WATER LEADERS FORUM (WLF-6) | 9th INDIA INTERNATIONAL WATER WEEK 2026

Influence of Climate Change on Extreme Events

Session: Climate Resilient Adaptation Measures in Water Resources

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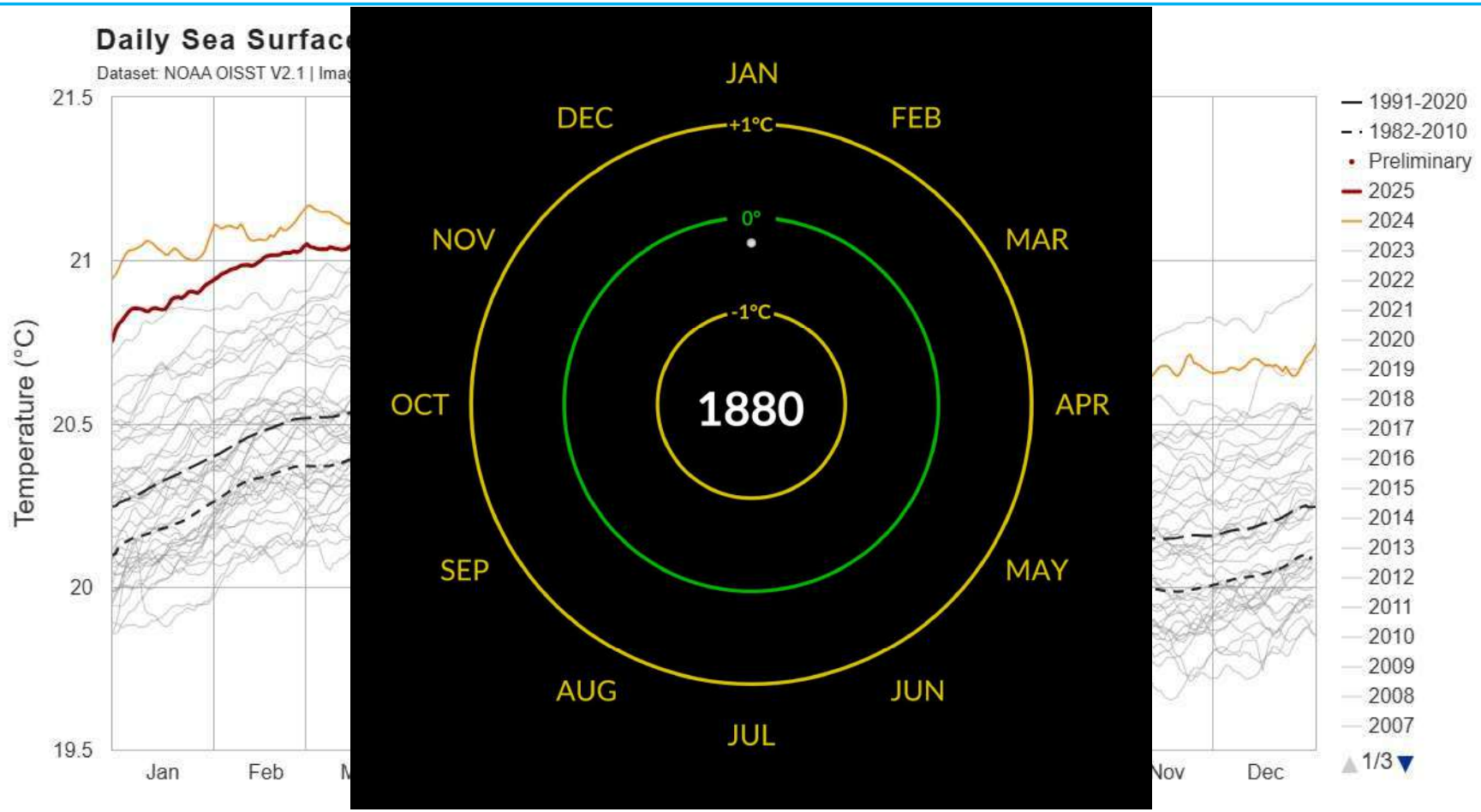
National Disaster Management Authority

24 September 2026 • Bharat Mandapam, New Delhi

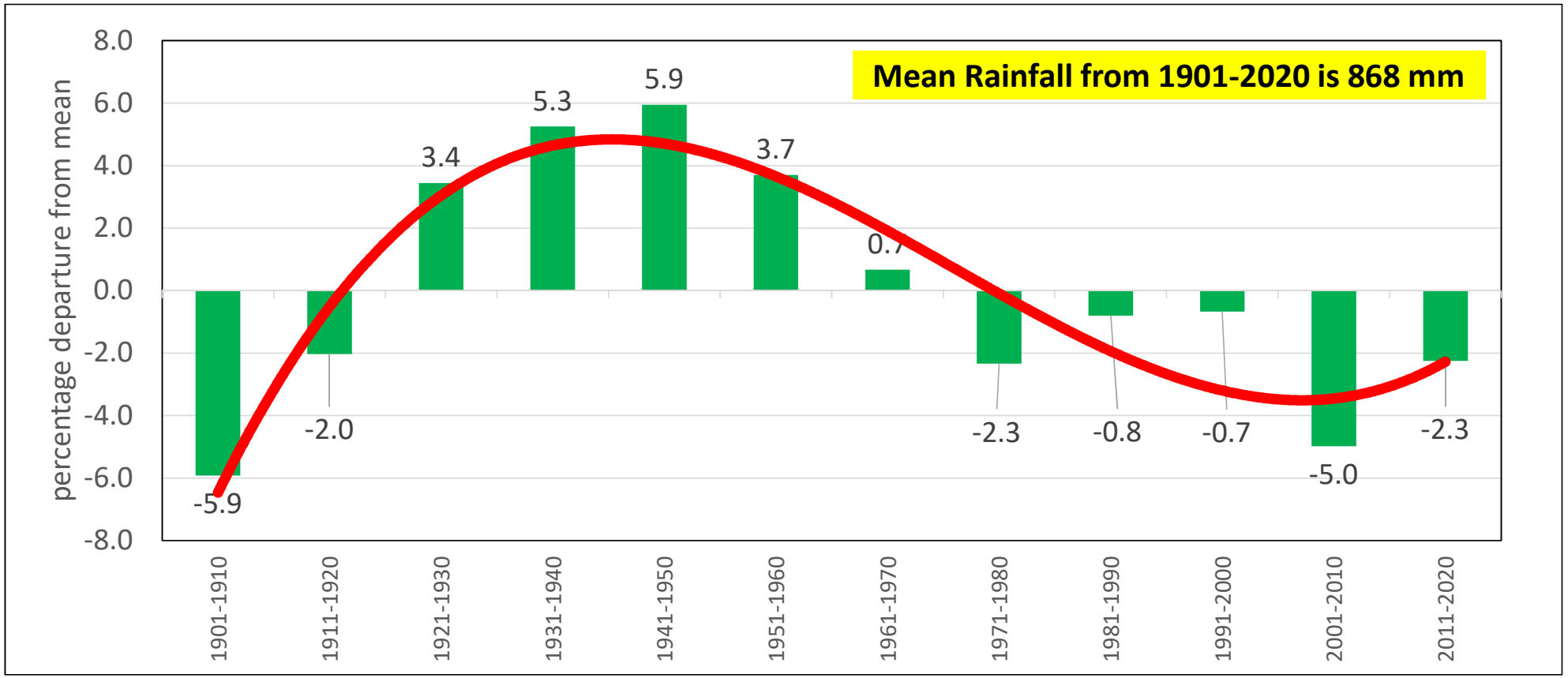
Structure of Presentation

1. Climate Assessment
2. What we have witnessed
3. GLOF Risk Landscape
4. NDMA's Interventions
5. Adaptation Priorities for Water Sector
6. Implications for Disaster Management
7. Way Forward

