Outburst of the Thorthormi Subsidiary Lake II on June 20, 2019

Wangchuk Namgay
Geologist
Cryosphere Services Division ,NCHM
Bhutan

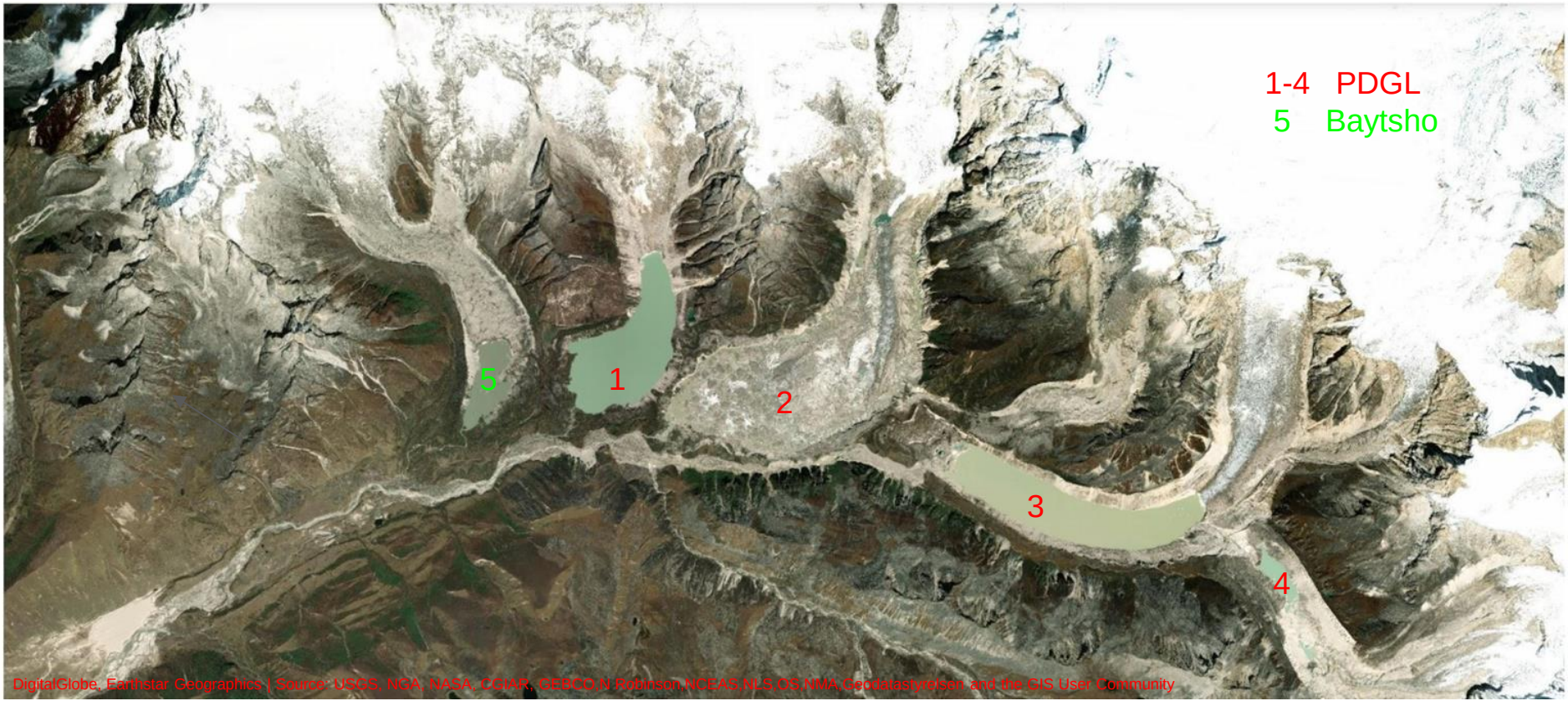
Overview

- Introduction
- Incident and detection by GLOF EWS
- Action by the agency
- Remote Sensing
- Result from the Analysis
- Conclusion
- Impact
- Current status

Introduction

- Bhutan has approximately 700 glaciers (BGI 2018,NCHM) and 2674 glacial lakes(Mool et al, 2001b) in the head waters of Bhutan.
- With the identification of 17 PDGL (Reassessment of PDGL 2018,NCHM) in Bhutan,11 are situated in the head water of Punatsangchu Basin(9 in Pho chhu and 2 in Mo chhu).
- Lunana Region consist of 4 PDGL out of which Thorthormi Lake is identified as one of the critical lake that is expanding rapidly.

Lunana Complex



Incident and Detection of GLOF by the GLOF EWS

- The rise in water level was detected by the Thorthormi GLOF EWS remote monitoring station on 18:55 on 20th June,2019.
- Reported to Flood Monitoring and Command Room,HQ at 1900 hours on June 20, 2019.
- The water level increased from ***6.55 m*** at 6:05 PM to ***8.04 m*** at 7:20 PM.
- WL receded to **5.36m** at 10:40 PM.
- Sharp increase followed by sudden receding is a typical GLOF scenario as per our GLOF EWS System logic. (Fig 2)

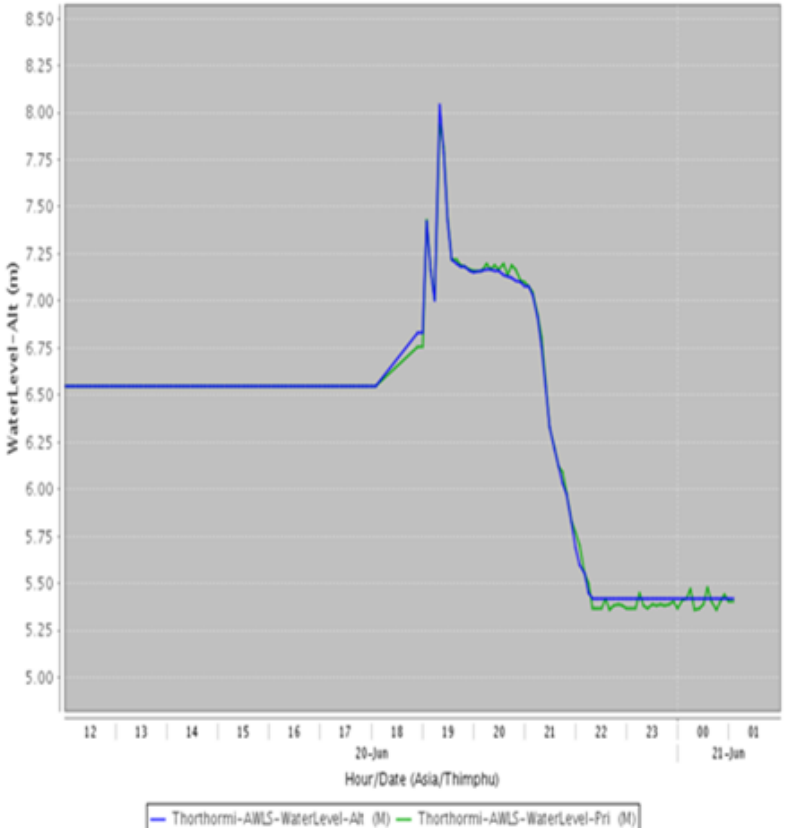


Figure 02. Hydrograph from Thorthormi Station.

