



# Increasing extreme events in the central Himalayas

**Third Pole Climate Forum**

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04 June 2025, New Delhi



# Mountain hazards- From compound events to cascading disasters

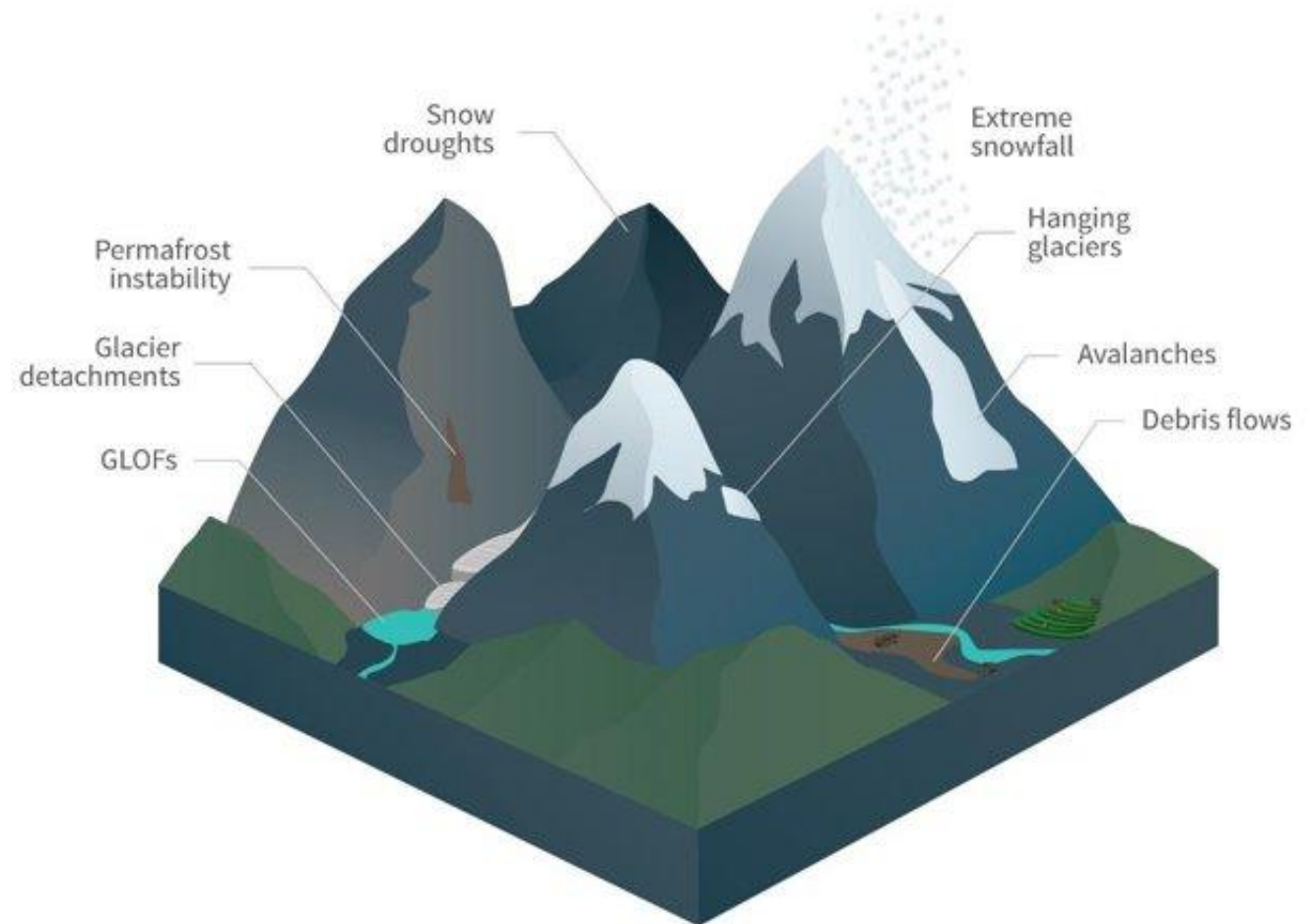
Single hazard and **multi hazards**

Due to compound drivers, hazards have become **cascading in nature** (primary hazard triggering secondary hazard)

