Extreme Climate Events during June-October ,2024

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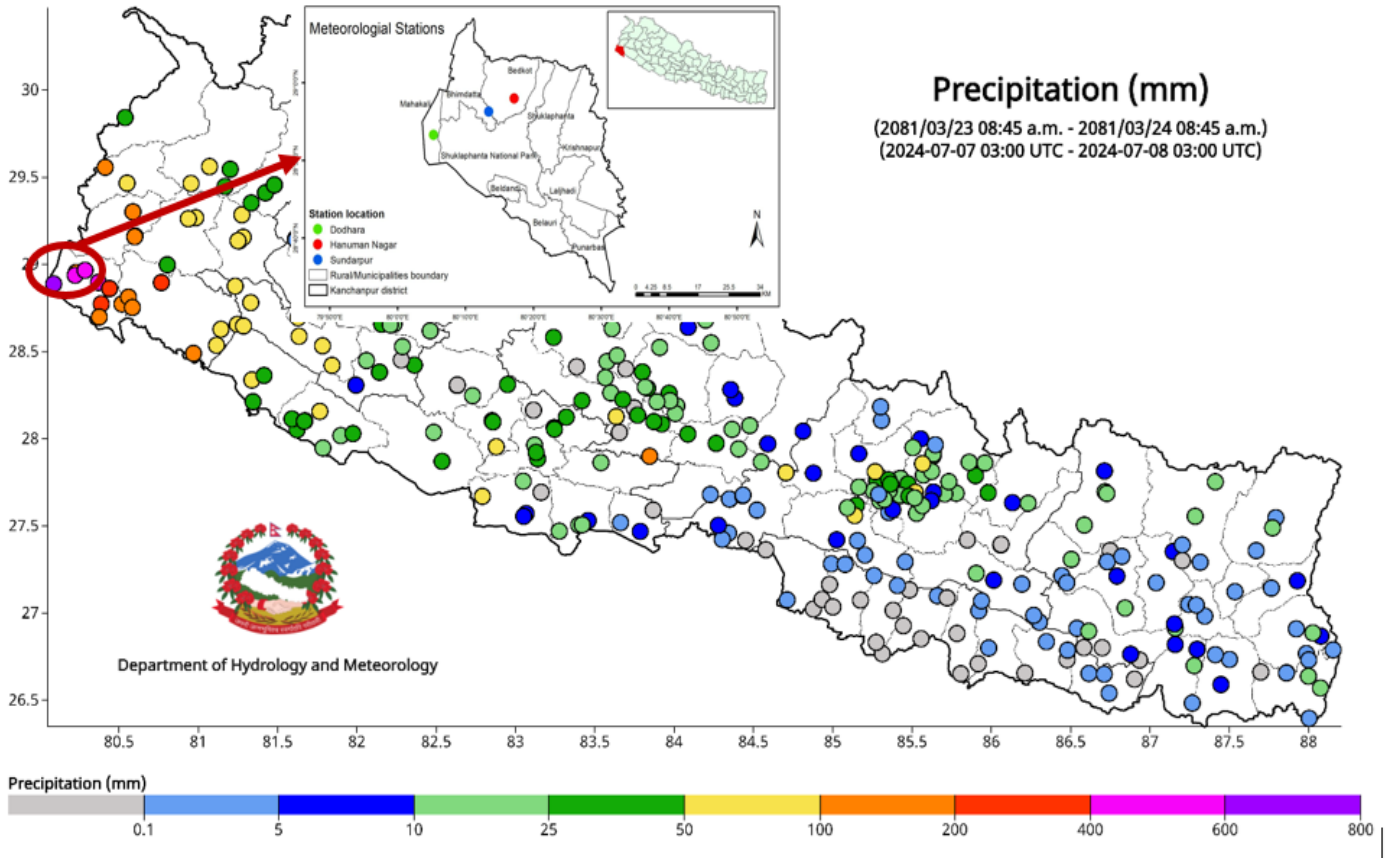
- **Extreme Precipitation Event**
- **Extreme Temperature Event**
- **GLOF Event**

Extreme Precipitation Event Case 1:Heavy Downpour in Kanchanpur District of Nepal - 7 and 8 July 2024

Historical and Observed Precipitation

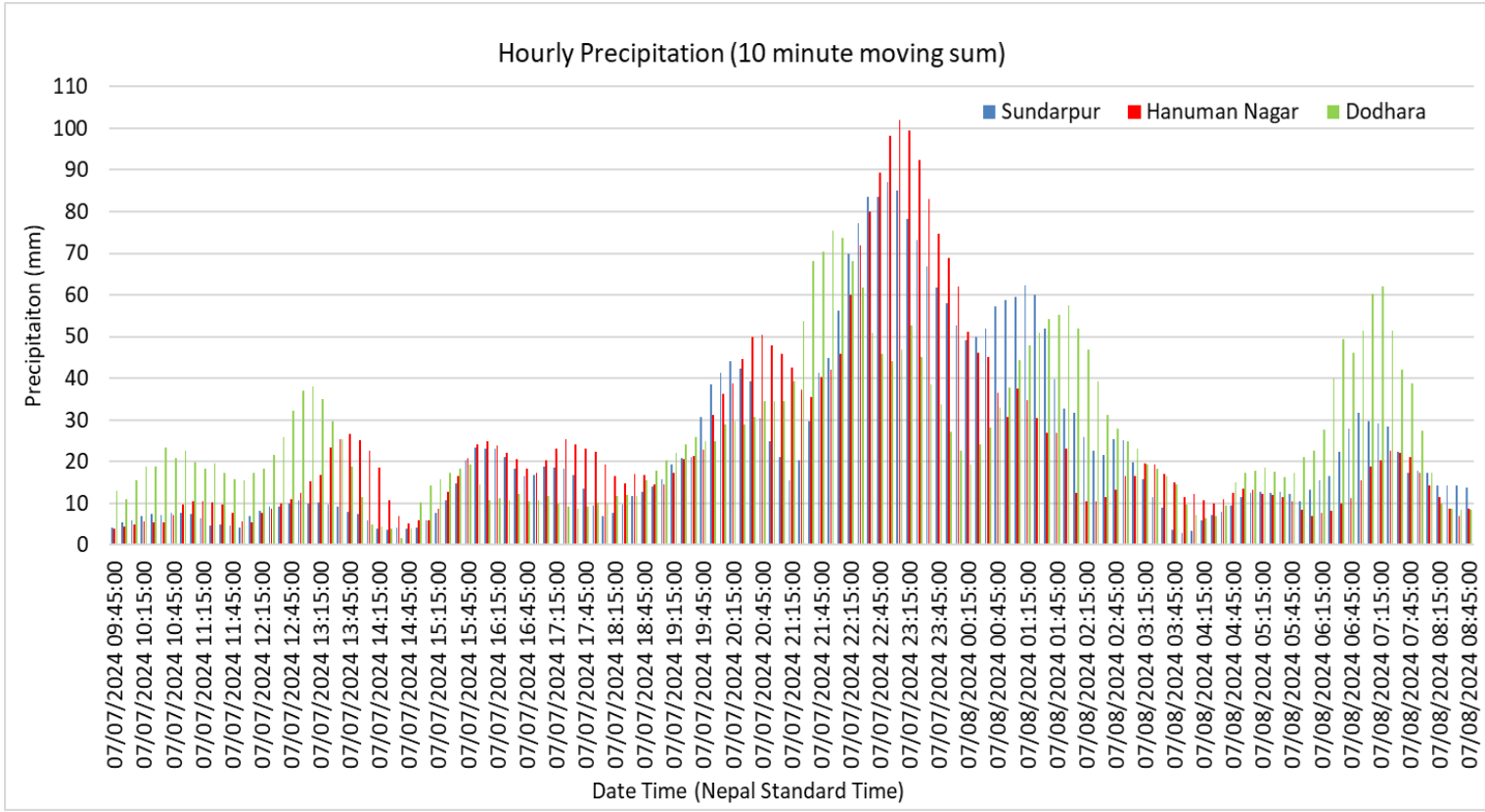
- The 24 hour accumulated precipitation recorded at 8:45 A.M. on July 8 at Dodhara Precipitation station was 624.0mm, Hanuman Nagar station was 573.6mm and Sundarpur station was 555.8mm.
- Data available from 1947 A.D. shows the observed rainfall at Dodhara, Hanuman Nagar and Sundarpur are the highest till now.
- Before this event Hetauda station recorded the highest rainfall of 516.2mm on 2017 August 13. Department of Soil Conservation recorded highest rainfall of 540mm in Tistung station of Makwanpur district on 1993 July 20.