Direction of water flow

Detection cont…..

•Thanza AWLS also detected a slight rise in water level.

•No significant rise was noticed at Dangsa AWLS.

•People from the villages downstream were evacuated for safety measure in case of a recurring GLOF due to damaged moraine.

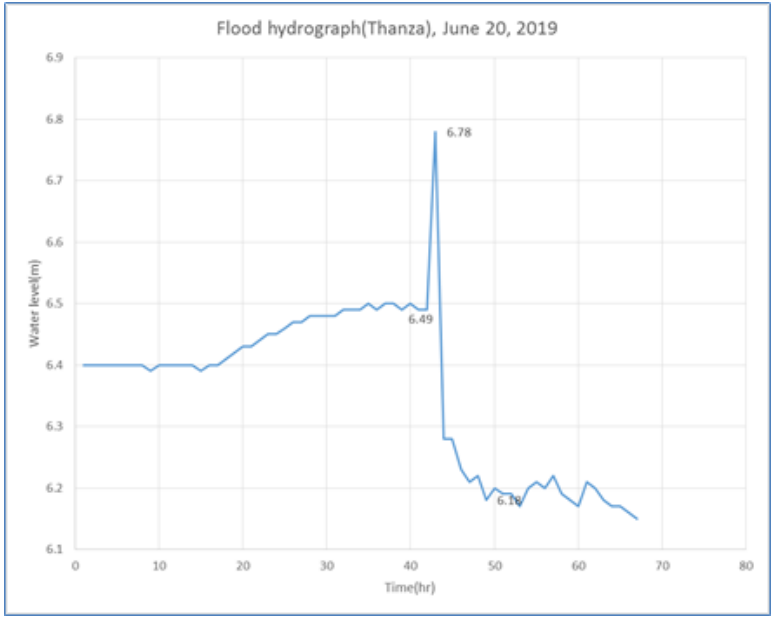
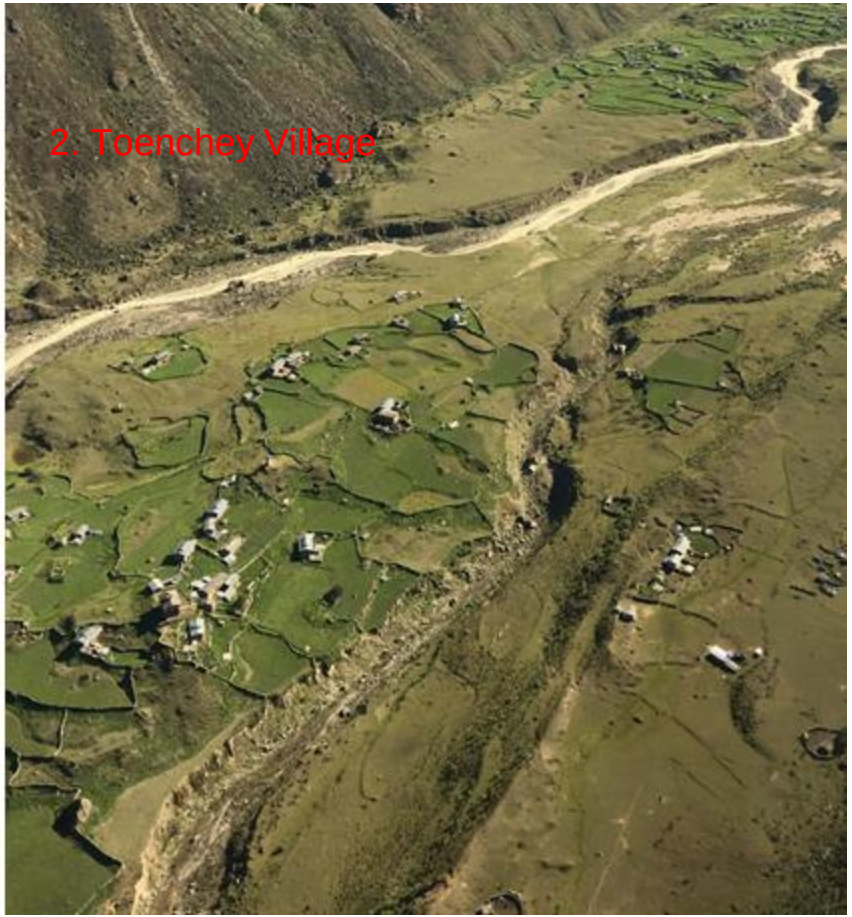


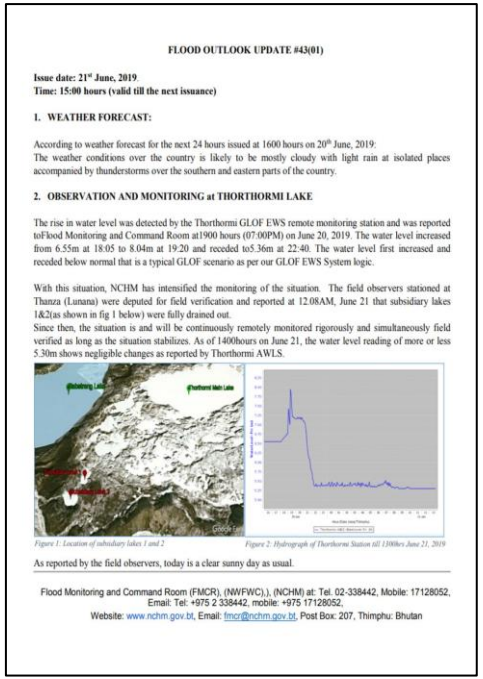
Figure 03. Flood Hydrograph (Thanza)


1 Thanza village


2. Toenchey Village

Action Taken

- NCHM intensified the monitoring with 24/7 Monitoring by the Flood Control Room at the HQ,Thimphu.
- Flood Advisories were issued to the public via, social media, national NEWS, and mail to relevant stakeholders to be prepared in case of flood.
- The cause of the flood was still a mystery by that time so a team was formed to visit the site for rapid assessment of the lake.



FLOOD OUTLOOK UPDATE #43(01)

Issue date: 21st June, 2019.
Time: 15:00 hours (valid till the next issuance)

1. WEATHER FORECAST:

According to weather forecast for the next 24 hours issued at 1600 hours on 20th June, 2019:
The weather conditions over the country is likely to be mostly cloudy with light rain at isolated places accompanied by thunderstorms over the southern and eastern parts of the country.

2. OBSERVATION AND MONITORING at THORTHORMI LAKE

The rise in water level was detected by the Thorthormi GLOF EWS remote monitoring station and was reported toFlood Monitoring and Command Room at1900 hours (07:00PM) on June 20, 2019. The water level increased from 6.55m at 18:05 to 8.04m at 19:20 and receded to5.36m at 22:40. The water level first increased and receded below normal that is a typical GLOF scenario as per our GLOF EWS System logic.