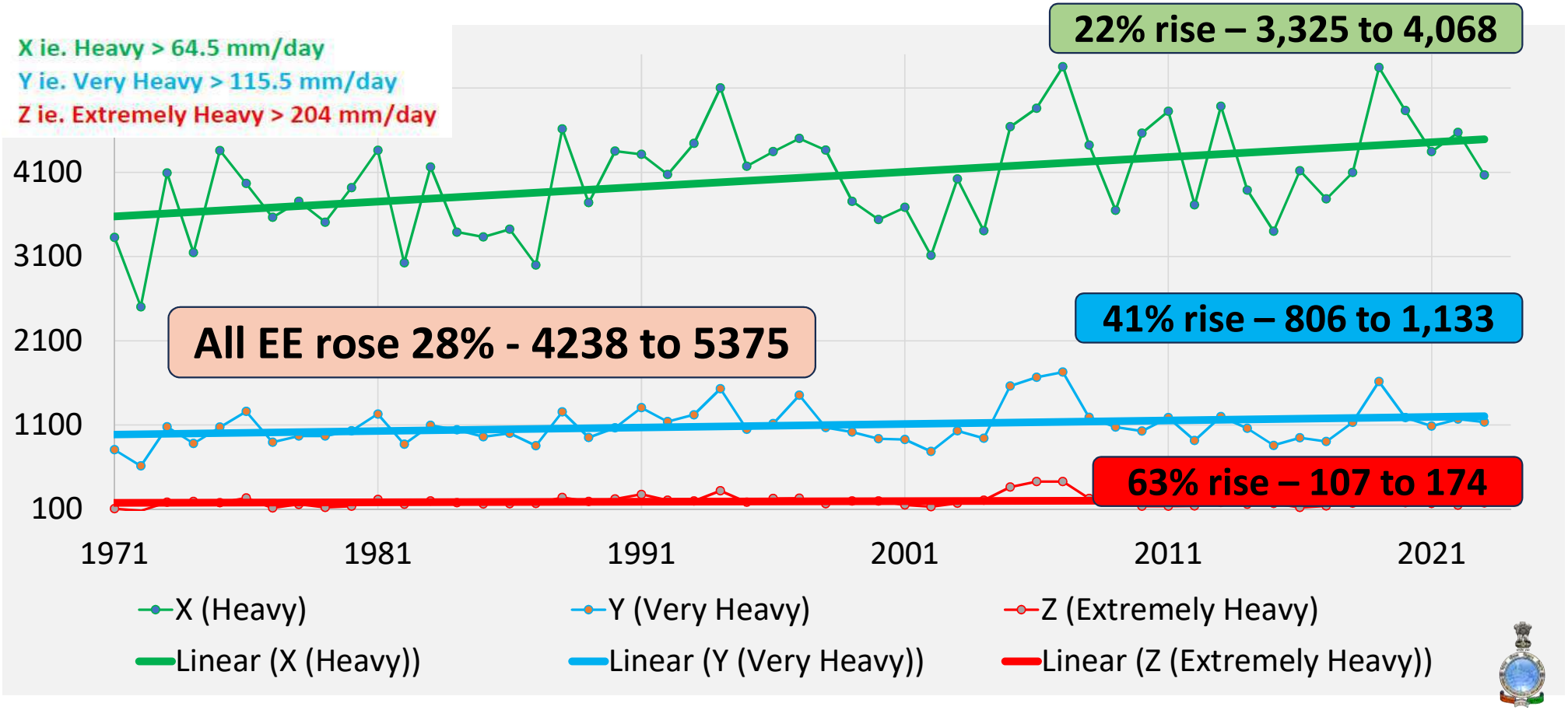
1. Climate Assessment


Daily Sea Surface
Dataset: NOAA OISST V2.1 | Imag
Temperature (°C)
21.5
21
20.5
20
19.5
Jan
Feb
Nov
Dec
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
+1°C
0°
-1°C
1880
1991-2020
1982-2010
Preliminary
2025
2024
2023
2022
2021
2020
2019
2018
2017
2016
2015
2014
2013
2012
2011
2010
2009
2008
2007
1/3

Polynomial Decadal Variation (% from average)



Extreme Rainfall Events (1971-2023)



Understanding Extreme Events

Extreme weather and climate events are rare occurrences that fall in the tails of the statistical distribution of a climate variable – typically beyond the 90th or 95th percentile – and can cause significant socio-economic and environmental impacts.



Heavy Precipitation & Floods



Heatwaves & Temperature Extremes



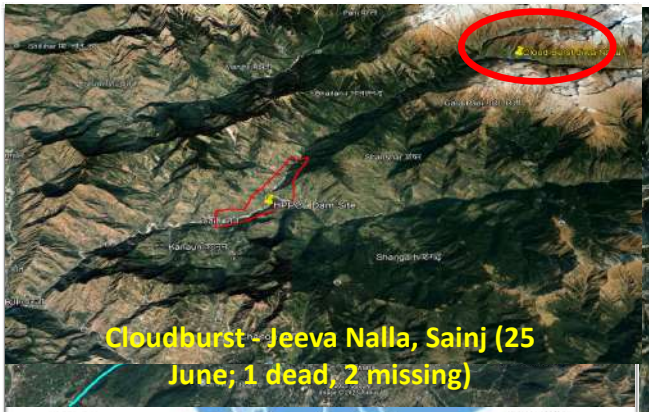
Droughts & Water Scarcity



Compound & Cascading Events

2. What we have witnessed

Seraj, Karsog, Janjehli Area of Mandi in HP

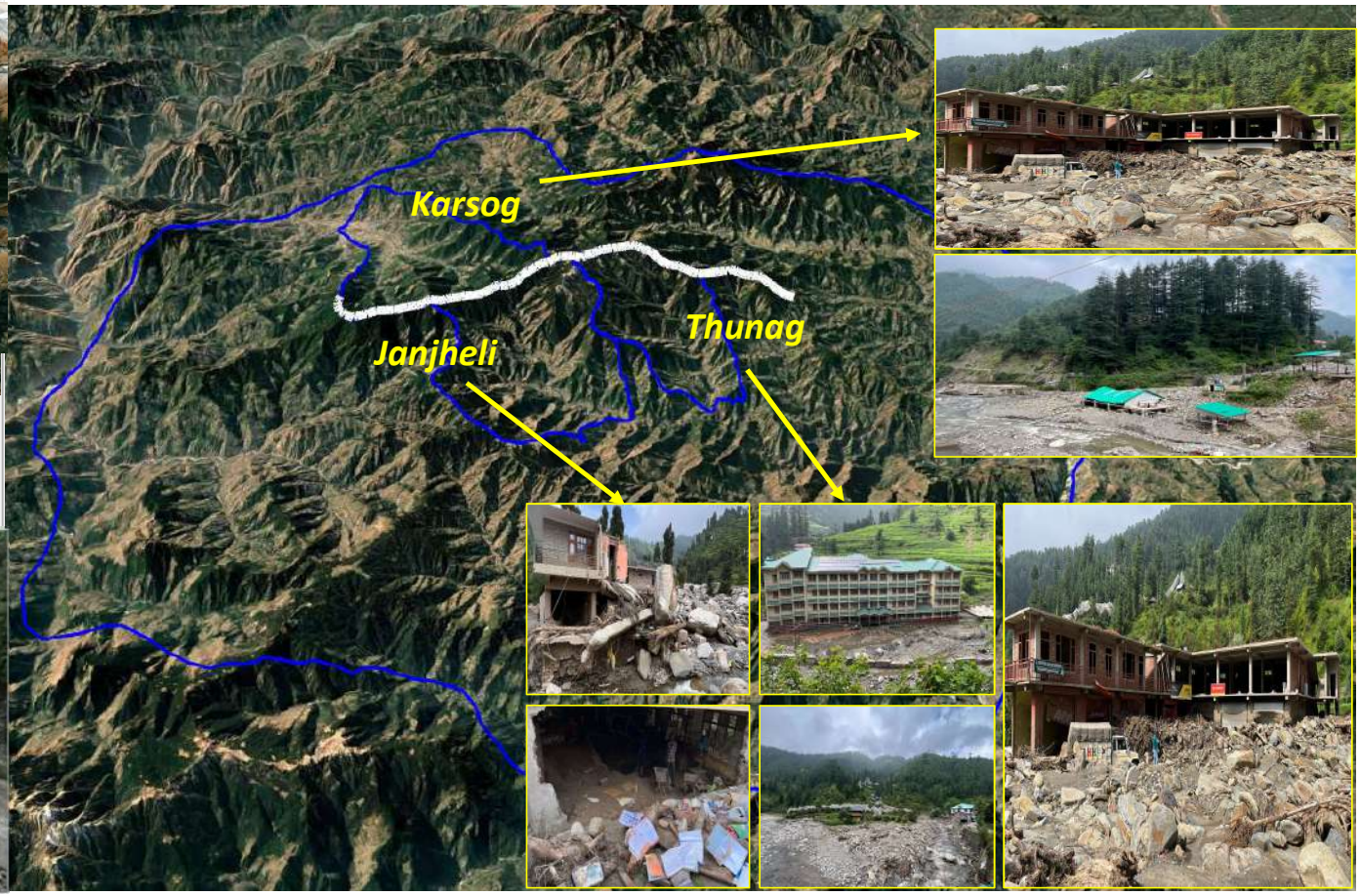


Cloudburst - Jeeva Nalla, Sainj (25 June; 1 dead, 2 missing)