**Cascading disaster** creates bigger impact than a single hazard

Increasing number of disasters is primarily due to increased exposure

Frequency of such disasters may increase due to climate change



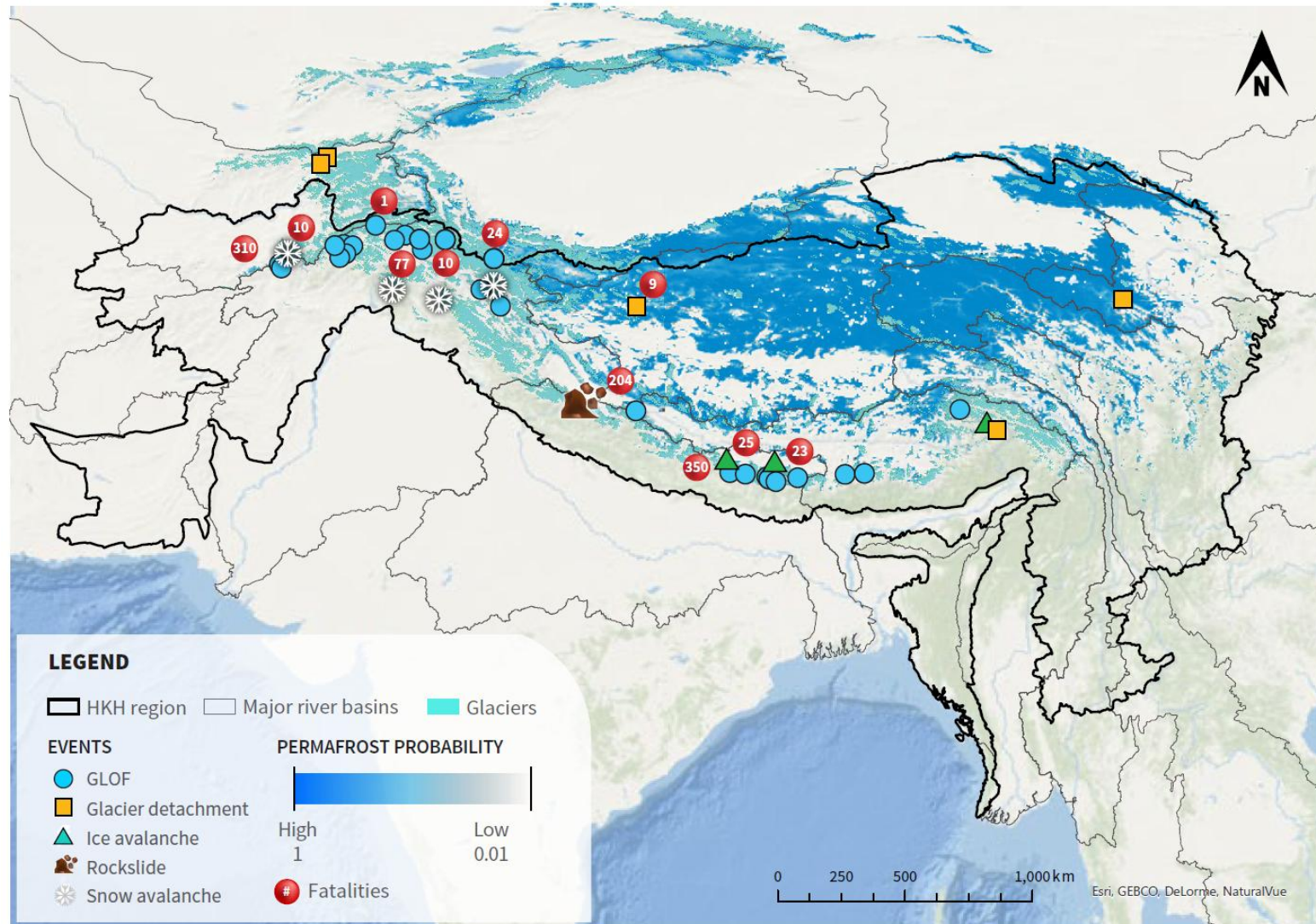
# Cryosphere-related events since 2015

Many recent disasters related to cryospheric changes documented

- GLOF
- Glacier detachment
- Ice avalanche
- Rockslides
- Snow avalanche

Casualties and infrastructure damages are recorded

Source: HIWISE report, ICIMOD



# Extreme events 2016-2025

Description	Date	Location	Impact
Bhote Koshi GLOF	August 2016	Tibet, China, Nepal	Infrastructure, Roads and agriculture land
Melamchi GLOF	June 2021	Sindhupalchowk, Nepal	
Tamakoshi floods	June 2022	Tibet, China, Nepal	
Manang Floods	June 2021	Manang, Nepal	
Gorkha floods – Birendra Tal	2023		
Barun river flood	2017	Barun Tal, Nepal	
Thame GLOF	August 2024	Solokhumbu, Nepal	
Central Nepal floods	Sept 2024	Central Nepal	
Dodhara Chandani rainfall	July 2024	Farwest Province, Nepal	
Limi GLOF	May 2025	Humla, Nepal	
Kagbeni floods	2023	Mustang, Nepal	



# Bhote Koshi GLOF: Nepal 2016

## Bhote Koshi – 45 MW Hydroelectric project

Transboundary - 6 km d/s from border between China and Nepal

Poiqu (China)/Bhote Koshi drainage basin extends to more than 6,000 m



**Event: July 2016 GLOF-** moraine-dammed lake 24 km u/s burst in the Zhangzangbo River basin

**Impact:** Significant damage to the headworks and powerhouse - large boulders, up to 8 m diameter, desanding basin, erosion of the abutment walls and the highway > US\$ 10 million

