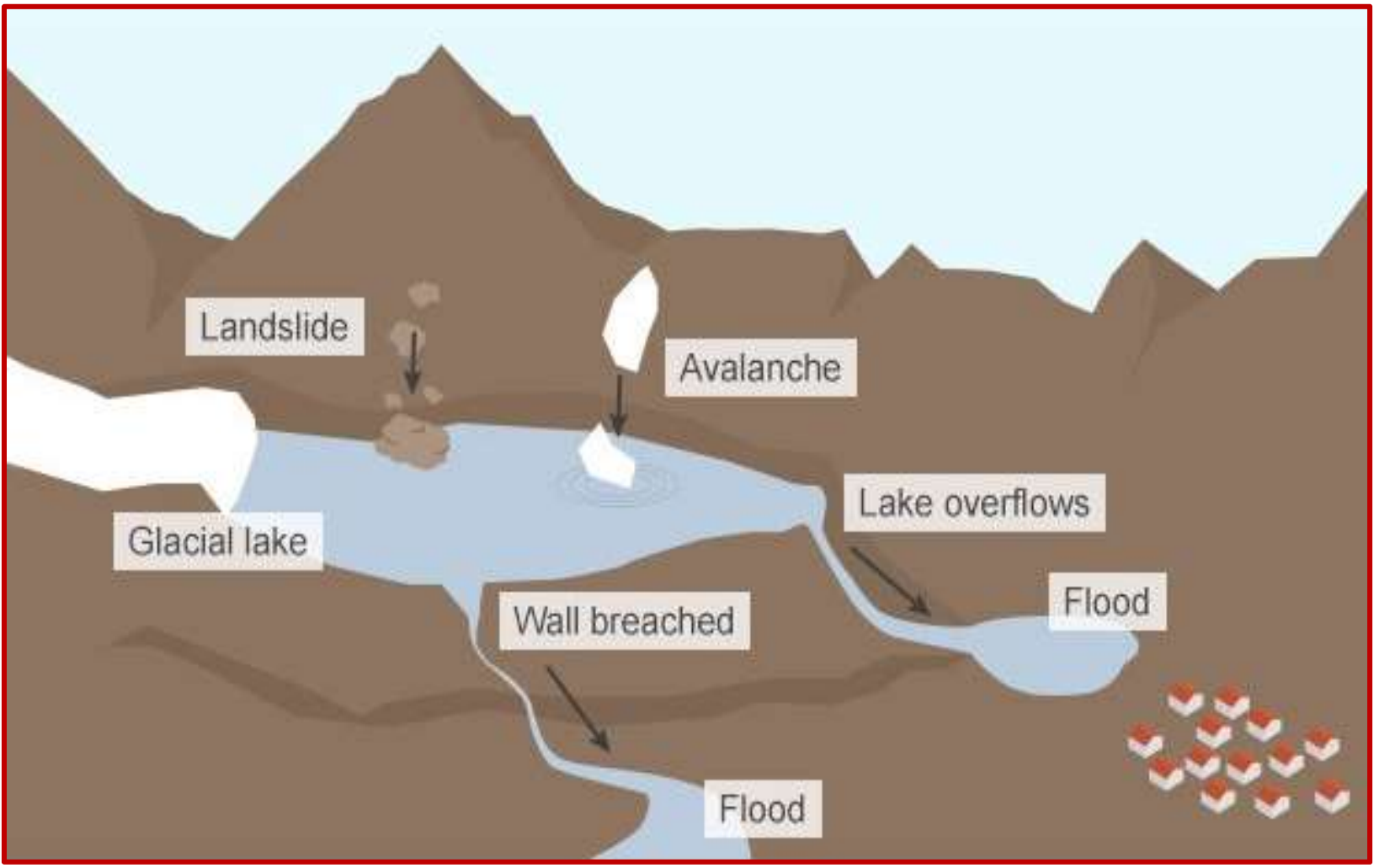
Topic: How Glacial Lake Outburst Flood (GLOF) & Landslide Lake Outburst Surveillance System Works?

