Progress Report

Long-Term Monitoring of Gangotri Glacier, Garhwal Himalaya

(October- December 2022)

By

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Submitted to

Uttarakhand State Disaster Management Authority
(Government of Uttarakhand)
Dehradun

(Grant No. 1765/XVIII-B-1/21-12(5)/2021)

January 2023

Long-Term Monitoring of Gangotri Glacier, Garhwal Himalaya

Background

The Himalayan Mountain Range contains thousands of glaciers of varying properties, which are spread over 37000 km^2 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), Dehradun 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.

WIHG has made the following progress in the project from October to December 2022:

1. Two (02) watch and wards have been stationed at Bhojwasa for manual observations at Bhojwasa and visit the snout region at regular intervals, with the recent visit during 24-27 December 2022.
2. The process of recruitment of the project staff including 0ne (01) project scientist and one (01) project assistant was completed and the project staff joined WIHG in November-December 2022.
3. The process of procurement of instruments (manual meteorological observatory, 02 Automatic Weather Stations, 01 Automatic Water Level and Velocity Recorder, 02 Broadband Seismometers) requested under the project is ongoing. The inventory of the required high-resolution satellite data is completed and will be purchased shortly.
4. Once the instruments are operational in the field and satellite data is purchased, all the available data will be integrated and provided to USDMA through API. At present the observations are field-based (manual) and freely available satellite images, the link to which can be shared with USDMA.

5. During the end of December 2022, the surface water of the Bhagirathi River near the snout was frozen, while the meltwater stream is flowing below the frozen layer (**Figure 1**).

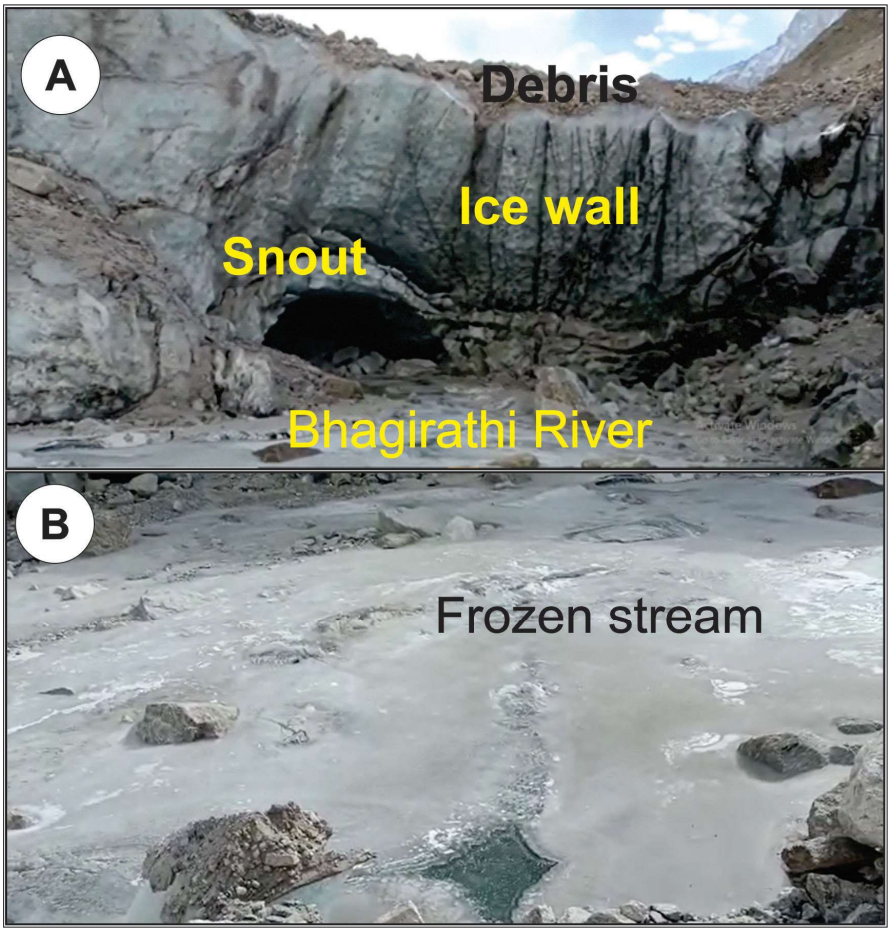

Figure 1. Field photographs showing the snout and meltwater stream of Gangotri Glacier (A) and the frozen surface of the stream (B).