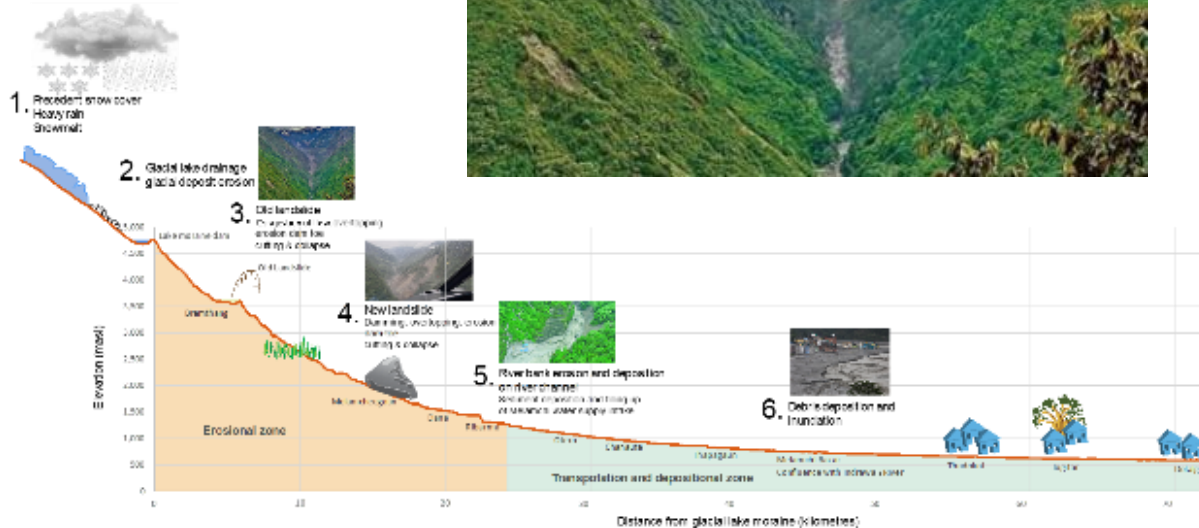


<https://www.hydroreview.com/world-regions/surviving-three-natural-disasters-lessons-learned-at-upper-bhote-koshi-in-nepal/#gref>

# Melamchi GLOF: Nepal

**Melamchi** - 320 km<sup>2</sup> basin – 5200 m

Cascading hazards with GLOF, landslides, LDOF and impacts



**Event: June 2021 GLOF-** Pemdang Khola a tributary of Melamchi

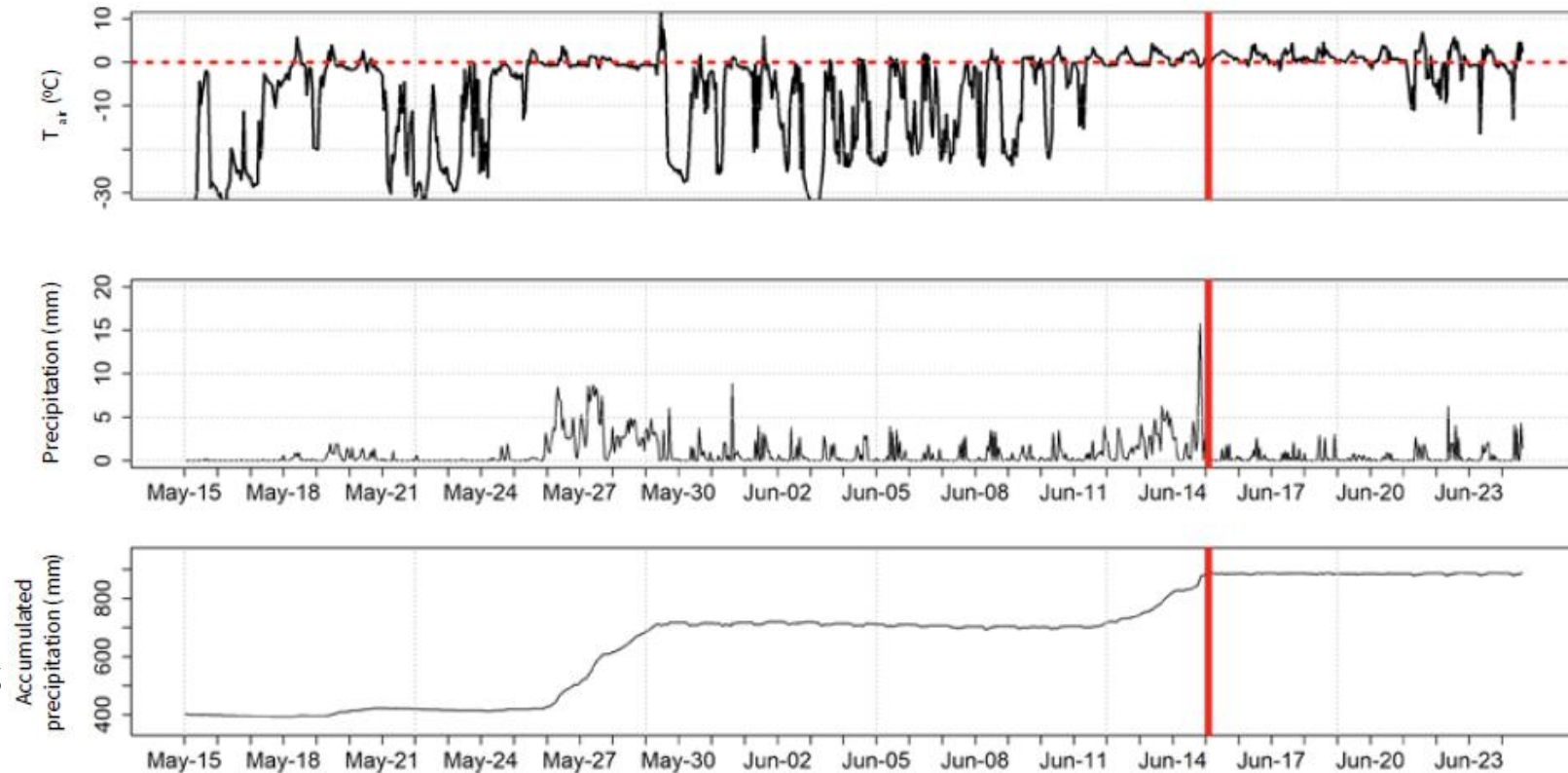
**Impact:** 25 people killed, Significant damage to d/s settlements, 6 bridges washed away, 15 meters of aggradation





