Glacial Lake Outburst Floods

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Glacial Lake Outburst Floods: A Rising Himalayan Threat

Context

On **July 8, 2025**, a massive **Glacial Lake Outburst Flood (GLOF)** in Nepal destroyed a **China-built friendship bridge** and severely impacted nearby **hydropower projects**. This incident has triggered concerns across the **Himalayan belt**, especially in **Sikkim, Ladakh, and Uttarakhand**, where similar risks are rising due to climate change.

Introduction: What is a GLOF?

A **Glacial Lake Outburst Flood (GLOF)** is the sudden release of water from a glacial lake, often caused by the failure of **moraine or ice dams**. These floods are highly destructive and pose threats to **human life, infrastructure, and fragile ecosystems**, particularly in the **Indian Himalayan Region (IHR)**.

Causes of GLOFs

Natural Factors

- **Glacial Retreat** due to warming leads to unstable lake formation.
  *India has over **7,500 glacial lakes**, mostly above **4,500m**.*

- **Avalanches** of ice or rock displace water and breach dams.
  E.g., South Lhonak Lake (Sikkim, 2023).

- **Heavy Rainfall/Cloudbursts** increase lake volume rapidly.
  E.g., Kedarnath GLOF (2013).

- **Seismic Activity** destabilizes loose moraine dams.
  *Uttarakhand falls in **Seismic Zones IV & V**.*

- **Internal Seepage** erodes moraine dams gradually from within.

Anthropogenic Factors

- **Unregulated construction** disturbs fragile glacial zones.
  Teesta-III Dam collapsed in 2023.

- **Climate Change** accelerates glacial melt globally.
  *2023 and 2024 were the **hottest years on record**.*

Types of Glacial Lakes

- **Supraglacial Lakes**: Form on glacier surfaces; unstable during summer.

- **Moraine-Dammed Lakes**: Blocked by loose debris; prone to breaching.
  Examples: South Lhonak (India), Tsho Rolpa (Nepal).

Impacts of GLOFs

On Human Settlements

- Sudden floods lead to **loss of life**, displacement, and economic hardship.

- **Infrastructure damage** includes washed-away roads, bridges, and hydropower plants.
  Teesta-III (1200 MW) was wiped out in 2023.

On Environment

- **Riverbed silting** and **course shifts** disrupt river ecosystems.

- **Habitat fragmentation** and **long-term ecological imbalance** follow sedimentation and water regime changes.

NDMA’s 5-Point GLOF Strategy

- **Hazard Mapping**: Identified **195 high-risk glacial lakes** based on size and vulnerability.

- **AWWS Installation**: Real-time data from automated stations in Sikkim.
- **Early Warning Systems**: Manual alerts by ITBP; digital systems piloted in vulnerable states.
- **Engineering Interventions**: Artificial channels, ERT scans, bathymetry for controlled drainage.
- **Community Engagement**: Local participation with sensitivity to cultural beliefs.

India’s GLOF Risk Mitigation Measures

Institutional Initiatives

- **National GLOF Programme**: A **$20 million** plan targeting 195 lakes.
- **Committee on Disaster Risk Reduction (CoDRR)** ensures coordinated action.
- **16th Finance Commission** prioritizes climate-resilient infrastructure (FY27–31).

Technological Tools

- **SAR Interferometry** for slope movement detection.
- **ERT Scans** to identify internal ice cores in moraine dams.
- **UAVs and Bathymetric Surveys** assess terrain and lake volume.

Community Involvement

- Expeditions to **40 high-risk lakes** across Himalayan states in 2024.
- **Manual alerts** through ITBP in remote areas.
- Continuous local engagement in monitoring efforts.

Conclusion

GLOFs are a growing threat in the Himalayas, driven by **climate change**, **seismic vulnerability**, and **unplanned development**. India has shifted from reactive relief to a **proactive risk-reduction model** using **technology**, **institutional coordination**, and **community participation**. Long-term resilience requires **sustained investment**, **cross-border data sharing**, and **focused climate adaptation** across the Himalayan region.