National Institute of Disaster Management, Ministry of Home Affairs, Govt. of India

Date and Time: 20th October 2023, (Friday); 02:30 PM - 04:30 PM (IST)



Webinar

on

NIDM
WEBINAR SERIES - 20

HOW GLACIAL LAKE OUTBURST FLOOD (GLOF) & LANDSLIDE LAKE OUTBURST FLOOD (LLOF) SURVEILLANCE SYSTEM WORKS?

DATE : 20TH OCTOBER, 2023 (FRIDAY)

TIME: 02:30 PM - 04:30 PM (IST)

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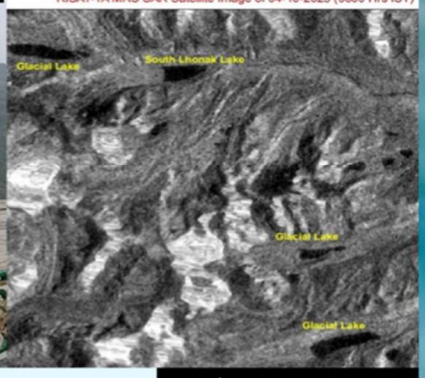
Sikkim,2023 GLOF

South Lhonak Lake and Surroundings
RISAT-1A MRS SAR Satellite Image of 04-10-2023 (0600 Hrs IST)



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Pakistan,2010 LLOF

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Follow Proper Hand Hygiene

Maintain Social Distancing

Get Vaccinated

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Website: www.nidm.gov.in

Brief Webinar Report

Topic: How Glacial Lake Outburst Flood (GLOF) & Landslide Lake Outburst Surveillance System Works?

National Institute of Disaster Management, Ministry of Home Affairs, Govt. of India

Date and Time: 20th October 2023, (Friday); 02:30 PM - 04:30 PM (IST)

The Glacial Lake Outburst Flood (GLOF) and Landslide Lake Outburst Surveillance System is a sophisticated and comprehensive framework designed to monitor and mitigate the risks associated with glacial lake outbursts and landside-induced lake outbursts. This system integrates advanced technologies, real-time monitoring, and community engagement to enhance early warning and response capabilities.

Key Terminologies/ Features

Definitions:

- **GLOF (Glacial Lake Outburst Flood):** A GLOF is a flood resulting from the sudden and rapid release of water from a glacial lake, often caused by the failure of a moraine dam or ice dam.
- **LLOF (Landslide Lake Outburst Flood):** An LLOF occurs when water is impounded by a landslide, typically blocking a river or a valley, and the natural or human-made dam formed by the landslide ruptures, leading to a sudden release of water.

Triggering Mechanism:

- **GLOF:** The primary trigger for a GLOF is the collapse or breach of a moraine dam or ice dam holding back water in a glacial lake. This can be caused by factors such as glacial melt water, avalanches, or volcanic activity.
- **LLOF:** Landslide Lake Outbursts are triggered by landslides that block river valleys, creating impounded lakes. The failure of the landslide dam, often due to erosion or structural instability, results in the release of water.

Formation of the Impounded Lake:

- **GLOF:** Glacial lakes are typically formed by the accumulation of melt water from glaciers. The lake is held back by moraine (accumulation of glacial debris) or ice dams.
- **LLOF:** The impounded lake in LLOFs is formed when a landslide obstructs a river or valley, creating a natural dam. This dam holds back water, forming the lake until the dam eventually breaches.

Geographical Distribution:

- **GLOF:** Commonly associated with glacial regions, especially in mountainous areas with significant glacial activity. Examples include the Himalayas, Andes, and Alps.
- **LLOF:** Can occur in various geological settings where landslides block rivers or valleys, leading to the formation of landslide-dammed lakes. This can happen in mountainous regions, but it's not exclusive to glaciated areas.

Risk Factors:

- **GLOF:** Climate change-induced glacial melt, seismic activity, and changes in glacial morphology are key risk factors for GLOFs.
- **LLOF:** Slope instability, intense rainfall, earthquakes, or volcanic activity can trigger landslides that block rivers and lead to the formation of landslide-dammed lakes.

Impacts:

- **GLOF:** GLOFs can result in devastating downstream flooding, destruction of infrastructure, and loss of life.
- **LLOF:** Similar to GLOFs, LLOFs can cause significant downstream flooding, and the rapid release of water can pose serious threats to communities located downstream.