# Melamchi GLOF: Nepal

- Data from the automatic weather station (AWS) in the upper part of the Melamchi watershed at an elevation of 4962 masl
- Provided evidence of the possible cause of the GLOF and subsequent disasters
- However, the station networks in higher elevations is very thin



Source: ICIMOD (data from AWS operated by ICIMOD at Ganja La in the upper Yangri Khola), Maharjan et al (2021)



# Tamakoshi floods: Nepal 2021

## Tamakoshi – 456 MW Hydroelectric project

Transboundary - 6 km d/s from border between China and Nepal

**Event:** Heavy rainfall in the upstream in the Rongxar area causing floods and temporary damming





# Manang floods: Nepal 2021

**Marshyangdi river flooding in the mountain district in Gandaki Province**

**Impact:** Five houses, including the postal office, were swept away by flood

**Event: June 2021** – Heavy rainfall leading to floods

Significant damage to the roads and bridges - Around 200 people from more than 50 families have been displaced from Naso Rural Municipality



THE KATHMANDU POST

<https://www.hydroreview.com/world-regions/surviving-three-natural-disasters-lessons-learned-at-upper-bhote-koshi-in-nepal/#gref>



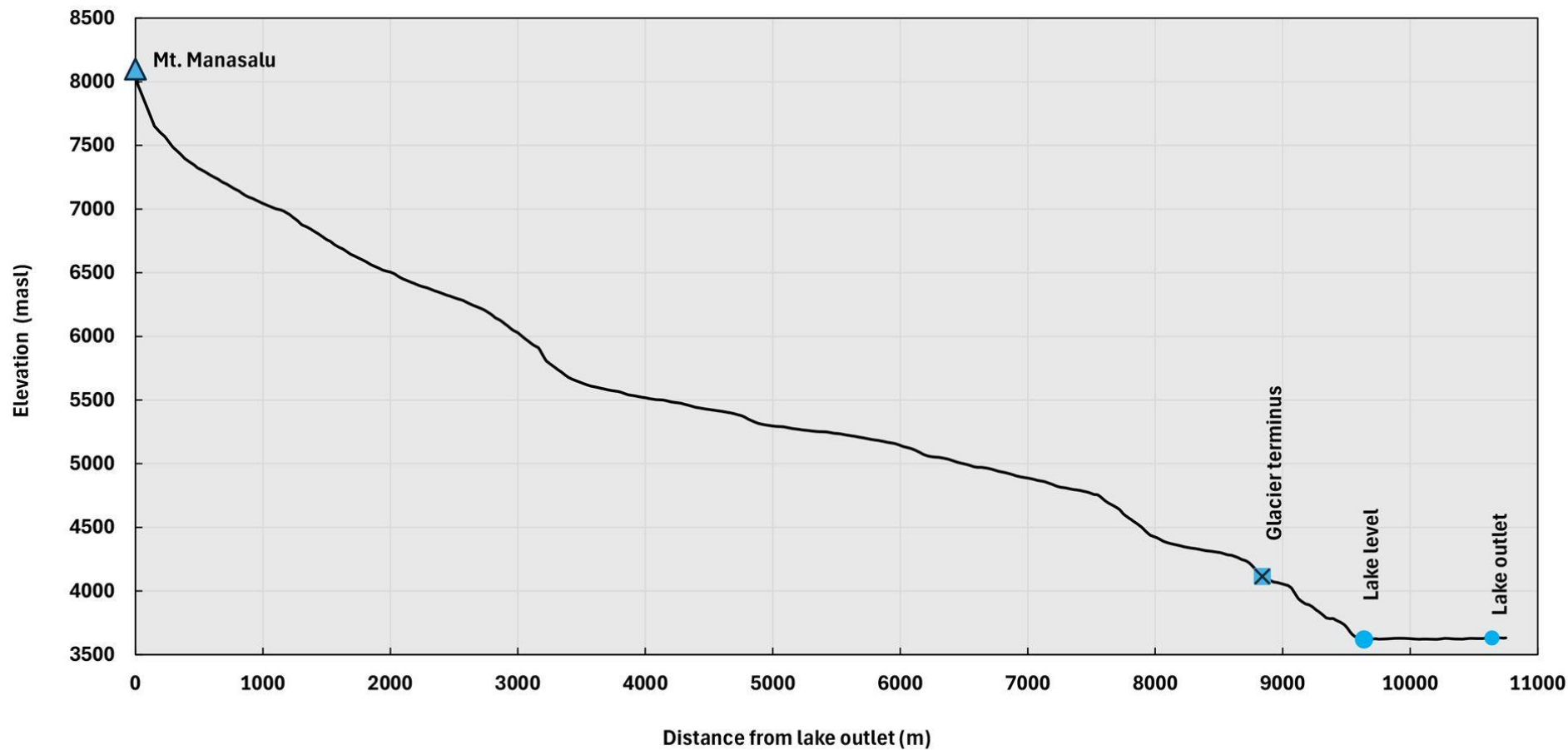
# Birendra Tal: Nepal 2023

Birendra Tal, a glacial lake (3600 m) at Samagaun, Chumanubri rural municipality-1, Gorkha

