

Progress Report

Long-Term Monitoring of Gangotri Glacier, Garhwal Himalaya (July -September 2022)

By



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Background

The Himalayan Mountain Range contains thousands of glaciers of varying properties, which are spread over 37000 km² and a stretch of 2400 km from East to West. The glacier inventory by the Geological Survey of India indicates there are 9575 glaciers in the Indian Himalayan Region (IHR). It is well-established fact that changes in the glaciers are a key indicator of climate change; recent observation shows that snow accumulation is reducing while the ablation is increasing in the Himalaya. However, there are only a handful of ground-based studies on Himalayan glaciers. Therefore, the Department of Science and Technology (DST) has given the Wadia Institute of Himalayan Geology (WIHG), Dehra Dun the mandate to monitor Himalayan Glaciers. Presently, Uttarakhand State Disaster Management Authority (USDMA) has sponsored a project entitled "Long-term monitoring of Gangotri Glacier, Garhwal Himalaya" to WIHG (Letter no. 1765/XVIII-B-1/21-12(5)/2021 dated 21.12.2021) for which the funds were allocated 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.

Based on the work plan submitted to USDMA, WIHG has carried out the following tasks from July to September 2022:

1. Permission for the establishment of meteorological, hydrological and seismological observatories within the Gangotri National Park from the district administration and forest department is still awaited. The meeting for the same will be conducted with DFO Gangotri national park for the site selection of all the instruments proposed in the project.
2. Watch and wards are stationed at Bhojwasa throughout July to September 2022 and will continue during the winter for manual observations and to monitor the region for unusual events.
3. The recruitment processes for the appointment of project staff (one project scientist and project assistant) have been completed and the result for the same is awaited.

4. Specifications of the instruments (manual meteorological observatory, 02 Automatic Weather Stations, 01 Automatic Water Level and Velocity Recorder, 02 Broadband Seismometers) to be purchased in the project have been finalized and are ready for tender notification through GeM portal.

