A Report on

"Scientific Field Survey of Western Himalayas"

From 16th Sept. 2021 to 2nd Oct. 2021

Under SERB-DST Research Project No. TAR/2019/000354

Estimation and validation of seasonal snow cover maps using Ku-band SCATSAT-1 data over the Western Himalaya, India

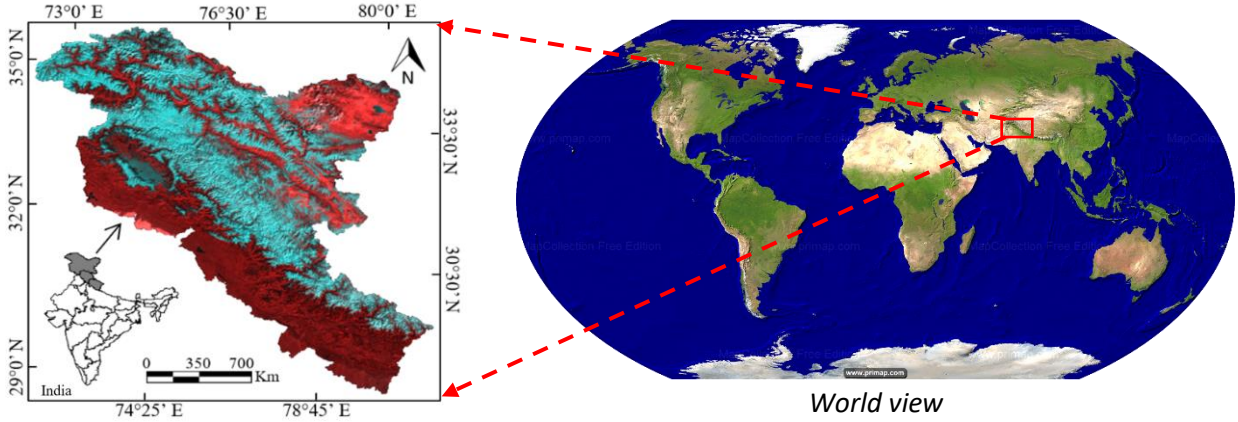
Submitted by

Dr. Sartajvir Singh, (TARE Awardee)

Associate Prof. (ECE), Chitkara University (HP)

Introduction

The Himalayas span from the Karakoram to the Eastern Himalaya, over 2000 km[1], making it one of the largest glacier mountain systems in the world. The Indian Himalayan glaciers have been of socio-economic importance in providing freshwater downstream, hydropower or acting as a climatic barrier. Still, they have also been held responsible for devastating calamities like floods and mudslides owing to their continuous deglaciation.