6. Based on the physical observations and satellite-based information during the period of October to December 2022, it has been indicated that there is no change in the meltwater stream and snout of Gangotri Glacier since the observations from July to September 2022. Bhagirathi River is flowing uninterrupted during the observation period (**Figure 2**)
7. Further, the changes in the snow-covered area (SCA) of the Gangotri Glacier basin during the period from October to December 2022, indicate that the higher reaches of the basin witnessed snowfall during early October 2022 while November and December months were dry. Also confirmed by field observations.
8. The basin was covered by ~81% snow on 13th October 2020 which significantly reduced to 35% on 16th December 2022 reflecting a consistent reduction in SCA between October and December 2022 (**Figure 3**).

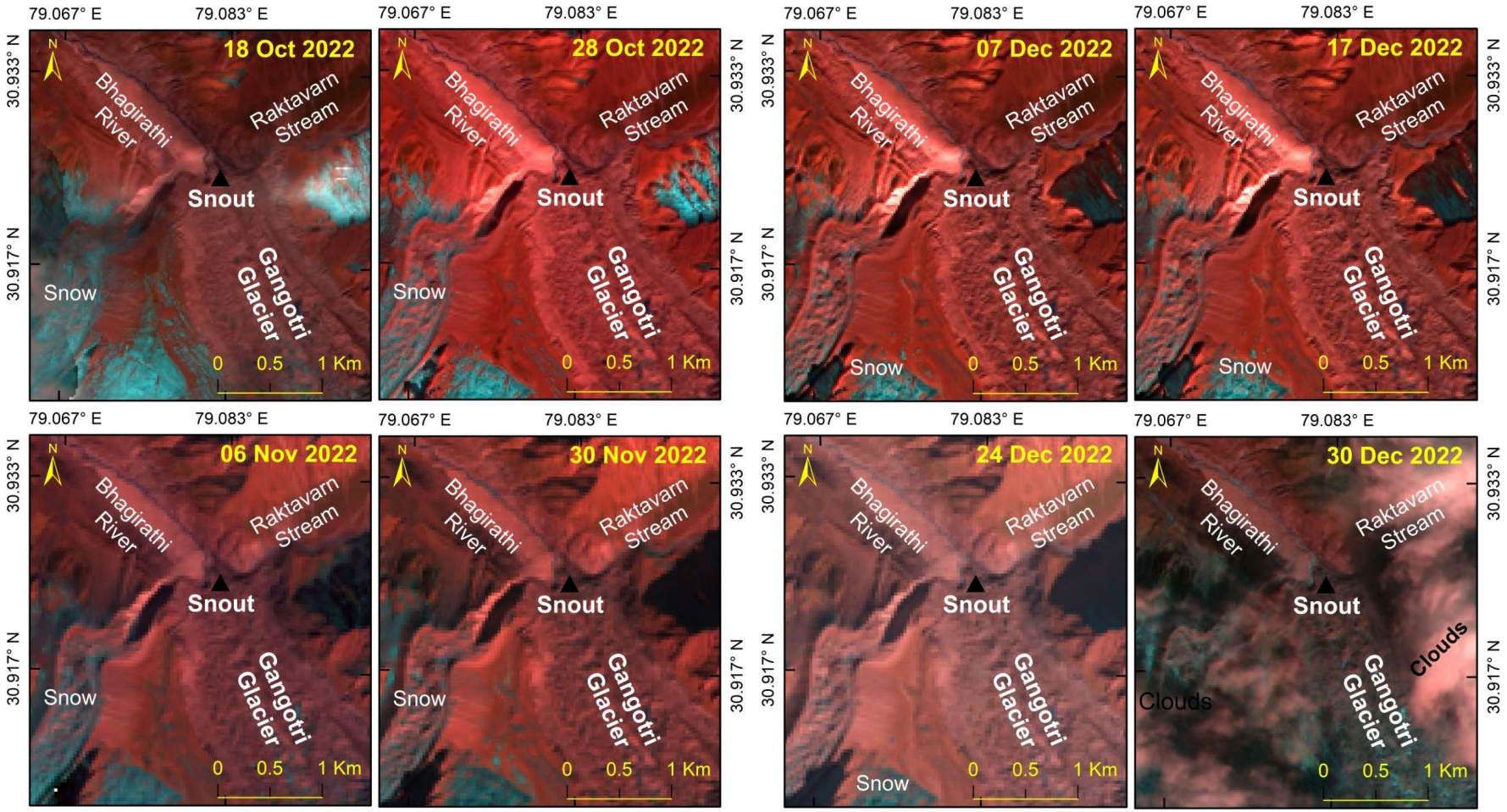

Figure 2. Satellite images indicating the presence of debris, no damming or lake, and uninterrupted natural flow of Bhagirathi River in the frontal region of Gangotri Glacier from October to December 2022.