https://www.dhm.gov.np/pressrelease_detail/44

Cloudburst at Hanuman Nagar

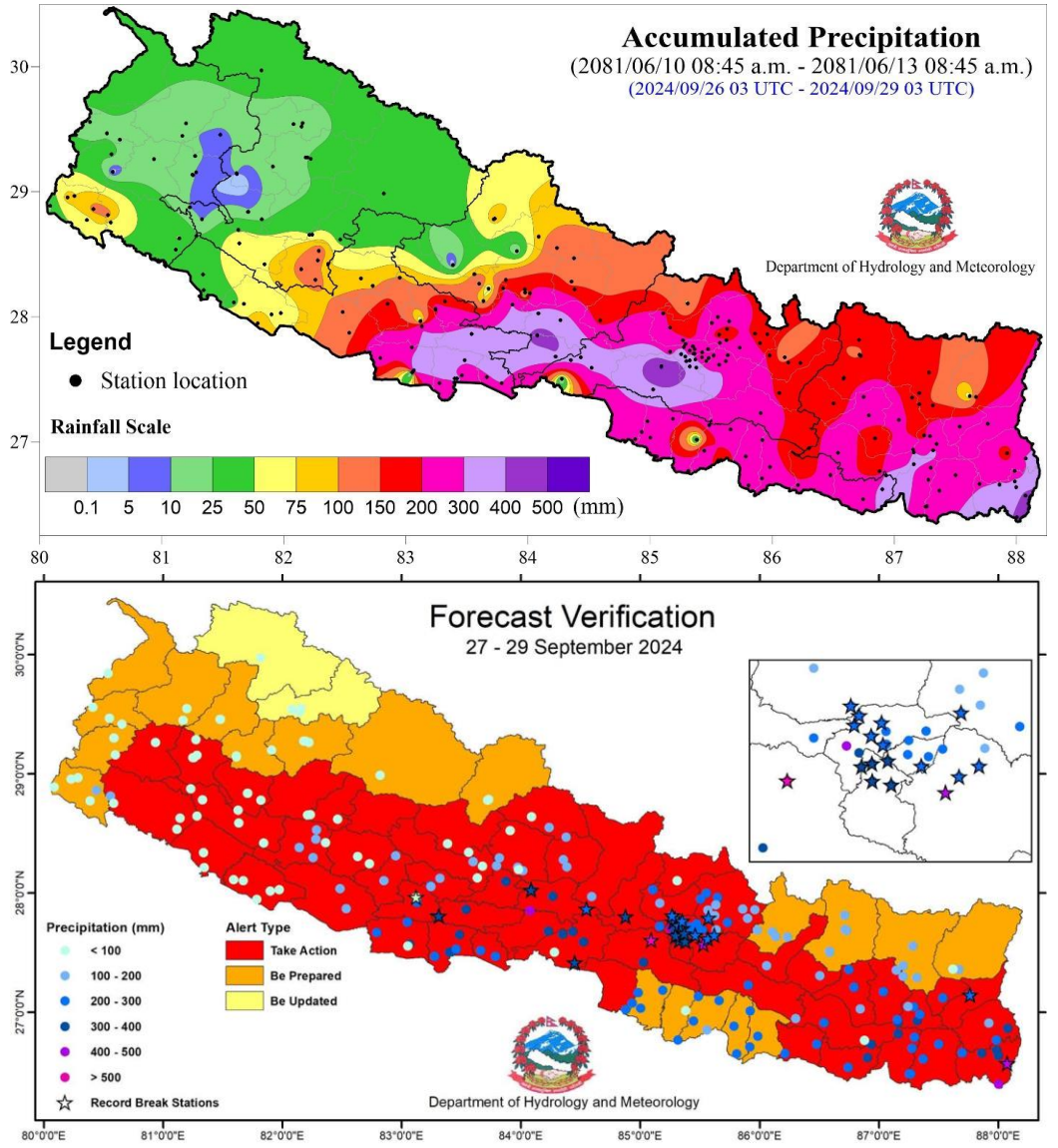
The 7th July incident that happened in the nighttime of 7th July shows the connections with upper air systems and satisfies the general definition of Cloudburst that rainfall in one hour must be 100mm which can be Seen at Hanuman Nagar with 10 minutes moving average as 102mm.



Extreme Precipitation Event Case 2: Extreme Precipitation and Flooding Event on 27-29 September 2024

Observed Extreme Precipitation and Flooding Event

- Monsoon became active at the end of September and brought very heavy to extremely heavy precipitation across the country.
- Persistent rainfall caused extensive damage and disruption impacting various sectors.
- Heavy rainfall caused landslides, flooding, inundation and road closures, significantly affecting daily life, transportation, and overall safety.
- 25 stations of 14 districts (Kathmandu, Lalitpur, Bhaktapur, Kavrepalanchowk, Arghakhanchi, Chitwan, Dhading, Jhapa, Makwanpur, Nuwakot, Palpa, Panchthar, Sindhupalchowk, Tanahun) made the new record of extreme 24 hour precipitation on 28 September.



https://www.dhm.gov.np/uploads/dhm/downloads/Situational_Report_on_Extreme_Precipitation_and_Flooding_Event_of_27-29_September_2024.pdf

Record breaking precipitation stations (24-hour accumulated) on 28 September, 2024 at 8:45 A.M.

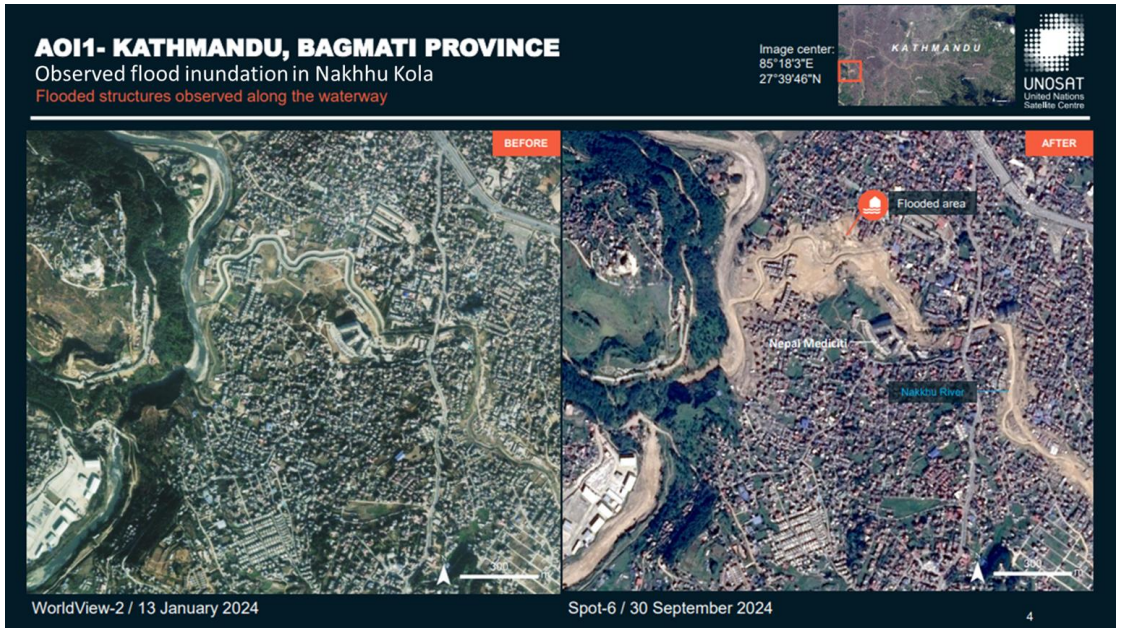
Arghakhanchi - 1 station
Bhaktapur - 1 station
Chitwan - 1 station
Dhading - 1 station
Jhapa - 1 station
Kathmandu - 5 stations
Kavrepalanchowk - 3 stations
Lalitpur - 5 stations
Makwanpur - 1 station
Nuwakot - 1 station
Palpa - 1 station
Panchthar - 1 station
Sindhupalchowk - 1 station
Tanahun - 2 stations

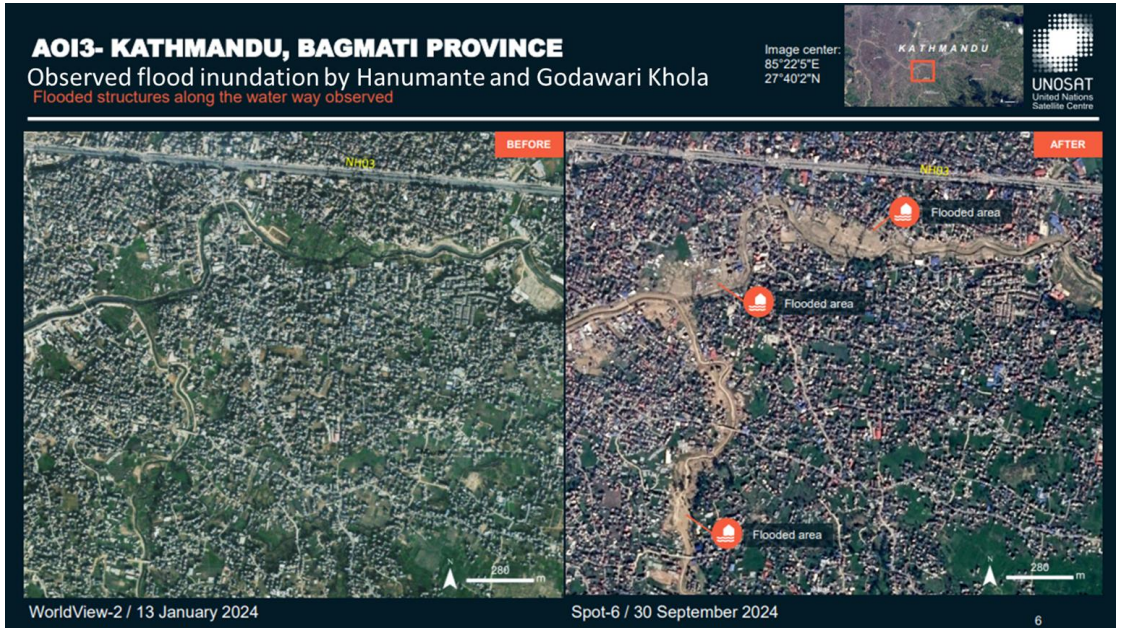
S. N.	Station Name	District	Precipitation (mm) recorded on 28 September (8:45 AM)	Previous record (mm)	Date of previous record
1	Sandhikharka	Arghakhanchi	196.6	166.0	16-Jun-2021
2	Nangkhel	Bhaktapur	194.5	191.5	23-Jul-2002
3	Govindabasti	Chitwan	264.0	196.0	19-Jul-2024
4	Gajuri	Dhading	261.2	131.3	2-Jul-2021
5	Chandragadi Airport	Jhapa	256.0	188.2	28-Jun-2022
6	Panipokhari	Kathmandu	206.6	198.0	14-Jun-1971
7	Kathmandu Airport	Kathmandu	239.7	177.0	23-Jul-2002
8	Buddhanilakantha	Kathmandu	178.3	159.0	23-Jul-2002
9	Jitpurphedhi	Kathmandu	178.3	128.2	7-Jul-2019
10	Nagarjun	Kathmandu	205.4	147.5	13-Sep-2014
11	Khopasi(Panauti)	Kavrepalanchok	331.6	276.9	3-Sep-2015
12	Panchkhal	Kavrepalanchok	232.5	145.0	21-Oct-1999
13	Dhulikhel	Kavrepalanchok	224.6	220.0	23-Jul-2002
14	Godavari	Lalitpur	311.6	225.2	23-Jul-2002
15	Khumaltar	Lalitpur	294.4	136.0	10-Aug-2022
16	Tikathali	Lalitpur	264.0	207.0	23-Jul-2002
17	Khokana	Lalitpur	297.3	249.2	23-Jul-2002
18	Chapagaun	Lalitpur	323.5	200.5	23-Jul-2002
19	Daman	Makwanpur	410.0	373.2	20-Jul-1993
20	Kakani	Nuwakot	169.2	161.0	28-Jul-1972
21	Baldyanggadi	Palpa	252.0	90.4	16-Sep-2012
22	Phidim	Panchthar	172.0	148.9	20-Oct-2021
23	Baunepati	Sindhupalchok	190.6	137.5	16-Jul-1978
24	Sakhar at Tanahun	Tanahun	214.0	173.2	21-Jul-2020
25	Khairini Tar	Tanahun	252.3	241.9	17-Jul-1983