Both GLOFs and LLOFs highlight the complex interactions between glacial and geological processes, emphasizing the importance of monitoring and mitigation efforts to reduce the risks associated with these natural hazards.

The key prospects depicting of how this surveillance system works:

Remote Sensing and Satellite Technology:

- Utilizes satellite imagery and remote sensing technology to monitor changes in glacial lakes and identify potential threats.
- Tracks variations in lake size, water levels, and the formation of new lakes, providing valuable data for risk assessment.

Ground-Based Monitoring Stations:

- Establishes ground-based monitoring stations strategically located in high-risk areas.
- These stations measure parameters such as water level, temperature, and seismic activity, contributing to the overall surveillance and early warning system.

Real-Time Data Collection and Analysis:

- Implements real-time data collection and analysis systems to process information from remote sensors and monitoring stations.
- Utilizes advanced algorithms to detect anomalies and potential signs of lake instability or landslide activity.

Risk Assessment Models:

- Develops sophisticated risk assessment models that integrate data from various sources, including geological surveys, climate data, and historical records.
- These models help predict the likelihood of glacial lake outbursts or landslide-induced lake outbursts, allowing for proactive measures.

Community Engagement and Early Warning Systems:

- Engages local communities in the surveillance process, fostering awareness and understanding of the risks.
- Establishes early warning systems that can quickly communicate alerts to communities downstream, enabling timely evacuation and emergency response.

Mitigation Strategies:

- Formulates and implements mitigation strategies based on the surveillance data and risk assessments.
- This may include engineering solutions, such as the controlled release of water from glacial lakes, construction of protective infrastructure, or reforestation to stabilize landslide-prone areas.

Emergency Preparedness and Response Planning:

- Develops and communicates emergency preparedness plans to communities at risk.
- Coordinates with local authorities, emergency responders, and relevant stakeholders to ensure a swift and effective response in the event of a potential outburst.

Continuous Monitoring and Adaptation:

- Maintains continuous monitoring of glacial lakes and landslide-prone areas, adapting the surveillance system based on evolving conditions and new data.
- Regularly updates risk assessments and incorporates lessons learned from past events to enhance the system's effectiveness.

The Glacial Lake Outburst Flood and Landslide Lake Outburst Surveillance System thus combines advanced technology, scientific expertise, and community involvement to create a robust framework for monitoring, predicting, and mitigating the risks associated with these natural hazards.

Key Words: *Geological Risk Assessment, Valley blockage, Landslide lake monitoring, Glacier Melt water, GLOF monitoring, etc.*

Figure: Sikkim Glacial Lake Outburst Flood Glimpses
Source: https://www.gofundme.com/f/sikkim-glacial-lake-outburst-flood-recovery-fund

Purpose of the Webinar

The webinar aims to equip participants with a thorough grasp of the intricate mechanisms and advanced technologies integral to the surveillance and mitigation of risks posed by Glacial Lake Outburst Floods (GLOFs) and Landslide Lake Outburst Floods (LLOFs). Through this educational event, participants will gain insights into the tools, methodologies, and real-world applications employed in monitoring these natural hazards, fostering a deeper understanding of the strategies implemented to minimize their impact on vulnerable regions.

Objectives:

1. To establish a foundational understanding of GLOF and LLOF.
2. To explore and highlight the functionality of the Glacial Lake Outburst Flood and Landslide Lake Outburst Surveillance System.
3. To explore varied strategies and measures implemented to mitigate the impact of potential outbursts.
4. To provide a knowledge platform for the participants to connect with experts, share experiences, and expand their professional networks within the field of drone technology.