WSS Scheme was damaged in Balichowki Block

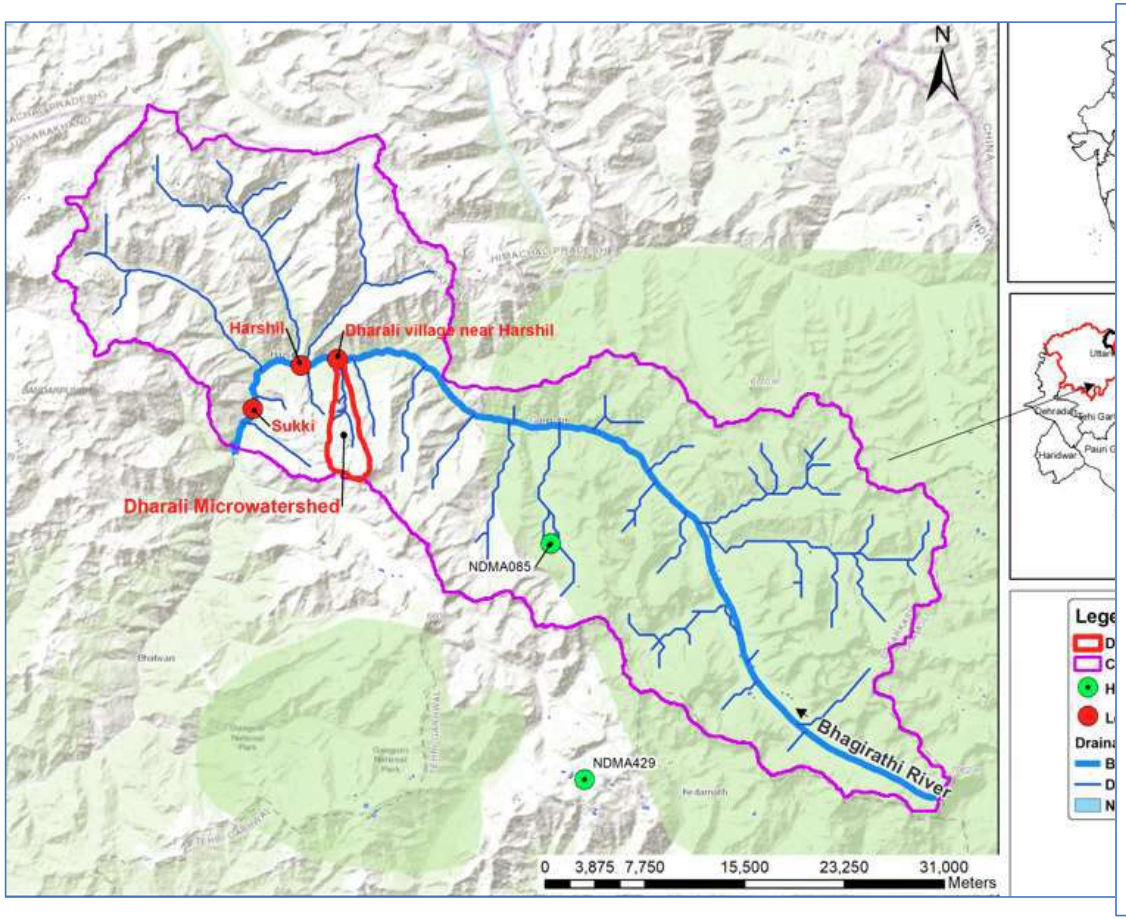


Janjehli Area of Mandi in HP (Drone footage)

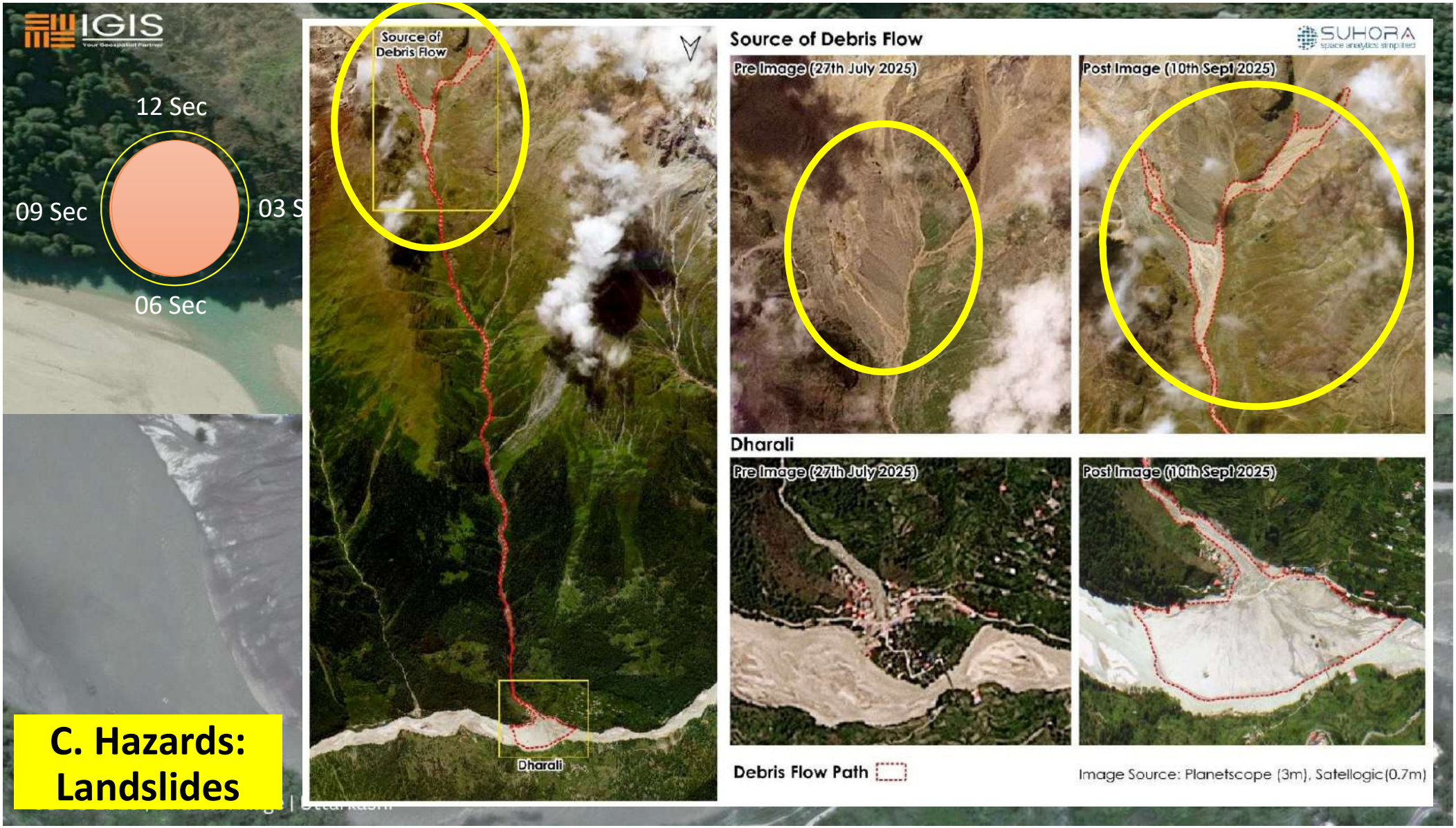




Dharali, Uttarkashi: Cascading Glacio-Fluvial Hydro-Met Landslide



- Catastrophic flash floods and debris flows in Dharali, Uttarkashi (Aug 5, 2025)
- Likely causes: Cloudburst, Glacial Lake Outburst Flood (GLOF), slope failures
- Losses: 5–60+ lives, ₹200–12,000 crore, tourism hit
- Altered river morphology, ecosystem damage
- **Infrastructure Impact Assessment -** ISRO's comparative satellite imagery analysis identified 130+ structures directly impacted or destroyed by the debris flow

