

Progress Report

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

(January – March)

By

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Long-Term Monitoring of Gangotri Glacier, Garhwal Himalaya

Background

The Himalayan Mountain Range encompasses thousands of glaciers, spanning over 37,000 km² along a stretch of 2,400 km from East to West. According to the glacier inventory conducted by the Geological Survey of India, there are 9,575 glaciers in the Indian Himalayan Region (IHR). It is widely recognized that changes in these glaciers serve as crucial indicators of climate change. Recent observations indicate a reduction in snow accumulation and an increase in ablation in the Himalayas. Despite this significance, ground-based studies on Himalayan glaciers are limited. Hence, the Department of Science and Technology (DST) has entrusted the Wadia Institute of Himalayan Geology (WIHG), Dehra Dun, with the responsibility of monitoring Himalayan Glaciers. Currently, the Uttarakhand State Disaster Management Authority (USDMA) has sponsored a project titled "Long-term monitoring of Gangotri Glacier, Garhwal Himalaya" to WIHG (referenced in Letter no. 1765/XVIII-B-1/21-12(5)/2021 dated 21.12.2021), with funds 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 during January to March 2024

1. The two watch and ward personnel, previously appointed on an annual basis, will continue to be stationed in Bhojbasa. They will report on ongoing activities and monitor and maintain our base camp facilities and instruments.

2. Dr. Litan Kumar Mohanty, the Project Scientist, joined in the last week of January 2024, marking the completion of the selection process.
3. All instruments installed in October-November 2023 are functioning well also the watch and ward personnel confirms their operational status during last winter **(Figure1)**.
4. Starting in May 2024, the collection of data from meteorological, hydrological, and seismological observatories will initiate. This effort aims to gather approximately six months of uninterrupted scientific data, to be followed by subsequent reporting.
5. Maintenance of accessories such as batteries, data recorders, solar panels, and mounting plates will be carried out during the field visit, if necessary.
6. Sensitive instruments will be protective by temporary fencing around them, through project grant. Permissions for the same will be obtained from the district administration and forest department as well.
7. Protection measures will be implemented for the automatic water level and velocity recorder (AWLVR) to ensure the flood protection during monsoon season. This include the wall of boulders inside the gabion box mesh around 20 meter long.
8. The purchase of manual equipment for the manual observatory has been completed in December 2023. Therefore, the installation of a manual observatory will be completed to record daily rainfall, snowfall and air temperature etc during visit in May.
9. Plans are underway to establish a real-time connectivity of all the instruments via VSAT technology for real-time data acquisition. The tender for the same will be floated shortly through GeM.
10. Progress continues on the purchase order for required high-resolution satellite data, with ongoing discussions with administrators.
11. During December 2023 to January 2024, surface water of the Bhagirathi River near the snout was frozen, with melt-water flowing below. The river will gradually thaw from late March to April 2024.
12. The WIHG team of project staff marked the current location of the snout during the last field visit along with the changes in the region after the debris flow event 2017.
13. The selection of the required high-resolution satellite data is currently in progress and being order shortly.
14. Between December 2023 and January 2024, the surface water of the Bhagirathi River near the snout was frozen, while the melt-water stream flowed beneath the frozen layer. However, the river will gradually begin to melt after winter, continuing until

late March to April 2024.

15. During the last field visit, the WIHG team marked the current location of the snout on a large boulder for both 2023 and 2022. With the assistance of watch and ward personnel, this was done to facilitate future assessments of glacier retreat, during which measurements will be taken again.



Figure 1. Recent field photos of Installed instruments and the proof, that our instruments are continuously working well and collecting data, (A) AWS at Bhojbasa, (B) AWS at Chirbasa, (C) AWLR at Bhojbasa near Bhagirathi river, (D) data Logger of BBS showing green lights on which means it is continuously working, (E) The charge controller of AWS Bhojbasa, (F) Display of AWS showing snow depth data and other information. (G) The display of data showing AWS at Chirbasa.