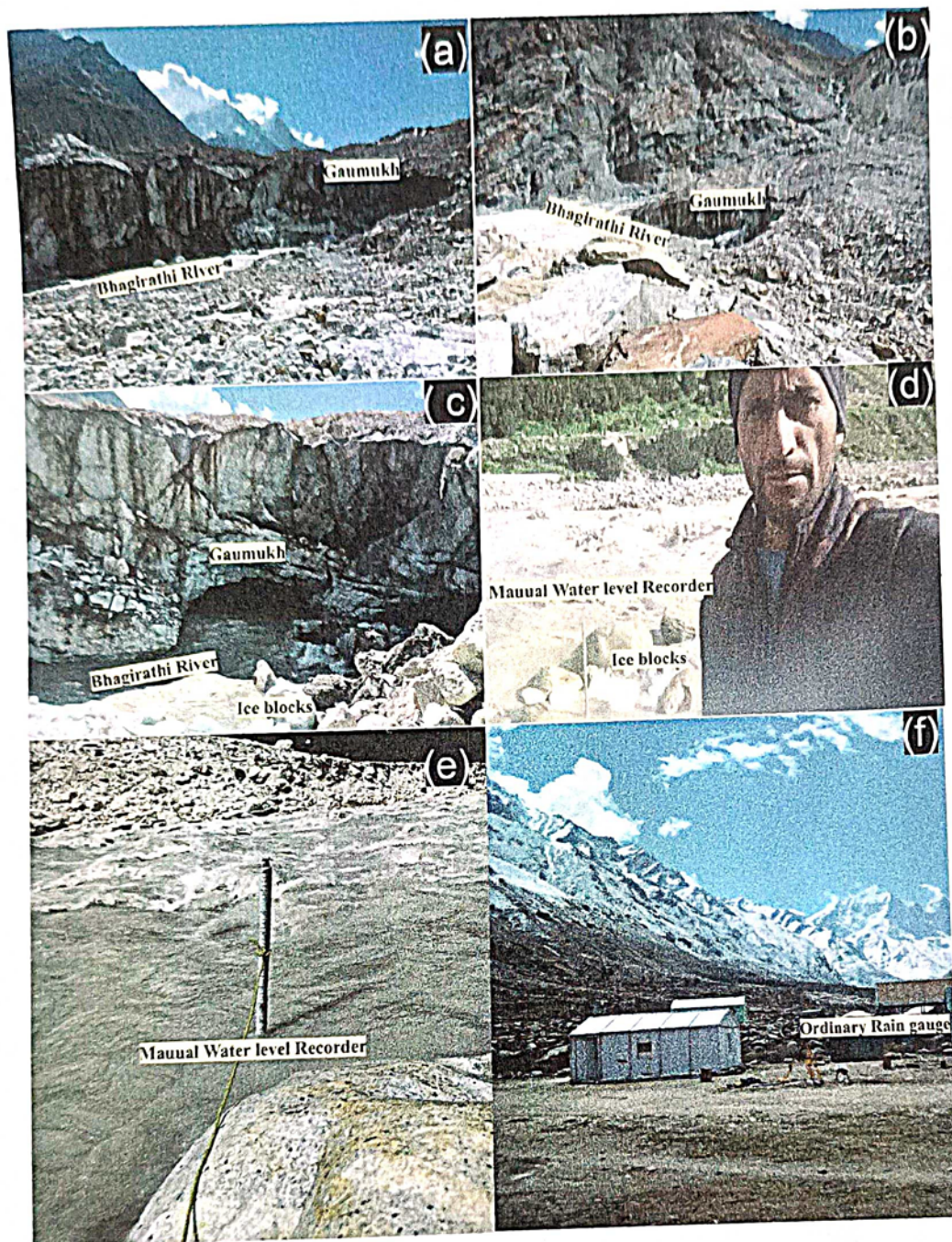


Figure 1. Path of Bhagirathi River flowing across the snout of Gangotri Glacier in September 2022 (a); frontal part of the Gangotri glacier (left to right view) covered with ice and debris and exposure of pro-glacial stream emerging from Raktvarn Glacier during September 2022 (b); the opening of Gaumukh (snout) and broken ice blocks scattered in the river during the peak melting season (c); and transported ~3 km downstream at Bhojwasa (d); location of manual river gauge installed for the recording of water level during the melting season (e); and location of ordinary rain gauge installed near the base camp at Bhojwasa (f).

5. Based on the physical observations and satellite-based information during the period July to September 2022, it has been indicated that the meltwater stream from Gangotri Glacier is originating near the left lateral moraine, flowing across the snout of the glacier (Gaumukh) before moving downward (**Figure. 1a**).
6. The pro-glacial stream emerging from Raktvarn is exposed from the right bank of Gaumukh, i.e. the ice wall retaining the debris material has been evacuated and the stream is now joining the main Bhagirathi River on the surface, which was earlier discharging into the sub-glacial channel of Gangotri Glacier (**Figure. 1b**).
7. The ice from the Gaumukh (snout) breaks and falls into the Bhagirathi stream during the melting season (May to October) which is a natural process (**Figure 1c**) and is transported downstream up to Bhojwasa (**Figure 1d**).
8. A manual water level recorder at the Bhagirathi River (**Figure 1e**) and an ordinary rain gauge (**Figure 1f**) was installed near the base camp at Bhojwasa for the monitoring of extreme events. The estimation of total rainfall and water level observed during the glacier melting period (May-October, 2022) is under processing.