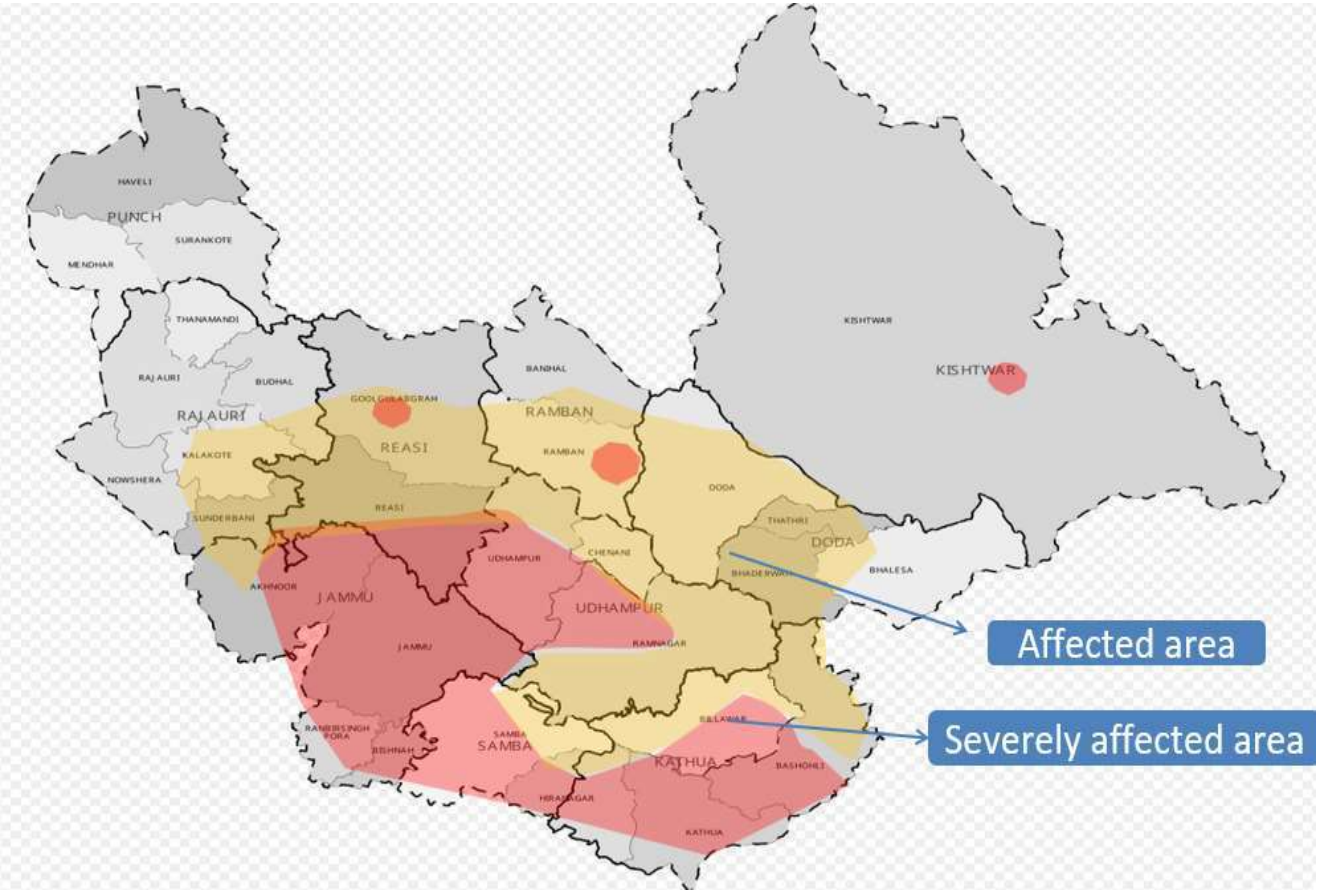


C. Hazards: Landslides

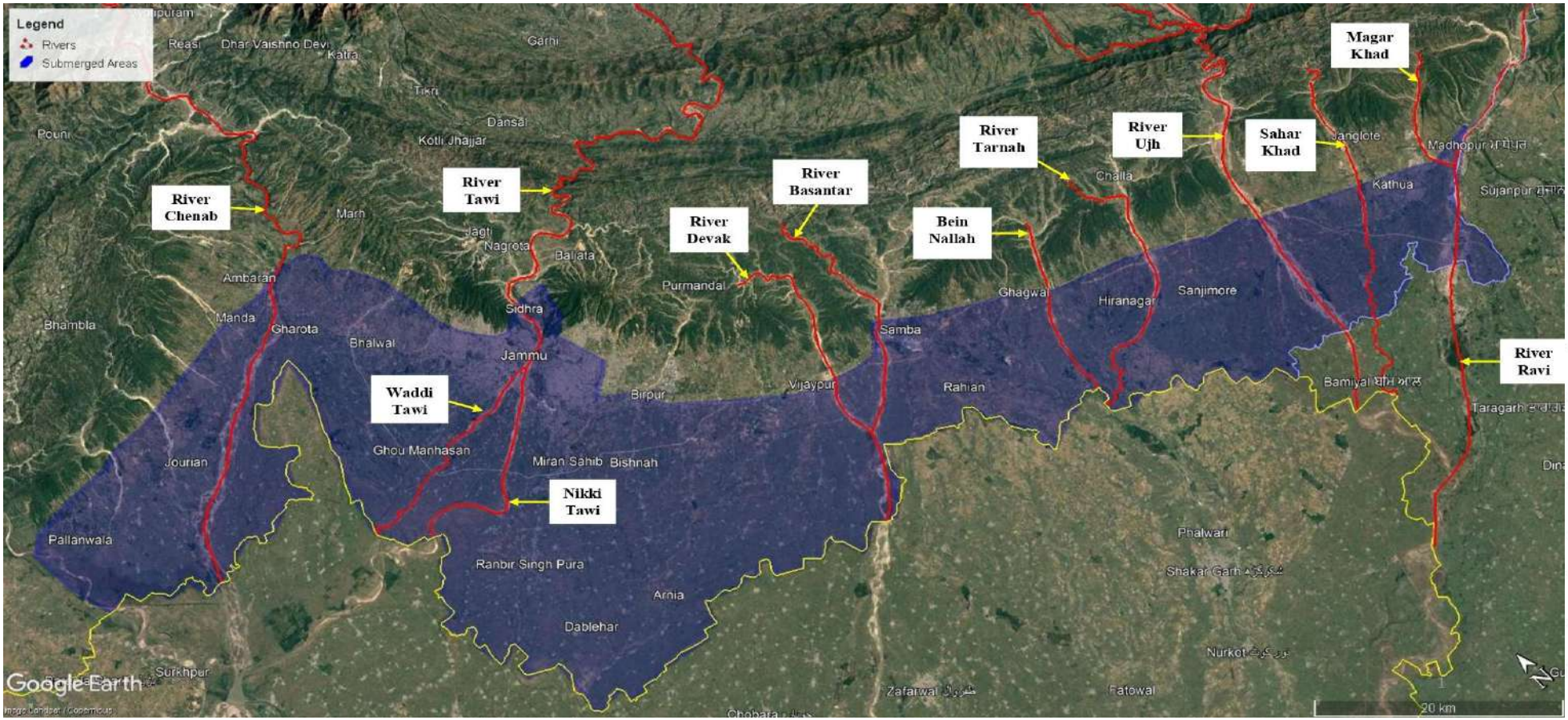
Jammu and Kashmir

Heavy rainfall, floods and landslides in Jammu Division

- August 14, 2025 - Chishoti (Kishtwar)
- August 16-17, 2025 – Kathua
- August 26-27, 2025 - Jammu, Samba, Kathua, Reasi, Udhampur and Doda
- August 30, 2025 - Rajgarh (Ramban) and Baddar (Reasi)



