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Climate Responsive Land Governance and Disaster Resilience: Safeguarding Land Rights

Assessment of Glacier retreat and Glacial Lake Development Trend in Western Nepal

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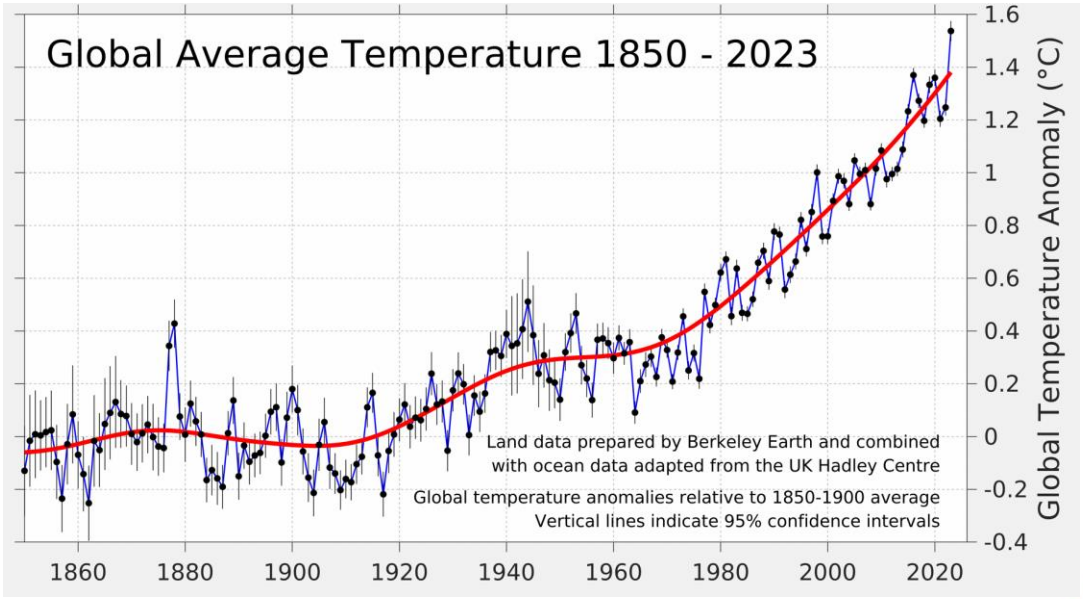
Outline:

- **Introduction**
- **Study area**
- **Objective of the Study**
- **Methodology**
- **Results**
- **Environmental Impact**
- **Limitation**
- **Conclusion And Recommendation**

Introduction:

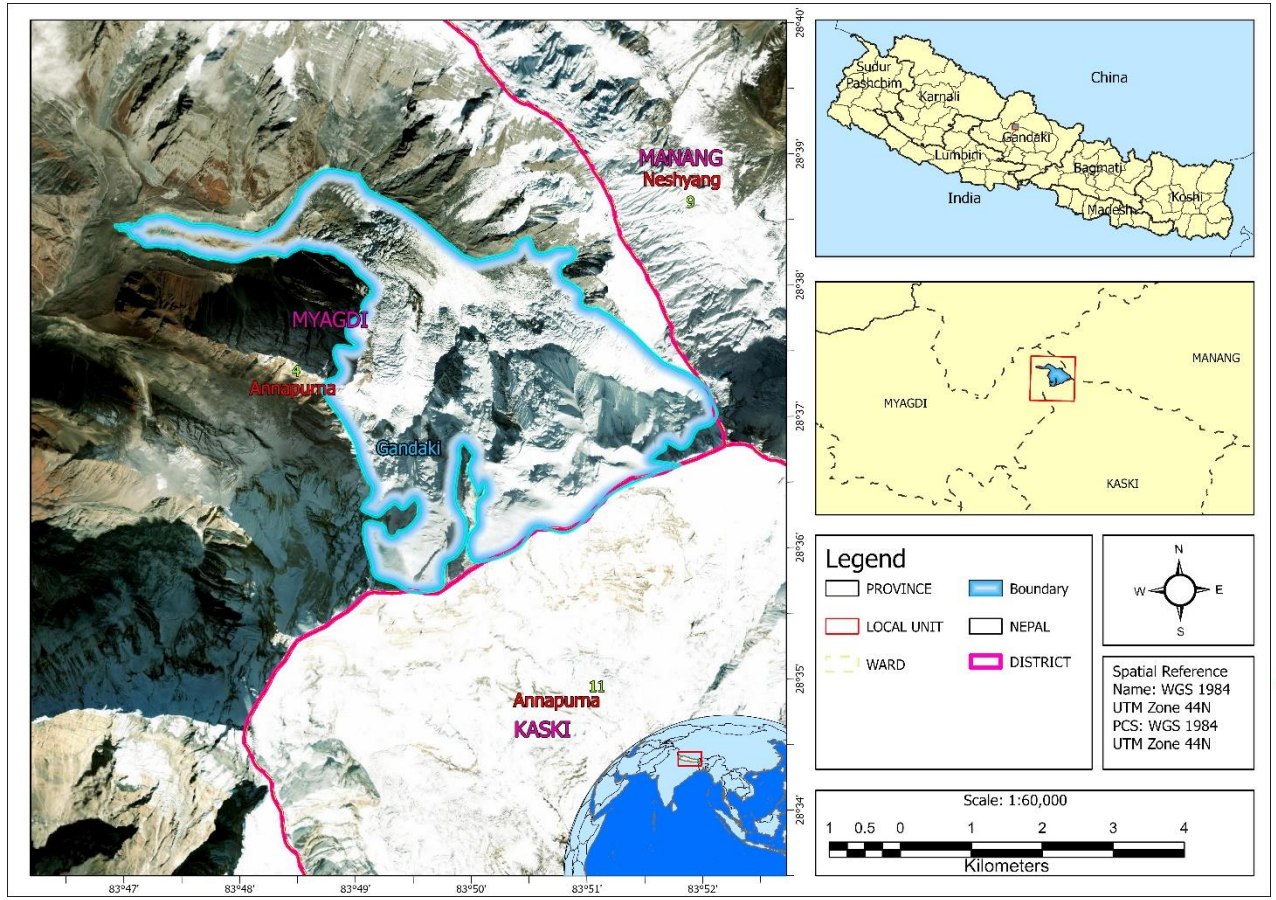
- **Glacier lakes, which are formed by melting of glaciers, are a common phenomenon in mountain region.**
- **Natural behavior of glacial lakes has been changing in recent decades**
- **Rapid glacial lake formation and expansion in the Himalayas due to rising temperatures.**