**Event:** The lake was destabilized after a huge avalanche originating in the Mt Manaslu

Authorities raised alarms over the potential for a flood in the Budhigandaki, emphasizing the **substantial risk posed to settlements downstream.**

**Impact:** Significant damage to the roads and bridges - Around 200 people from more than 50 families have been displaced from Naso Rural Municipality





# Dodhare Chandani: Nepal 2023

On July 7 and July 8, Dodhara in Kanchanpur recorded the heaviest rainfall

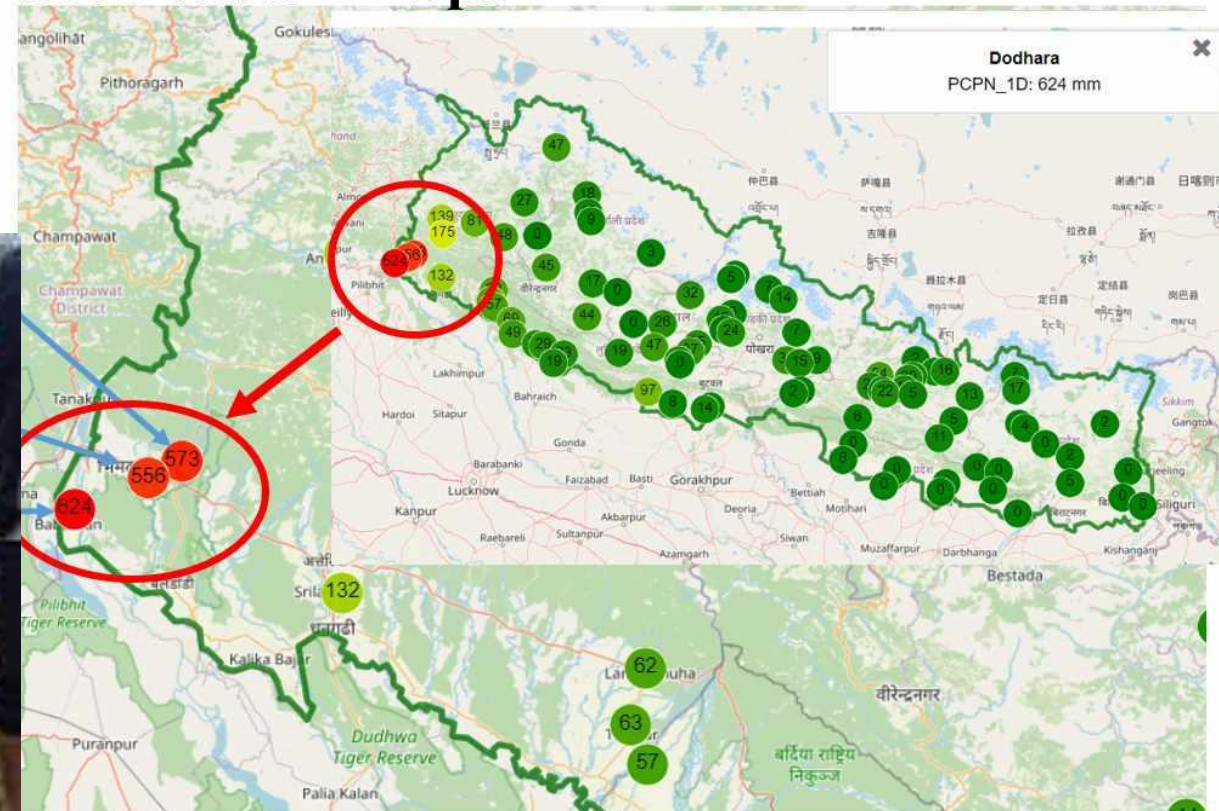
Located at banks of Mahakali river in Kanchanpur district