Jammu and Kashmir – Aug 23-27



Jammu and Kashmir – Aug 23-27



Damaged houses, 4th Bridge Jammu



Peer Kho (Jammu)



Tawi River (Jammu) on 26th August



Tarnah River (Kathua) on 17th August



Submergence at Kathua



IIIM Hostel (Jammu)



4th Bridge Tawi, Jammu

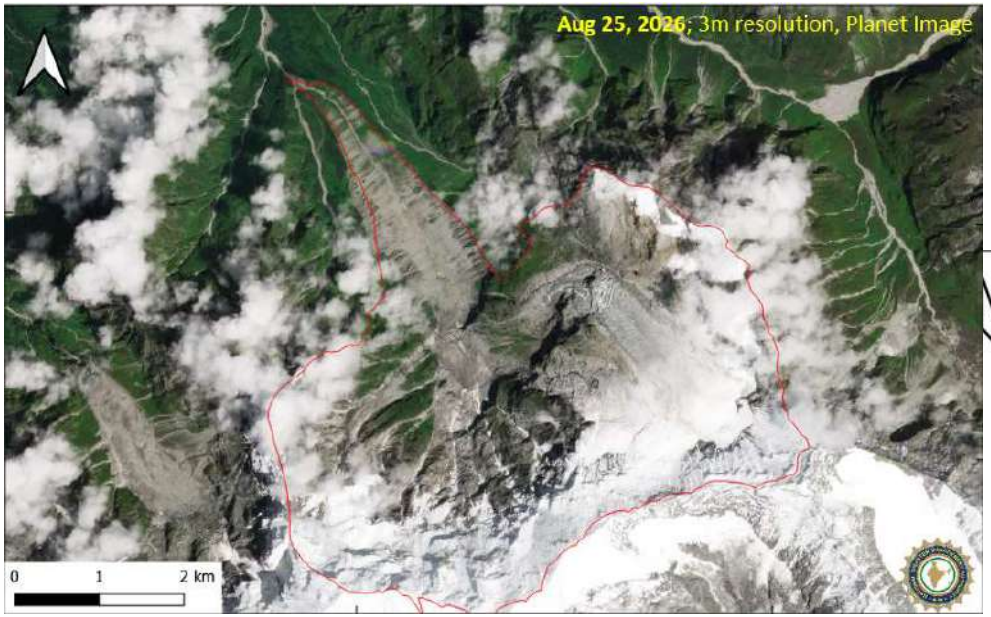


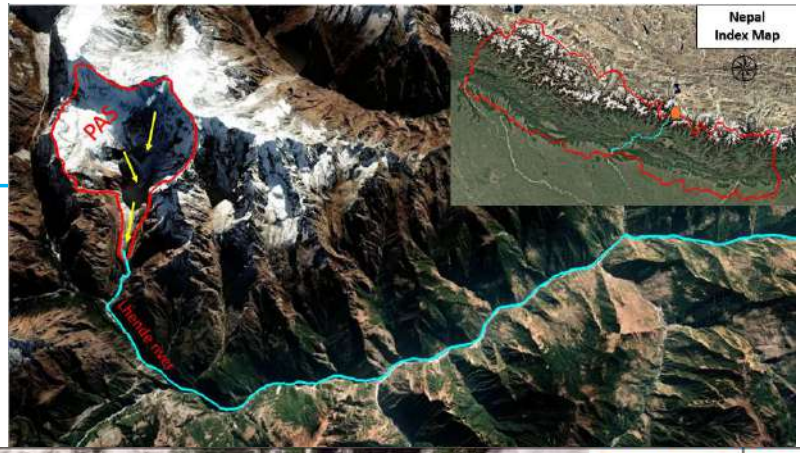
R.S.Pura (Jammu)



SKAUST-Jammu

Rasuwa/Bhote Koshi flood– Aug 26

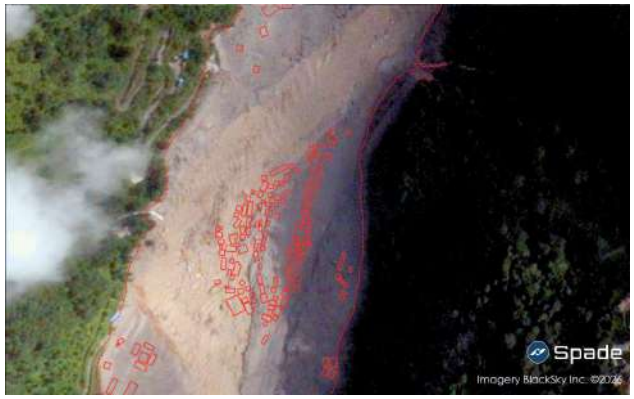




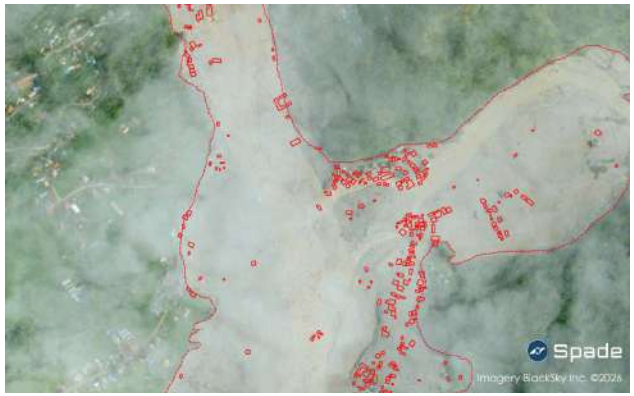


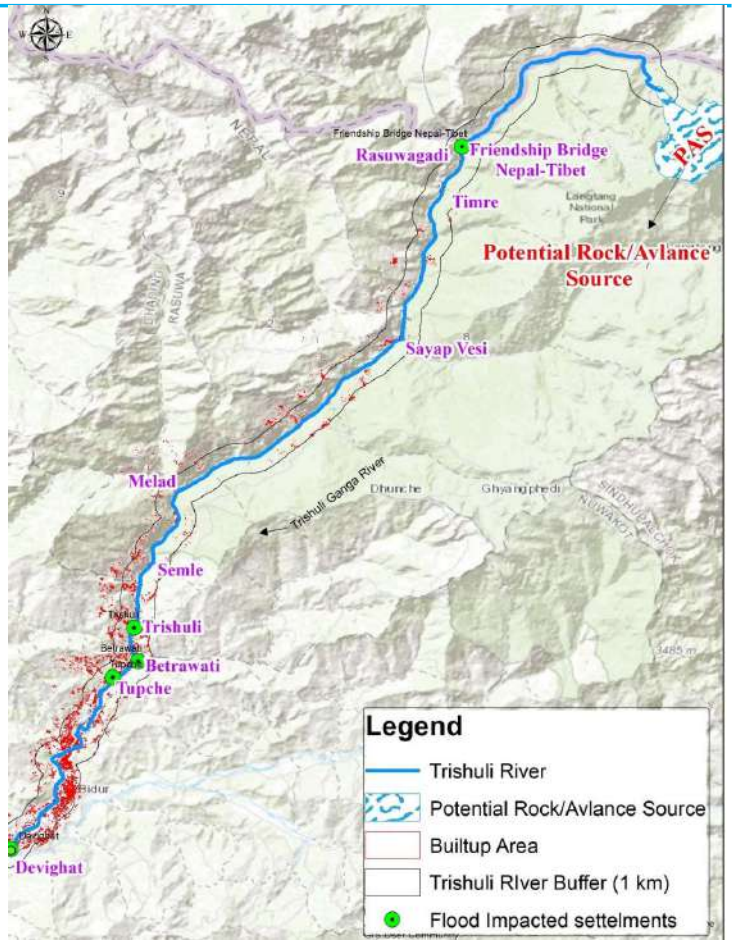
Impacted Downstream Area-Trisuli River Catchment