Source: Berkeley Earth

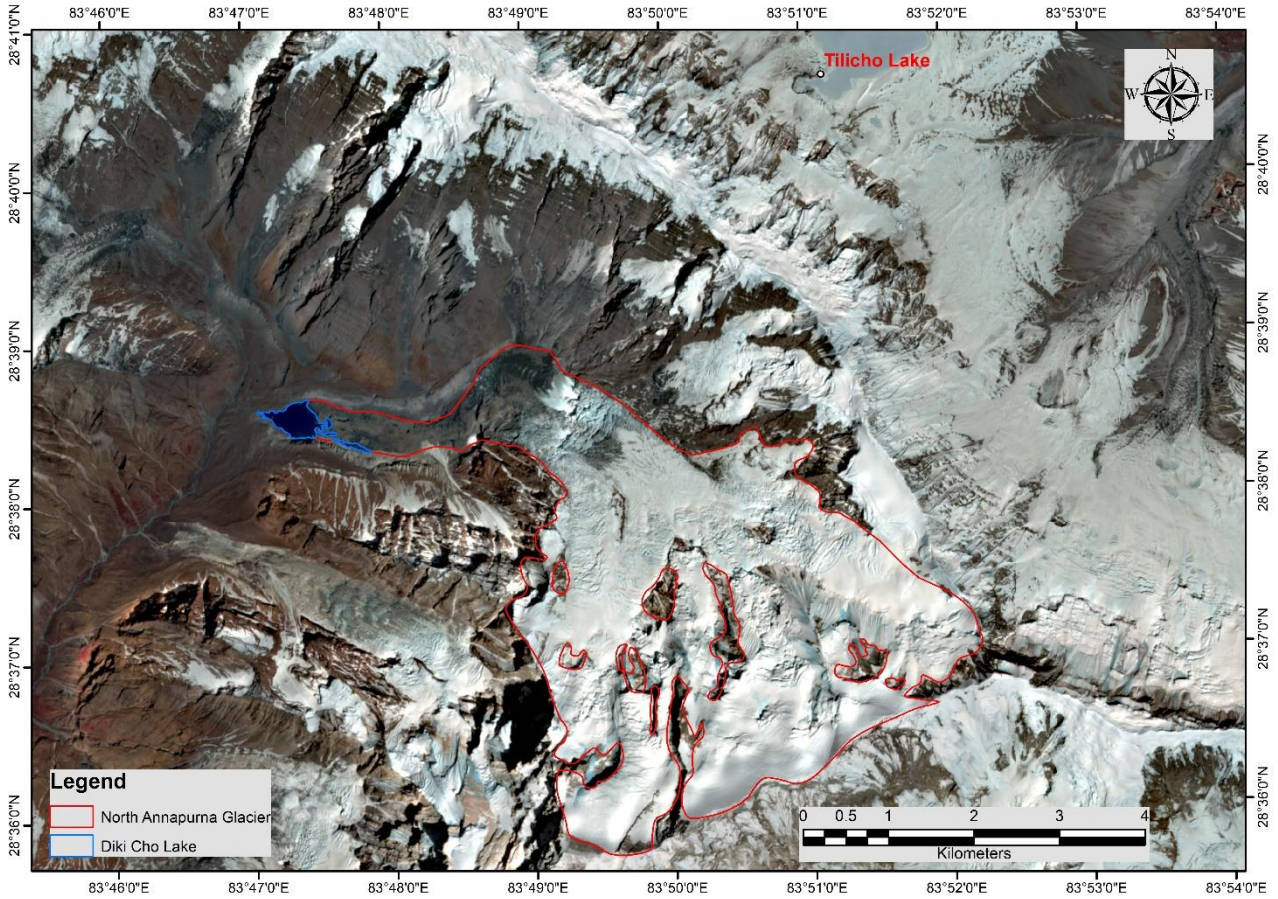
Study area:

- **Location: North Annapurna Glacier in Gandaki Province, Nepal.**
- **High-altitude area (4050m - 6400m) and limited prior research**