## Impact based forecast delivered by DHM through SMS

## No human lives lost

**624.0 mm of rain fell in Dodhara**, 573.6 mm in Hanumannagar, and 556.4 mm in Sundarpur within a 24-hour period.

## Extreme Precipitation in 7<sup>th</sup> to 8<sup>th</sup> July 2024 in Southwestern Nepal





Date: 2024 / 7 / 7 19:00-19:59 UTC Submit

-1 day -3 hour -1 hour Latest +1 hour +3 hour +1 day

GSMaP\_STD

Cloud

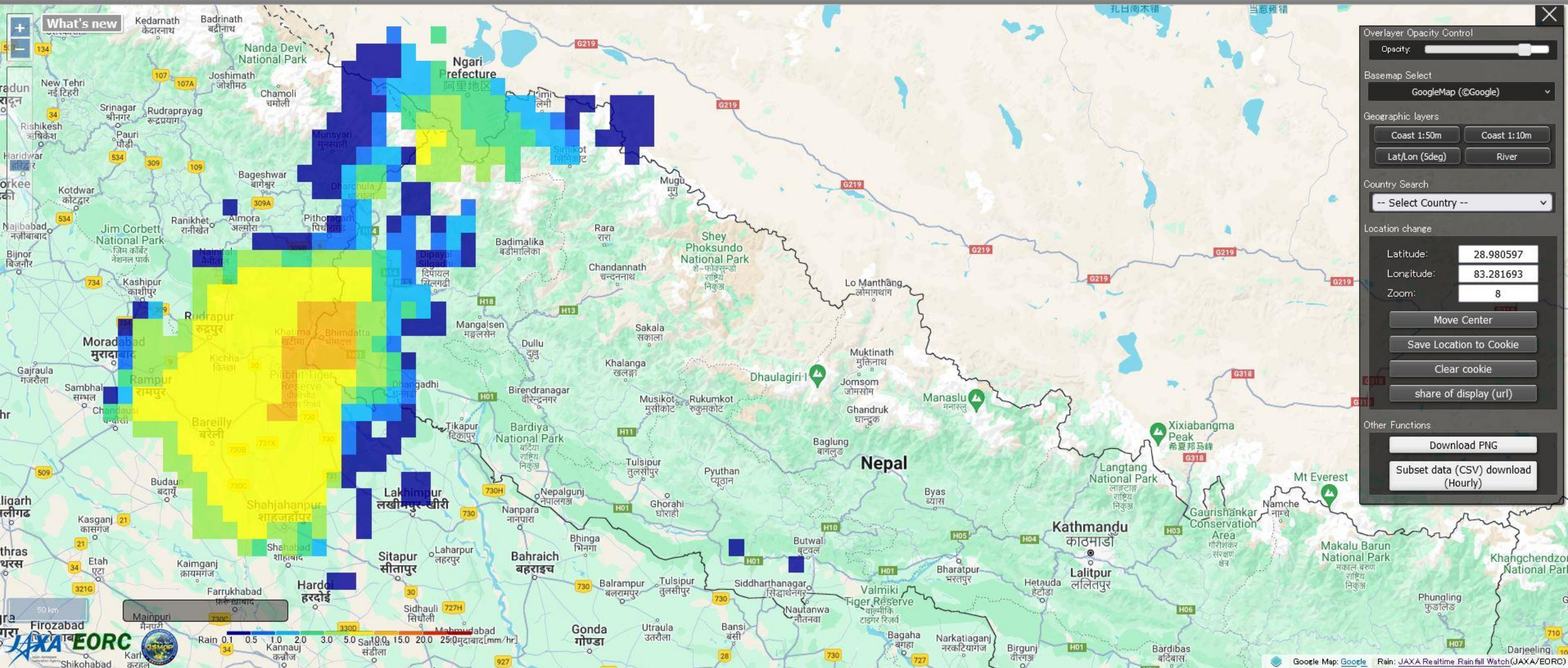
Rain

Time and Satellite

12h rainfall  
accumulation

24h rainfall  
accumulation

72h rainfall  
accumulation



Overlay Opacity Control

Opacity:

Basemap Select

GoogleMap (©Google)

Geographic layers

Coast 1:50m Coast 1:10m

Lat/Lon (5deg) River

Country Search

-- Select Country --

Location change

Latitude: 28.980597

Longitude: 83.281693

Zoom: 8

Move Center

Save Location to Cookie

Clear cookie

share of display (url)

Other Functions

Download PNG

Subset data (CSV) download (Hourly)



# Thame GLOF

GLOF struck  
Thame, a village  
(3800 m) in the  
Everest region in  
Solukhumbu  
District of Nepal  
on 16 August 2024