https://www.cgiar.org/news-events/news/the-era-of-climate-crisis-in-nepal-a-call-for-urgent-action/

Observed Flood Inundation

- During this period, major flooding was observed in Koshi Basin, Bagmati Basin and Narayani Basin.
- Based on the DHM's observation from the ground station, it was confirmed that the Sunkoshi River at Hampachuwar, Saptakoshi at Chatara, Trishuli River at Kali Khola and Narayani River at Devghat have crossed the historic maximum flood level.
- All other stations within these catchments have reported water levels exceeding the designated danger levels though below their historic levels.





https://www.dhm.gov.np/downloads

Government of Nepal
Ministry of Energy, Water Resource and Irrigation
Department of Hydrology and Meteorology
Babarmahal, Kathmandu

Date: 08 October 2024

Situational Report on Extreme Precipitation and Flooding Event of 27-29 September 2024

1. Background

Monsoon became active at the end of September and brought very heavy to extremely heavy precipitation across the country. Persistent rainfall caused extensive damage and disruption impacting various sectors. Heavy rainfall caused landslides, flooding, inundation and road closures, significantly affecting daily life, transportation, and overall safety. 25 stations of 14 districts (Kathmandu, Lalitpur, Bhaktapur, Kavrepalanchowk, Argakhanchi, Chitwan, Dhading, Jhapa, Makwanpur, Nuwakot, Palpa, Panchthar, Sindhupalchowk, Tanahun) made the new record of extreme 24 hour precipitation on 28 September. Daman recorded the highest three-day accumulated precipitation of 517.0 mm.

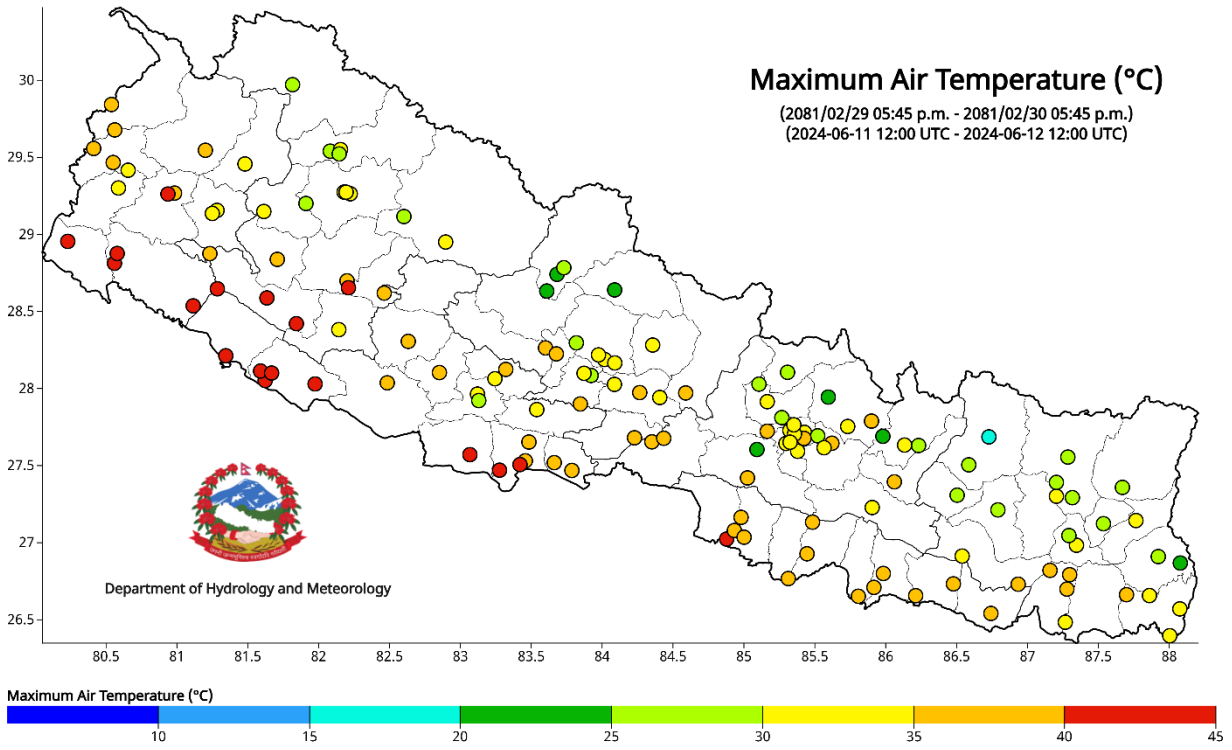
The floods induced from the heavy precipitation significantly affected river basins, particularly the Bagmati, Narayani, and Koshi basins. Rivers such as Bagmati, Narayani, and Sunkoshi and their tributaries swelled beyond their historic flood levels, leading to catastrophic flooding in several areas resulting in more than 200 deaths, dozens still missing as floodwaters swept away homes and entire villages. Localized flash floods and landslides damaged homes, public infrastructure, and agricultural land.

2. Preliminary Synoptic Analysis

A deep cyclonic circulation, extended up to mid-tropospheric level and with north-south elongated trough, was located over the northern part of Madhya Maharashtra region (India) on 27 September (Figure 1a) . This system moved northward (towards Nepal) over the southwest Madhya Pradesh region (India) on 28 September. A westerly trough in the mid-troposphere (500 hPa) persisted from 27 to 28 September (Figure 1d-1e) supported in intensifying the circulation storm system. Preliminary analysis shows this elongated trough from northeast Arabian Sea to northwest Bihar, supported by mid-tropospheric westerly trough induced favorable conditions for the sufficient moisture supply from Arabian sea and Bay of Bengal to Nepal causing the widespread precipitation throughout the country on 27 and 28 September. On 29 September, this

Extreme Temperature Event Case 1: Hot Days and Heat Wave

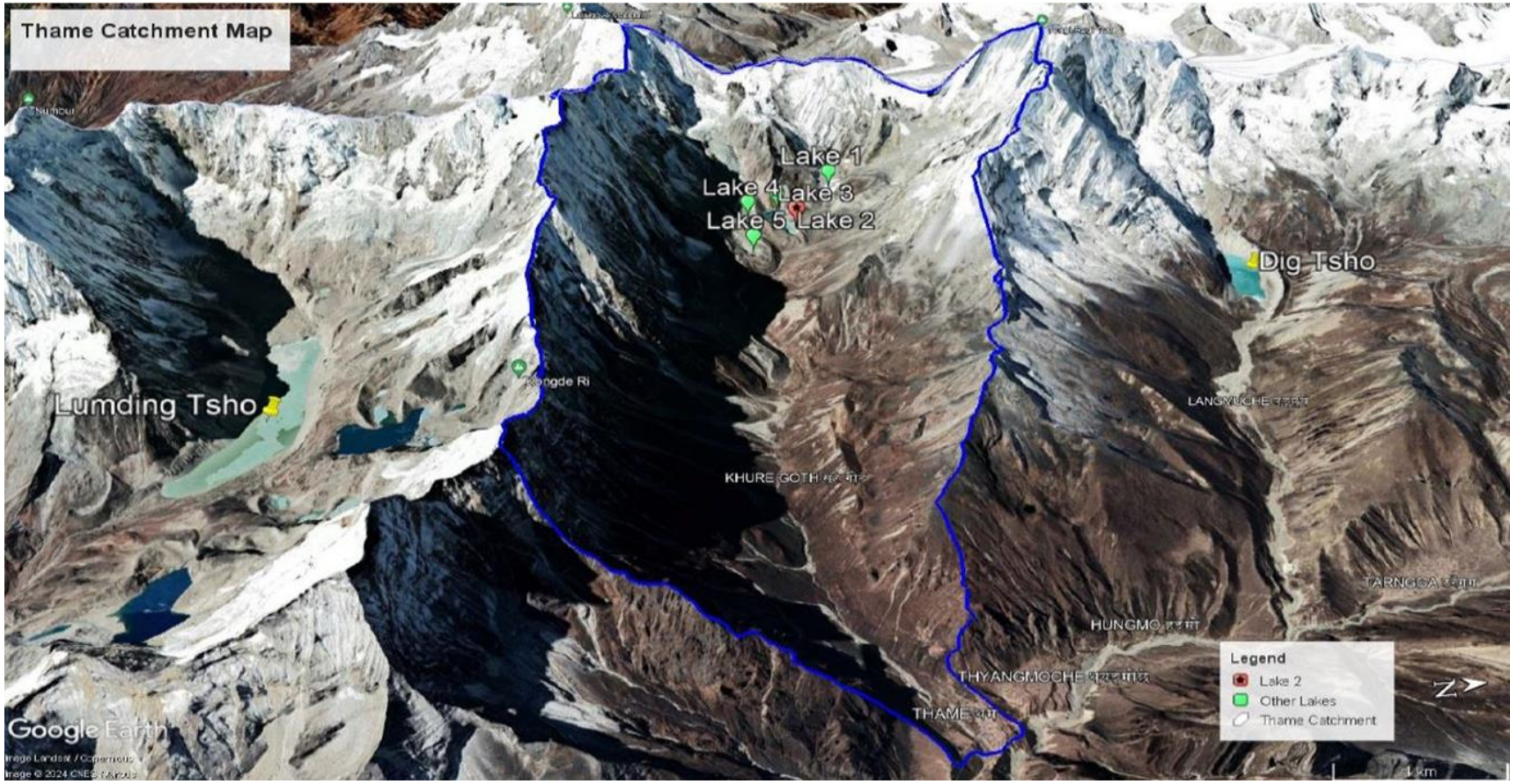
Hot days and heat waves were observed on the first, second and third week of June in several parts of the western Terai. The temperature was exceeding 40°C for a few days mostly in Kailali, Banke, Dang, Kapilbastu, Rupandehi and Parsa districts.

