



सत्यमेव जयते

Government Of India

**Concept Note: 2-Day Workshop  
'Strategies for GLOF Risk Reduction'**

**Jacaranda Hall, India Habitat Centre  
Delhi**

**11<sup>th</sup> & 12<sup>th</sup> November 2024**



सत्यमेव जयते

जल शक्ति मंत्रालय  
MINISTRY OF JAL SHAKTI  
DoWR, RD & GR

**Co-Organizers:  
National Disaster Management Authority  
(NDMA) & Department of Water  
Resources (DoWR)**

## Contents

Introduction .....	3
Background .....	3
Objectives.....	4
1.    Comprehensive Understanding of GLOF Dynamics .....	4
2.    Enhance Technical Expertise and Build Capacity .....	4
3.    Foster Collaboration and Strategy Development.....	4
4.    Exploring Mitigation Strategies .....	5
5.    Advancing Monitoring and Early Warning Systems .....	5
6.    Strengthening Policy and Institutional Frameworks .....	5
Workshop Technical Sessions.....	5
Technical Session 1: International Perspectives & Experiences on GLOF Risk Mitigation .....	5
Technical Session 2: High-Risk Glacial Lake Expedition Outcomes from Summer of 2024.....	5
Technical Session 3: Gaps and Challenges in Mitigating GLOF Risks.....	6
Technical Session 4: Hazard Assessments and Geo-Spatial Monitoring of High-Risk Glacial Lakes....	6
Technical Session 5: Orienting Tech Start-Up Products Towards GLOF Risk Mitigation .....	6
Technical Session 6: Discussion: Optimal Designs for Automated Weather Stations and Early Warning Systems.....	7
Technical Session 7: Discussion: Best Practices - GLOF Mitigation .....	7
Expected Outcomes .....	7
1.    Enhanced Knowledge and Understanding for Effective Mitigation .....	7
2.    Collaborative Actionable Strategies for Risk Reduction.....	7
3.    Strengthened Institutional and Community Capacities.....	7
4.    Improved Monitoring and Early Warning Systems .....	7
5.    Policy Recommendations.....	7
Conclusion and Way Forward .....	7

## Introduction

The National Disaster Management Authority (NDMA) under the aegis of the Ministry of Home Affairs (MHA) formed the Committee on Disaster Risk Reduction (CoDRR) in the aftermath of the Sikkim GLOF event of October 2023. NDMA instituted the CoDRR mechanism to provide a multi-disciplinary approach to GLOF Risk Reduction in collaboration with DRDO/DGRE, MoJS – DoWR, CWC, CDAC, GSI, IMD, NRSC/IIRS/NESAC, NIH, NCPOR, NGRI and other government agencies and departments.

The CoDRR Mechanism paves the way for a whole-of-government approach to mitigate the risks from Glacial Lake Outburst Floods (GLOF), Earthquakes, Landslides, Coastal Erosion, Monsoon Variability's impact on Urban Floods and Droughts and to build upon the importance of Disaster Risk Financing and Psycho-Social Support for sustainable long-term interventions.

The 4<sup>th</sup> CoDRR GLOF Workshop is part of NDMA's initiatives to ensure policy development and implementation is undertaken in a whole-of-society approach. The CoDRR International Level Workshops are designed to bring all stakeholders to a common platform to engage in scientific discourse and open avenues for collaboration.

A remote sensing satellite study conducted by NRSC, ISRO in April 2024 reports significant expansion in 676 glacial lakes between 1984 & 2023 across the Indus, Ganga, & Brahmaputra River basins, highlighting the growing risk of Glacial Lake Outburst Floods (GLOFs) in the Indian Himalayas. Notably, 601 lakes (89%) have expanded more than twice their original size, 10 lakes have grown by 1.5 to 2 times, and 65 lakes have increased by 1.5 times.

The National Disaster Management Authority (NDMA) with a budget of ₹150 approved by the Ministry of Home Affairs (MHA) is implementing the *National GLOF Risk Mitigation Programme (NGRMP)* for four states – Arunachal Pradesh, Himachal Pradesh, Uttarakhand, Sikkim and two union territories – Jammu & Kashmir and Ladakh. The NGRMP has the following objectives -

- *Hazard and Risk Assessment:* Inventory and classification of glacial lakes.
- *Monitoring and Early Warning System:* Utilization of advanced technologies for early breach detection.
- *Mitigation Measures:* Site-specific interventions such as reinforcing moraine dams or controlling lake water levels.
- *Community Awareness and Capacity Building:* Enhancing local preparedness and response capabilities.

