Quarterly Progress Report of the Project

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

(April 2026 – June 2026)

Submitted

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.

WIHG has carried out the following tasks during the April 2026 to June 2026.

- To ensure the commencement of monitoring activities from April, as the summer season approaches and the movement of visitors and tourists towards Bhojwasa and Tapovan started**, two (02) watch and ward personnel were engaged in project-related activities**. They regularly visited the sites, ensured the safety and security of the installed instruments, and checked their proper functioning at the Bhojwasa, Chirwasa, and Maneri sites **(Figure 1)**.
- The interviews were conducted in March for the positions of Project Scientist and Project Associate to ensure the smooth functioning of the project and to initiate the scientific objectives related to fieldwork. Following the selection process, **Mr. Sourabh Anand joined as Project Associate-II, and Mr. Shivyank Singh Negi joined as Project Assistant**.
- During the last review of the project, it was planned to install one integrated GPRS module for real-time data transmission from **Broadband seismic station installed at Maneri and one Automatic Water Level and Velocity Recorder (AWLVR), already procured from WIHG funds, at Bhojwasa in May 2026.** Therefore, to initiate the tender for VSAT communication as mentioned earlier, the new AWLVR has been plan to install at Bhojwasa.
- The receipt of the third installment of the project funds has been received and the procurement process for a new AWLVR, to replace the AWLVR that was washed away, is initiated.
- To achieve these activities, a field programme was conducted from **11th May to 22th May 2026**. Two field teams were constituted to undertake the transportation of scientific instruments, installation of monitoring equipment, and collection of hydro-meteorological and seismic data from the Gangotri Glacier region, including Bhojwasa, Chirwasa, and Maneri. The field programme commenced on 11 May 2026, with one team travelling from Dehradun to Uttarkashi to obtain the necessary permission from the Forest Department before proceeding to Gangotri.

- Upon reaching Gangotri, the first team coordinated with the watch and ward staff to arrange porters and mules for transporting few instrument components and other field equipment from Gangotri to Bhojwasa. The field engineer, who travelled directly from Delhi and joined the team at Gangotri, was assisted by the WIHG team in selecting a suitable site for the installation of the AWLVR. The team also assisted in constructing a stable foundation to ensure the secure installation and reliable operation of the instrument under high-altitude conditions.
- The teams also inspected the operational status of all monitoring instruments and successfully retrieved data from the observational network. However, data could not be downloaded from the Automatic Weather Station (AWS) at Bhojwasa because the data logger was unresponsive during field inspection **(Figure 1)**. Despite this communication issue, the AWS was found to be continuously recording observations, indicating that the sensor system remained operational and that the stored data could be retrieved after servicing or replacement of the data logger. The same has already reported this malfunction to the firm. They have agreed to visit the site to inspect and resolve the issue.
- The second team proceeded to Gangotri on 14 May 2026, where logistical arrangements, including the engagement of porters and mules, were coordinated with the watch and wards staff for transporting the instrument sensors and associated equipment from Gangotri to Bhojwasa. Upon reaching the site, the engineer mounted the sensors on the cantilever structure and installed the solar panel and battery system to provide an uninterrupted power supply. The AWLVR sensors were successfully installed on a stable boulder at the designated monitoring location. Following installation and testing, the system became operational and started transmitting continuous water level and flow velocity data **(Figure 2)**.

Figure 1. Showing the manual observatory, Automatic Weather Station (AWS), and broadband seismic station established at Bhojwasa.

- The team also collected suspended sediment and water samples for isotopic analysis from the site where the Automatic Water Level and Velocity Recorder (AWLVR) were installed. In addition, a manual water gauge, marked up to 2m on a stable rock, was established to facilitate the calibration and validation of the water level data recorded by the instrument **(Figure 2)**.

Figure 2. Newly established Automatic Water Level and Velocity Recorder (AWLVR) at the Bhojwasa site, installed for continuous monitoring of stream stage and flow velocity in the Gangotri Glacier meltwater channel.

- Both teams visited the Gomukh region to conduct field investigations and collect GPS observations. A detailed field survey was carried out in and around the Gomukh, with particular emphasis on the area affected by the debris flow originating from a tributary glacier (Meru Bamak). The team documented geomorphological features, recorded GPS coordinates, and assessed the extent of the debris deposition **(Figure 3)**.

Figure 3. The team carried out a field survey using a portable GPS around Gomukh and the surrounding debris flow region.