Broad Points Covered

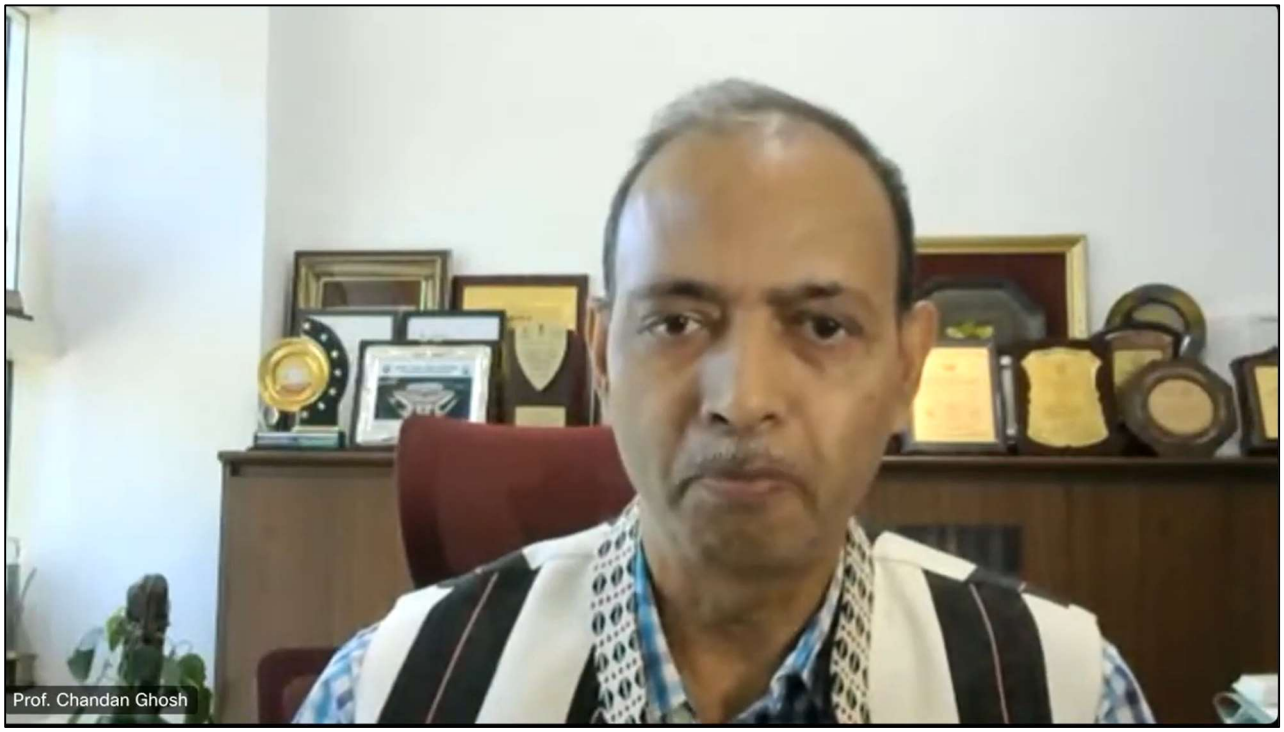
The broad points covered during the webinar are as follows:

- **Early Warning Importance:** The presentation underscored the pivotal role of early warning systems in mitigating the impact of Glacial Lake Outburst Floods (GLOF) and Landslide Lake Outburst events.
- **Electromagnetic Physics Application:** The discussion highlighted the application of electromagnetic physics in devising surveillance systems for GLOF and Landslide Lake Outburst scenarios, showcasing the fusion of science and technology for effective monitoring.
- **Ground Penetrating Radar (GPR):** A major takeaway centered on the use of Ground Penetrating Radar (GPR) as a crucial technology in these surveillance systems. The advantages and specific applications of GPR were detailed, shedding light on its role in monitoring and assessing potential risks.
- **GLOF Case Study - Sikkim:** The presentation likely featured a case study, possibly from Sikkim, illustrating real-world applications and the success of the surveillance system in monitoring and managing GLOF incidents.
- **Comprehensive Monitoring and Assessment:** Attendees gained insights into the comprehensive nature of the surveillance systems, emphasizing not only early warnings but also detailed monitoring and assessment capabilities.
- **Interdisciplinary Approach:** The talk highlighted the interdisciplinary nature of the surveillance systems, showcasing collaboration between fields such as physics, geology, and technology for a holistic approach to GLOF and Landslide Lake Outburst management.
- **Risk Mitigation Strategies:** The presentation likely touched upon strategies for mitigating risks associated with GLOF and Landslide Lake Outburst, providing a roadmap for proactive measures to minimize potential disasters.
- **Technological Advancements:** Discussed the latest technological advancements in surveillance systems, demonstrating how cutting-edge tools contribute to improved accuracy and efficiency in monitoring these natural hazards.
- **Community Engagement:** It emphasized the importance of community involvement in the surveillance and early warning process, recognizing the role of local populations in responding to alerts and ensuring a coordinated approach to disaster preparedness.
- **Global Relevance:** Key takeaways which included the global relevance of these surveillance systems, acknowledging their applicability in various geographical regions facing similar challenges related to glacial and landslide-induced flooding.