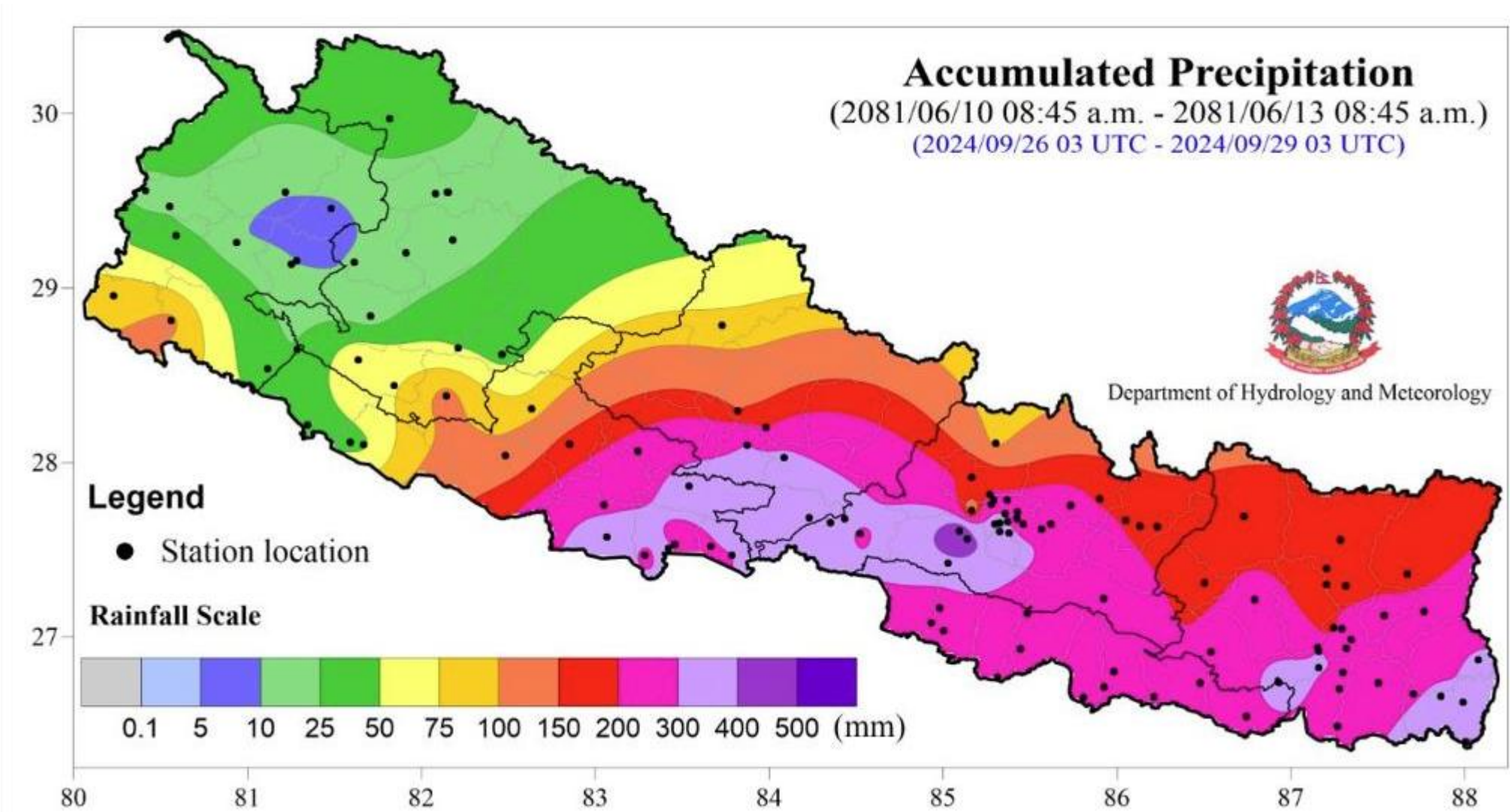
GLOF occurred  
from the outburst  
of Thyanbo glacial  
lake (4750 m).