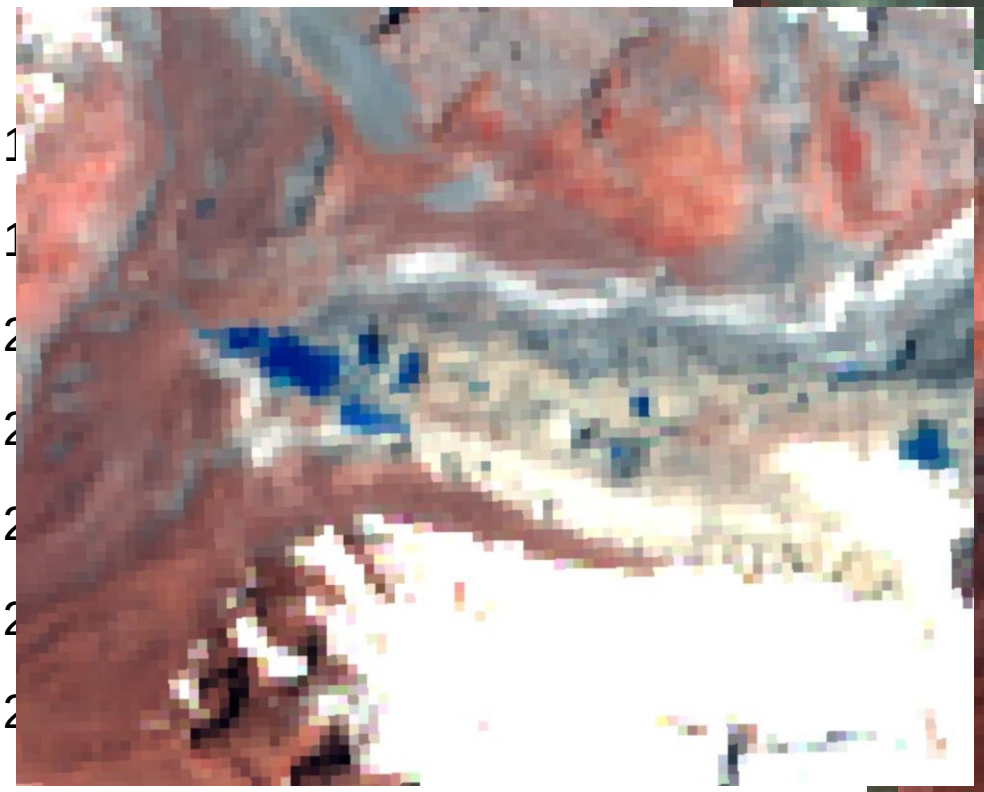


Objective of the Study:

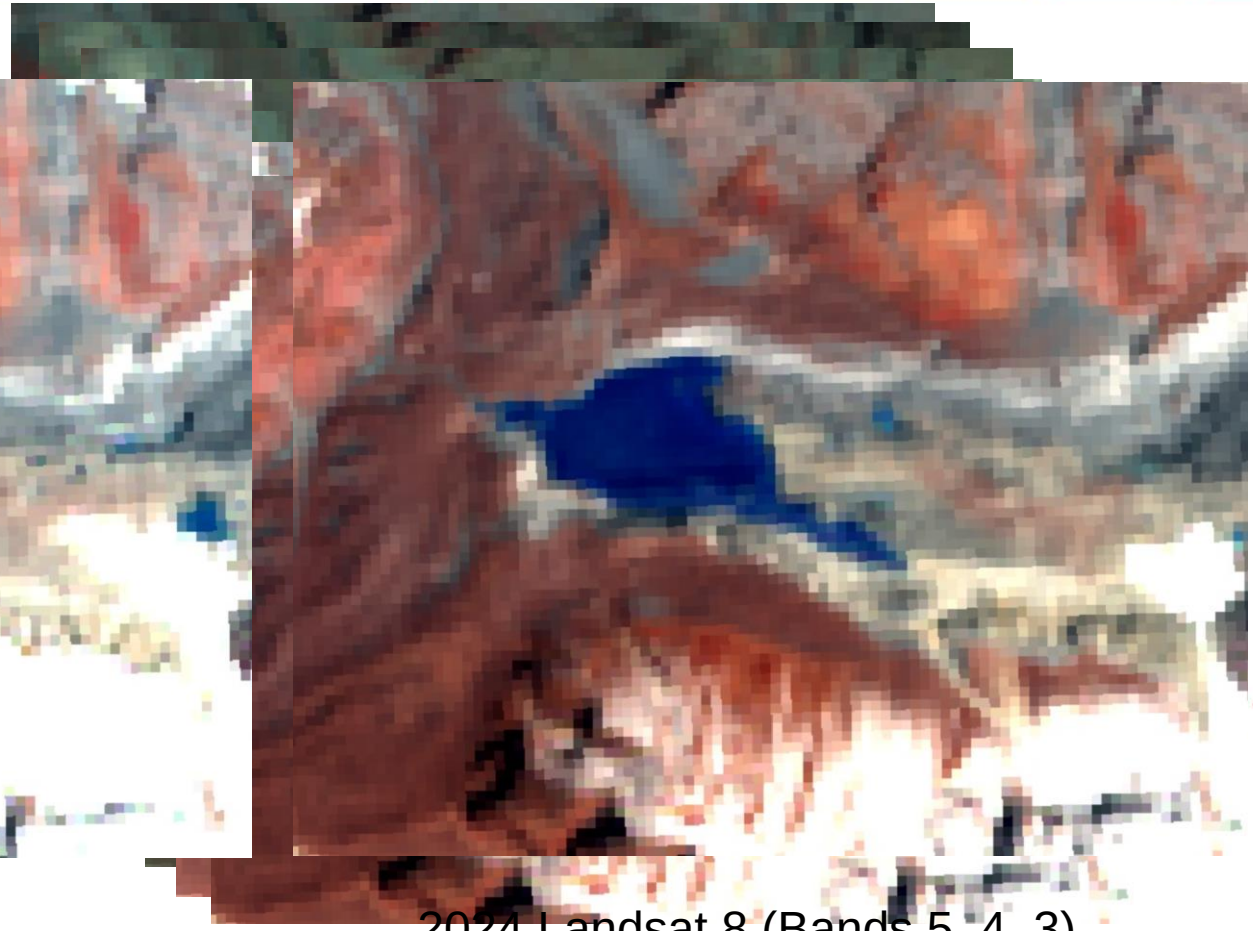
- **Measure glacier retreat and glacial lake expansion from 2016 to 2023**



Project Area Overview:

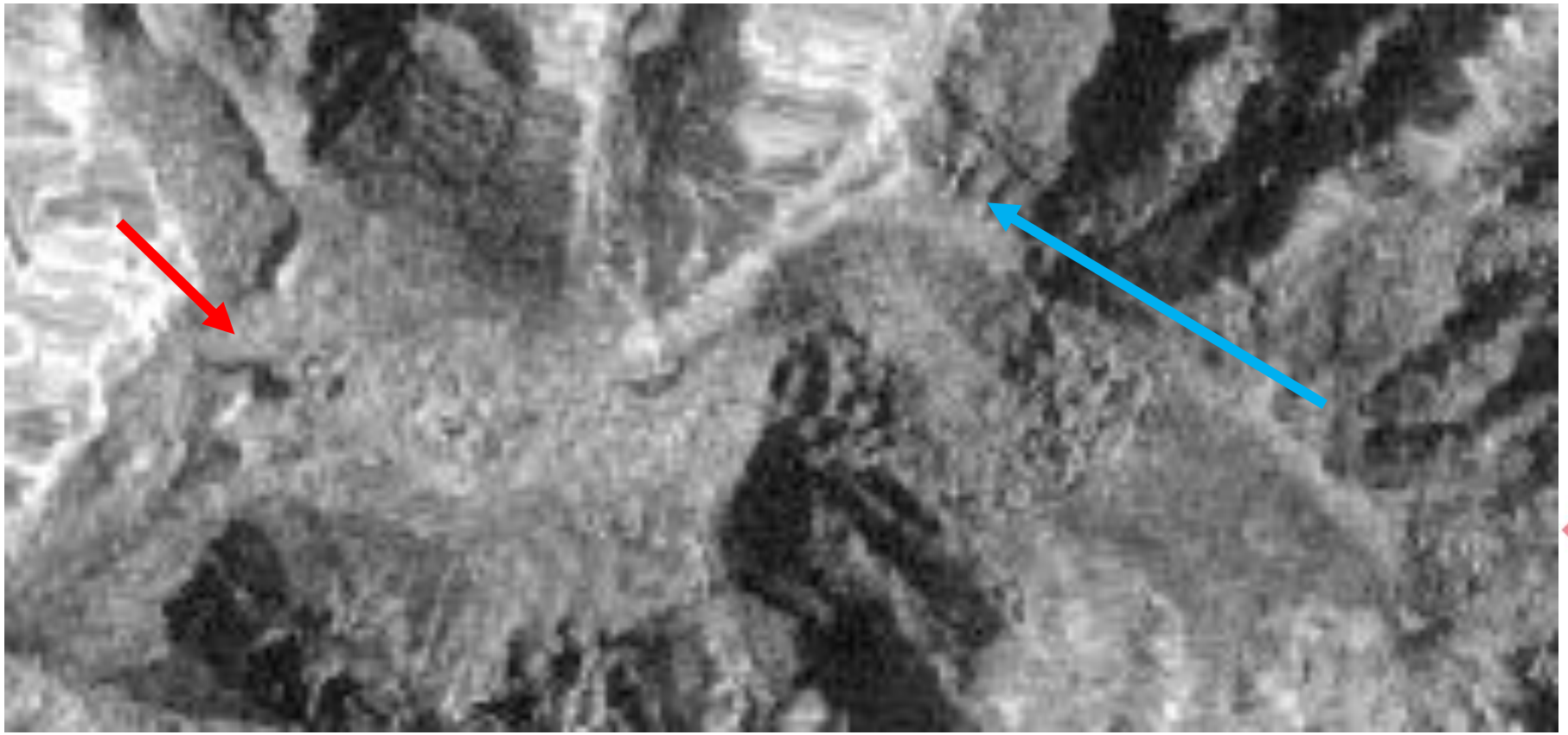


2015 Landsat 8 (Bands 5, 4, 3)



2024 Landsat 8 (Bands 5, 4, 3)

Project Area Overview: Sentinel 1 GRD image from 2014-2023



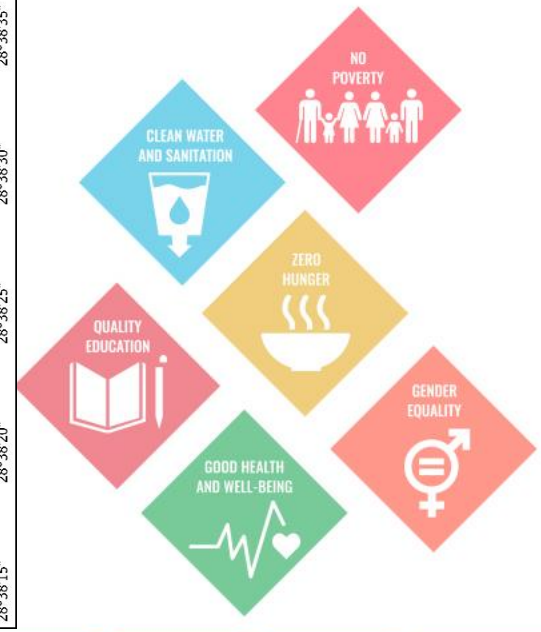
Project Area Overview:

Project Area Overview:

- **Timelap video from the collection sentinel 2 images (2016-2023)**
- **Prepared on**