- During the survey, it was observed that the affected area is highly unstable due to the presence of ice-cored moraine, making the terrain susceptible to continued erosion and mass movement. The trekking route from Gomukh to Tapovan was found to be particularly hazardous, with frequent rockfalls and unstable boulders along the trail. Strong winds carrying large amounts of dust further reduced visibility and increased the difficulty and risk of field operations in the area **(Figure 3)**.
- Upon returning from Bhojwasa to Gangotri, the team collected meteorological data from the Automatic Weather Station (AWS) installed at Chirwasa **(Figure 4)**. The AWS was found to be functioning satisfactorily, and the recorded data were successfully retrieved. The team stayed overnight at Gangotri and proceeded to the Maneri site the following day.
- The team reached Maneri and visited the observatory on 21 May 2026. Team checked the operational status of the Broadband Seismic Station (BBS) and successfully retrieved the recorded data, and integrated the IGM module with the BBS to enable real-time data transmission to WIHG **(Figure 5)**. A separate power supply was provided to the IGM module by connecting it to a new battery and solar panel. For this, a new Sim card was purchased and inserted in the module with data pack of 2G/day for the Months of May and June 2026.

Figure 4. Showing the, Automatic Weather Station (AWS), station established at Chirwasa.

Figure 5. Photograph of the IGM integrated with the BBS at the Maneri site, showing the complete field installation. The system is powered by two solar panels and supported by two batteries, providing a reliable and continuous power supply for uninterrupted operation under field conditions.

- Finally, on our return drive to Dehradun, we stopped at the Maneri site one last time on 22 May 2026 to check the status of the existing BBS and IGM modules. This was done to facilitate the configuration of the IP password so that, at WIHG, we can operate the instrument remotely whenever required **(Figure 6)**.
- The temporal monitoring of snow cover and snowmelt dynamics within the basin was carried out over an annual cycle using multispectral satellite data, primarily derived from Landsat 7/8, Sentinel-2 and field observations were complemented by satellite-based analysis.

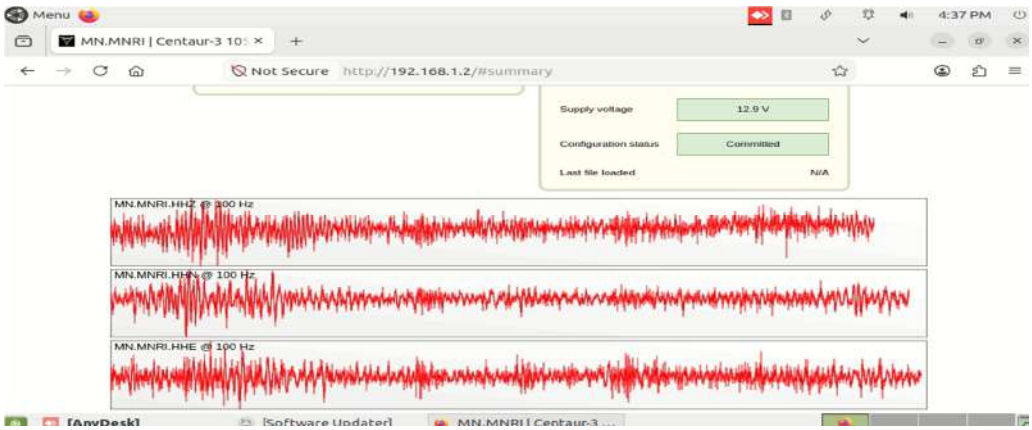

Figure 6. Screenshot showing the real-time operation of the IGM module before configuring it for remote operation from WIHG.

- The analysis of Snow Cover Area (SCA) indicates a continuous decline in snow-covered area across the basin from April to June, reflecting the progression of seasonal snowmelt. On April 10, approximately 93% of the total basin area was covered by snow, which gradually decreased to 89% on April 15, 85% on April 20, and 79% on April 25 (**Figure 7)**.