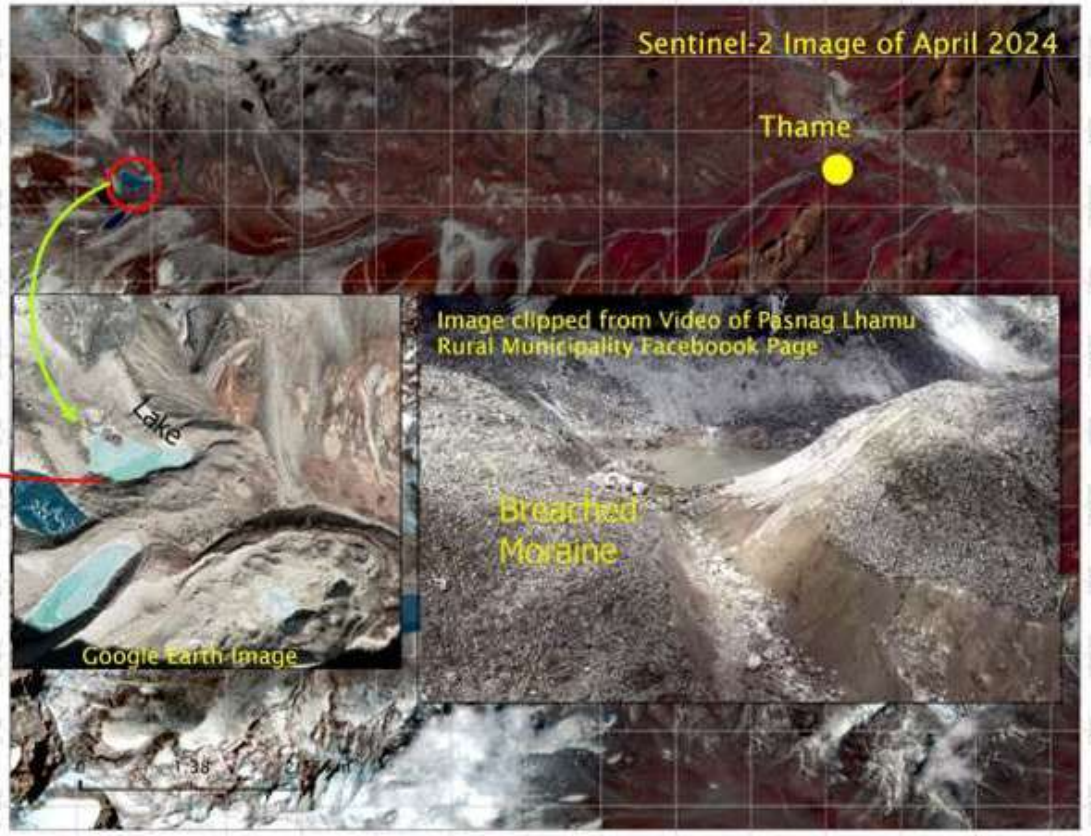




Thame Flood, Nepal, 16 Aug 2024



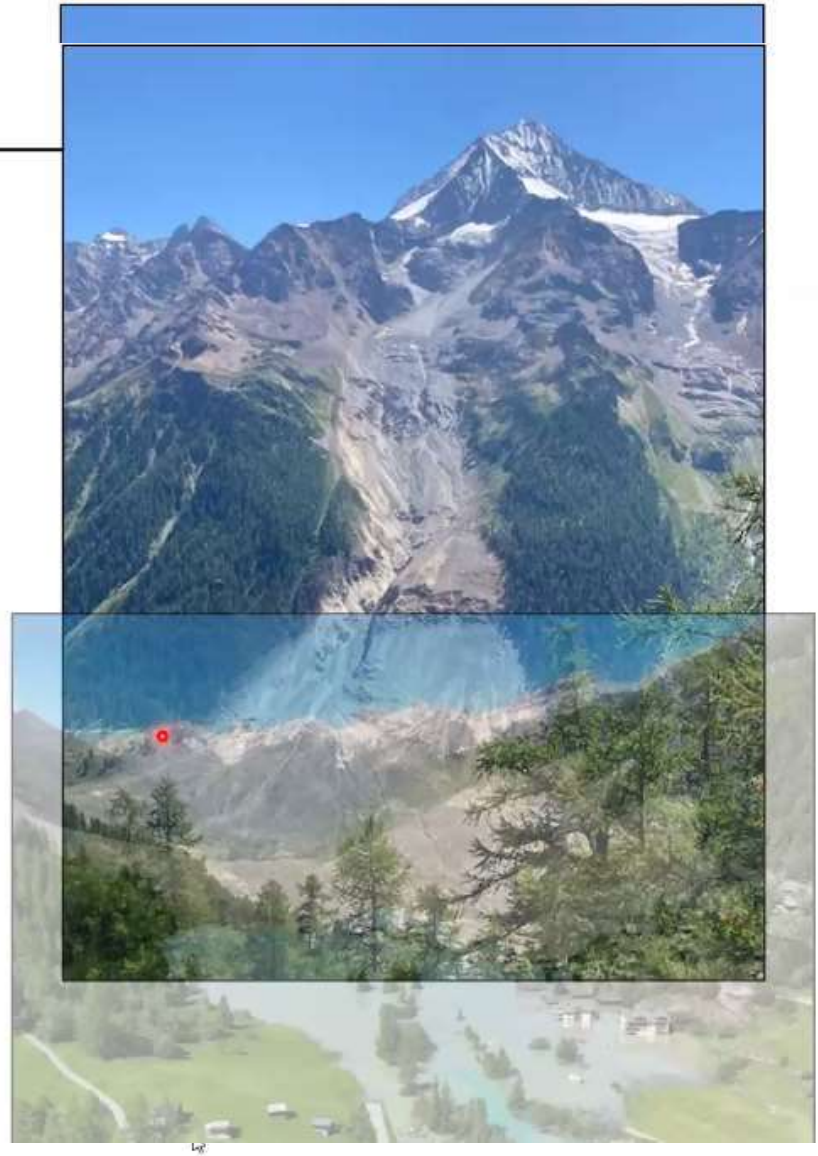
- About 135 displaced
- > 20 houses destroyed
- Elementary school
- Clinic