## Background

The Indian Himalayan Region (IHR) often referred to as the "Third Pole," faces increasing risks from Glacial Lake Outburst Floods (GLOFs), a phenomenon exacerbated by climate change and glacial retreat. Glacial Lake Outburst Floods (GLOFs) pose a significant threat to communities in high-altitude regions, particularly in the Himalayas, where the impacts of climate change are most pronounced. The rapid melting of glaciers, accelerated by rising global temperatures,

has led to the formation of numerous glacial lakes. These lakes, perched precariously on mountain slopes, breach suddenly, releasing millions of cubic litres of water and debris.

The Hindu Kush-Himalayan (HKH) region is one of the most alpine glacier-rich areas outside Antarctica and Greenland, with approximately 33,000 square kilometres of glacial ice in the Himalayas. The HKH spans 3,500 kilometres across eight countries, and feeds 10 major river basins. The increasing frequency and intensity of GLOFs necessitate a comprehensive understanding of the risk landscape and the development of robust mitigation and risk reduction strategies.

The rapid melting of glaciers and the expansion of proglacial lakes from 2018 to 2022 has led to an exponential increase in Glacial Lake Outburst Flood (GLOF) incidents. Particularly susceptible regions include Afghanistan (Panjshir, 12<sup>th</sup> July 2024), India (South Lhonak Lake, October 2023, and Thyanbo Lake, August 2024), Nepal (Birendra Glacial Lake, April 2024), Bhutan (Thorthormi Tsho, June 2019), Pakistan (Thame, August 2024), China (June 2020), placing over 6,353 km<sup>2</sup> area at risk.

GLOF events have also occurred in other mountainous regions globally. In Peru, the outburst from Lake Palcacocha on 13<sup>th</sup> December 1941, flooded Huaraz, claiming 1,800 to 6,000 lives. In Switzerland, the Giétro Glacier ice dam burst on 16<sup>th</sup> September 1818, causing major flooding from Lake Mauvoisin. These events demonstrate the global nature of GLOF risks, underscoring the urgent need for international collaboration in mitigation efforts.

In response to these escalating risks, the National Disaster Management Authority (NDMA) is organizing a 1 and ½ day policy workshop '*Strategies for GLOF Risk Reduction*' focused on GLOF mitigation and risk reduction. This workshop aims to bring together experts, policymakers, researchers, and community representatives to share knowledge, discuss ongoing research, and develop actionable strategies to mitigate GLOF risks.

## Objectives

The workshop will aim to achieve the following objectives:

1. **Comprehensive Understanding of GLOF Dynamics** Delve into the causes, triggers, and processes of GLOFs, with a focus on the latest scientific research and case studies from the Himalayas and other mountain ranges such as the Alps, Tian Shan Range and the Andes.
2. **Enhance Technical Expertise and Build Capacity** Develop greater understanding to enhance technical expertise at the National and State level. Build capacity through discussions and experience sharing, ensuring that states are well-informed and equipped to handle GLOF risks.
3. **Foster Collaboration and Strategy Development** Facilitate collaboration among experts, policymakers, and stakeholders to develop and implement comprehensive strategies for monitoring and mitigating GLOF risks, thereby safeguarding lives and property in affected regions.

4. [Exploring Mitigation Strategies](#) Examine structural and non-structural mitigation measures, including controlled breaching, siphoning, and the construction of outlet control structures, as well as community-based approaches.
5. [Advancing Monitoring and Early Warning Systems](#) Discuss the integration of satellite-based monitoring, Geographic Information Systems (GIS), and remote sensing technologies in predicting GLOFs. Explore the development and implementation of early warning systems tailored to the unique challenges of the IHR.
6. [Strengthening Policy and Institutional Frameworks](#) Formulate policy recommendations that can be integrated into national and regional disaster management plans. Highlight the importance of cross-border cooperation and the involvement of local communities in GLOF risk management.

## Workshop Technical Sessions

The *4th CoDRR Workshop* focuses on *GLOF Risk Reduction & Mitigation* and features six key technical sessions designed to provide a comprehensive understanding of mitigation strategies, technological advancements, and global best practices. These sessions bring together national and international experts to discuss strategies for safeguarding vulnerable Himalayan regions from Glacial Lake Outburst Floods (GLOFs).

### Technical Session 1: International Perspectives & Experiences on GLOF Risk Mitigation

- *Objective:* This session will explore international best practices in GLOF risk mitigation, with insights from experts across diverse mountain ranges. Participants will discuss lessons learned and technological advancements used to manage GLOF risks in the Alps, Tien Shan, Andes, and the Himalayas.
- *Key Topics:*
  - Case studies from Switzerland, Costa Rica, Nepal, Bhutan, and the global experience of GLOF risk mitigation.
  - Comparative analyses of GLOF risk reduction strategies in different geographical contexts.
  - Role of geospatial risk assessments in understanding vulnerabilities.
- *Outcome:* Develop a framework for incorporating global insights into India's GLOF risk mitigation strategies.