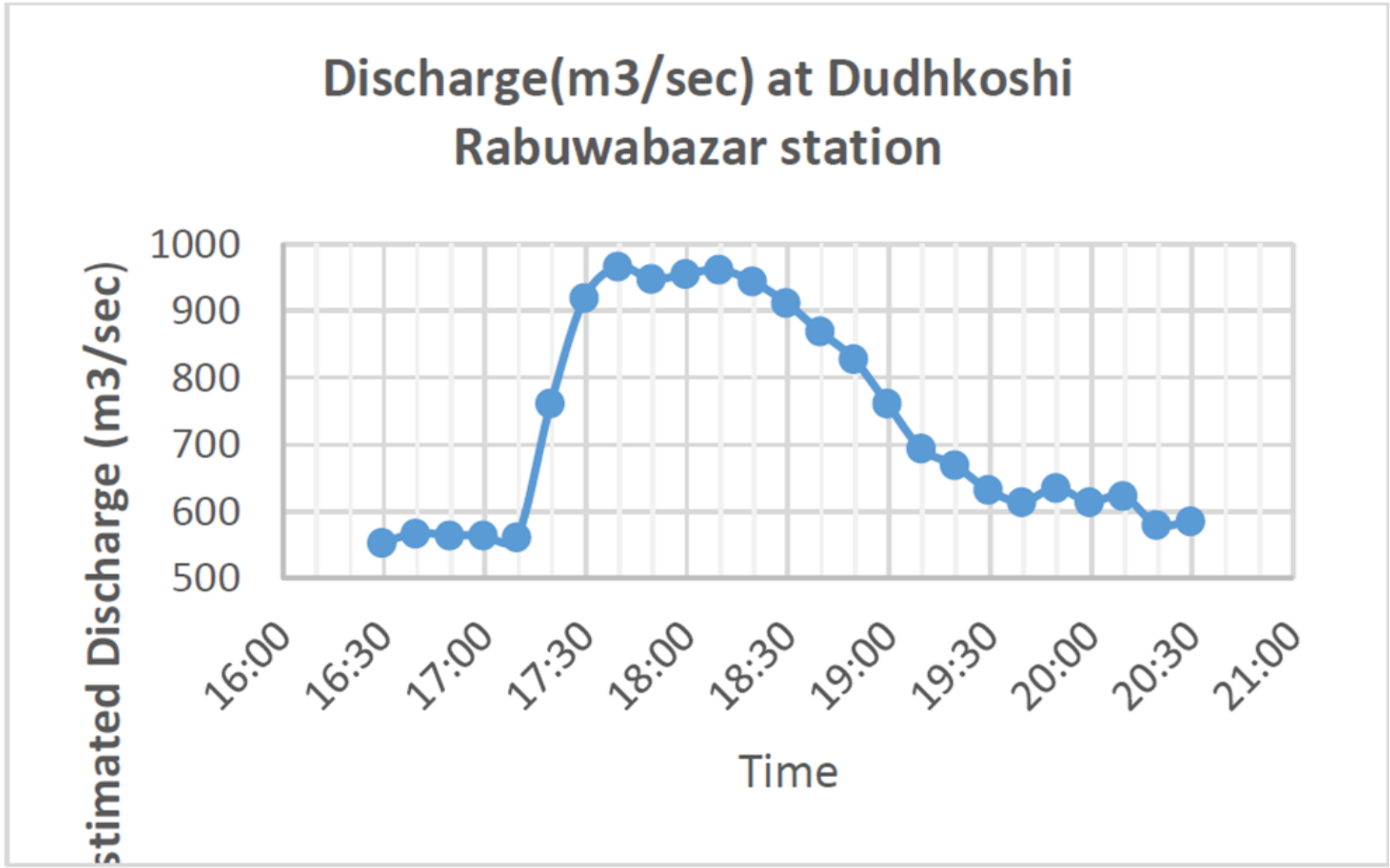


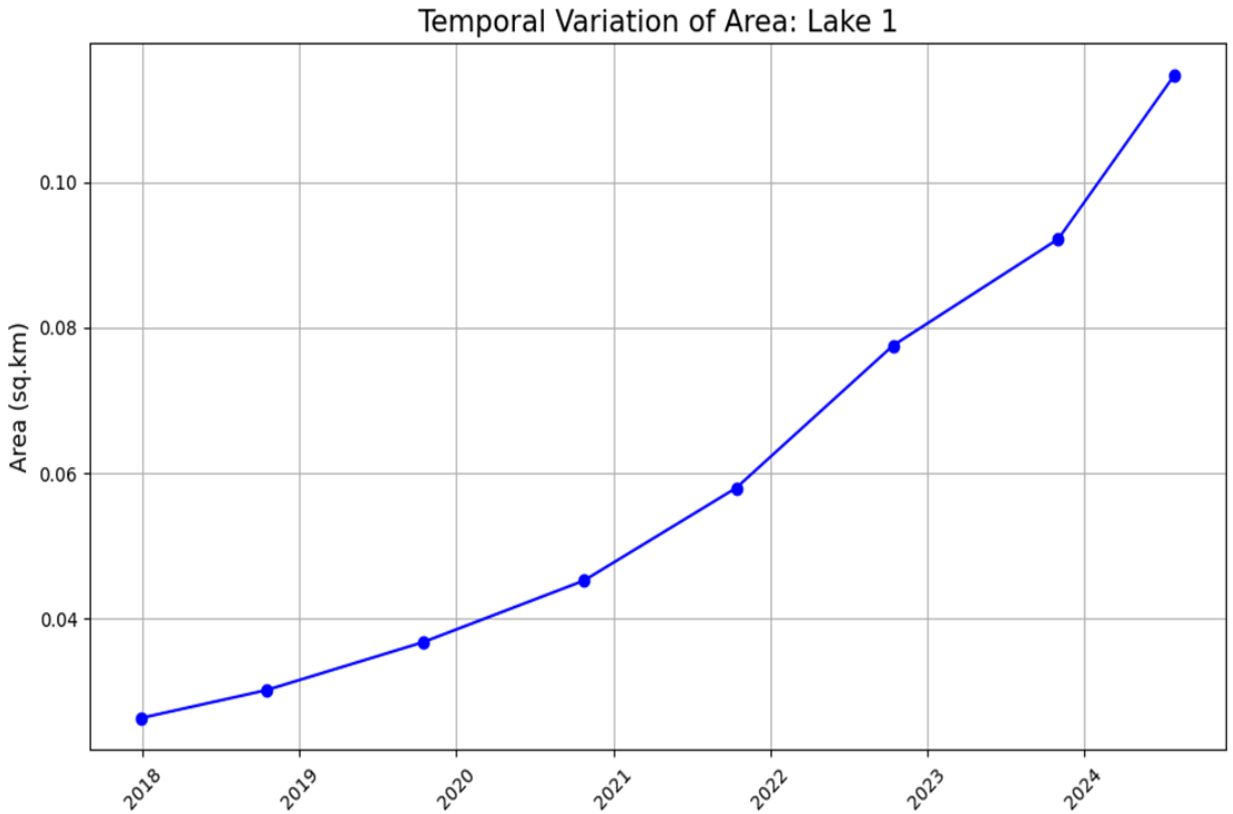
GLOF event Case1: Flood at Pashanglahmu Rural Municipality-5, Thame Solukhumbu district on 14 August 2024