Blatten

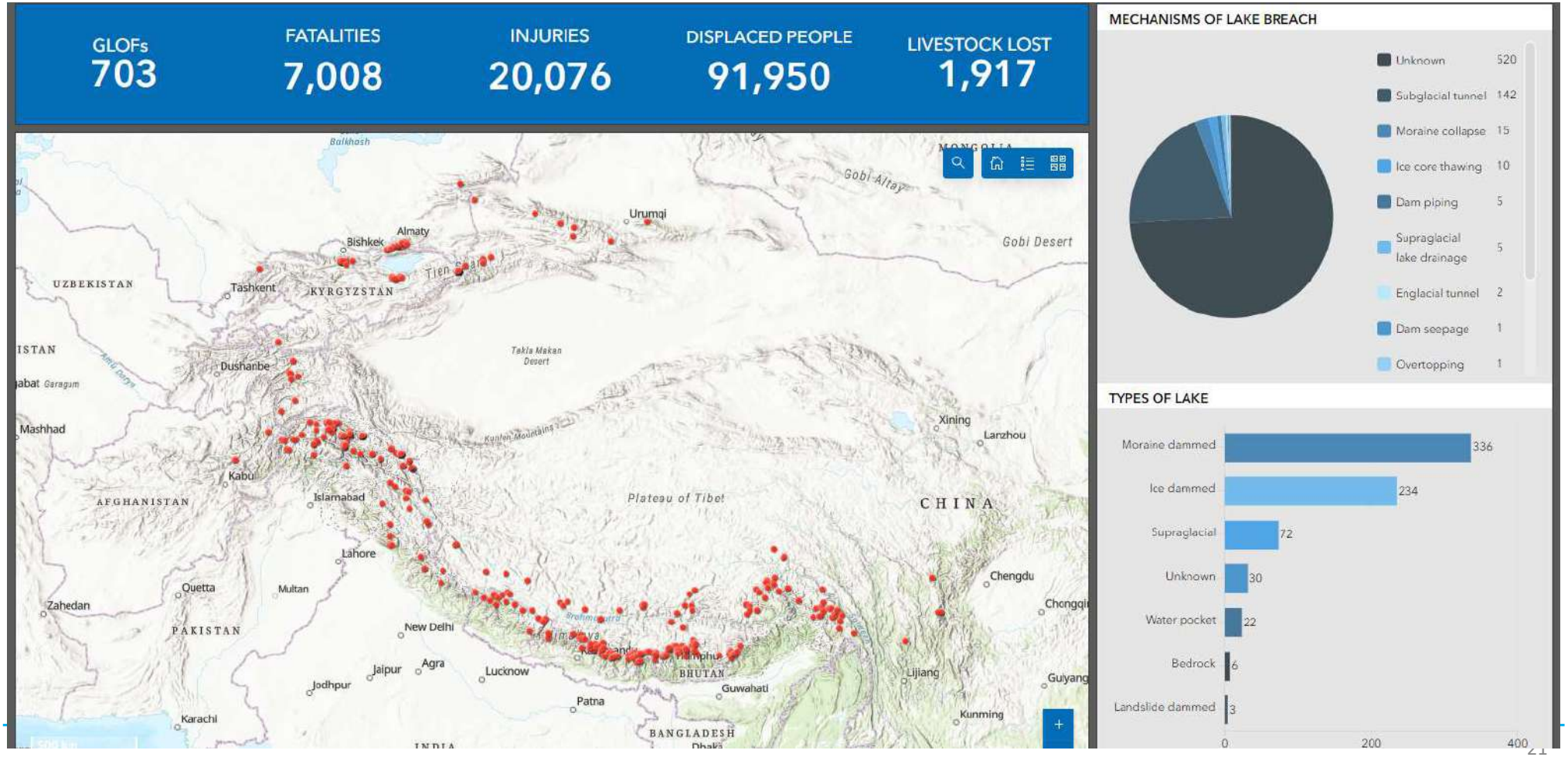


map.geo.admin.ch, SRF

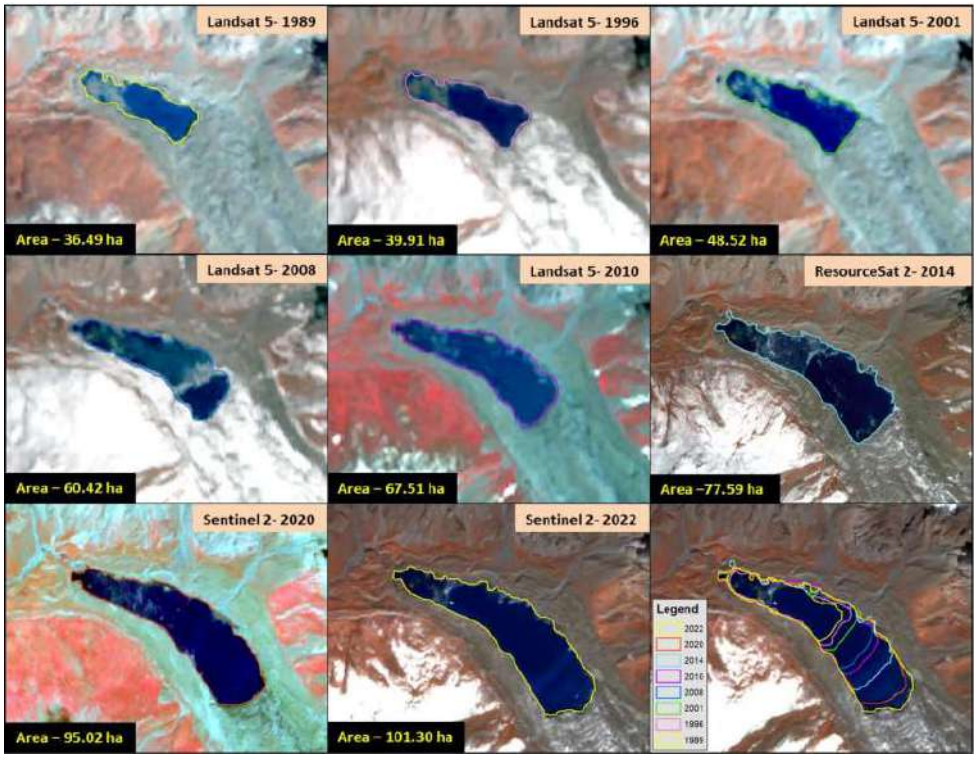


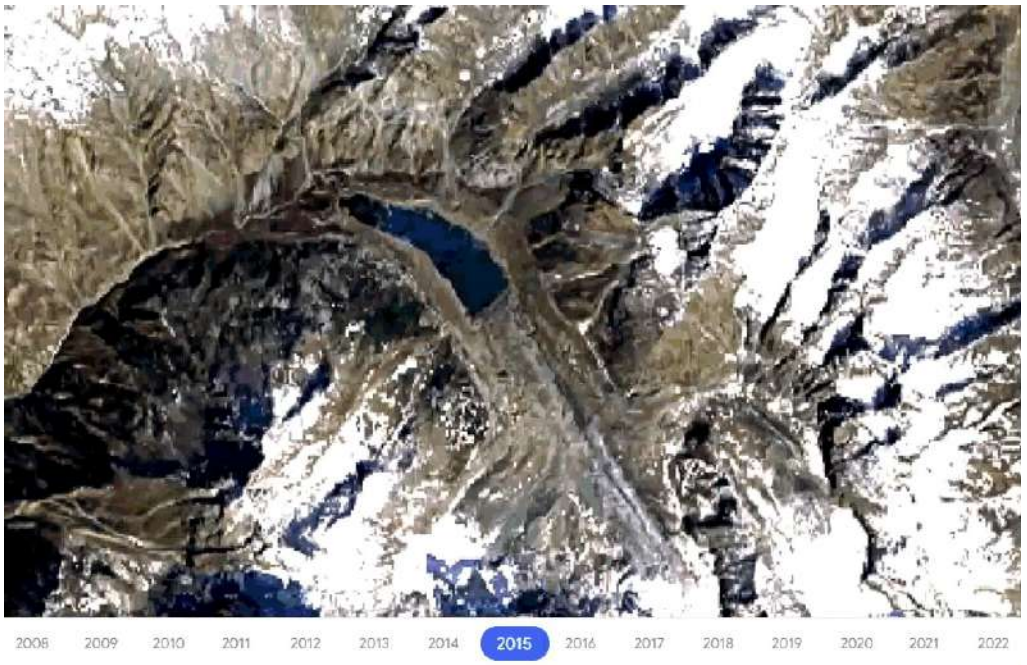
3. GLOF Risk Landscape

GLOFs in High Mountain Asia



Development of Glacial Lake (Ghephang Gath GL)