Session's Summary

The webinar started with a welcome note by Avipsha Mohanty. Young Professional, Resilient Infrastructure Division, NIDM. First of all, she welcomed the expert speaker, chairperson and participants. She explained the purpose of this webinar.

<u>Inaugural Address:</u> Prof. Chandan Ghosh, Head of Resilient Infrastructure Division, NIDM, Ministry of Home Affairs, Govt. of India



He kicked off the event by giving a hearty welcome to our esteemed guest speaker and patrons. Stepping onto the stage, Prof. Ghosh delved into their remarkable journey, highlighting groundbreaking achievements. The crux of the discourse then turned towards the technological dimensions of Disaster Management. The speaker, with expertise and authority, presented innovative solutions within this realm. The audience was treated to a detailed examination of a pertinent case study, specifically delving into the Glacial Lake Outburst Flood (GLOF) scenario in Sikkim. This transition provided a tangible and practical application of the theoretical aspects discussed. The case study from Sikkim not only illuminated the challenges posed by GLOF but also showcased how technological solutions play a pivotal role in managing and mitigating such disasters.

<u>Patron Remarks:</u> Prof. S.K. Singh, Vice Chancellor of Rajasthan Technical University; Chairman of Institution of Engineers:

He delved into the pressing issue of climate change and its ominous consequences, emphasizing the devastating impacts it inflicts. A substantial part of the speaker's talk was dedicated to unraveling the implications of these frequent and intense weather events, particularly drawing attention to their profound ramifications on societies. The speaker made the issue tangible and relatable by drawing parallels with the tragic events in Uttarakhand, a region that experienced the dire consequences of such natural disasters.

The urgency of the matter was palpable as the speaker urged immediate attention to the pressing challenges posed by climate change and its associated phenomena. The call to action extended beyond mere acknowledgment; the speaker emphasized that the present juncture demands a concerted effort. This effort, he asserted, should involve a proactive exploration of viable solutions and the implementation of effective mitigation measures.

Technical Session

<u>Speaker 1*Dr. Rupendra Singh, Glaciology Specialist at the School of Science, Jawaharlal Nehru University, Delhi*-</u>

Dr. Rupendra delivered a comprehensive presentation covering various aspects related to glaciers, their types, and the intricate process of glacier formation. A focal point of the discussion was the examination of the glacial status in the Shyok sub-basin scenario, with a specific focus on the Chong Kumdan Glacier after experiencing surging. This provided valuable insights into the dynamic nature of glacial systems.

One noteworthy segment of the talk involved the elucidation of a comparative sketch, offering a visual representation of the size of the lake formed upstream. This visual aid likely played a crucial role in enhancing the audience's understanding of the geographical and hydrological changes associated with glacier surging.

The discourse then shifted to a nuanced exploration of the multifaceted reasons behind Glacial Lake Outburst Floods (GLOF). The speaker conveyed a sophisticated understanding of the diverse factors contributing to these events, emphasizing the need for a holistic approach to GLOF study.

Addressing the challenges inherent in GLOF and Landslide Lake Outburst Flood (LLOF) study, the speaker provided insights into the complexities and obstacles faced in understanding and mitigating the risks associated with these natural phenomena.