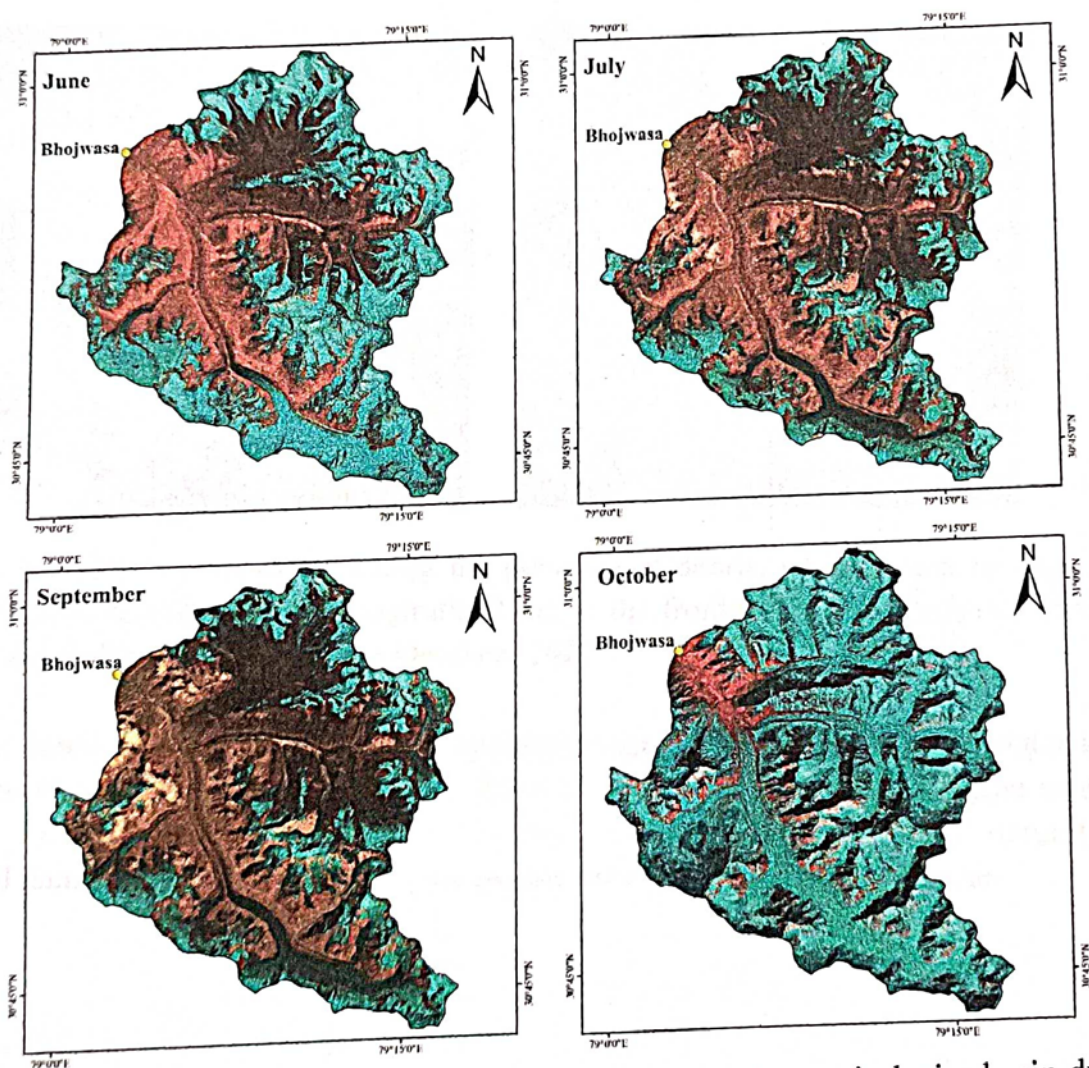


Figure 2. Overview of the snow cover pattern in the Gangotri glacier basin during the summer season of 2022

9. Depletion of snow cover during the melting season over the Gangotri glacier basin is depicted using satellite images. The upper region of the basin is covered with permanent snow. Also, a fresh snowfall event (7.62 cm) was witnessed on 11 October 2022 at Bhojwasa, which is confirmed by the satellite image (Figure 2).