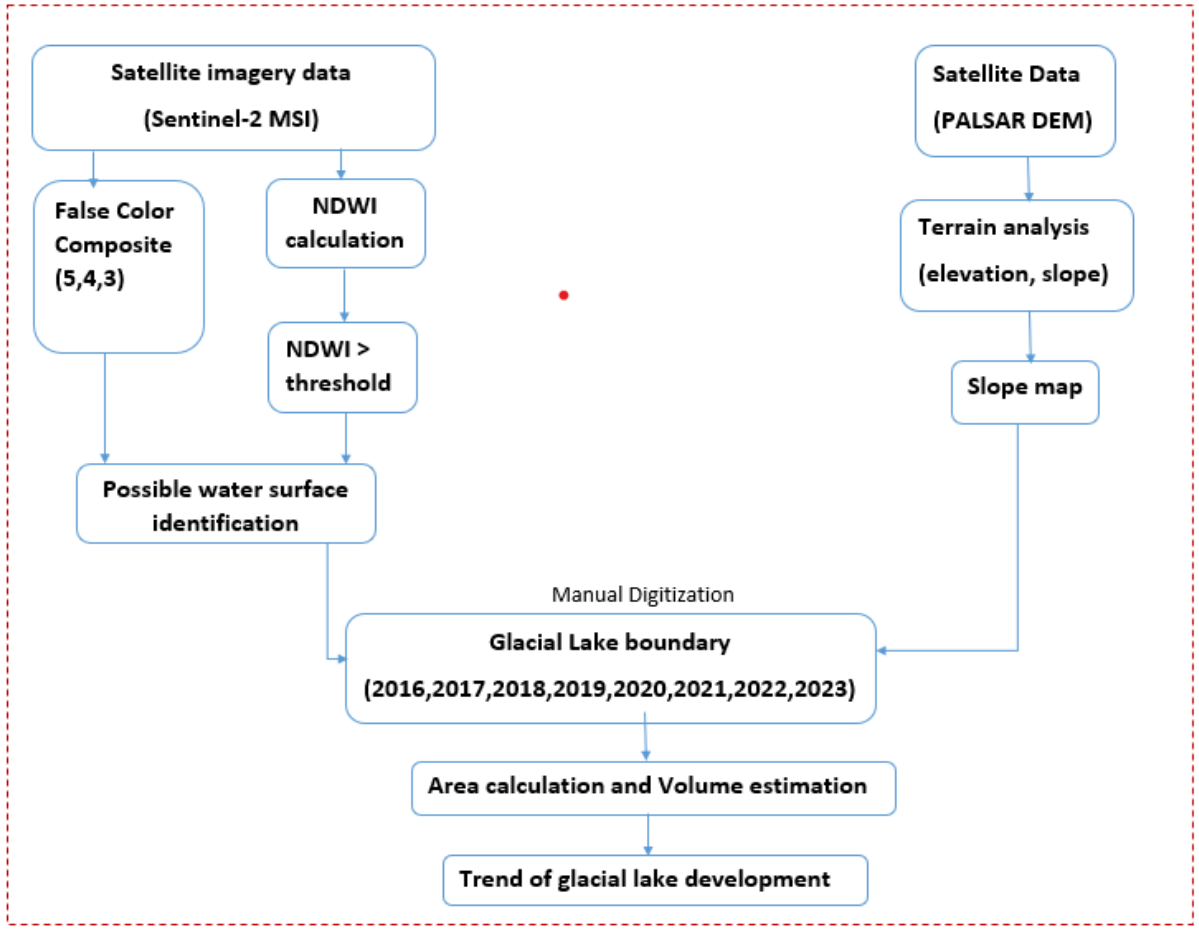
Project Area Overview:

- Orthophoto generated from the drone images that has been captured during field expedition



Methodology:

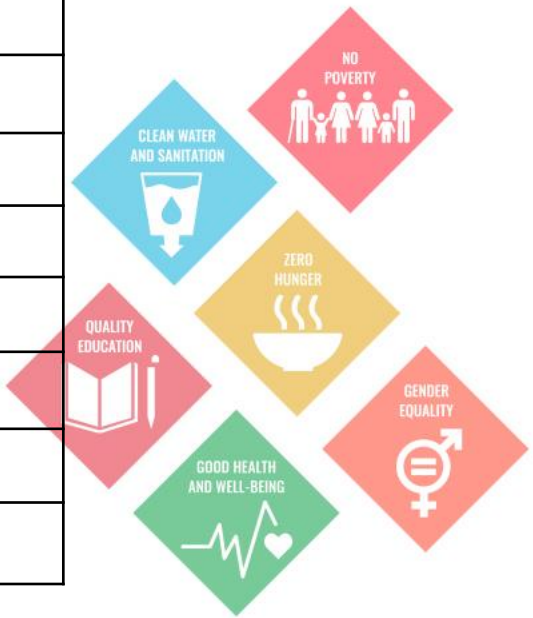
- **Remote sensing using Sentinel-2 imagery (2016-2023) and PALSAR DEM for lake boundary delineation.**
- **NDWI (Normalized Difference Water Index) for lake area detection.**



Methodology:

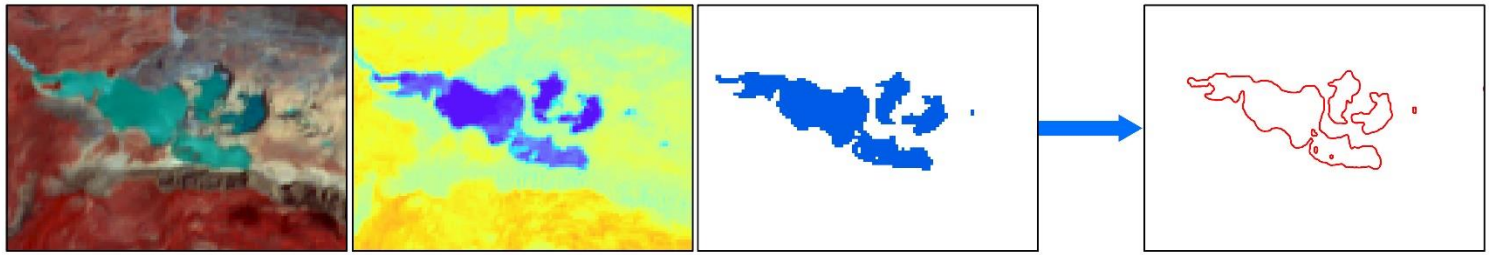
- **Data Sources: Sentinel-2 satellite images (2016-2023)**

SN	Image Name	Date	Resolution
1	S2A_MSIL1C_20160804T045702_N0204_R119_T44RQS	2016-08-04	10m
2	S2A_MSIL1C_20170521T045701_N0205_R119_T44RQS	2017-05-21	10m
3	S2B_MSIL1C_20180521T045659_N0206_R119_T44RQS	2018-05-21	10m
4	S2A_MSIL1C_20190521T045701_N0207_R119_T44RQS	2019-05-21	10m
5	S2A_MSIL1C_20200624T045701_N0209_R119_T44RQS	2020-06-24	10m
6	S2A_MSIL1C_20210927T045701_N0301_R119_T44RQS	2024-09-27	10m
7	S2A_MSIL1C_20220415T045701_N0400_R119_T44RQS	2022-04-15	10m
8	S2A_MSIL1C_20230530T045701_N0509_R119_T44RQS	2023-05-30	10m



Results:

2016

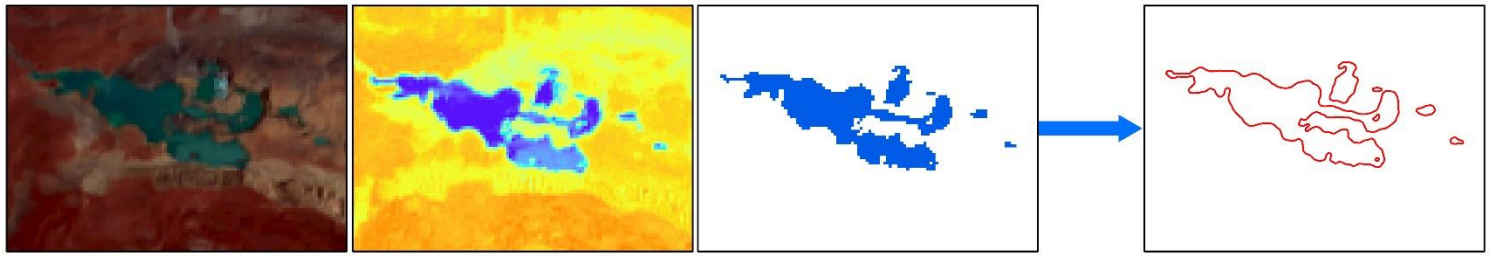


2016- Sentinel 2 False Composite (B8,B3,B2)

NDWI Threshold μ>0.28

Lake Boundary

2017



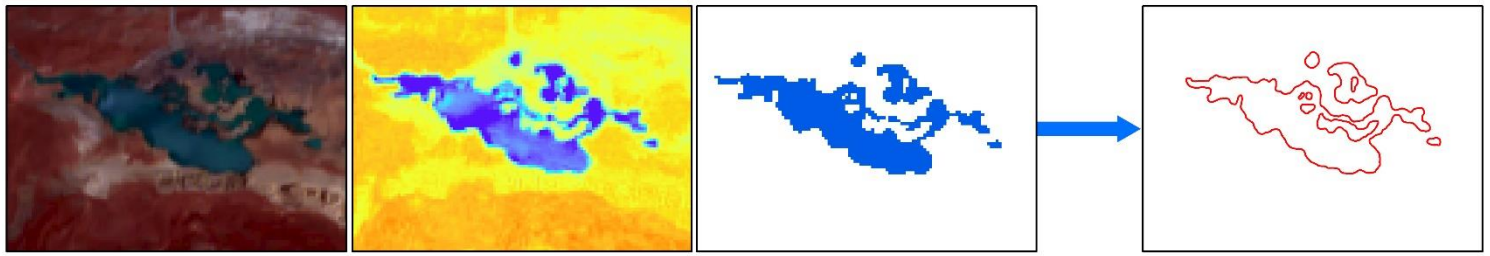
2017- Sentinel 2 False Composite (B8,B3,B2)

NDWI Threshold μ>0.28

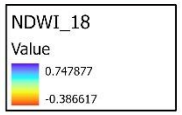
Lake Boundary

Results:

2018



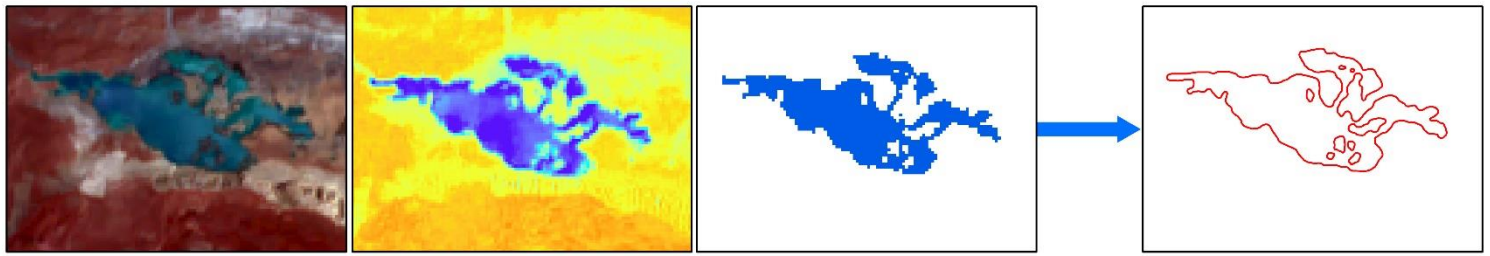
2018- Sentinel 2 False Composite (B8,B3,B2)



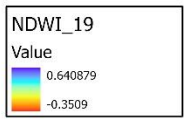
NDWI Threshold μ>0.28

Lake Boundary

2019



2019- Sentinel 2 False Composite (B8,B3,B2)