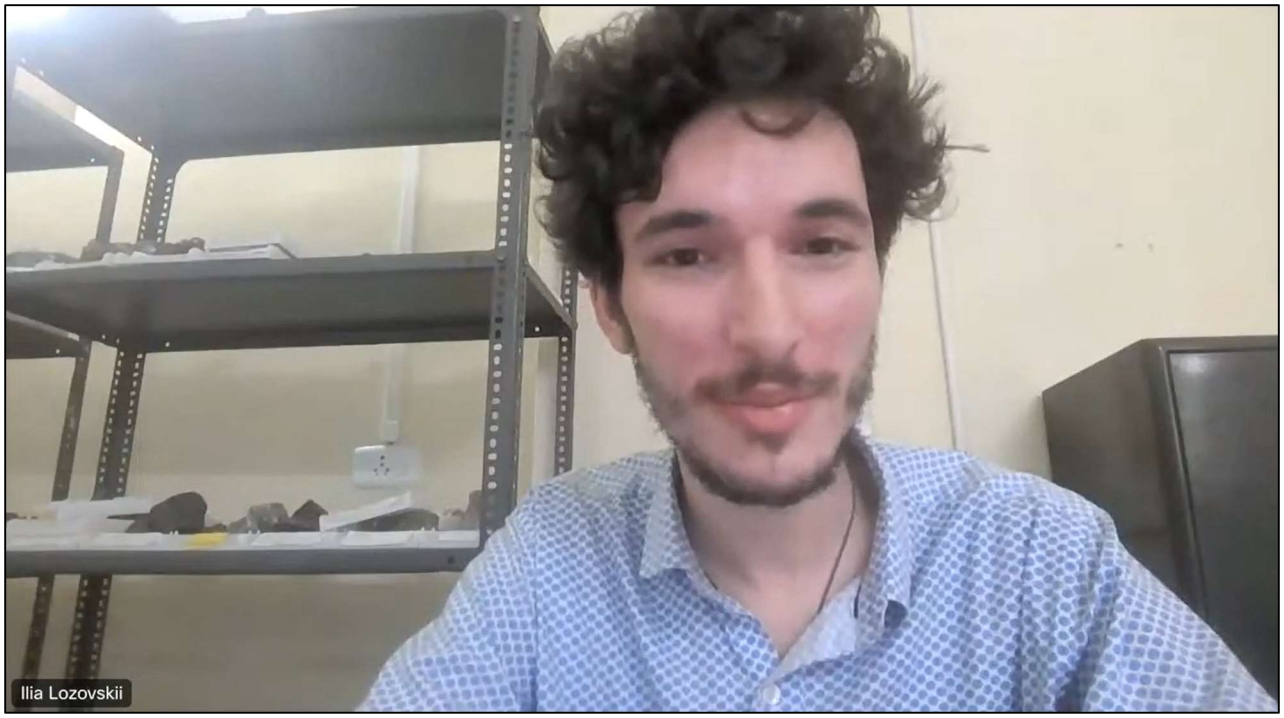
The presentation gained further depth through the inclusion of various case studies. The speaker showcased historical incidents, such as the 1926 lake burst, and more recent scenarios, such as the Shyok Valley Flood and the Kuwari Village in Uttarakhand. Additionally, the talk featured case studies on the GLOF scenario in Sikkim, offering a diverse range of examples to illustrate the varied impacts and dynamics of glacial and lake

outburst events. Overall, the talk provided a rich and multidimensional perspective on glacier-related phenomena, combining scientific insights with real-world case studies to enhance the audience's understanding of the complex interactions within glacial systems.

<u>Guest of Honour Presentation</u>: Mr. Ilia Lozovsky, a Russian Research Scholar from NEHU:

Mr. Ilia underscored the vital importance of early warning systems, directing attention to their critical role in mitigating the impact of Glacial Lake Outburst Floods (GLOF). In a thorough exploration of the technological aspects, the speaker delved into the application of electromagnetic physics to enhance our understanding of GLOF occurrences.

A significant portion of the discussion was dedicated to elucidating the advanced technology of Ground Penetrating Radar (GPR) and its pivotal role in monitoring and assessing GLOF events. The audience was provided with a detailed understanding of the advantages inherent in GPR technology and how it contributes to a more nuanced and accurate assessment of potential risks associated with glacial lake outbursts.



The emphasis on electromagnetic physics and the practical application of GPR underscored the speaker's commitment to providing in-depth insights into the technological solutions available for monitoring GLOF events. The discourse not only highlighted the theoretical underpinnings but also connected them with tangible tools and methodologies, fostering a comprehensive understanding of the strategies employed in early warning systems for glacial lake outburst events.

Speaker 2: Prof. Chandan Ghosh, Head of Resilient Infrastructure Division, NIDM, Ministry of Home Affairs, Govt. of India

Prof. Ghosh provided a comprehensive overview, addressing several key aspects related to glacier dynamics. The discussion began by delving into the fundamental forces at play in glaciers, particularly focusing on the intricate interplay between gravity and frictional forces. This foundational understanding laid the groundwork for a more in-depth exploration of glacier-related phenomena.