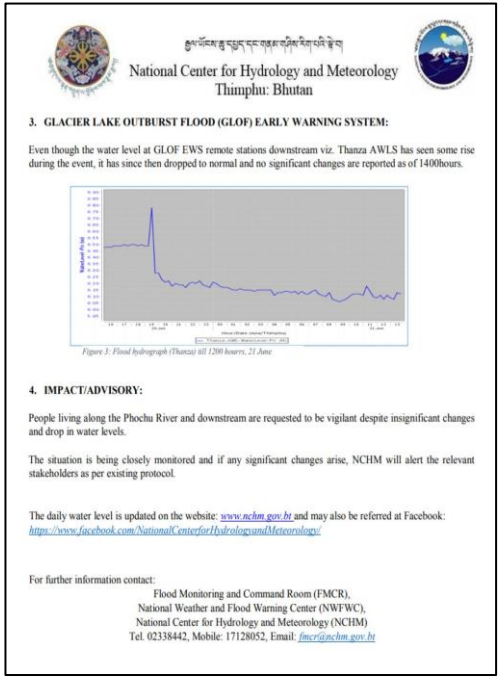
With this situation, NCHM has intensified the monitoring of the situation. The field observers stationed at Thanza (Lunana) were deputed for field verification and reported at 12.08AM, June 21 that subsidiary lakes 1&2(as shown in fig 1 below) were fully drained out.
Since then, the situation is and will be continuously remotely monitored rigorously and simultaneously field verified as long as the situation stabilizes. As of 1400hours on June 21, the water level reading of more or less 5.30m shows negligible changes as reported by Thorthormi AWLS.

Figure 1: Location of subsidiary lakes 1 and 2

Figure 2: Hydrograph of Thorthormi Station till 1300hrs June 21, 2019

As reported by the field observers, today is a clear sunny day as usual.

Flood Monitoring and Command Room (FMCR), (NWFWC),), (NCHM) at: Tel. 02-338442, Mobile: 17128052, Email: Tel: +975 2 338442, mobile: +975 17128052,
Website: www.nchm.gov.bt, Email: fmcr@nchm.gov.bt, Post Box: 207, Thimphu: Bhutan



National Center for Hydrology and Meteorology
Thimphu: Bhutan

3. GLACIER LAKE OUTBURST FLOOD (GLOF) EARLY WARNING SYSTEM:

Even though the water level at GLOF EWS remote stations downstream viz. Thanza AWLS has seen some rise during the event, it has since then dropped to normal and no significant changes are reported as of 1400hours.

Figure 3: Flood hydrograph (Thanza) till 1200 hours, 21 June

4. IMPACT/ADVISORY:

People living along the Phochu River and downstream are requested to be vigilant despite insignificant changes and drop in water levels.

The situation is being closely monitored and if any significant changes arise, NCHM will alert the relevant stakeholders as per existing protocol.

The daily water level is updated on the website: www.nchm.gov.bt and may also be referred at Facebook: https://www.facebook.com/NationalCenterforHydrologyandMeteorology/

For further information contact:
Flood Monitoring and Command Room (FMCR),
National Weather and Flood Warning Center (NWFWC),
National Center for Hydrology and Meteorology (NCHM)
Tel. 02338442, Mobile: 17128052, Email: fmcr@nchm.gov.bt

Figure 04. Flood Outlook and advisories

Remote Sensing

- GLOF detection from the Satellite Imagery at Lunana was initiated by the center but due to lack expert GIS and little knowledge on satellite Imagery.
- Emergency Observation Request to the Sentinel Asia Team was initiated which was well received by Sentinel Asia.
- Received the Emergence Observation(pre-post detection map) by ALOS-2 satellite from JAXA and AIT (both JPT members).
- Various Climate data and Satellite Imagery of the vicinity of the lake were collected and analysed to find the cause of the GLOF.

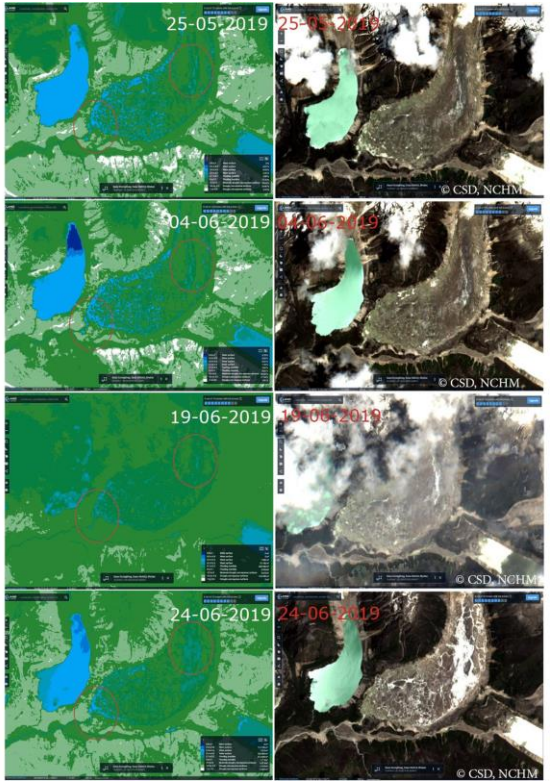


Figure 05. NDWI of the lake using thr trial version of LandViewer

Data Recieved from Sentinel Asia Community

- Glacial Lake Velocity Analysis from 1st june till 13rd june shows that there were active movement between as low as 0.2 m to as high as 1.22 m on the Thorthormi glacier.
- This concluded that GLOF was not initiated by external triggering agents like landslide or rockfall or avalanche.

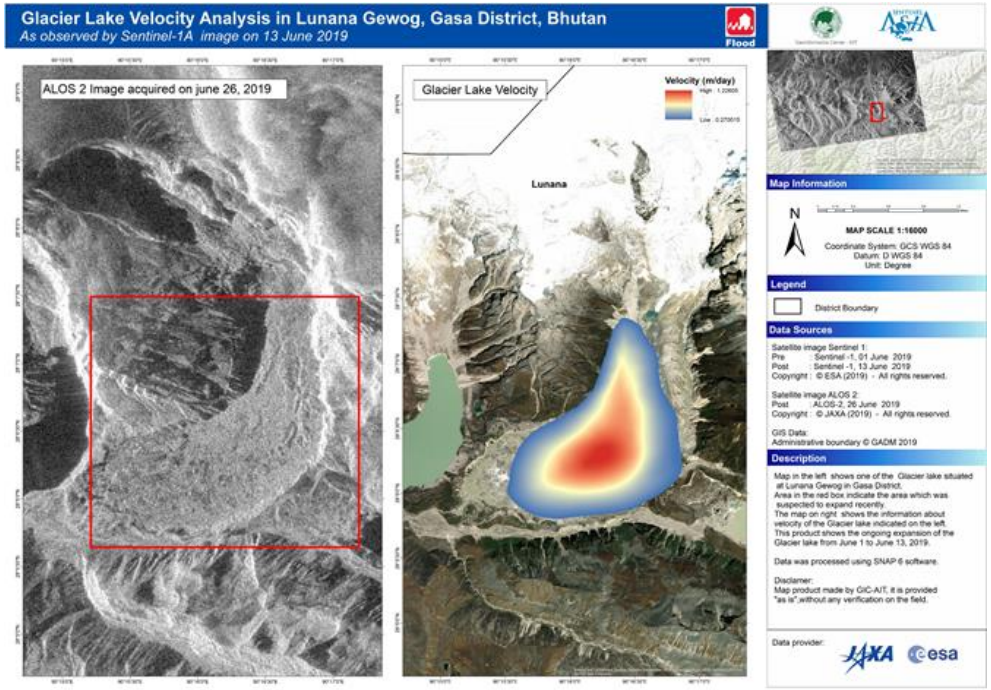


Figure 06. Glacier Lake Velocity Analysis by Geoinformatic Center , Asian Institute of Technology (JPT member)