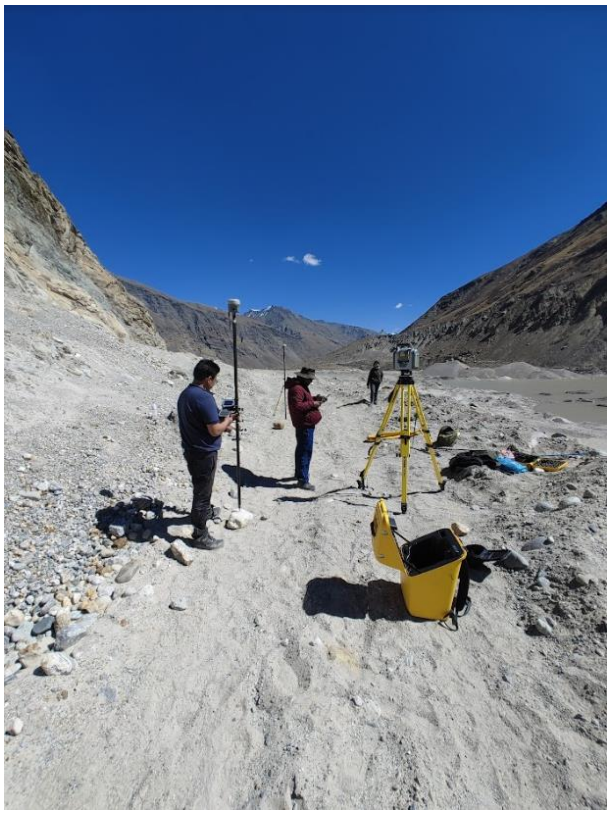


A glimpse of Western Himalayas, India

Such response of the Himalayan glaciers could be attributed to the accelerated rate of climate change. Glaciers are one of the most sensitive indicators of climate change[1], hence an ideal subject when such studies are considered. In an agrarian economy like India, apart from rainwater, people are hugely dependent on freshwater from the basins of the Ganges, Indus, and Brahmaputra. In other words, the Indian Himalayan glaciers play a vital role in controlling the economy of the country[2–4]. Therefore, glacier health in terms of thickness and volume changes must be monitored to understand the amount of glacial wastage in a quantitative manner.

Image acquired on 23-Sep-2021 at Samundra Tapu Galcier (Lahaul and Spiti, HP)

However, due to the remoteness of the Himalayan region, most of the researchers focused on remote sensing-based measurement. Also, the remote sensing-based study is beneficial in the regional glaciological analysis due to extensive spatio-temporal coverage. However, a minimum number of field data is significant in the case of remote sensing glaciology as the data is required to calculate the data validation and remote sensing-based uncertainty.



A glimpse of field observations at Samundra Tapu Glacier (Lahaul & Spiti, HP) and Drang-Drung Glacier (Pensi La, Ladakh).

Glacier Selection

In our study, we have selected two glaciers from different zone.

- The first one is the Samudra Tapu (ST) glacier from the western Himalaya region, and
- The second one is the Drang Drung (DD) glacier from the Zanskar range.

ST is a debris-covered glacier. On the other hand, DD is a clean glacier. Along with that, these two glaciers are easily accessible from the road. That is why we have selected these two glaciers for the field survey.

A glimpse of field observations at Samundra Tapu Glacier (Lahaul & Spiti, HP) and Drang-Drung Glacier (Zanskar, Ladakh).

Details Itinerary

On 16th-17th Sep, 2021, preliminary inspection of each equipment has been conducted at IIT Ropar, Punjab. Some of the repairs have been done. On 18th Sep 2021, we have reached Manali. The next day we have purchased the necessary gear for camping and ration. Also, a field guide and porter have arranged from Manali on the same day. On the third day, our team moved toward Chandrataal, but due to unfavourable weather conditions, we reached Chhattru. The next day, we left Chhattru in the early morning and reached our base station in Chandrataal. After that, the rest of the day has been spent to set base camp and other necessary facilities. On the fifth day, we have approached to reach the glacier again bad weather hampers our plan. Unfortunately, we have reached the snout area of the Samudra Tapu glacier. Following two days, we have surveyed the ST glacier. To do so, bathymetric data, UAV data, resistimeter data and differential global navigation satellite system (DGNSS) coordinate have been collected. After examining the ST glacier, we left the ST glacier on the 8th day. After 5 hours walk, we reached our base camp on the same day we reached Sissu late at night.

Next day also, we have covered more than 400 km to reached Leh. On the next day we have taken rest to acclimatation our body with high altitude land. In the 11th day we reached Rangdum village in the Kargil district. The entire 12th day we spend to collected data from the famous Drang Drung glacier. In details. We have scanned the snout area of the large DD glacier.

Along with that, we have also collected DGNSS data for better confidence. The next day we have reached Srinagar via Kargil. The 14th day of the trip has been very well spent with the glaciology team of the University of Kashmir. The entire day has been spent on laboratory visits and scientific discussions. On the following day, we have returned to our hometown.

On 16th-17th Sep, 2021, preliminary inspection of each equipment has been conducted at IIT Ropar, Punjab.

