

Progress Report

Long-Term Monitoring of Gangotri Glacier, Garhwal Himalaya

(October –December 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 October to December 2025 to meet the objectives of the mentioned project.

- The progress of the project from **April 2025 to September 2025** (Six months) was presented at USDMA in October 2025. During the meeting, it was informed to USDMA that the work proposed under the project could not be carried out due to the Dharali event, particularly the fencing of the observatory. Additionally, the proposed installation of the Automatic Water Level Recorder (AWLR) purchased by WIHG could not be installed in this region.
- All required permissions to visit the Gangotri Glacier region were obtained from the forest authorities, and approval from the competent authority at WIHG for engaging watch and ward staff at Bhojwasa has been granted until March 2026.
- The positions of both the Project Assistant and Project Scientist are currently vacant. To ensure continuity of the project, the recruitment process will be initiated to fill both positions, with relaxed qualification criteria specifically for the Project Scientist post, for which approval has been granted by the competent authority of USDMA.
- During the period **October to December 2025**, watch and ward staff 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, Chirbasa, and Bhojwasa.
The installation of the Automatic Water Level Recorder, along with fencing of the observatories and maintenance of hydrological sites using gabion mesh, is planned to be carried out after the winter season, likely from May 2026, as the Gangotri Glacier

experienced multiple snowfall spells during October–December 2025. Logistic operations were also difficult during this period. As a result, the team could not install the AWLR purchased by WIHG. The production of a documentary film is planned once all instruments are connected to real-time monitoring facilities.



Figure 1. The base camp at Bhojwasa and field instruments remained under snow during October and November, while the snout (Gomukh) was clearly visible with snow cover across the region and a snow-free landscape during December.

- During several visits conducted between October and December 2025, the watch and ward staff confirmed that the Bhagirathi River continued to flow along its original course, with no unusual activity observed near the Gangotri Glacier region. The Gomukh region and the base camp at Bhojbasa were found to be largely free from seasonal snow cover, except for fresh snowfall events (**Figure 1**).



Figure 2. The base camp at Bhojbasa and Chirbasa remained under snow during October and November, while the observatories were clearly visible and snow-free during December.

- In October and November, a spell of rainfall followed by snowfall blanketed the entire Gangotri region, resulting in complete snow cover over the base camp and fully burying the observatories and instruments installed at Bhojwasa and Chirwasa (**Figure 2**). The accumulation of snow made access and routine visit difficult during this period.
- Analysis of Sentinel-2 and Landsat images acquired on **12th, 17th, and 27th October** was carried out to independently verify field-observed snowfall and quantify its spatial extent across the basin. The snow cover area (SCA) was very high (**~83%**) on **12th October**, reflecting widespread fresh snowfall immediately after the event. **By 17th October, snow cover reduced to ~58%**, indicating rapid melting and compaction at lower elevations following the rainfall–snowfall transition. **By 27th October, snow cover increased again to ~67%**, suggesting snowfall at higher elevations under cooler post-event conditions (**Figure 3**). These observations highlight the short-term variability of snow cover in response to precipitation and meteorological conditions within the basin.

