anomalies at the snout region suggested that it remained largely unaffected during this period (**Figure 1**).
- In early August 2025, the watch and ward team inspected the broadband seismic station at Maneri Dam. While returning toward Gangotri, heavy rain intensified conditions across the valley. By morning, the Dharali event had triggered landslides and flooding, severing the Bhatwari–Harsil–Gangotri road at multiple points (**Figure 2**). With bridges damaged and debris blocking the route, the team was stranded at Bhatwari and coordinated with local authorities while relaying limited updates. Once weather improved and partial access was restored, the team reached Gangotri and confirmed that the Gangotri region had remained largely unaffected. All installed instruments were operational, except manual thermometers showing abnormal readings due to damaged mercury columns.

- A WIHG team was scheduled to visit the Gangotri Glacier during this period to initiate the field activities proposed under the project; however, the visit could not be undertaken due to the Dharali event (August 5<sup>th</sup> 2025). As a result, essential tasks, including fencing and securing the observatory, were not completed. Moreover, the planned installation of the WIHG-procured Automatic Water Level Recorder (AWLR) in the region could not be carried out.
- During the period July to September 2025, watch and wards, stationed at Bhojwasa monitored day-to-day activities at the base camp, oversaw the instruments, and ensured their safety. They regularly checked the instruments to confirm their proper functioning at Maneri, Chirwasa, and Bhojwasa sites. The staff continuously provided updates regarding road conditions and the feasibility of travelling to the Gangotri region following the Dharali event. Based on their regular communication, it was reported that access to the valley was severely restricted, with essential road links disrupted (**Figure 2**).



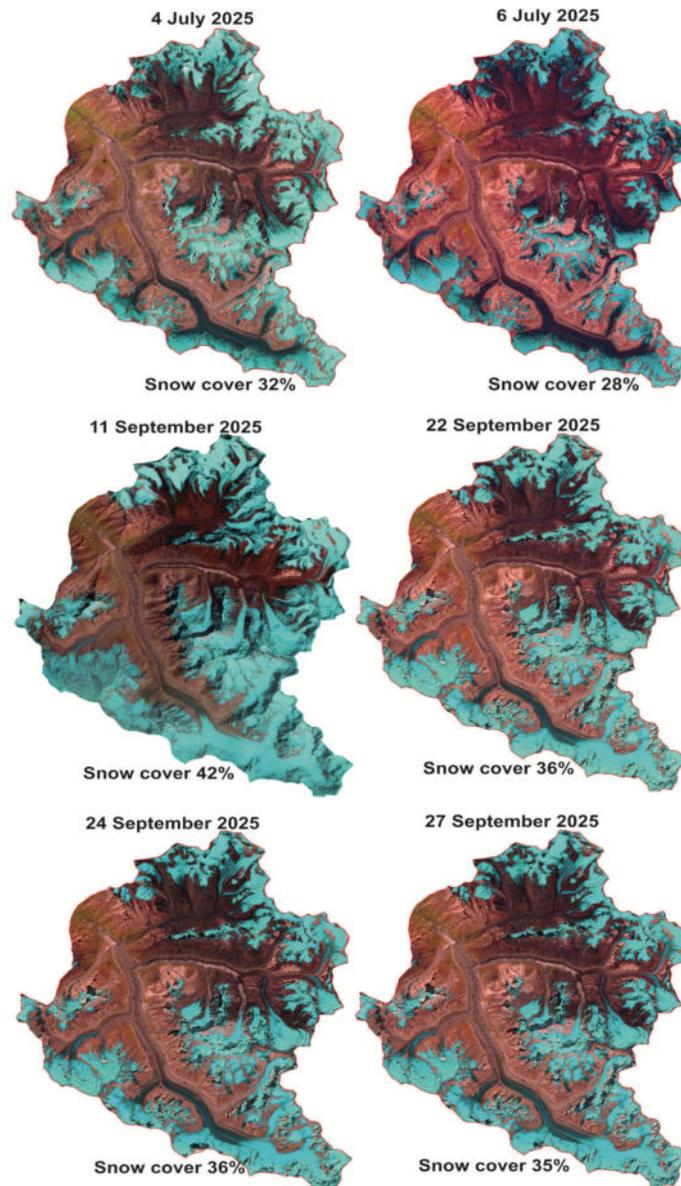
**Figure 1.** Showing the Gomukh (snout) and the meltwater stream emerging from the Raktavan–Meru (tributary) glaciers, which subsequently joins the main Bhagirathi River.

- In September 2025, field observations recorded increased meltwater activity near the snout. The Meru Glacier produced a steady meltwater stream that flowed into the Bhagirathi River, cutting more deeply along the left lateral moraine. Similarly, the Raktavan Glacier supplied continuous meltwater to the river, gradually eroding the right lateral moraine. Meltwater discharge from the main glacier trunk was also noticeably high, likely driven by sustained ablation and limited fresh snowfall across the basin (**Figure 1**).



**Figure 2.** Showing the road condition along the Gangotri Highway, where debris flows have washed away sections of the road, caused cracks, and rendered the flood-affected Bhagirathi valley without any motorable route.

- I officially visited Dharali shortly after the event and found that travel beyond Harsil toward Gangotri was extremely challenging. Even the road connectivity between Uttarkashi to Harsil was disrupted, making ground movement unsafe. These on-ground updates from the watch and ward effectively informed the project team of the overall situation and the persistent difficulty in accessing the glacier area.
- The Project Scientist selected in June 2025 under the project did not join the position, and the Project Assistant who joined subsequently resigned after a short duration. As a result, both positions have remained vacant for most of the project period, leading to periods with no dedicated technical staff. This situation has adversely affected the continuity of field activities and may have impacted the overall progress of the project.



**Figure 2.** Snow-covered distribution in the Gangotri Glacier basin at the onset of the summer season, derived up to Bhojwasa, where the Automatic Water Level Recorder (AWLR) is installed.

Seasonal snow cover analysis indicated a noticeable reduction during the melt period. Snow-covered area decreased from 32% on 4<sup>th</sup> July to 28% by 6<sup>th</sup> July, reflecting rapid ablation under prevailing meteorological conditions. In September, snow cover declined from 42% on 11<sup>th</sup> September to 36% on 22<sup>nd</sup> September, stabilized at around 36% on 24<sup>th</sup> September, and then sustained near 35% by 27<sup>th</sup> September, suggesting short-term fresh accumulation or a temporary reduction in melt rates toward the end of the month.

*All the scientific instruments installed in the region, including the Automatic Weather Stations at Bhojwasa and Chirbasa, as well as the Broadband Seismic Stations at Bhojwasa and Maneri Dam, have remained fully functional to date, with no operational issues reported. Field visits conducted between July to September 2025, supplemented by satellite imagery, revealed no fresh evidence of major debris flow activity in the vicinity of the Gomukh region. Furthermore, no major glacial lake formation was detected near Gomukh at the onset of the summer season.*