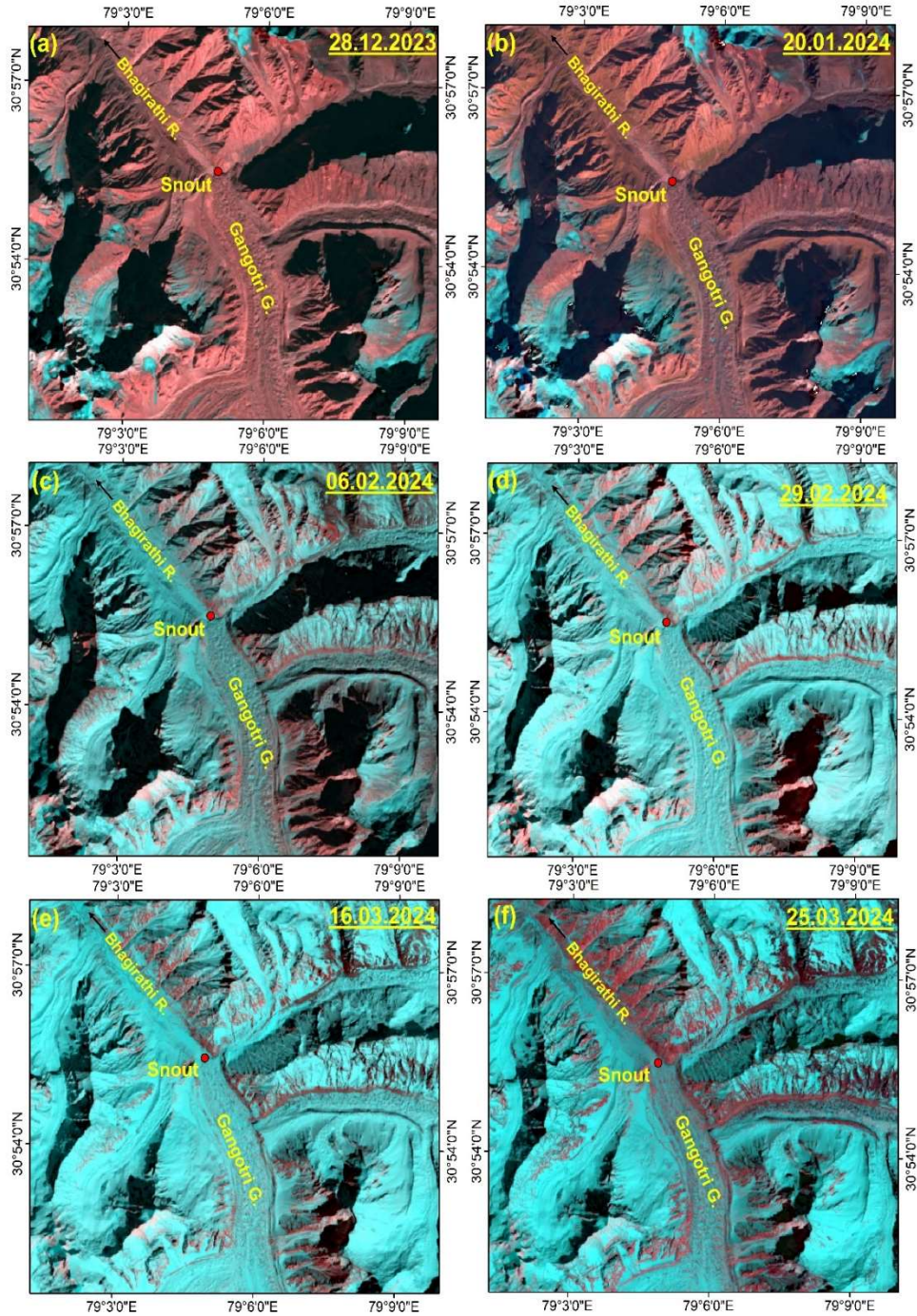


Figure 2. The snow cover analysis using Landsat-8 satellite images shows diurnal and seasonal changes in frozen snow, exposure of debris covered or uncovered by snow, no damming of the lake, and uninterrupted natural flow of Bhagirathi River, however in winter Bhagirathi is frozen slightly in the frontal region of the snout from December 2023 to March 2024 at Gangotri basin, the study area by WIHG under the project.