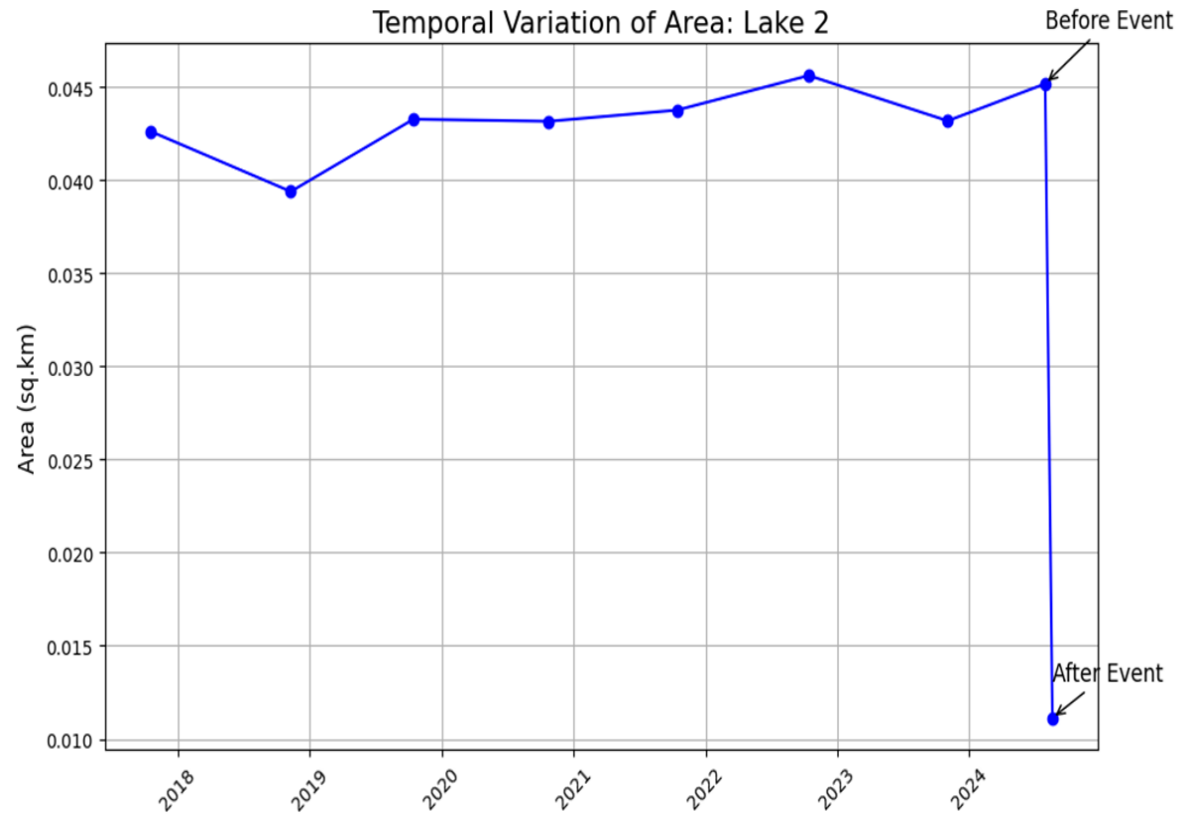
https://www.dhm.gov.np/uploads/dhm/pressrelease/Thame_Flood_Solukhumbu_16_August_Information_.pdf

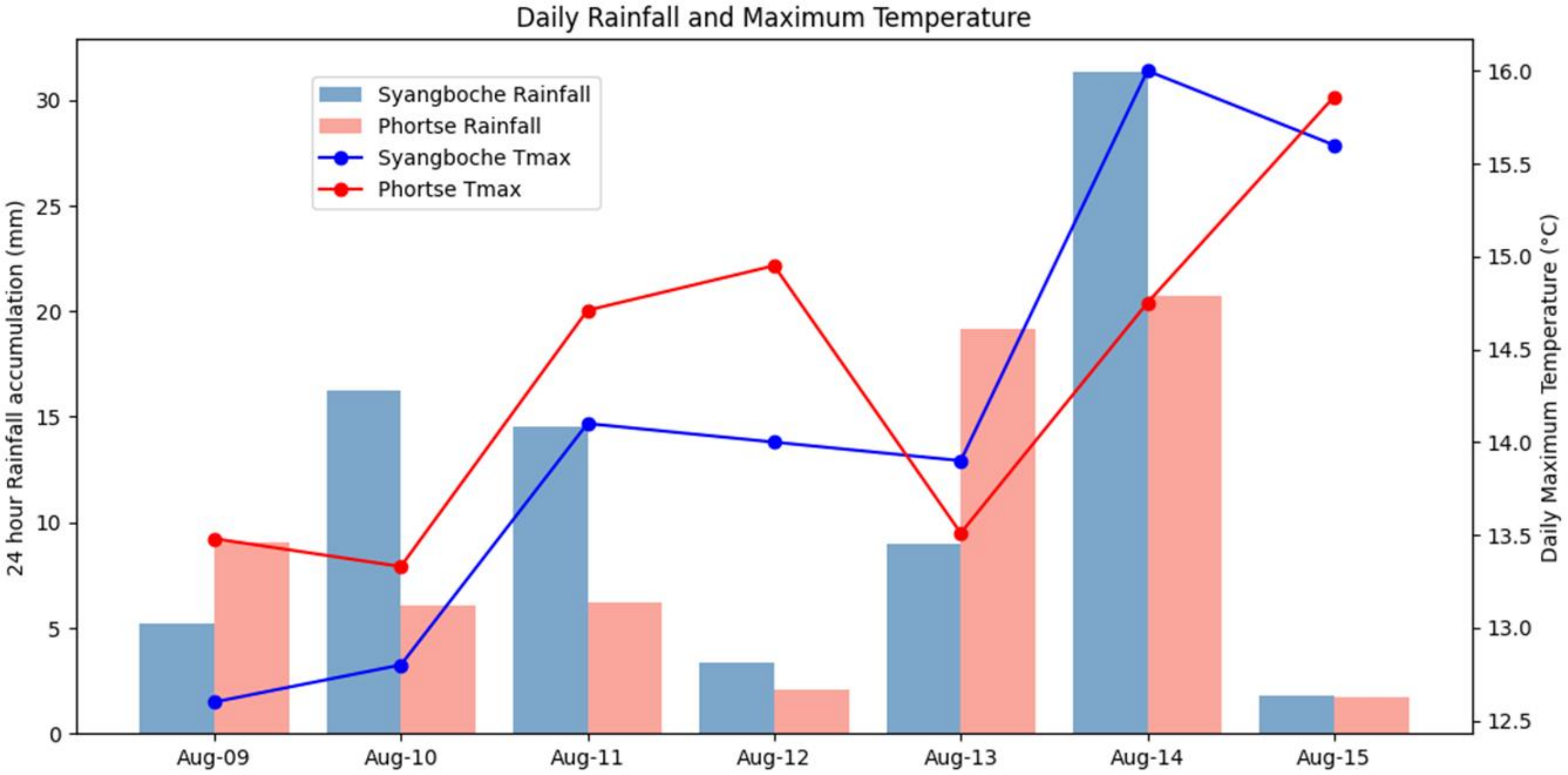
Thame GLOF

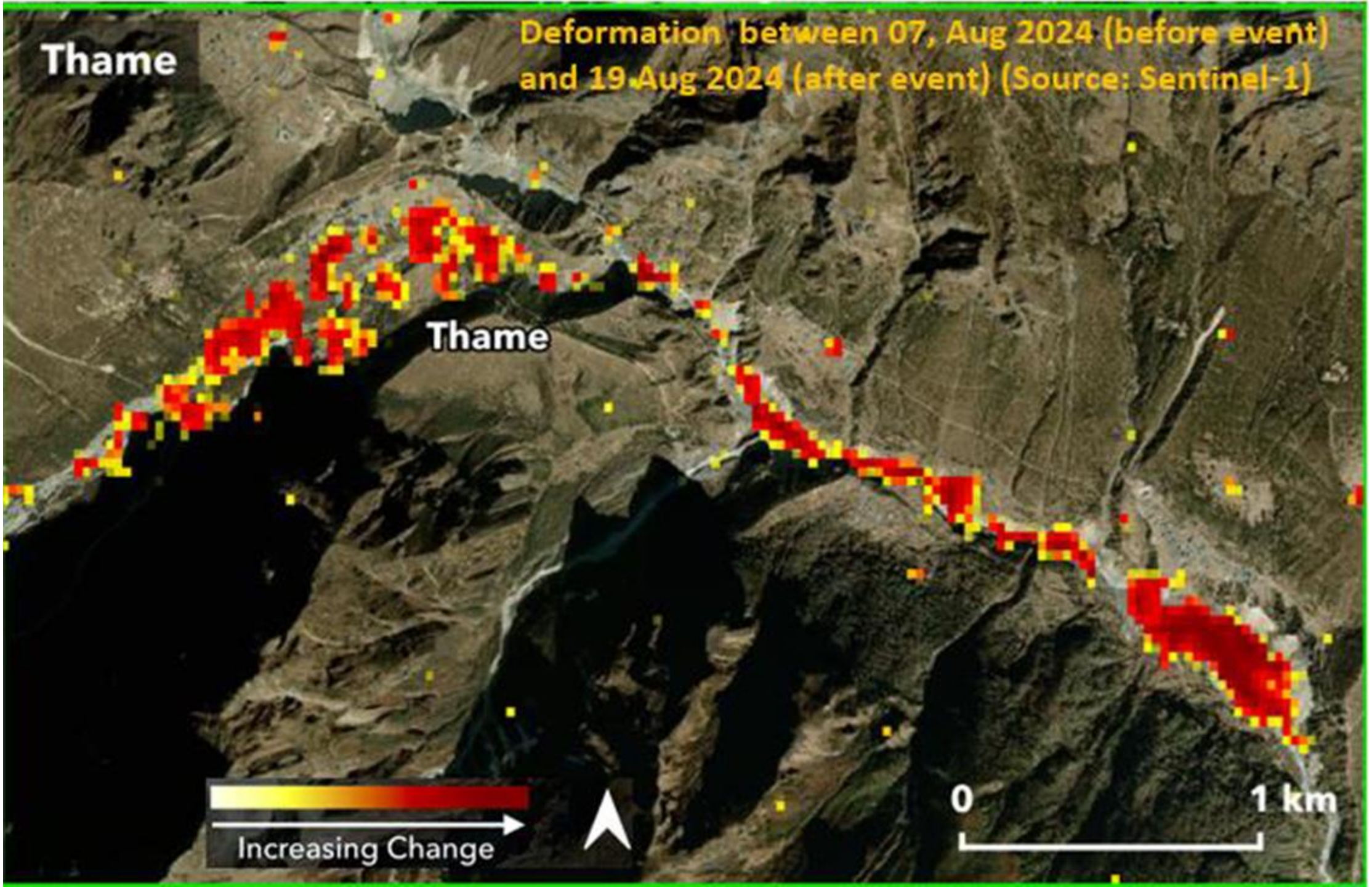

Thame Catchment Map
Lake 1
Lake 4
Lake 3
Lake 5
Lake 2
Dig Tsho
Lumding Tsho
Kongde Ri
LANGMOCHE
KHURE GOTH
TARNGGA
HUNGMO
THYANGMOCHE
THAME
Legend
Lake 2
Other Lakes
Thame Catchment
Google Earth
1 km