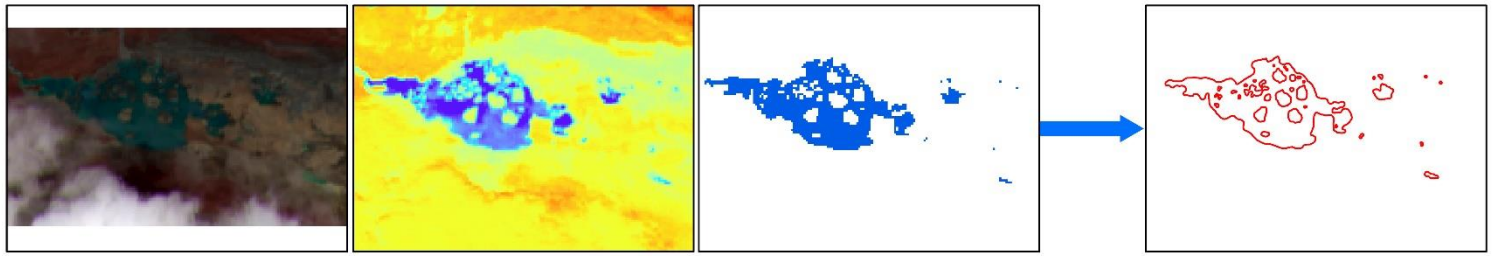


NDWI Threshold μ>0.28

Lake Boundary

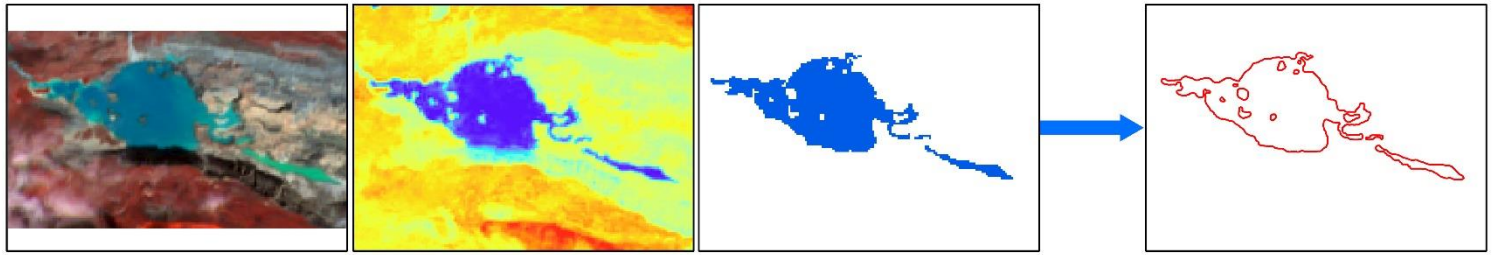
Results:

2020



2020- Sentinel 2 False Composite (B8,B3,B2) | NDWI Threshold μ>0.28 | Lake Boundary

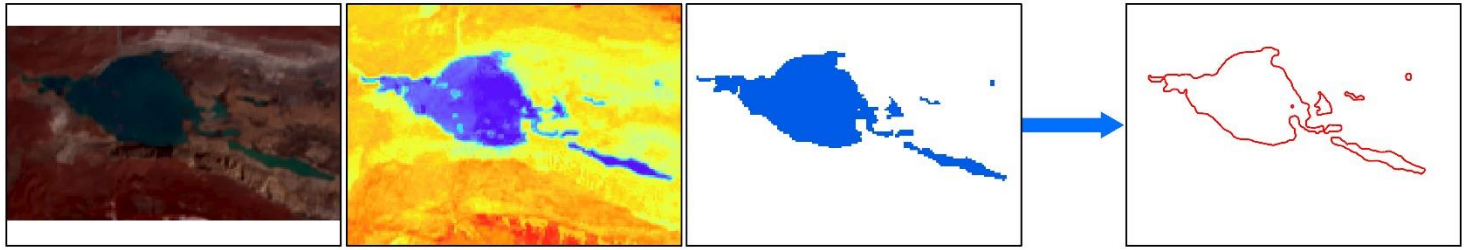
2021



2021- Sentinel 2 False Composite (B8,B3,B2) | NDWI Threshold μ>0.36 | Lake Boundary

Results:

2022

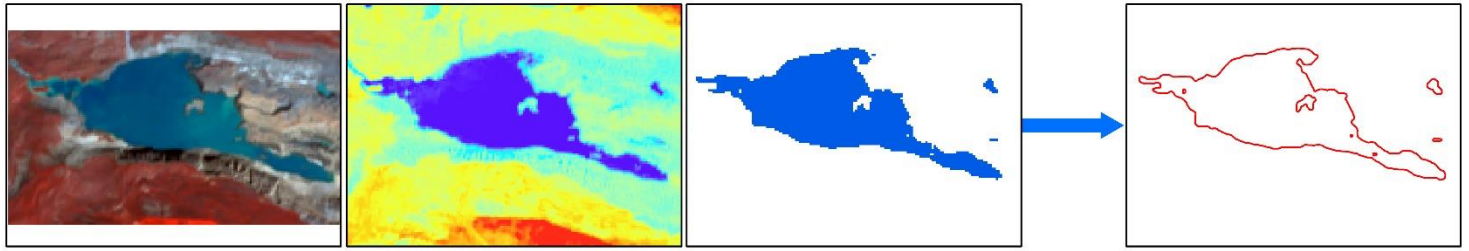


2022- Sentinel 2 False Composite (B8,B3,B2)

NDWI Threshold μ>0.12

Lake Boundary

2023



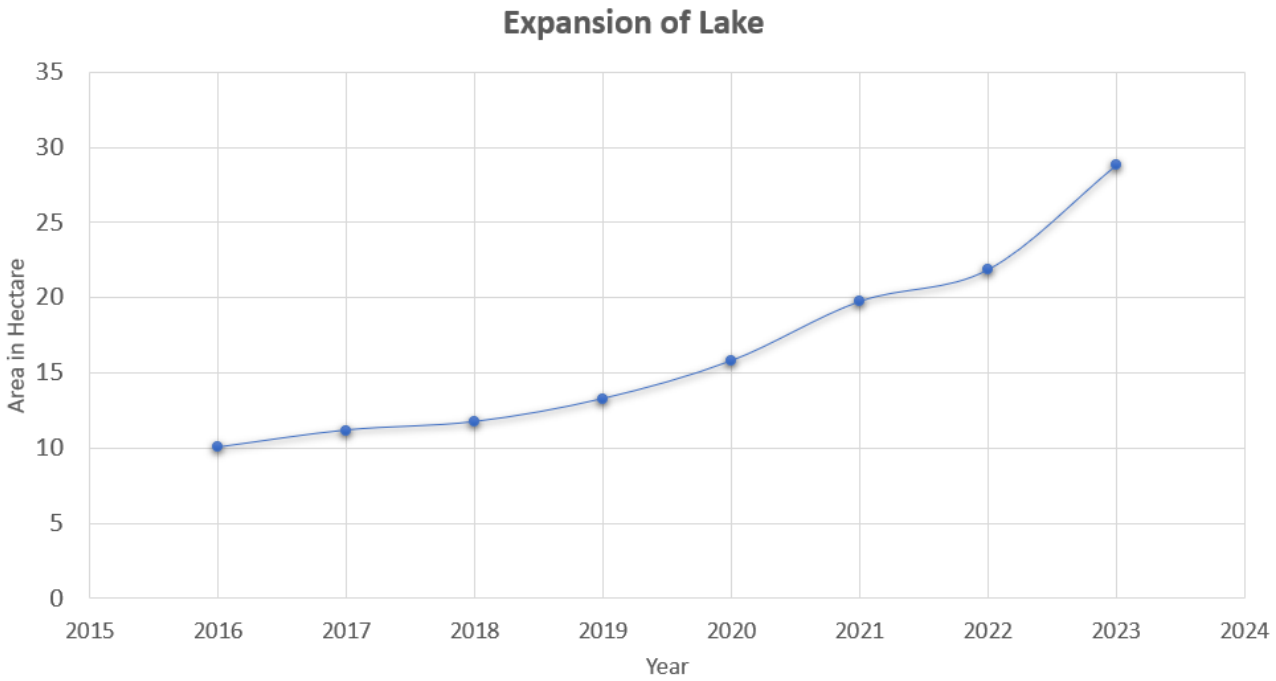
2023- Sentinel 2 False Composite (B8,B3,B2)