Source: NDRRMA



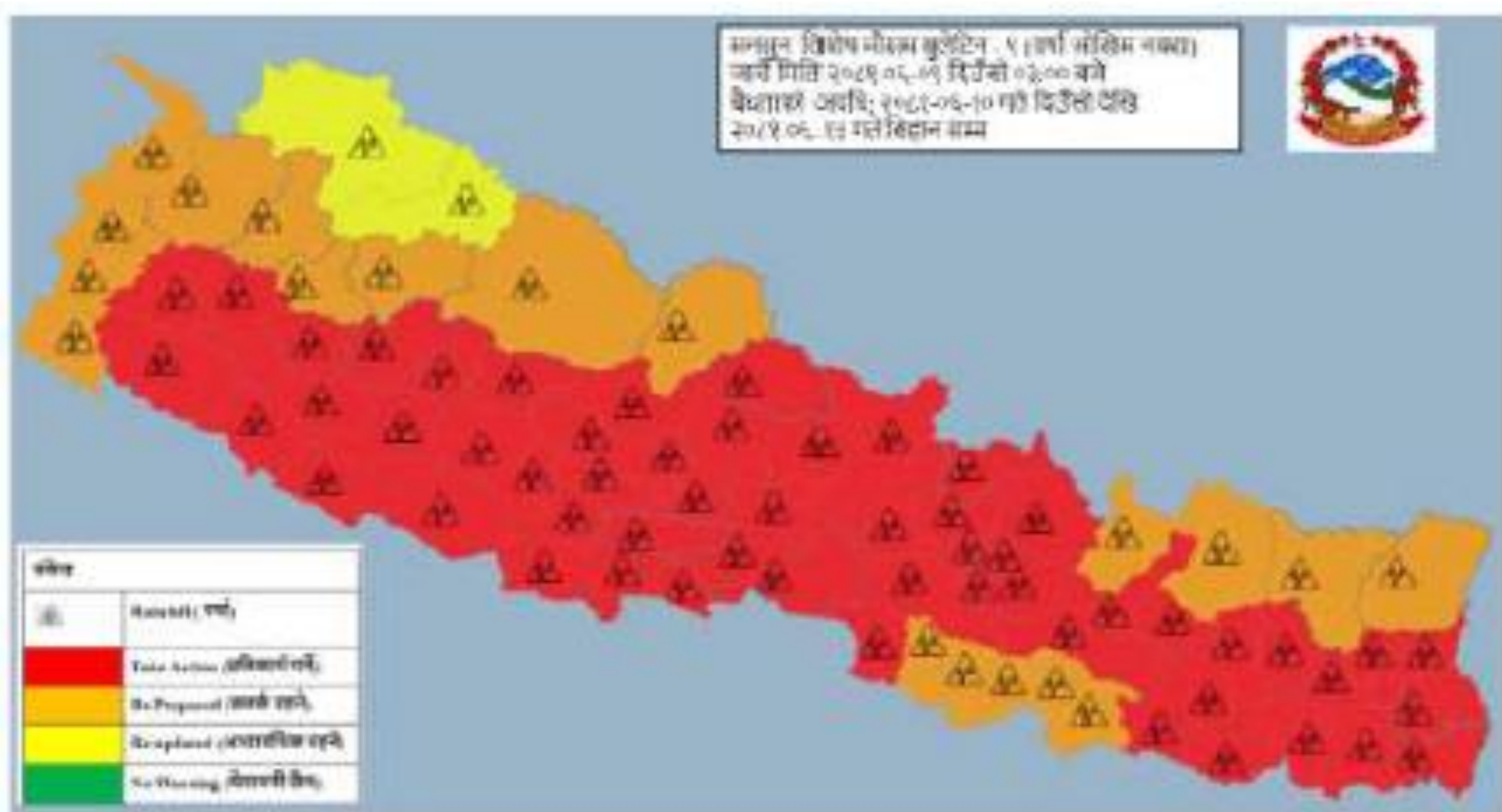


# 3-day accumulated ppt in Nepal: September 2024





# Special bulletin: 25 September





# Rapid assessment of the floods in the Bagmati river in Kathmandu Valley

**ANALYSED AREA**  
~450 km<sup>2</sup>

**TOTAL POPULATION IN ANALYSED AREA**  
~5 M

**TOTAL CROPLAND IN ANALYSED AREA**  
~120 km<sup>2</sup>

**TOTAL BUILDINGS IN ANALYSED AREA**  
~800,000

**FLOOD EXTENT**  
~8 km<sup>2</sup>

**POPULATION POTENTIALLY AFFECTED**  
~46,000

**POTENTIALLY AFFECTED CROPLAND**  
~4 km<sup>2</sup>

**POTENTIALLY AFFECTED BUILDINGS**  
~5,000

### Flood Impact assessment of the Capital city of Kathmandu, Bagmati Province, Nepal as of 30 September 2024

This map illustrates the floods using Spot-6 image acquired on 30 September 2024 at 14:20 local time (08:35 UTC). Within the analysed area of about 450 km<sup>2</sup>, a total of about 8 km<sup>2</sup> of land appears to be affected by flood waters, and about 4 km<sup>2</sup> of cropland appears to be inundated. Based on Worldpop spatial demographic data, about 46,000 people are exposed or living close to flooded areas.

UNITAR-UNOSAT identified about 5,000 potentially affected structures within the analysed area.

This is a preliminary analysis and has not yet been validated in the field. Please send ground feedback to the United Nations Satellite Centre (UNOSAT).

#### Legend

- Potentially affected structure
- City/Town
- River
- Primary road
- District boundary
- Permanent water
- Satellite detected water extent (30 Sep. 2024)

**Kathmandu**

**BAGMATI**

**Lalitpur**

**Bhaktapur**

**INSET 1**

**INSET 2**

See inset 1 for close up view

See inset 2 for close up view

Map location

cnes



# Nakhu khola

## AOI1- KATHMANDU, BAGMATI PROVINCE

Flooded structures observed along the waterway

Image center:  
85°18'3"E  
27°39'46"N



WorldView-2 / 13 January 2024



Spot-6 / 30 September 2024

4





# Kagbeni Floods: Nepal 2023

On Aug 13, village of Kagbeni, Mustang district is struck by a flood

The Kag khola, dammed upstream by a landslide, burst flooding the lower reaches.

Originated from above 3600 m.

**Impact:** washed away 29 houses and displaced more than 150 people

One motorable bridge, 1 steel truss bridge and 3 temporary bridges were destroyed





# Limi Floods: Nepal 2025

On May 15, village of Til, Limi valley in the remote Humla district is struck by a flood (4100 m elevation)

A similar flood occurred in May 2011

“If the cryosphere is a barometer of the planet, then Limi is the siren. And the alarm is blaring” - Tashi Lhazom

**Impact:** lost critical infrastructure - primary drinking water source, a recently constructed hydropower plant, 25 agricultural fields, four irrigation canals, a water mill, the main road to the local monastery, and the community water tank.





# Extremes in the future

RCP 4.5

RCP 8.5

Average Q

( $\text{m}^3\text{s}^{-1}$ )

0

>4000

**Mean Relative Change [%]**

0

100

200

300

Extremes will increase strongly during the 21st century, almost doubling in magnitude by the end of the century

Source: Wijngaard et al. (2017)



TRAINING ON

# **Spatial and temporal analysis of climate change indices using the Climate Data Analytical Tool and CORDEX datasets over South Asia**

21–24 June 2022 | Dhulikhel and Kathmandu, Nepal

**Organised by**

International Centre for Integrated Mountain Development (ICIMOD)  
and Met Office (MO)





# Key messages

**Frequency and intensity of extreme events in higher elevations** are increasing

**Co-develop and co-design solutions/ EWS with new innovative techniques and approaches** as cascading disasters are on the rise for resilient infrastructure development and climate resilience

**Science-based evidence** at local level and **tailored climate services** that is actionable is critical for decision making

**Governments must invest in** glacial lake monitoring, transnational EWS and open data-sharing to improve preparedness. The focus of adaptation strategies should integrate long-term perspectives and emphasize socioeconomic impact assessments.





**Thank you**