Discharge(m3/sec) at Dudhkoshi Rabuwabazar station
stimated Discharge (m3/sec)
1000
900
800
700
600
500
16:00
16:30
17:00
17:30
18:00
18:30
19:00
19:30
20:00
20:30
21:00
Time

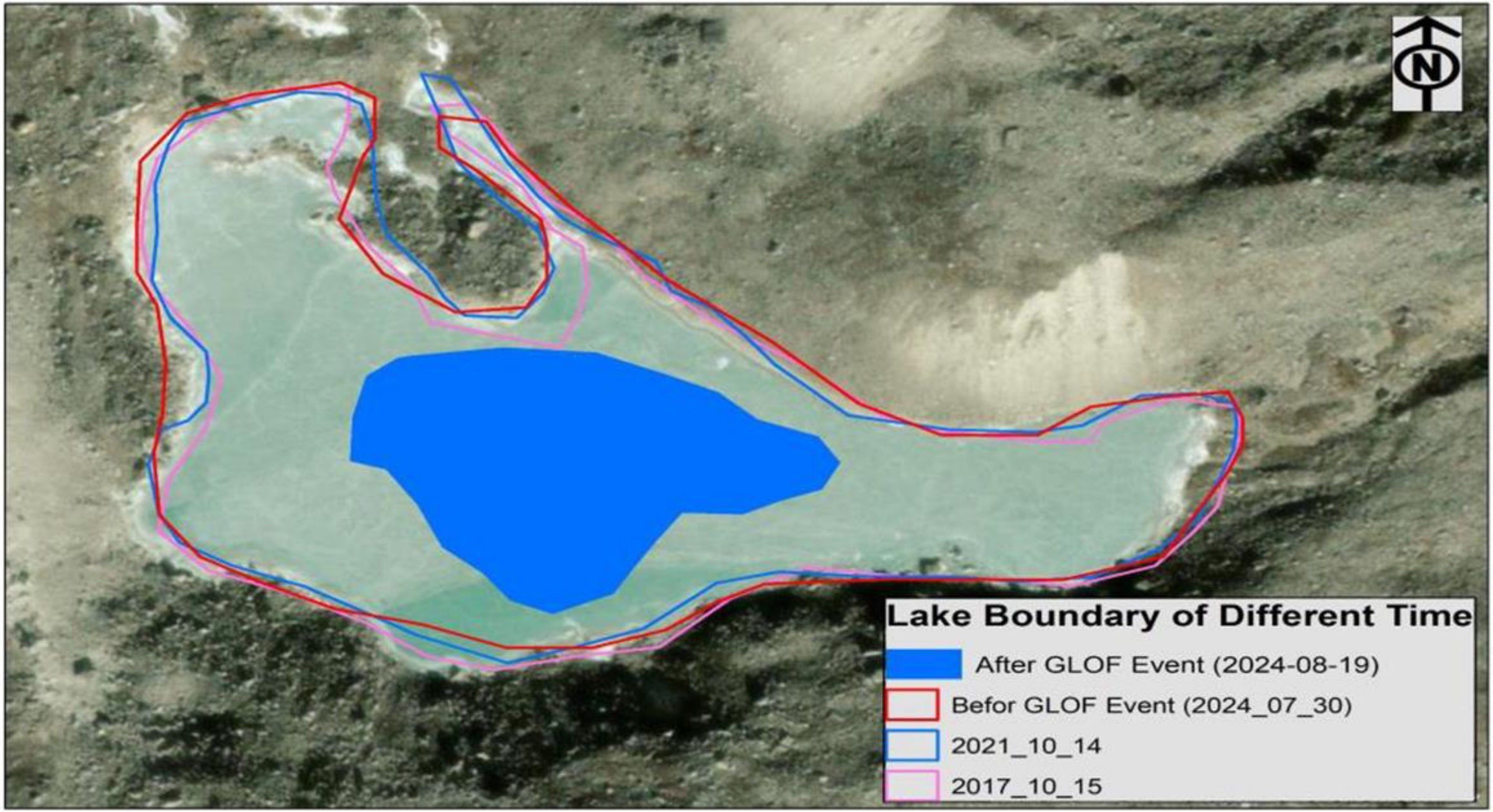

Temporal Variation of Area: Lake 1
Area (sq.km)
0.10
0.08
0.06
0.04
2018
2019
2020
2021
2022
2023
2024


Temporal Variation of Area: Lake 2
Before Event
After Event
Area (sq.km)
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
2018
2019
2020
2021
2022
2023
2024


Daily Rainfall and Maximum Temperature
Syangboche Rainfall
Phortse Rainfall
Syangboche Tmax
Phortse Tmax
24 hour Rainfall accumulation (mm)
Daily Maximum Temperature (°C)
0
5
10
15
20
25
30
12.5
13.0
13.5
14.0
14.5
15.0
15.5
16.0
Aug-09
Aug-10
Aug-11
Aug-12
Aug-13
Aug-14
Aug-15

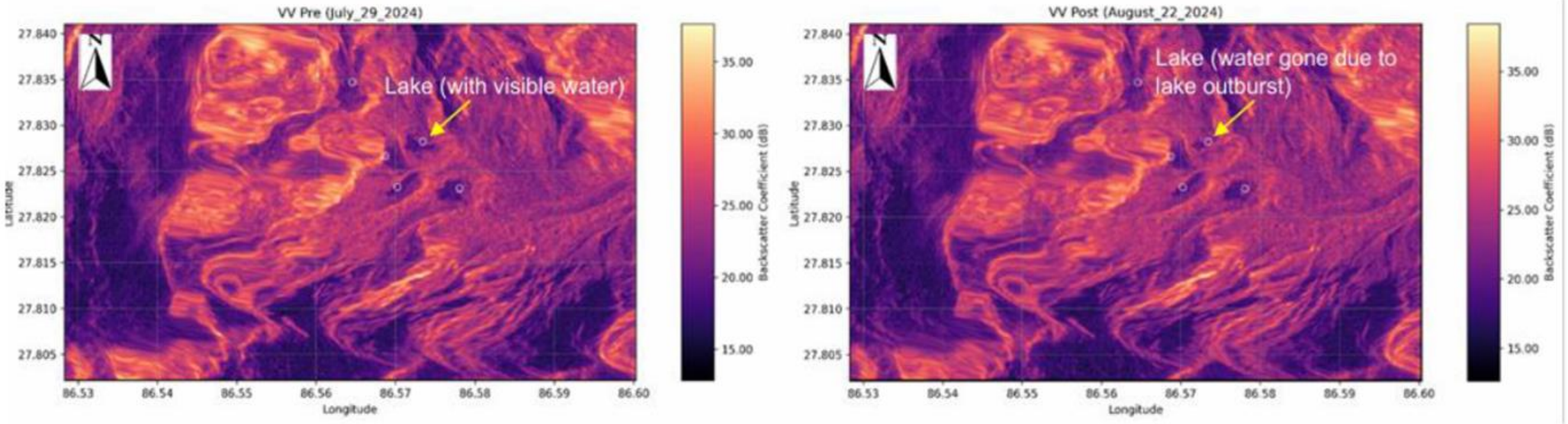

Thame
Deformation between 07, Aug 2024 (before event) and 19 Aug 2024 (after event) (Source: Sentinel-1)
Thame
Increasing Change
0
1 km