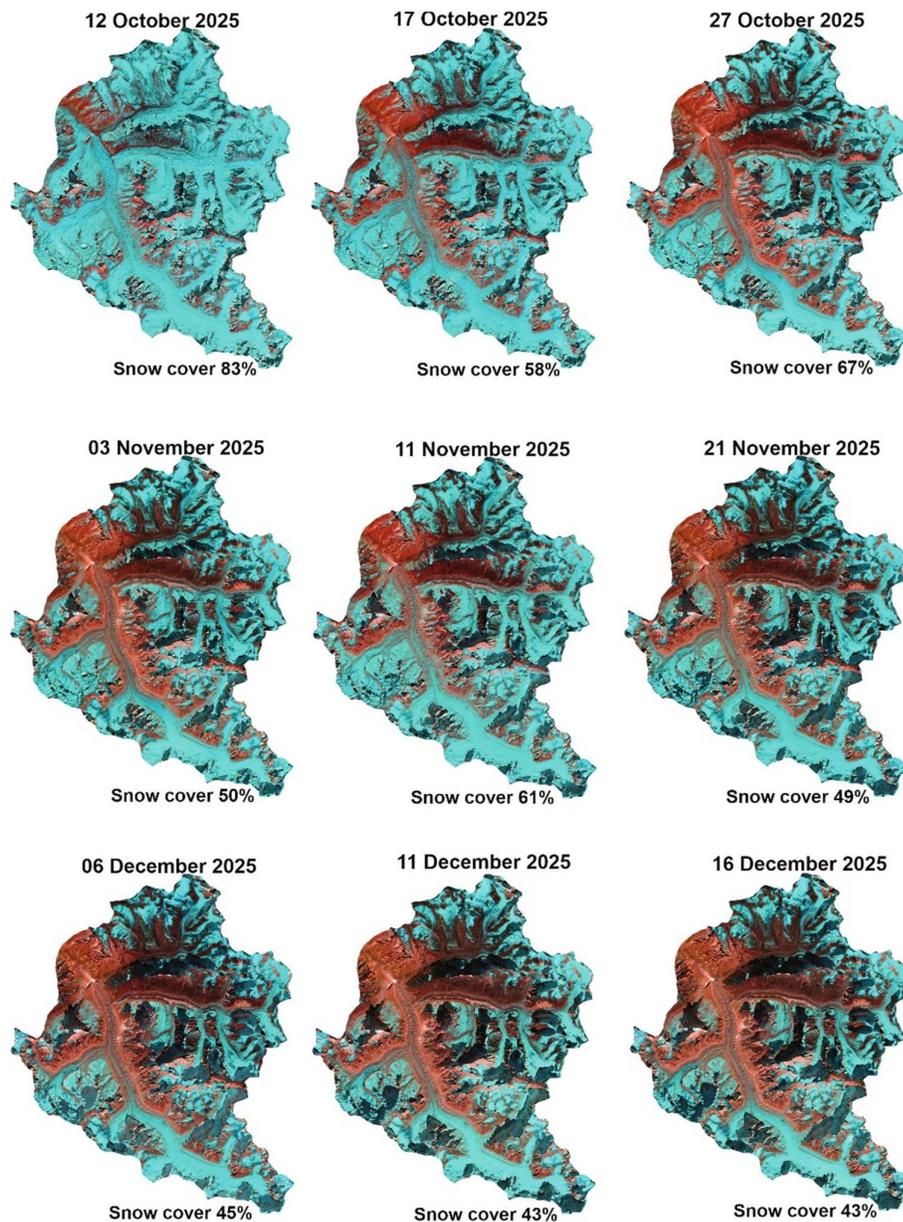


Figure 3. Snow-cover distribution in the Gangotri Glacier basin during October–December 2025 extended down to Bhojwasa

Nearly two months after the Dharali event, fresh snowfall occurred in the first week of November, covering the base camp and Chirwasa (**Figure 1 & 2**). The watch and ward team conducted field visits to the snout of the Gangotri Glacier to assess potential impacts, including the development of any proglacial lake and debris flow from the Meru Glacier region. Field observations revealed that although the glacier snout and adjacent areas were covered by fresh snow, no significant morphological changes or geomorphological disturbances were observed (**Figure 1 & 2**).

- Snow cover in the basin up to Bhojwasa showed a dynamic pattern during November: on 3rd November, ~50% snow cover represented the baseline before fresh snowfall; by **11th November, snow cover expanded to ~61%**, marking the peak extent; and by **21st November, it declined to ~49%**, slightly below the initial baseline, indicating melting, or sublimation, after the snowfall. This sequence demonstrates the rapid accumulation and ablation of snow in response to short-term weather events.
- In December 2025, watch and ward officials visited the Gangotri Glacier region to ensure the smooth functioning of scientific instruments installed at Bhojwasa, Chirwasa, and Maneri. Routine inspections confirmed the operational status of all equipment under harsh winter conditions (**Figure 2**).
- Field observations and satellite imagery indicated that no major snowfall occurred in December. Snow cover remained stable, with **45% on 6th December, 43% on 11th December, and 43% on 16th December**. Minor reductions in snow cover were attributed to compaction, sublimation, or localized melting. Field photographs from **29th December 2025** highlighted snow-free areas around Bhojwasa, while frozen water sources indicated the low temperatures that preserved the November snowfall as the primary snow cover throughout the month (**Figure 2**).

During October–December 2025, the monitoring instruments deployed at Bhojwasa, Chirwasa, and Maneri were verified to be fully operational. Early and late October precipitation events, comprising rainfall followed by snowfall, led to a marked increase in basin-scale snow cover, reaching a maximum of ~83% and subsequently stabilizing between 58–67%. In November, a fresh snowfall event in the first week increased snow cover from ~50% on 3rd November to ~61% by 11th November, followed by a decline to ~49% by 21st November due to ablation/sublimation processes. Snow cover in December remained relatively stable (~43–45%), reflecting the absence of additional snowfall and the persistence of the November snowpack under sustained low temperatures, as indicated by frozen water sources. Integrated analysis of field observations and satellite imagery (Sentinel-2 and Landsat) confirmed the absence of debris flows, proglacial lake formation, or significant geomorphic disturbances in the vicinity of the Gangotri Glacier throughout this period. The Bhagirathi River maintained its normal flow regime, with no anomalous hydrological activity detected. Overall, the snow cover dynamics in the basin exhibited high short-term variability in response to episodic meteorological events, while the glacier and surrounding landscape remained geomorphologically stable, and the monitoring instrumentation functioned reliably under harsh weather conditions.