NDWI Threshold μ>0.12

Lake Boundary

Results:

SN	Year	Area in Hactare
1	2016	10.027
2	2017	11.165
3	2018	11.727
4	2019	13.260
5	2020	15.775
6	2021	19.714
7	2022	21.827
8	2023	28.781



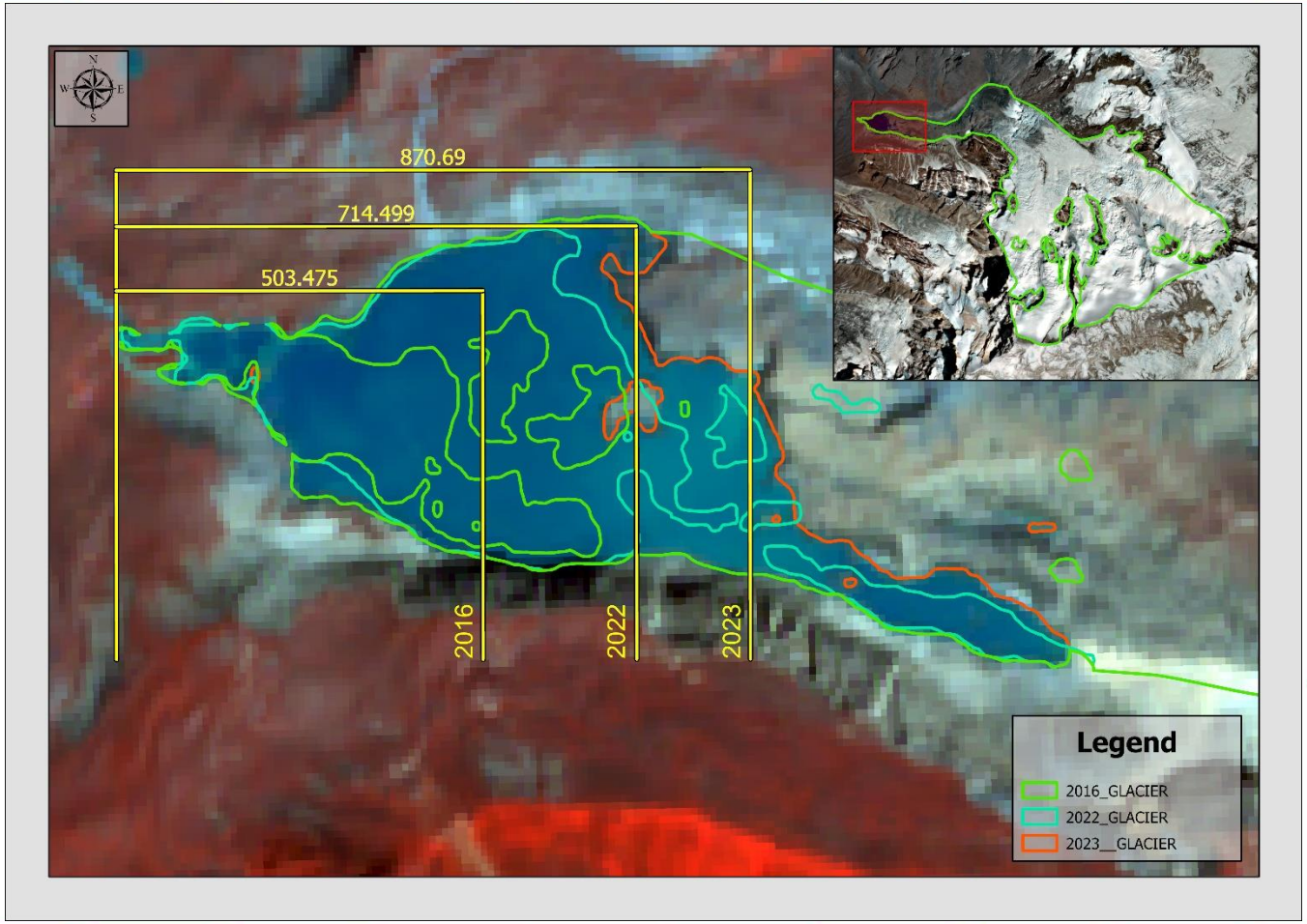
Lake Expansion Rate= **2.67 ha/yr**

4 Football Field per Year

Almost 3 times in 7 Years

Results:

Glacier Retreat More than 350m in 7 yrs



Environmental Impact:

- **Impact of Glacial Lake Expansion:**
- **Potential GLOF risks to downstream communities.**
- **Effects on local ecosystems and freshwater resources.**

Limitation:

- **Temperature and precipitation data were not directly incorporated due to a lack of nearby measurement stations.**
- **Field measurements for glacier boundaries and retreat rates were not conducted, relying instead on remote sensing, which can lack the precision of direct observations.**
- **Limited to annual images which may overlook short-term or seasonal changes in glacier dynamics and lake expansion.**
- **Factors like wind patterns, solar radiation, and humidity, which could influence glacial melt rates, were not part of the analysis.**

Conclusion And Recommendation:

- **Rapid lake expansion underscores climate change impact.**
- **Glacier retreat and lake growth highlight increased GLOF risk.**

Source: Kantipur

Acknowledgments:

- **Shristi Paudel**
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- **Geotech Engineering Space Pvt. Ltd.- Mapping Team**

Thank You

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