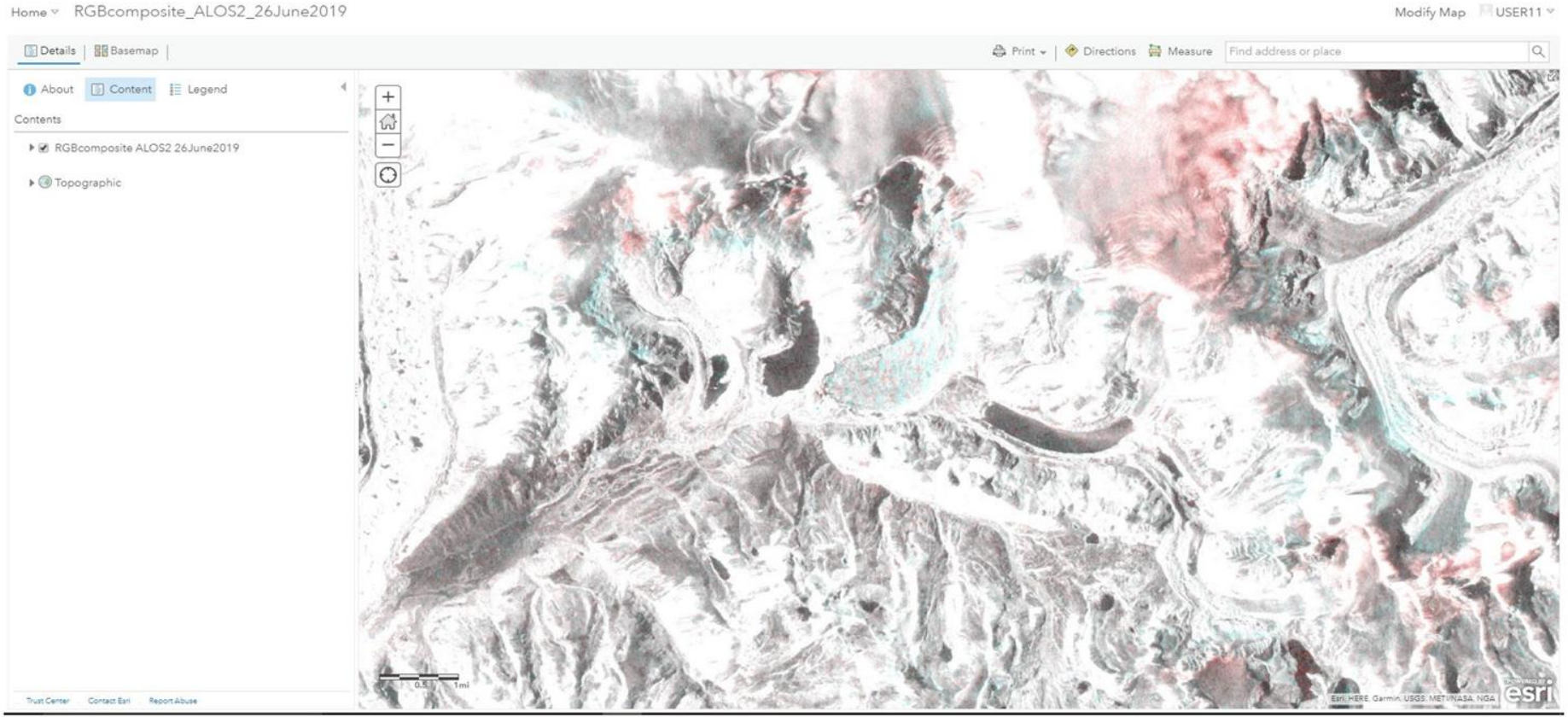


Figure 07 . The RGB composite image of the Thorthormi area by JAXA using ALOS2, (R: 12 June 2019, G: 26 June 2019, B: 26 June 2019)