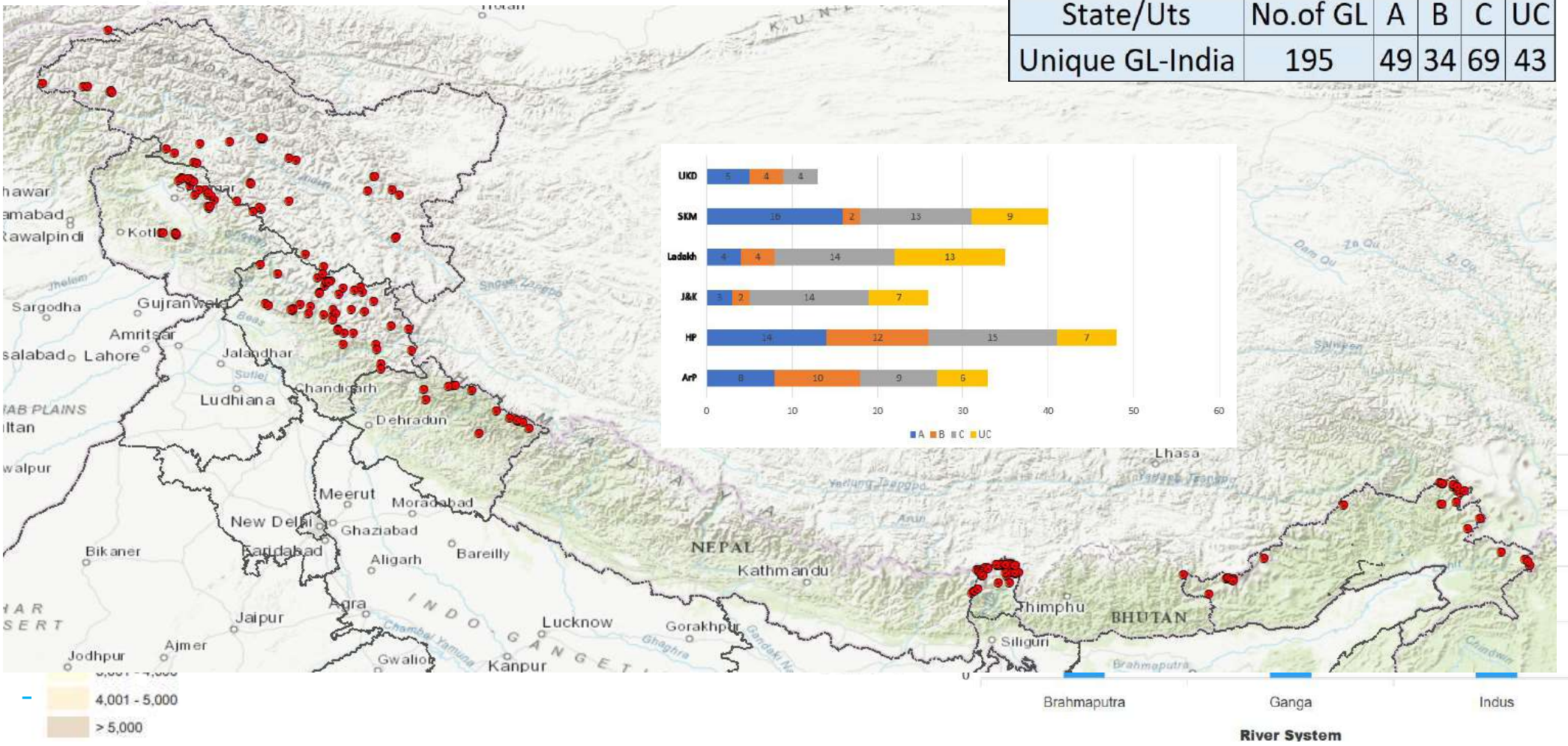




Long-term changes in Ghepang Ghat Glacial Lake water spread area

GLOF Risk in Indian Himalayan Region

State/Uts	No.of GL	A	B	C	UC
Unique GL-India	195	49	34	69	43



Why Priority Attention is Essential

~7,500+

Glacial lakes in the
Indian Himalayan Region

195

High-risk lakes prioritised
by NDMA for action

6

States / UTs covered
HP, UK, Sikkim, Arunachal, J&K, Ladakh

- Sudden release of millions of m^3 of water can generate peak flows of several thousand cumecs.
- Downstream impacts extend tens to hundreds of kilometres - hydropower, roads, bridges, settlements.
- GLOFs cascade into landslides, debris flows and channel avulsion, amplifying multi-hazard impact.
- Transboundary and domestic events (Rasuwa, South Lhonak, others) show the urgency of anticipatory action.

4. NDMA's Interventions

Mitigation Programmes Supported by NDMA

- National GLOF Risk Mitigation Programme (NGRMP) : 4 Himalayan states (₹ 150 Cr)
- National Landslide Risk Mitigation Programme (NLRMP), : 15 states (₹ 1000)
- Urban Flood Risk Mitigation Programme (UFRMP-I , ₹3,075.65 Cr): seven most populous cities Mumbai, Pune, Hyderabad, Kolkata, Bengaluru, Ahmedabad and Chennai) , (UFRMP-II, 2444 Cr): eleven cities — Guwahati, Patna, Kanpur, Trivandrum, Vishakhapatnam, Bhubaneswar, Bhopal, Jaipur, Indore, Lucknow and Raipur
- River and Costal Erosion Risk Mitigation Programme
- Flood Risk Mitigation Programme (FRMP)
- Heatwave and Drought Mitigation Programme

5. Adaptation Priorities for Water Sector

Adaptation Priorities for Water Sector

Science & Data

Strengthen observation networks, high-resolution climate projections and real-time hydro-meteorological services.

Infrastructure

Climate-resilient design of dams, canals, embankments and urban drainage; nature-based solutions where feasible.

Governance

Mainstreaming climate risk into water policies, river-basin plans and disaster management frameworks.

Knowledge & Capacity

Build institutional and community capacity for anticipatory action, early warning and adaptive management.

Spatial Planning

Risk-informed land-use, floodplain zoning and protection of critical ecosystems that buffer extremes.

Finance & Investment

Scale up climate finance, risk transfer mechanisms and resilient infrastructure investment pipelines.

Implications for Disaster Management

Risk Assessment

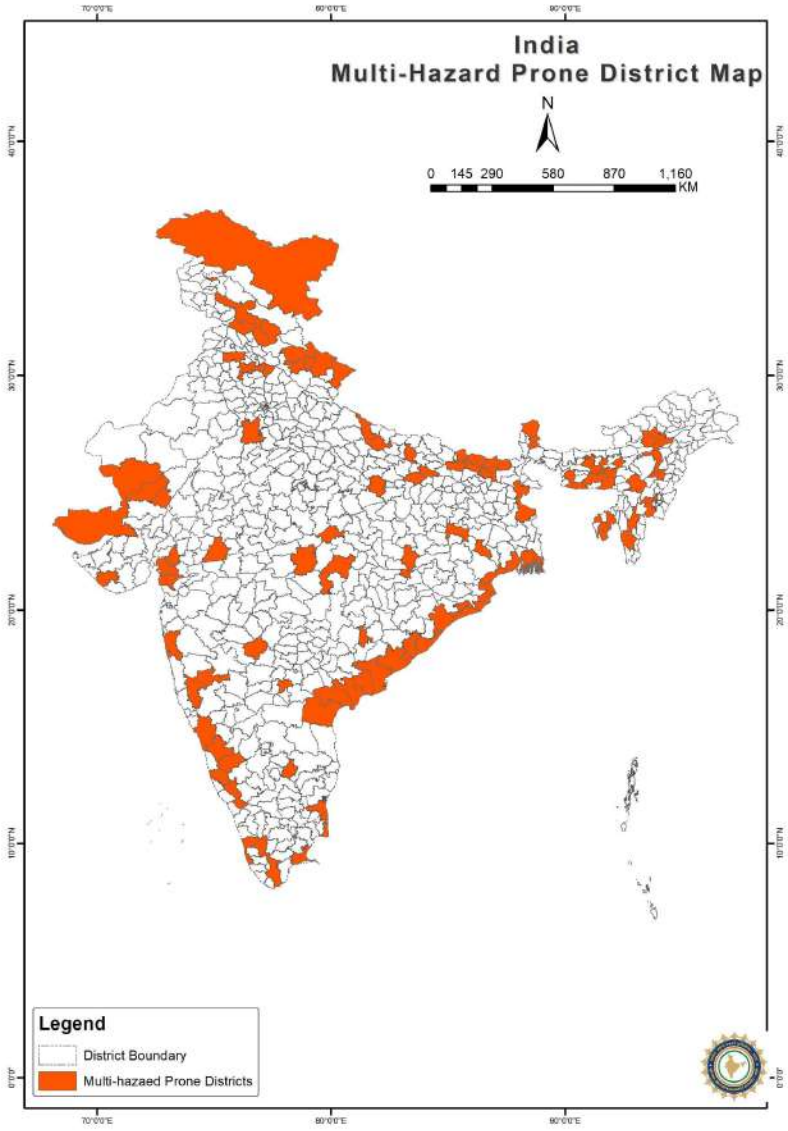
- **Update hazard maps** with non-stationary climate data
- Incorporate **compound and cascading** scenarios
- Strengthen **early-warning systems** for multi-hazard events

Infrastructure Resilience

- Review design floods & freeboard for dams & embankments
- Climate-proof critical water infrastructure
- Promote nature-based solutions alongside grey infrastructure

Institutional Readiness

- Integrate climate projections into DM plans at all levels
- Enhance inter-agency coordination (NDMA–CWC–States)
- Build capacity for anticipatory action and recovery



Way Forward

01 Climate change is already intensifying the frequency, intensity and spatial reach of extreme hydro-meteorological events in India.

02 Water resources systems from Himalayan glaciers to urban drainage face rising and often compound risks that challenge existing design and operational norms.

03 Disaster risk reduction and climate adaptation must be fully integrated; siloed approaches are no longer adequate.

04 Robust early-warning systems, climate-informed infrastructure standards and nature-based solutions form the core of resilience.

05 Strengthened inter-agency coordination and capacity at national, state and local levels is essential for anticipatory action.

Thank You