Apart from these, the snow cover analysis has also been used to classify the diurnal changes and interconnected analysis, using Landsat-8 images showing monthly (seasonal) changes in snow cover area relative to the total area of the catchment covered inside the image which shows that the ablated snow cover start increasing by December 2023 to March 2024, influenced by climate, topography and quantity of snowfall, and **following the 86.14% of (highest) snow cover in mid-February to March end, 2024** using the composite image of different bands the observation of data shows that the snowfall has decrease by 25th March for this region (**Figure 2, Figure 3 & 4**). Satellite imagery and climate records can provide a comprehensive understanding of snow cover dynamics at both decadal and diurnal scales.

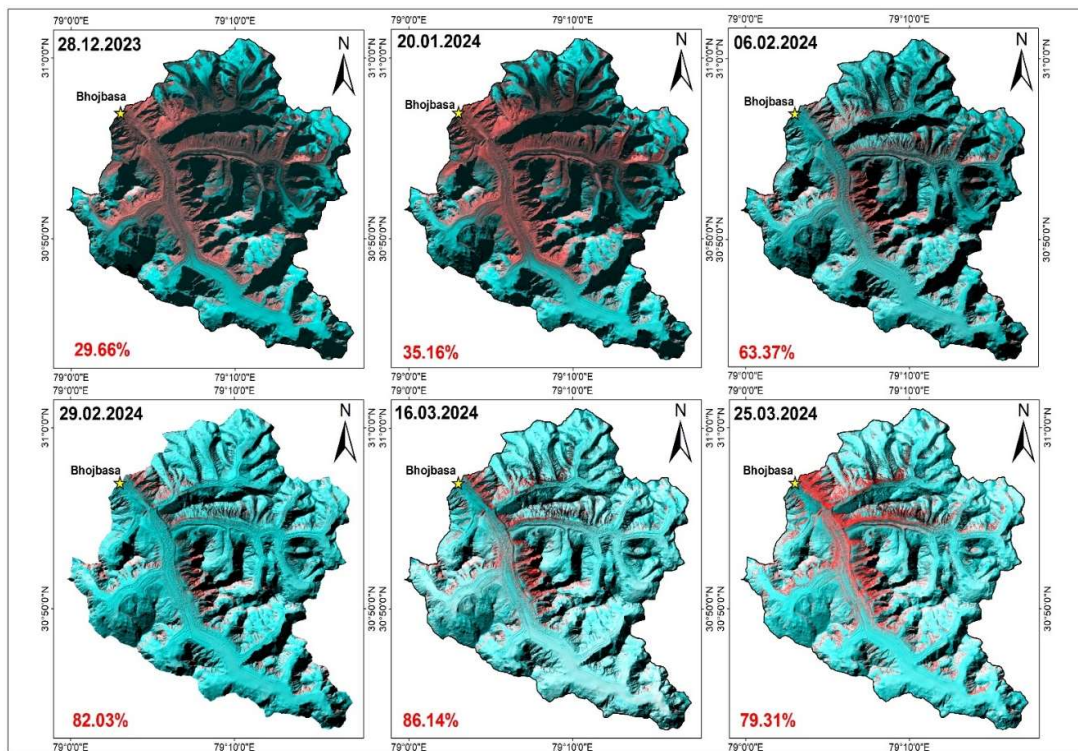


Figure 3. The map of Gangotri Basin shows the variation in snow cover area by percentage for January, February, and March months, 2024 (winter season) in the Gangotri Glacier basin up to Bhojbasa.