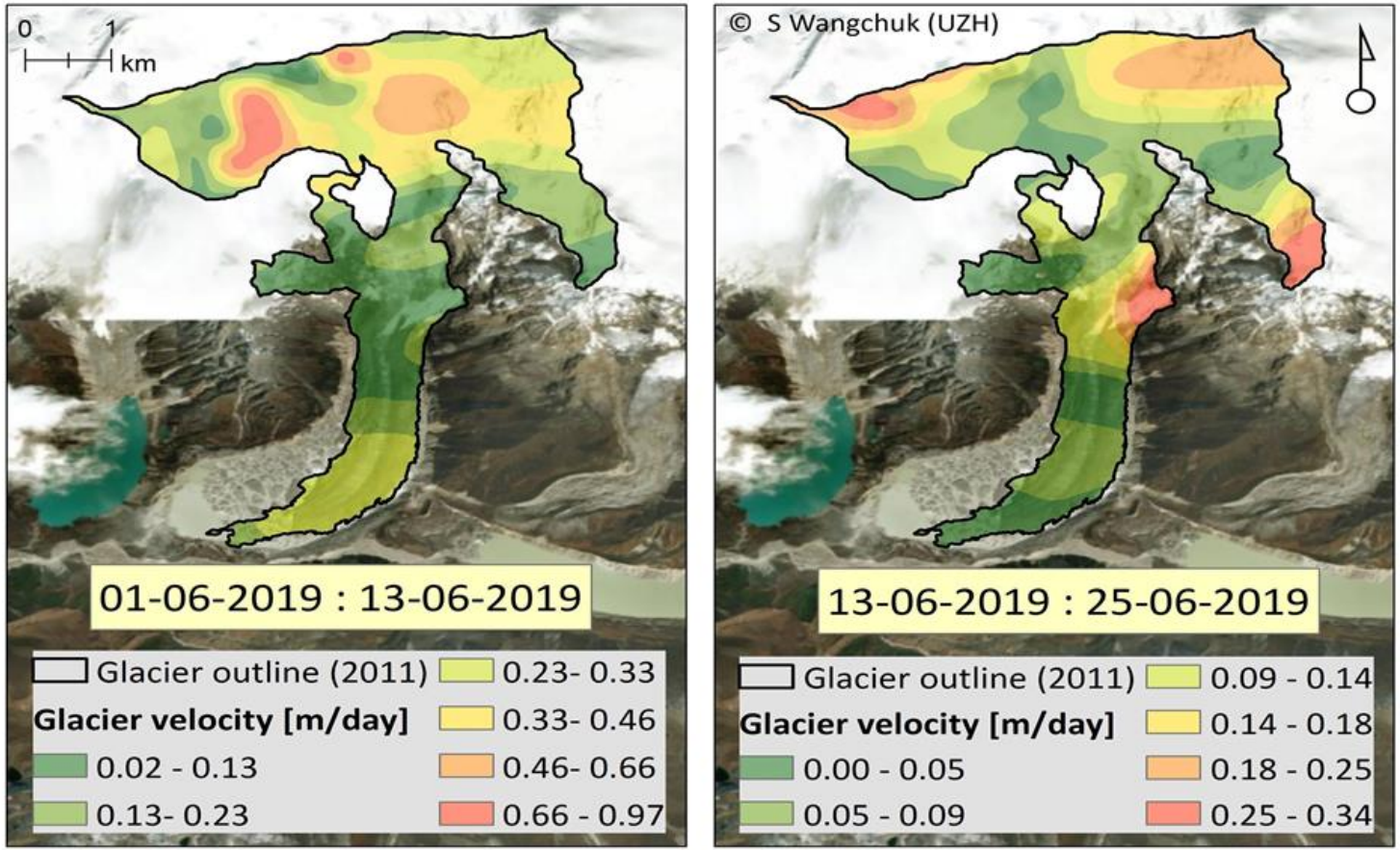


Figure 08. The Glacial Velocity map of the glacier before and after flood event (S Wangchuk (UZH)