Moving on, Prof. Ghosh shifted the spotlight to codal provisions, elucidating the National Disaster Management Authority (NDMA) guidelines for Glacial Lake Outburst Floods (GLOF). This segment likely provided a regulatory framework and guidelines essential for effective disaster management and risk reduction in the context of glacial events.

A significant portion of the talk was dedicated to GLOF mitigation measures, wherein the audience gained insights into strategies aimed at minimizing the impact of Glacial Lake Outburst Floods. This segment may have included both structural and non-structural measures designed to enhance resilience and preparedness.

The discourse extended beyond GLOF, incorporating a discussion on mitigation solutions for avalanche risk frameworks. This broader perspective showcased the speaker's commitment to addressing a spectrum of natural hazards associated with glacial regions.

Enriching the presentation further, the speaker incorporated case studies that offered practical examples of implemented solutions. Noteworthy instances included the GLOF warning system in Bhutan involving siren towers, demonstrating real-world applications of early warning infrastructure. Additionally, the discussion highlighted a Landslide Monitoring Early Warning System designed by IIT Mandi, showcasing cutting-edge technological solutions for landslide risk mitigation.

The session concluded with a dynamic question and answer segment, providing the audience with an opportunity to engage with the speakers and delve deeper into the presented topics.

Professor Chandan Ghosh delivered concluding remarks, likely summarizing key insights and reiterating the importance of the discussed measures. The event concluded on a positive note with Ms. Avipsha Mohanty extending a vote of thanks, expressing gratitude to the speaker and participants for their valuable contributions to the informative and engaging session.

Major Key Takeaways

The major key takeaways are as follows:

- **Early Detection and Warning Systems:** The presentation highlighted the crucial role of surveillance systems in providing early detection and warnings for Glacial Lake Outburst Floods (GLOF) and Landslide Lake Outburst events.
- **Integration of Technology**: It involves how advanced technologies are integrated into surveillance systems, showcasing the use of cutting-edge tools for monitoring and assessing potential risks.
- **Understanding Electromagnetic Physics:** The talk delved into the application of electromagnetic physics in designing and operating surveillance systems, emphasizing its importance in understanding and predicting GLOF and Landslide Lake Outburst phenomena.
- **Ground Penetrating Radar (GPR) Application in GLOF:** A major takeaway focused on the use of Ground Penetrating Radar (GPR) and its advantages in these surveillance systems, illustrating how this technology contributes to effective monitoring and assessment.
- **Risk Mitigation Strategies**: The presentation likely addressed strategies and measures for mitigating the risks associated with GLOF and Landslide Lake Outburst, providing a comprehensive approach to disaster risk reduction.
- **Community Involvement and Preparedness:** Key takeaways included the importance of community engagement in response to early warnings, highlighting the need for local preparedness and coordination in the face of potential disasters.
- **Interdisciplinary Collaboration:** It emphasized the interdisciplinary nature of surveillance systems, showcasing collaboration between various scientific and technological disciplines to create robust monitoring frameworks.
- **Global Applicability:** Involved the learnings about the global applicability of GLOF and Landslide Lake Outburst surveillance systems, recognizing that these technologies are relevant in diverse geographical settings facing similar challenges.

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Participants Categories

In this webinar, participants from multiple domains attended the session. It constitutes of 15% of Govt. Job, 3% from NGO/CSOs, 27% from private sector, 2% from public sector, 34% were students, 6% of the participants were self-employed and 17% of the participants were from other domain.

Certificate

Sl. No.: /

NATIONAL INSTITUTE OF DISASTER MANAGEMENT

(Ministry of Home Affairs, Govt. of India)

New Delhi

CERTIFICATE

This is to certify that

Participant Name

has participated in the webinar on "How Glacial Lake Outburst Flood and Landslide Lake Outburst Flood Surveillance System Works" on 20 Oct 2023 organized by National Institute of Disaster Management, Ministry of Home Affairs, Govt. of India in collaboration with The Building Material and Technology Promotion Council The Building Material & Technology Promotion Council

Prof Chandan Ghosh
Head Resilient Infrastructure Division
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