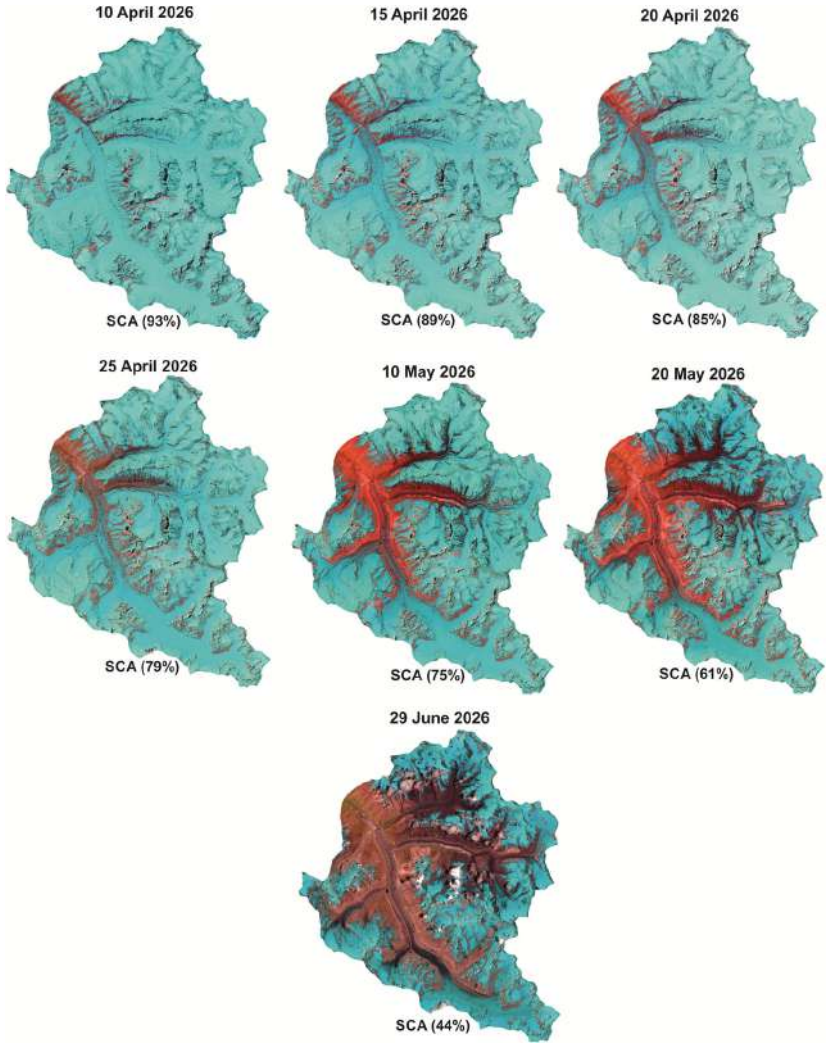

Figure 7. Distribution of snow cover conditions in Bhojwasa during January to March, derived from Sentinel-2 imagery.

- The SCA further declined to 75% by May 10 and showed a more pronounced reduction to 61% by May 20. By June 29, the snow-covered area had decreased to 44% of the total basin area. Overall, the SCA decreased by 49 percentage points between April 10 and June 29, corresponding to a relative reduction of approximately 52.7% from the initial snow-covered area (**Figure 7)**.The relatively gradual decline during April followed by a more rapid reduction during May and June indicates progressive acceleration of seasonal snowmelt, likely associated with increasing temperatures and enhanced solar radiation during the transition from spring to summer.
- The required satellite data will be acquired accordingly, preferably towards the end of the next summer season, to ensure appropriate seasonal coverage and mapping of supraglacial lakes develop in Gangotri Glacier.
- With the receipt of the third installment of the project grant, the necessary activities will be taken up as per the planned schedule. A documentary film will be prepared after completion of the major field activities and integration of the monitoring systems.

Based on the field visit, it was verified that the instruments installed at Bhojwasa, Chirwasa, and Maneri were functioning properly. The team successfully retrieved data from the Chirwasa and Maneri stations and integrated an IGM module at the Maneri site to enable real-time data transmission to Dehradun. A new Automatic Water Level and Velocity Recorder were installed over the River Bhagirathi at the Bhojwasa. Although the existing AWS at Bhojwasa was operational, the team was unable to retrieve data during the field visit due to a malfunction in the data logger. The issue was reported to the firm, and the engineer visited the site at the end of June to resolve it. They replaced the data logger with a new one and took the defective unit for checking. During the checking process, the data stored in the old data logger were successfully recovered and subsequently shared.

The Snow Cover Area (SCA) showed a continuous decline from 93% on April 10 to 44% on June 29, indicating substantial seasonal snowmelt across the basin. The accelerated reduction during May and June reflects the progression of seasonal snow ablation and the transition toward summer conditions. Available satellite data and field observations were jointly examined to identify any major events, such as debris flows or the formation of new glacial lakes near Gomukh. The analysis confirmed the absence of debris flows, major glacial lake development, or significant geomorphological changes in the vicinity of the Gangotri Glacier.

Considering the presence of ice-cored moraine, unstable boulders, frequent rockfalls, and strong winds along the Gomukh–Tapovan route, the area should be considered highly hazardous after moraine failure of Meru Bamak. It is recommended that the route be regularly monitored and assessed for stability, with necessary safety measures, controlled movement, and temporary restriction or rerouting of particularly unstable sections to minimize the risk to trekkers.

It was also observed that trekking agencies were pitching tents near the sophisticated and sensitive instruments installed by WIHG and around the WIHG hut, causing considerable noise and disturbance during observations. Since designated tenting areas have already been allotted at Bhojwasa, it is recommended that the concerned authority issue clear and strict instructions to all trekking agencies to use only the designated camping areas and maintain a safe distance from the WIHG instruments and hut. This will help prevent accidental damage to the instruments, minimize noise and disturbance, and ensure uninterrupted scientific observations.

Amit Kumar

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