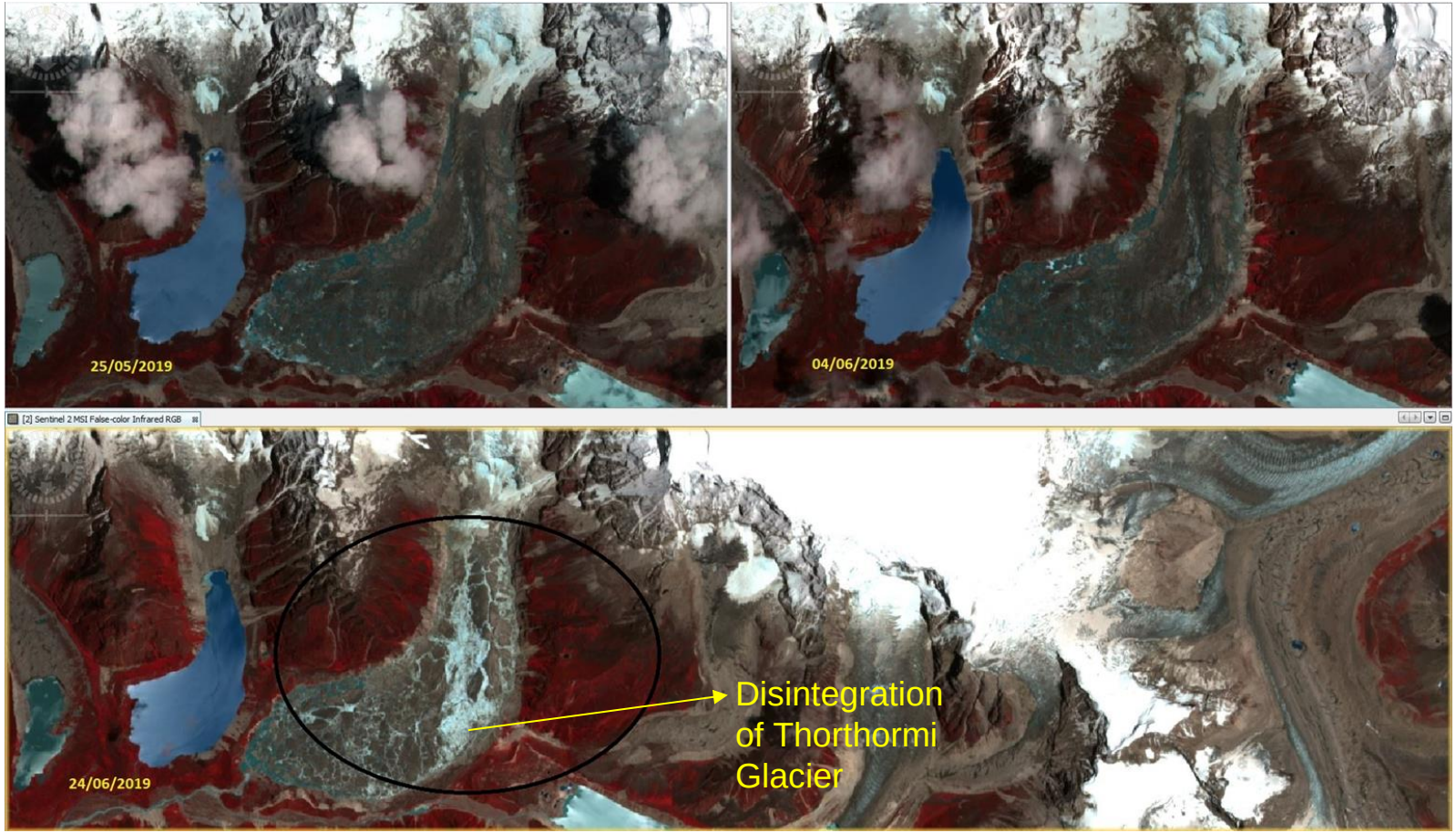


Figure 09. Sentinel 2 image comparison of the Thorthormi Glacier

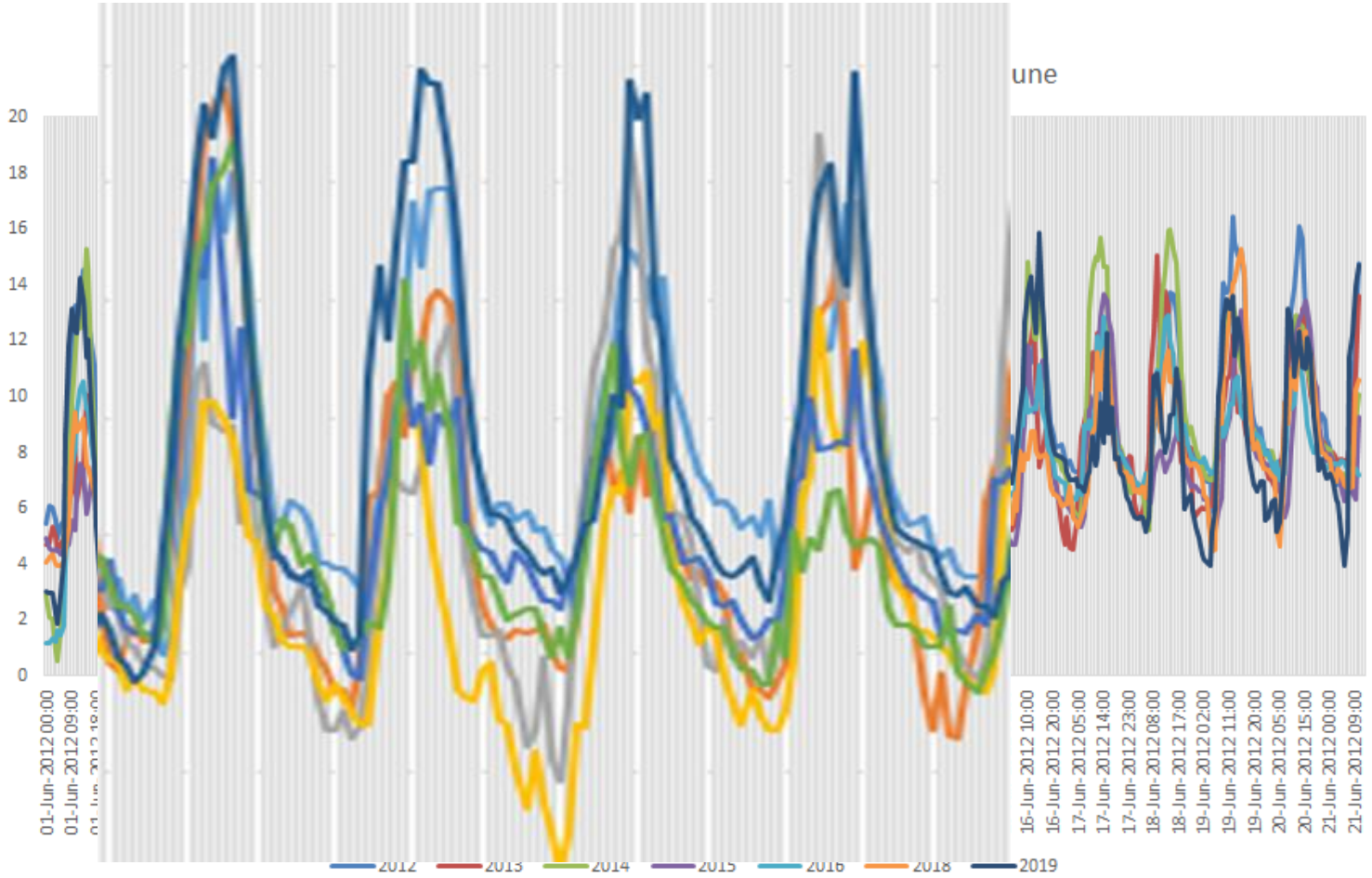


Figure 10. Temperature of Thanza Station,Lunana.