S.no.	Date	From	To
1	18/9/2021	Mohali	Manali
2	19/9/2021	Manali	Manali
3	20/9/2021	Manali	Chhatru
4	21/9/2021	Chhatru	Chandrataal
5	22/9/2021	Chandrataal	Samudra Tapu
6	23/9/2021	Samudra Tapu	Samudra Tapu
7	24/9/2021	Samudra Tapu	Samudra Tapu
8	25/9/2021	Samudra Tapu	Sissu
9	26/9/2021	Sissu	Leh
10	27/9/2021	Leh	Leh
11	28/9/2021	Leh	Rangdum
12	29/9/2021	Rangdum	Rangdum
13	30/9/2021	Rangdum	Srinagar
14	1/10/2021	Srinagar	Srinagar
15	2/10/2021	Srinagar	Ropar

Team Members:

1. Dr. Reet Kamal Tiwari, IIT Ropar
2. Dr. Sartajvir Singh, Chitkara University, HP
3. Dr. Anurag Linda, Central University, HP
4. Mr. Supratim, Research Scholar, IIT Ropar
5. Ms. Deepika Gaikwad, Research Scholar, IIT Ropar
6. Mr. Shanta Negi, Research Scholar, Central University, HP
7. Mr. Varun Sharma, Aimil Group
8. Mr. KL, Manager, Aimil Group

Equipment Used in the Field

1. The senseFly eBee X is our flagship fixed-wing mapping and surveying drone. It is lightweight, hand-launched and helps surveyors and geographic information system (GIS) professionals collect important aerial mapping data safely and efficiently via a suite of purpose-built mapping cameras. The raw aerial data collected from the drone can be used to create stunning high-resolution orthomosaics or it can be processed with photogrammetry software, such as Pix4Dmapper, to create topographic maps, including digital surface models (DSMs), digital elevation models (DEMs), 3D point clouds and more. The topographic data can be used to gain critical project insights and shared across teams for better decision-making. eBee X is also available with Real-time kinematic (RTK) or Post-Processed Kinematic (PPK) for greater positional accuracy.

A glimpse of field observations via SenseFly eBee X at Samundra Tapu Glacier (Lahaul & Spiti, HP)

2. Terrestrial Laser Scanning

Terrestrial laser scanning (TLS), also referred to as terrestrial LiDAR (light detection and ranging) or topographic LiDAR, acquires *XYZ* coordinates of numerous points on land by emitting laser pulses toward these points measuring the distance from the device to the target. The number of measurable points within a certain period is much larger than those of TS and LRF devices: a modern TLS device can measure 10^4–10^6 points per second with an accuracy of 10^{-1}–10^0 cm. Bespoke software packages are generally required for managing and analyzing the data because of the large amount of data stored in a TLS point cloud. A point cloud may be converted into a grid DEM to facilitate topographic mapping and spatial analyses.

A glimpse of field observations via Terrestrial laser scanning (LiDAR) at Drang-Drung Glacier (Zanskar, Ladakh).

3. ME 40 Unmanned Surface Vessels (USV)

Unmanned Surface Vessels (USV), offering autonomous solutions for several applications, including water quality sampling & monitoring, flow measurement, hydrographic survey, oceanographic research, security patrol, search & rescue, and maritime missions. Featuring advanced intelligent technology, Oceanalpha autonomous boats are used by commercial clients, government organizations, research institutes, and universities worldwide. The unmanned surface vessel platforms are a reliable way to improve working efficiency on the water and can be used for hydrology research, scientific exploration, hydrographic survey, emergency search and rescue, security patrol, fire control, and other tasks.

A glimpse of field observations via Terrestrial laser scanning (LiDAR) at Samundra Tapu Glacier (Lahaul & Spiti, HP)

4. SenseFly albris

The senseFly albris is a sensor-rich platform with the widest camera breadth of any civilian drone. Its fully stabilized triple view camera head allows you to switch between HD and thermal video imagery, live during your flight, plus you can capture high-resolution still images on demand. This data can be saved for further analysis postflight, and all without landing to change payloads.

A glimpse of field observations via SenseFly albris at Samundra Tapu Glacier (Lahaul & Spiti, HP).