### Technical Session 2: High-Risk Glacial Lake Expedition Outcomes from Summer of 2024

- *Objective:* This session will focus on identifying mitigation strategies that are effective for high-risk glacial lakes in India, drawing on the experience of various states and regions in the Himalayas.
- *Key Topics:*
  - State-level experiences from Sikkim, Himachal Pradesh, Ladakh, Jammu & Kashmir, Uttarakhand, and Arunachal Pradesh.

- Feasibility of structural and non-structural mitigation measures for high-risk glacial lakes.
- *Outcome:* Practical recommendations for scalable mitigation approaches tailored to the Indian Himalayan region.

### Technical Session 3: Gaps and Challenges in Mitigating GLOF Risks

- *Objective:* To identify the challenges and gaps in mitigating GLOF risks in India and discuss opportunities for improvement in risk mitigation frameworks.
- *Key Topics:*
  - Infrastructure challenges, risk management, and governance in mitigating GLOF risks.
  - Lessons learned from the role of military and public sector enterprises.
- *Outcome:* A set of actionable recommendations to address existing gaps in GLOF risk management.

### Technical Session 4: Hazard Assessments and Geo-Spatial Monitoring of High-Risk Glacial Lakes

- *Objective:* This session will highlight the importance of hazard assessments and the use of geo-spatial monitoring technologies to identify and monitor high-risk glacial lakes.
- *Key Topics:*
  - Hydrological hazard assessments of glacial lakes.
  - Geospatial tools and technologies for real-time monitoring.
- *Outcome:* Enhanced capacity for geo-spatial monitoring and risk identification of glacial lakes.

### Technical Session 5: Orienting Tech Start-Up Products Towards GLOF Risk Mitigation

- *Objective:* Aims to provide a collaborative platform to associated central and state government representatives, associated field organizations working in policy making or geospatial or technology domains on GLOF DRR.
- *Key Topics:*
  - Glacial monitoring using remote sensing
  - Hydrological modeling and water resource management
- *Outcome:* Comprehending user needs and service gaps in space based applications and promoting space enabled applications/products by the Indian private sector.

## Technical Session 6: Discussion: Optimal Designs for Automated Weather Stations and Early Warning Systems

- *Objective:* To explore the best possible designs for automated weather stations and early warning systems tailored to high-risk GLOF-prone areas.
- *Key Topics:*
  - Design innovations in weather stations and early warning systems.
  - Case studies from India and Switzerland.
- *Outcome:* Identification of suitable technologies for real-time monitoring and early warning systems.

## Technical Session 7: Discussion: Best Practices- GLOF Mitigation

- *Objective:* To evaluate the feasibility of mitigation measures in the Indian context, drawing on the experiences of various international and domestic experts.
- *Key Topics:*
  - Comparative analysis of global and Indian mitigation strategies.
  - Discussion on structural and non-structural interventions.
- *Outcome:* Development of context-specific mitigation strategies for the Indian Himalayas.

## Expected Outcomes

1. **Enhanced Knowledge and Understanding for Effective Mitigation** Participants will gain a deeper understanding of GLOF dynamics, vulnerabilities, and mitigation strategies.
2. **Collaborative Actionable Strategies for Risk Reduction** Identification of specific, actionable strategies for GLOF risk reduction, tailored to the unique challenges of the IHR.
3. **Strengthened Institutional and Community Capacities** Recommendations for strengthening institutional frameworks and enhancing community resilience to GLOF risks.
4. **Improved Monitoring and Early Warning Systems** Development of a roadmap for implementing advanced monitoring and early warning systems in the IHR.
5. **Policy Recommendations** A set of policy recommendations for integrating GLOF risk management into broader disaster risk reduction and climate adaptation strategies.

## Conclusion and Way Forward

This workshop will serve as a pivotal platform for catalysing collective action, empowering communities, and informing policy decisions to mitigate these risks. Engaging in collective

dialogue and sharing best practices, we can build resilience in vulnerable regions and safeguard lives, livelihoods, and ecosystems against the threat of GLOFs.

The increasing frequency and severity of GLOFs underscore the urgent need for coordinated action. By fostering collaboration among experts, policymakers, and communities, we can enhance the resilience and protect vulnerable populations from the devastating impacts of GLOFs.

The outcomes of this workshop will inform future policy and planning efforts, ensuring that GLOF risk management is integrated into global, national and regional disaster risk reduction frameworks. Moving forward, continued collaboration and innovation will be essential to safeguard the Indian Himalayan Region as well as other high-altitude ranges across the world and build a more resilient future for all.

\*\*\*\*\*