Daily Tmax and Tmin

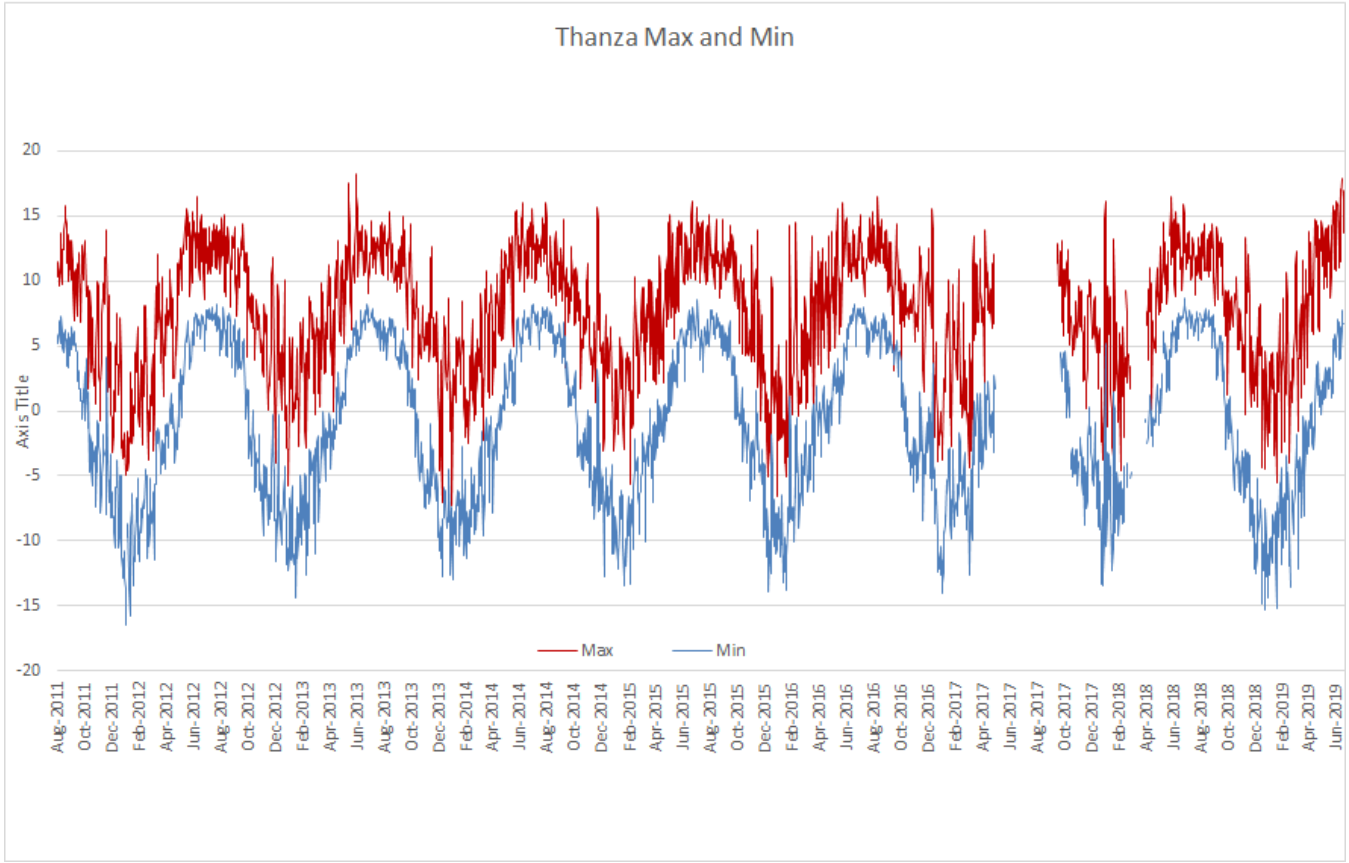
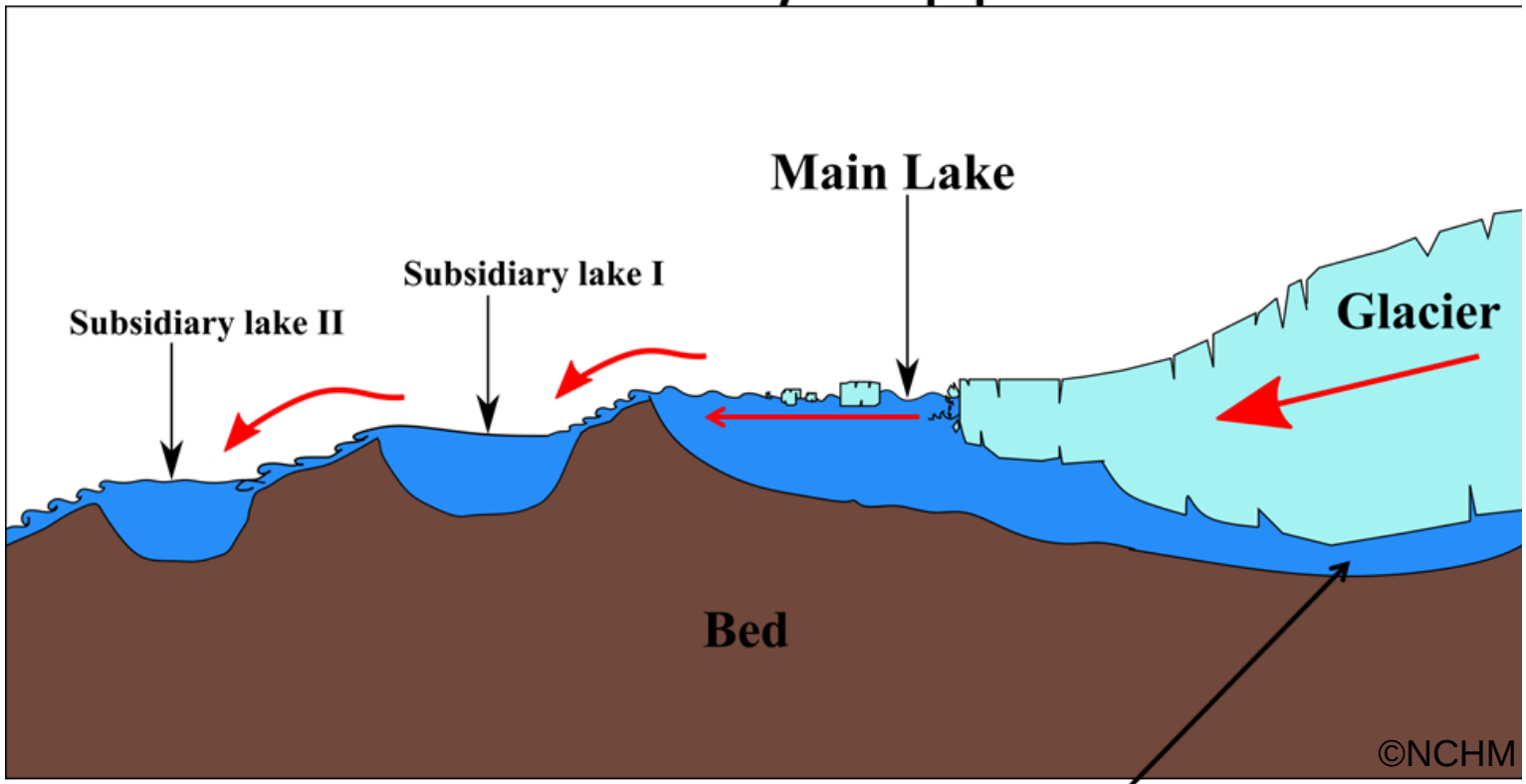
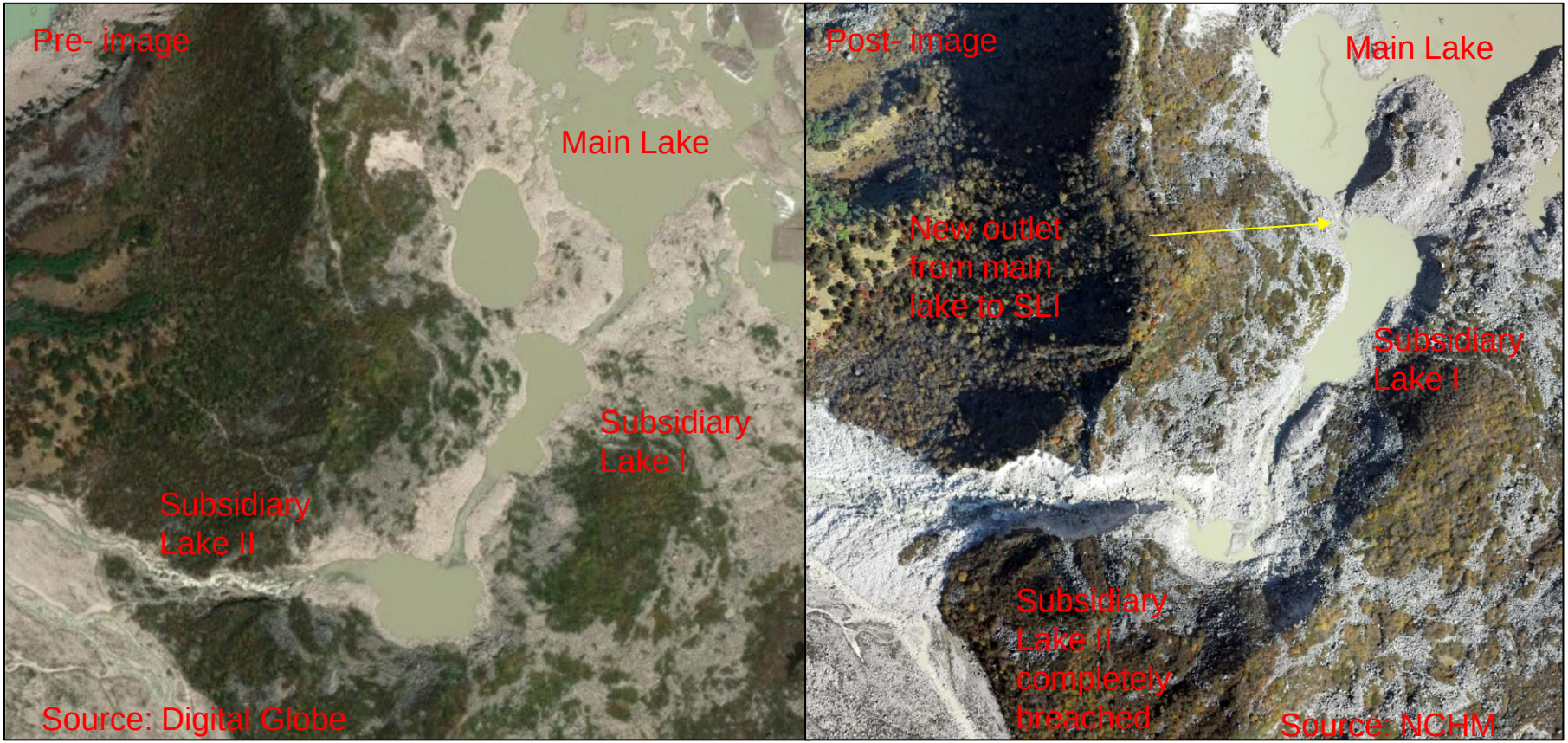


Figure 11. Daily Maximum and Minimum temperature of Thanza Station,Lunana.

What really happen?