5. Trimble R10

Collect more accurate data faster and easier – no matter the job or the environment, with the Trimble R10 GNSS System. Built with powerful technologies integrated into a sleek design, this system provides surveyors with a powerful way to increase data collection productivity in every job, every day.

- Powerful 672-channel solution with Trimble 360 technology delivers the most advanced satellite tracking
- Improved protection against sources of interference and spoofed signals
- Connect to Android or iOS mobile devices running supported apps via Bluetooth
- Trimble HD-GNSS processing engine enables surveyors to measure points more quickly
- Trimble SurePoint compensates for pole tilt. Conveniently measure points that were otherwise inaccessible with complete quality assurance
- Trimble CenterPoint RTX delivers GNSS corrections via satellite or internet connection anywhere in the world with unprecedented speed and accuracy for a precise point positioning (PPP) solution

A glimpse of field observations via Trimble R10 at Samundra Tapu Glacier (Lahaul & Spiti, HP) and Drang-Drung Glacier (Zanskar, Ladakh).

6. Syscal Pro Resistivity meter

The Syscal Pro is an all-in-one multi-node resistivity and induces polarization sounding and profiling system for environmental and engineering geophysical studies. The Syscal Pro gathers a 10 channels receiver and a 250 W internal transmitter, making it the more powerful system of the Syscal range. Compact, easy-to-use and field-proof, the Syscal Pro measures both resistivity and chargeability. It is ideal for environmental and civil engineering applications such as depth-to-rock determination, weathered bedrock mapping. With a maximal output voltage of 2000Vpp, the Syscal Pro is adapted to detect deep fault in fractured aquifers or characterize the depths and thickness of the groundwater aquifers. Several options are available with the Syscal Pro, such as the Fullwave mode to record complete time series of measured voltages during an acquisition and the Remote mode that automatically controls the Syscal Pro through a PC for monitoring purposes. Additional accessories are also available to use the Syscal Pro to increase the transmitter power to 1200 W, perform measurements in the borehole, test the 12V batteries, communicate via wifi, or upload data on an SD card.

A glimpse of field observations via Syscal Pro resistivity measurement at Samundra Tapu Glacier (Lahaul & Spiti, HP).

Outcome

- Bathymetric data has been collated from the ST glacial lake, which is essential to measure glacial lake outburst flood (GLOF). Another essential parameter, ground resistivity, has been estimated to understand groundwater flow. Also, a UAV survey has been conducted to calculate glacial length and thickness changes. RTK survey has been done to calculate the accuracy of the DEM generated by the UAV.
- In the DD glacier entire snout area has been scanned using SX10 LiDAR, which is helpful to understand glacial dynamics. Also, an RTK survey has been conducted.
- Other than data collection, the scientific field trip is very much helped us understand the various geomorphological features present in the glacier.
- Sharing of technical knowledge and emerging trends in the field of satellite image processing or remote sensing.
- In addition, it helps us to train and prepare our student according to the requirements of future industry. In future, it may introduce the various flexibilities in the curriculum.

References

1. Kääb, A., Berthier, E., Nuth, C., Gardelle, J. & Arnaud, Y. Contrasting patterns of early twenty-first-century glacier mass change in the Himalayas. *Nature* 488, 495–498 (2012).
2. Zulfiqar, M. *et al*. Agricultural Economy of Skardu is Based on Glaciers and Snow Melting -A Case Study of Burgay Watershed. *Sarhad*. *Journal of Agriculture* 35, 336–341 (2019).
3. Rasul, G. Food, water, and energy security in South Asia: A nexus perspective from the Hindu Kush Himalayan region. *Environmental Science and Policy* 39, 35–48 (2014).
4. Tiwari, P. C. & Joshi, B. Natural and socio-economic factors affecting food security in the Himalayas. *Food Security* 4, 195–207 (2012).

Submitted by Dr Sartajvir Singh
Associate Professor, Chitkara University (HP)
TARE Fellow, IIT Ropar (PB)