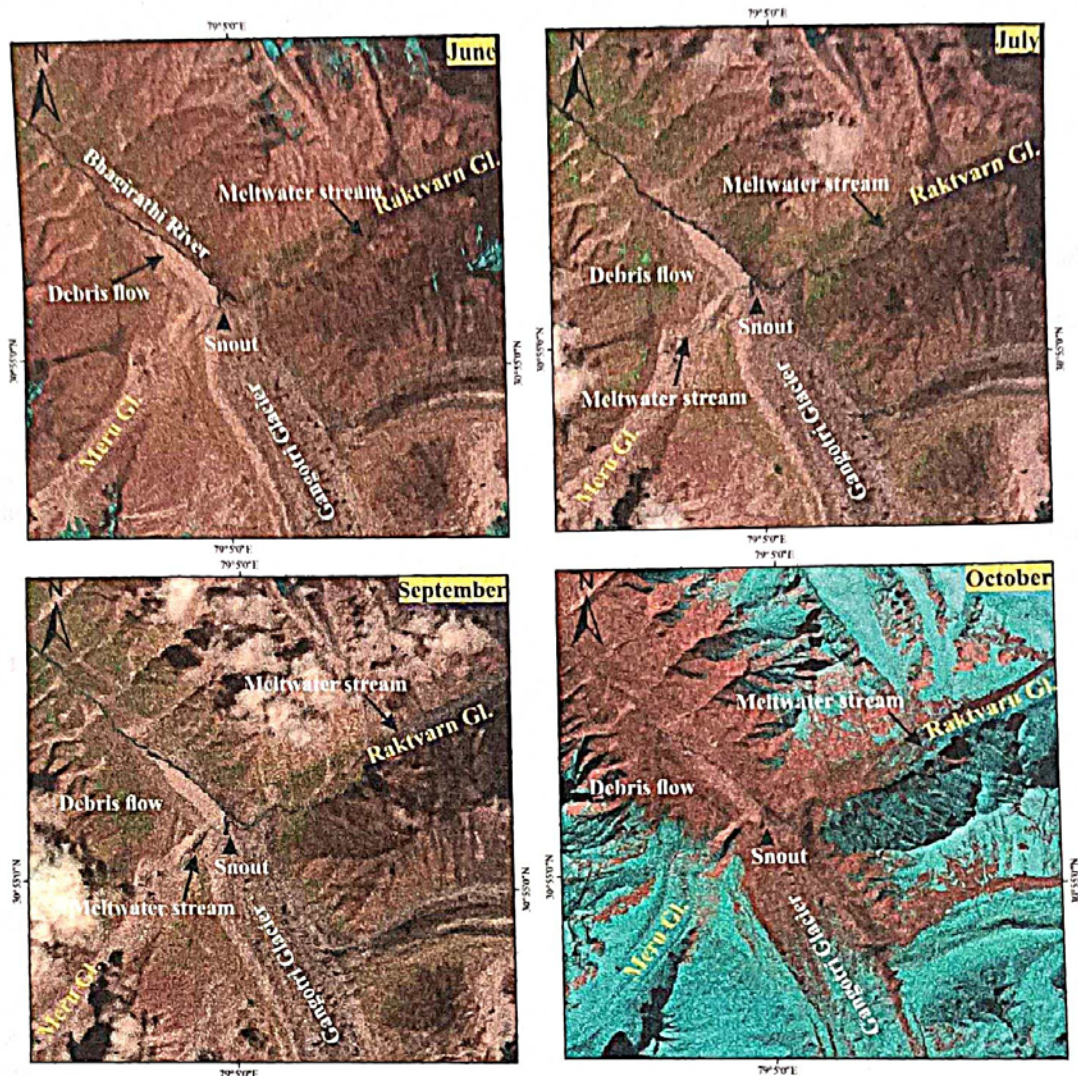


Figure 3. Satellite images indicating the presence of debris, no damming or lake, and uninterrupted natural flow of Bhagirathi River in the frontal region of Gangotri Glacier during the melting season (June to October) 2022.

10. Further, based on the field survey and satellite images, no development of a major lake has been observed in the Meru Bamak, Raktvarn Glacier and Gaumukh region to date (Figure 3). The Bhagirathi River is flowing uninterrupted without any natural or artificial damming from the debris in the proglacial region of Gangotri Glacier.