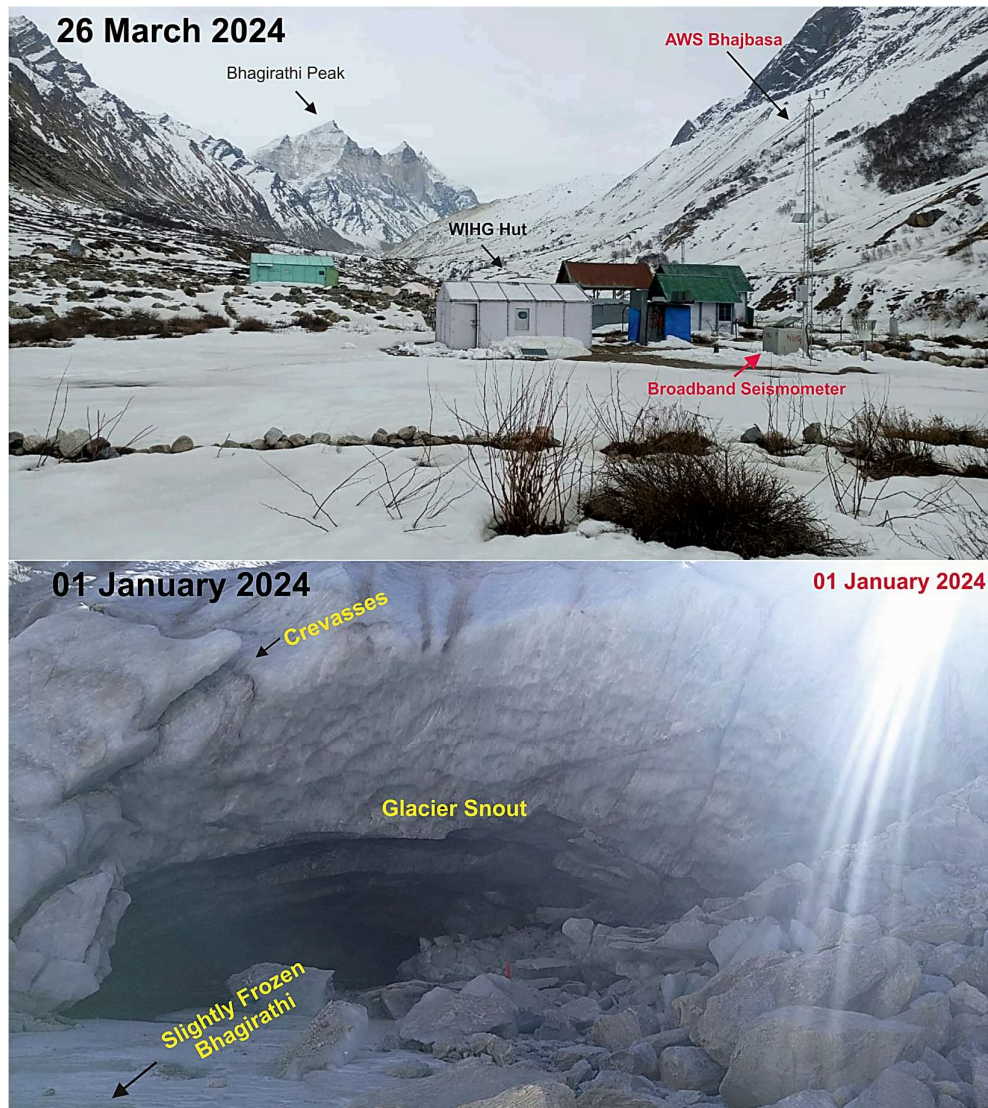


Figure 4. The overall scene of winter emphasizes the blanket of snow covering the terrain (Up), and the snout condition and frozen Bhagirathi River (Down).

However, based on both field visits and observations from satellite imagery, the team did not detect any indications of recent landslides, instances of river water damming, or the formation of glacial lakes around Goumukh. This suggests that there have been no significant geological events or changes in the landscape that could potentially impact the region's stability or pose threats to nearby communities or infrastructure.