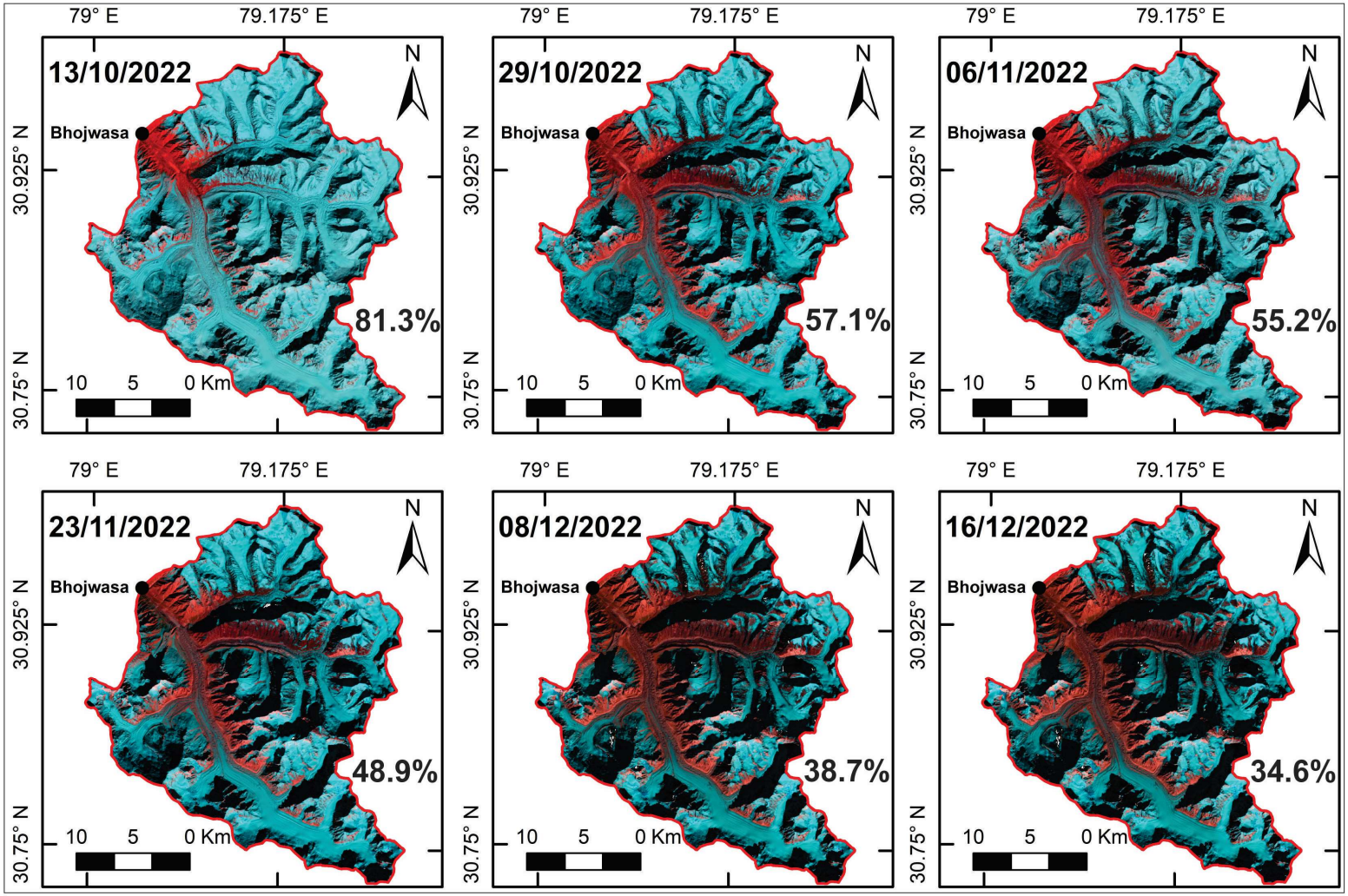

Figure 3. Distribution of Snow-covered area over the Gangotri Glacier basin from October to December, 2022.

9. The meteorological data and samples collected during the ablation season (May – October 2022) are being processed for further analysis.
10. A meeting was called by Secretary, USDMA with other officials of USDMA on 17.11.2022 for discussing the updates of the project. The difficulties faced by WIHG in implementation of the project were also discussed and the minutes for the same were communicated to the concerned departments.
11. Based on field observations and satellite data, there is no emanating threat observed in the region from October to December 2022.