Evolution of Glacier Lake 2 over different time



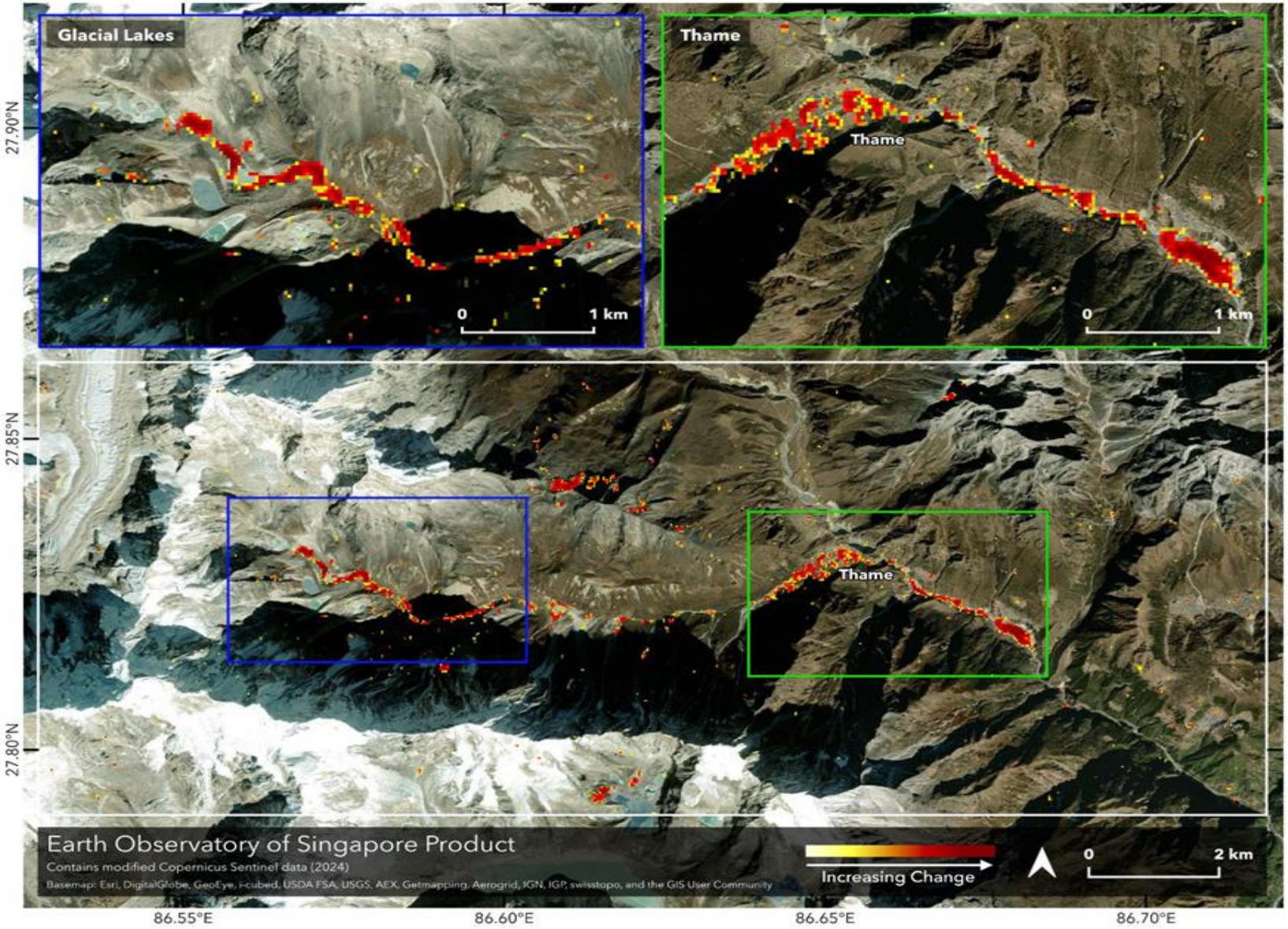
Sentinel Asia / Yamaguchi University

Nepal Glacier Lake Outburst



In the high mountains of Nepal, Sentinel-1 imagery revealed the aftermath of a Glacial Lake Outburst Flood (GLOF). The pre-event image from July 19, 2024, showed a glacial lake nestled in the rugged terrain. However, by August 22, 2024, the post-event image depicted a stark transformation where the lake once existed, there was now an empty basin, the water having surged down the valleys in a catastrophic flood. This rapid change, captured by Sentinel-1, was analyzed by a team of researchers at the Center for Research and Application of Satellite Remote Sensing (YUCARS), Yamaguchi University, Japan, underscoring the power of GLOF events and their impact on mountainous environments.

Sentinal-1



EOS-RS Damage Proxy Map: Nepal, Glacial Lake Outburst Floods, 19 Aug 2024, v0.9

The Earth Observatory of Singapore - Remote Sensing Lab (EOS-RS) created this preliminary Damage Proxy Map (DPM) depicting areas that are likely damaged in the vicinity of Thame, Solukhumbu, Nepal following a glacial lake outburst flood on 16 Aug 2024. This map was derived from synthetic aperture radar (SAR) images acquired by the Copernicus Sentinel-1 satellite operated by the European Space Agency (ESA) before (20 Apr 2024 to 7 Aug 2024) and after (19 Aug 2024) the event (16 Aug 2024).

The map covers an area indicated by the white polygon. Damage is shown by colored pixels of 30m in size, where yellow to red indicates increasingly significant ground surface change before and after the event. Preliminary validation was conducted using news reports, aerial imagery and videos, and ground-level imagery in selected areas. This map should be used as a guidance to identify damaged areas, and may be less reliable over vegetated or mountainous areas. Scattered pixels over vegetated or mountainous areas may be false positives, and a lack of colored pixels over such areas may not mean no damage.

The product contains modified Copernicus Sentinel data (2024), processed by ESA and analyzed by the Earth Observatory of Singapore - Remote Sensing Lab (EOS-RS).

More map details and files at: https://eos-rs-products.earthobservatory.sg/EOS-RS_202408_Nepal_Glacial_Lake_Outburst_Floods/

Legal Disclaimer: https://products.earthobservatory.sg/#/faq

Credits: Earth Observatory of Singapore - Remote Sensing Lab (EOS-RS), Contains modified Copernicus Sentinel data (2024)

EOS-RS Twitter: @eos_rs

Deformation Analysis Report received from: Earth Observatory Singapore

https://www.dhm.gov.np/downloads

नेपाल सरकार
ऊर्जा, जलस्रोत तथा सिंचाइ मन्त्रालय
जल तथा मौसम विज्ञान विभाग

सोलुखुम्बु जिल्लाको खुम्बु पासाङल्हामु गाउँपालिका ५ थामेमा हिमताल विष्फोटनबाट आएको बाढी सम्बन्धी थप जानकारी - २०८१/०५/०७

मिति २०८१।०४।३२ गते दिउँसो करिब १:३० बजे सोलुखुम्बु जिल्लाको खुम्बु पासाङल्हामु गाउँपालिका ५ थामे भइ बग्ने थामेखोलामा एक्कासी बाढी आएको घट्नाको प्रारम्भिक जानकारी सोही दिन विभागको वेबसाइट मार्फत सार्वजनिक गरिएको विदितै छ। सो सम्बन्धमा थप जानकारी देहाय बमोजिम रहेको छ ।

थामे जलाधारमा विभिन्न मितिमा प्राप्त सेटलाईट तस्बीरहरूको अध्ययन गर्दा तल चित्रमा देखाए अनुसार हिमतालहरू १, २, ३, ४ र ५ मध्ये हिमतालहरू २ (GL086573E27827N), ३ (GL086569E27826N) र ४ (GL086570E27823N) यस अघि सन् २०१५ मा अन्तर्राष्ट्रिय एकीकृत पर्वतीय विकास केन्द्र (ICIMOD) बाट प्रकासित हिमतालहरुको विवरण (Glacier Lake Inventory) मा पहिचान भएको देखिन्छ भने हिमतालहरू १ र ५ सो विवरण मा नभएपनि स-साना पोखरीको रूपमा रहेको सेटलाईट तस्बीरमा (चित्र-१) भने देखिन्छ।

चित्र-१: थामे खोला जलाधार र आसपासको हिमतालहरू (निलो घेराको जलाधार बाहिर ठूला हिमतालहरू- बाँयातर्फ लुम्दिङ च्छो र दायाँ तर्फ दिग च्छो) (स्रोत गुगल अर्थ प्रो, डिसेम्बर, २०२०)

Third Pole Climate Forum 1

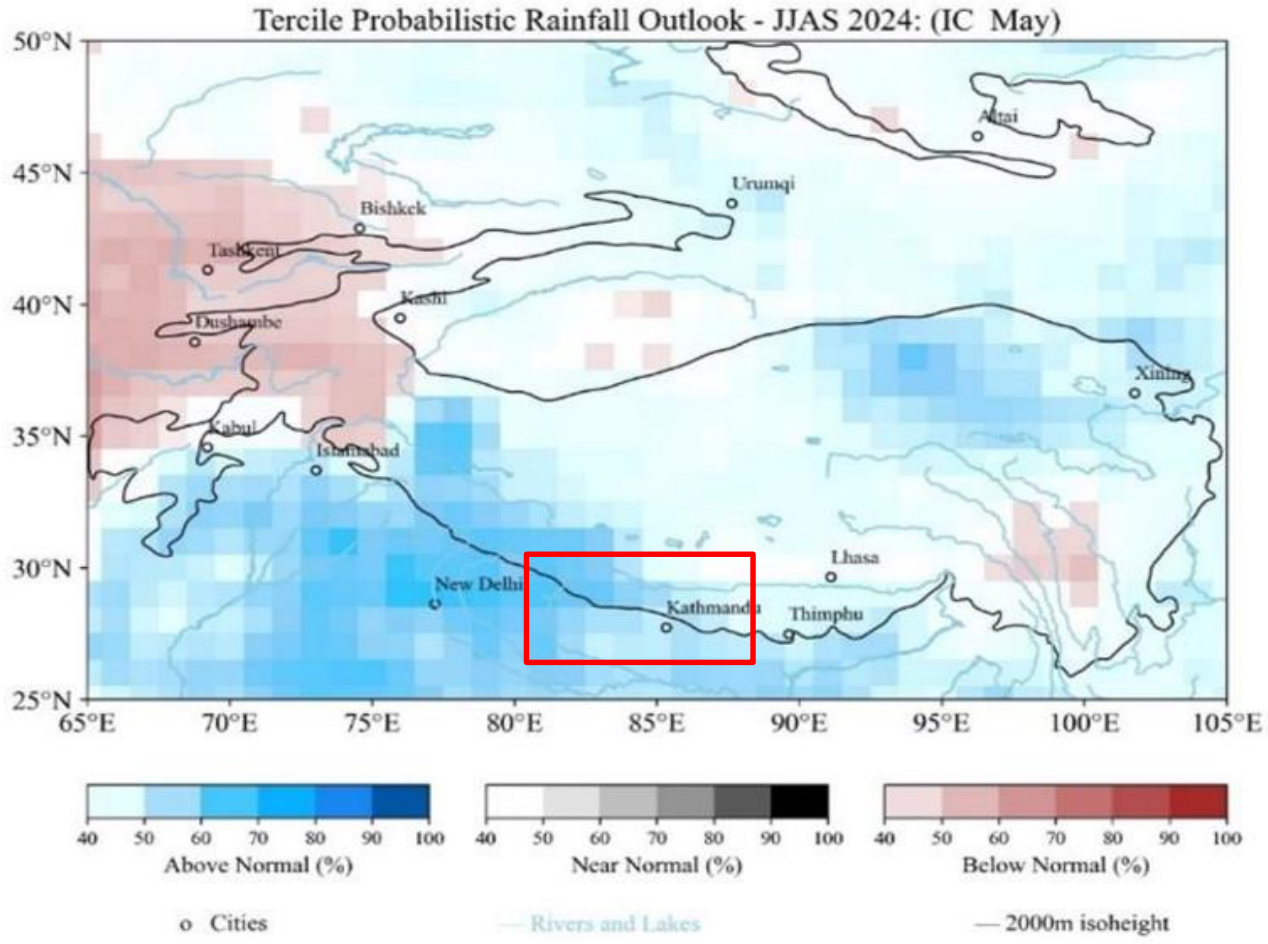
The Third Pole Regional climate Centre Network (TPRCC-Network) which launched its demonstration phase and initiated the first session of TPCF, co-organized by Beijing Climate Centre and WMO on 4-6 June 2024 in Lijiang, China.