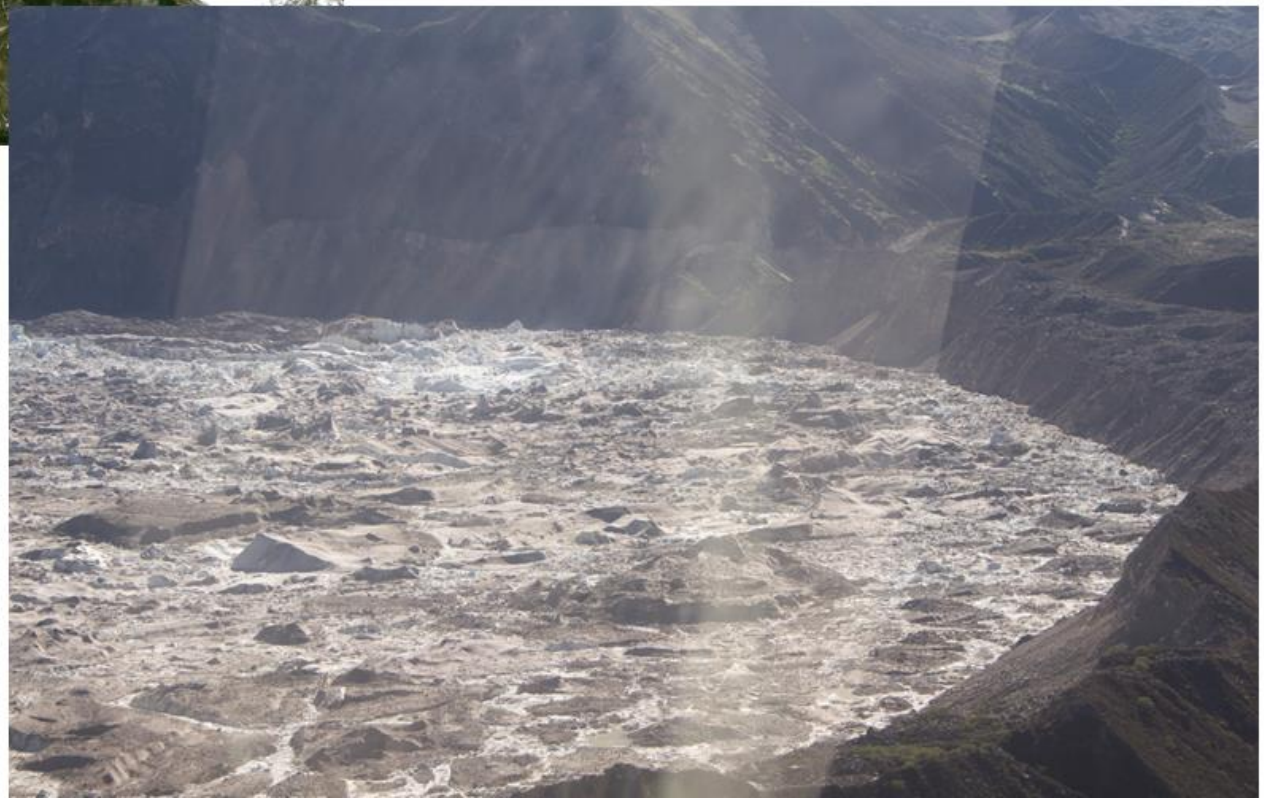


Presence of water accelerates glacier basal sliding


Pre- image
Main Lake
Subsidiary
Lake I
Subsidiary
Lake II
Source: Digital Globe
Post- image
Main Lake
New outlet
from main
lake to SLI
Subsidiary
Lake I
Subsidiary
Lake II
completely
breached
Source: NCHM

Main Lake

Main Lake



Main Lake

Main Lake

Impacts

- NO MAJOR IMPACTS REPORTED.
- The wooden bridge connecting Thanza and Tenchey village damaged and access to the bridge is cut-off.
- Volume of water discharged was not significant enough to cause any downstream flooding.

Figure 12. Bridge damaged by the Flood

Current Status

•Thorthormi looks stabilized for now.

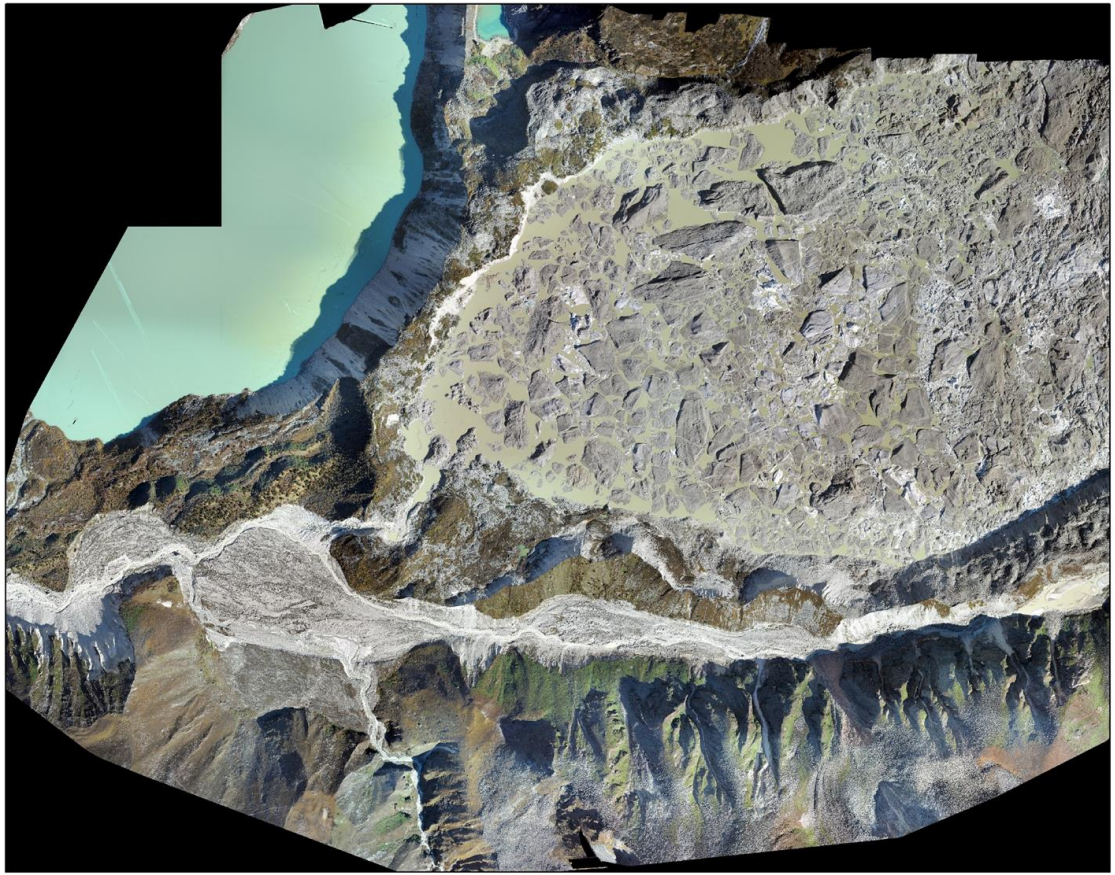
- Depends on factors such as weather & other external triggers (seismic activity)

•GLOF hazard from lakes in Lunana (Thorthormi, Rapstreng and Lugge) still high with higher temperature every year.

• Detail study of the lake such as UAS survey,dGPS survey done, but the data is still in processing stage, so the center will be publishing the detailed report soon in the website.

Sample

- EBee plus UAS survey giving 8.5cm resolution mosaic image and DSM of the lake vicinity.



Thank you for your time.
Tashi Delek