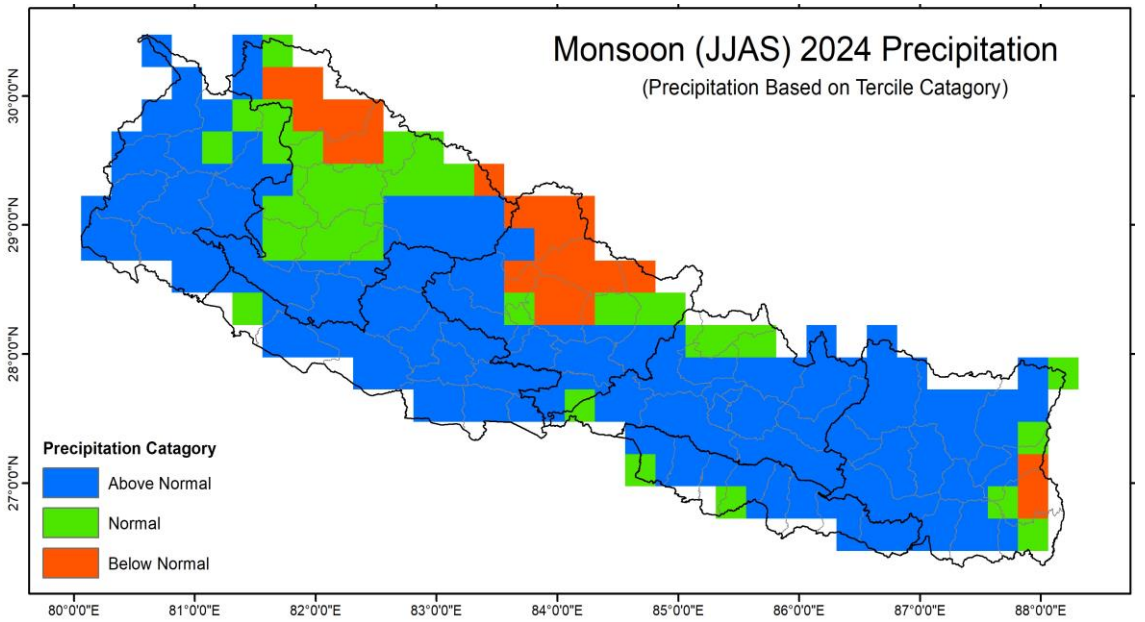
National Monsoon Forum was organized on 13th May, 2024 in Department of Hydrology and Meteorology, Kathmandu, Nepal along with stakeholders.

TPCF Forecast for Monsoon(JJAS)

- Surface air temperatures are likely to be above normal over most parts of the region, especially over the Karakoram. The southwestern and northwestern parts are likely to experience normal to above normal surface air temperatures.
- Precipitation is likely to be near or above the climatological normal over most parts of the TP region, however, it is likely to be below normal in the western and southeastern parts of the TP region.

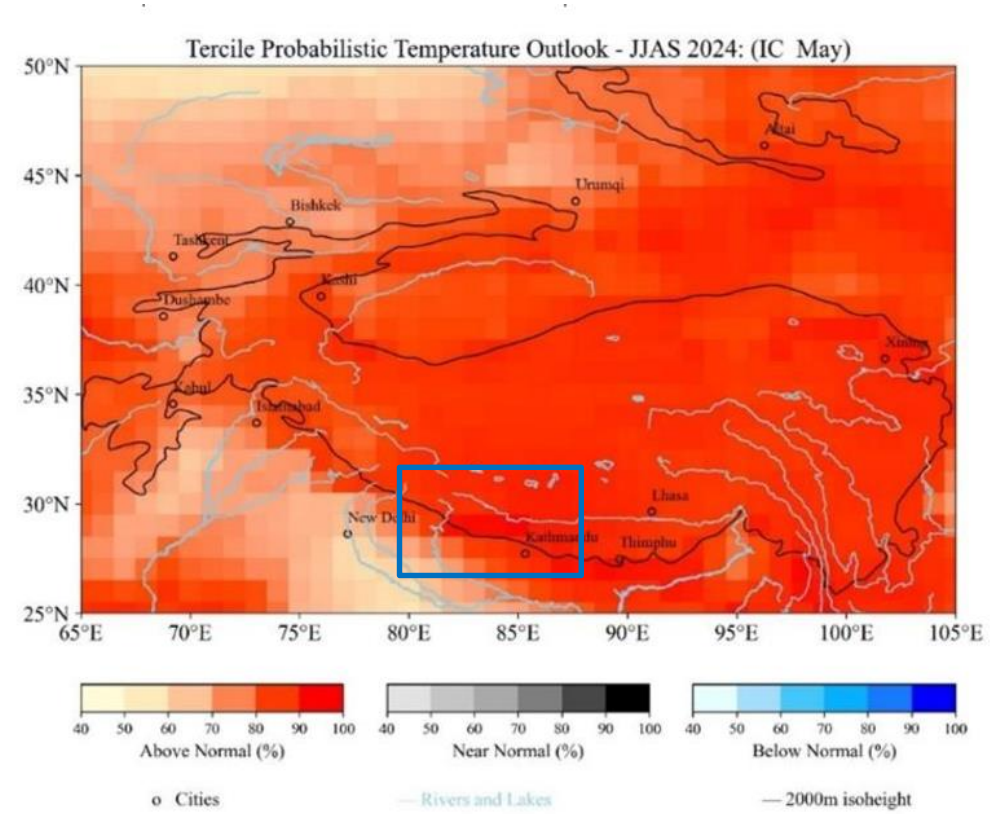
Forecast Verification: Precipitation

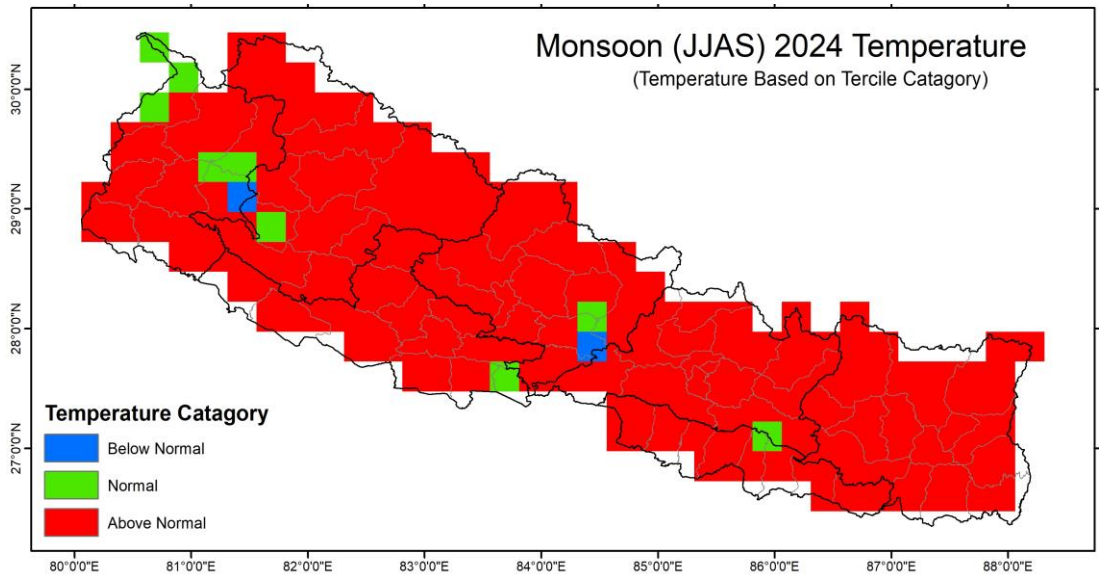




urface Precipitation Probabilistic outlook for June-September 2024

Forecast Verification: Temperature





Surface Air Temperature Probabilistic outlook for June-September 2024

Summary

- Unusual Weather and increase in frequency and magnitude of extreme events.
- Adaptation measures used in some cases
  - Advisory issued (but not enough lead time) but mainly these were unusual than normal expected so not prepared for the extent of forecast
  - travel advisories were issued in some cases of 2024 events
- Reduced loss of lives in IBF pilot areas but could not reduce economic and physical damage significantly.
- Climate outlooks from regional forums need to be prepared a month in advance to ensure timely dissemination of information to stakeholders.

Thank You