

IPL -283 Annual Progress Report - 2025

1. **Project Title:**

ZONING OF POTENTIAL ROCKSLIDE DISASTERS TRIGGERED BY SEISMICITY IN THE KOTMALE RESERVOIR AREA, SRI LANKA

2. **Main Project Fields:** Technology Development and Capacity Building

3. **Name of Project leader:**

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Core members of the Project

- Prof. K Sassa, Research Adviser, Secretary General/ICL, Kyoto, Japan
- Mr. A A Virajh Dias, Deputy Team Leader of WCOE-EGRG / PhD candidate, Postgraduate Institute of Science (PGIS), University of Peradeniya, Kandy.
- Prof. Sanjeeva Malaviarachchi, Department of Geology, University of Peradeniya.
- Ms. S V Gunatilake, University of Adelaide, Adelaide, Australia.
- Mr. Thilan Senevirathna, Research Assistant, Postgraduate Institute of Science (PGIS), University of Peradeniya.
- Mr. Prabhath Gunatilake, PhD candidate, Postgraduate Institute of Science (PGIS), University of Peradeniya.
- Prof. Nanda Balasooriya, Head, Department of Geology, University of Peradeniya, Kandy, Sri Lanka

4. **Objectives:**

The primary goal is to assess the potential risk of landslides in the Kotmale reservoir area induced by seismic activity. This will be achieved through a comprehensive analysis incorporating geomorphological, geological, geophysical, and seismological studies and mapping. Additionally, the project emphasizes a multi-faceted approach that involves gathering and disseminating knowledge, integrating advanced technologies, enhancing capacity development, and fostering international collaboration.

5. **Background Justification:**

Understanding and reducing the risk of landslide-induced tsunamis, particularly those triggered by earthquakes, is a key objective of the Kyoto Landslide Commitment 2020. In July 2024, the Mahaweli Authority of Sri Lanka and the International Consortium on Landslides jointly submitted a concept paper to Sri Lanka's External Resources Department to initiate a Japan–Sri Lanka project titled “Landslide Disaster Risk Identification and Planning of Risk Reduction Measures in the Central Mountainous Area of Sri Lanka,” focusing on earthquake-triggered landslides around the Kotmale Dam. Reservoir-related landslide risks pose significant challenges to sustainable development and disaster resilience under the SDGs and the Sendai Framework. Enhanced risk assessments will support preparedness and mitigation efforts for communities living around the Kotmale Reservoir and downstream areas.

6. **Study Area:** Kotmale dam and reservoir area; seismicity consideration for area bounded by minimum of 50km radius measured from the Kotmale dam

7. **Project Duration:** 5 years (2025 to 2030)

8. **Progress in the Project:**

8.1 The Kotmale Dam, commissioned in 1985, is the second largest hydroelectric power station in Sri Lanka with an installed capacity of 201 MW. Located in the central mountainous region, the reservoir area is highly susceptible to landslides due to complex geological, geomorphological, hydrological, and seismological conditions. Increasing extreme weather events and seismic activities further elevate the risk of large-scale slope failures around the reservoir. Landslides entering the reservoir can generate dangerous waves or overtopping events, posing severe threats to dam safety and downstream communities. Therefore, assessment and monitoring of landslide risks around the Kotmale Reservoir are critically important for disaster risk reduction in Sri Lanka.

8.2 The NBRO-ICL jointly installed four seismographs around the Kotmale Reservoir in July 2024 and commenced seismic monitoring on 29 July 2024. Analysis of the earthquake recorded on 8 August 2024 indicated a hypocenter approximately 4 km below the Kotmale International Training Institute, highlighting the presence of local induced seismic activity. The significantly higher Z-component acceleration suggests subsurface seismic influence beneath the reservoir region. These observations emphasize the urgent need to identify seismicity-induced landslide hazard zones and potential landslide-generated tsunami risks within the reservoir area. Accordingly, the project focuses on comprehensive seismic monitoring, interpretation, hazard identification, and development of effective risk reduction methodologies to enhance the safety and resilience of the Kotmale Dam and surrounding communities.

8.3 During the period from 2025 to 2026, significant progress was achieved in advancing the seismicity and landslide hazard assessment activities associated with the Kotmale Reservoir area. A comprehensive review of existing findings and technical investigations was conducted to evaluate available geological, geomorphological, seismic, and environmental data. As part of this process, a detailed inventory of

available datasets was prepared, while critical data gaps requiring further investigations and monitoring were identified for future studies.

- 8.4 Extensive field investigations were also carried out, including detailed geological mapping and geomorphological surveys within the reservoir surroundings and adjacent high-risk slope areas. These studies supported the identification of unstable rock masses, slope deformation patterns, drainage conditions, and potential landslide-prone zones. In parallel, seismic hazard analyses were undertaken using historical earthquake records, monitored seismic data, and probabilistic assessment models to evaluate possible induced seismicity and associated landslide risks in the Kotmale region.
- 8.5 In terms of technological collaboration, continuous efforts were made to establish a multidisciplinary network of engineers, researchers, practitioners, and policymakers from Sri Lanka and international institutions. This collaborative platform facilitated technical discussions, knowledge sharing, scientific exchange, and future research partnerships related to landslide risk reduction, reservoir safety, and seismic hazard assessment.

8.6. **Issues Related to the “Ditwah Cyclone” Effect on the Study Area**

The extreme rainfall associated with the “Ditwah Cyclone” event significantly increased slope instability within the Kotmale Reservoir catchment and surrounding mountainous terrain. Prolonged and intense precipitation caused rapid saturation of soil and rock masses, resulting in elevated pore water pressures, weakening of discontinuities, and reduction of slope shear strength. Several locations within the reservoir boundary exhibited tension cracks, minor slope failures, rockfall incidents, and progressive ground deformation following the event.

- 8.7 The cyclone also highlighted the vulnerability of highly weathered rock formations and steep geomorphological conditions in the Kotmale area. Surface erosion, blockage of natural drainage paths, and localized debris movements were observed in several high-risk slopes. These conditions may further destabilize reservoir-adjacent rock masses, especially when combined with seismic activity or reservoir water level fluctuations.
- 8.8 One of the major concerns identified after the cyclone event is the potential for large rockslides to enter the reservoir during periods of intense rainfall or seismic activity. The event further reaffirmed the critical importance of conducting high-level investigations and strengthening preparedness measures, as the ICL team had initially recognized the significance of this hazard in the Kotmale Reservoir area during preliminary assessments conducted in 2023. Such failures may generate displacement waves or localized reservoir tsunami effects, posing threats to dam safety, downstream settlements, hydropower infrastructure, and transportation networks.
- 8.9 The event also revealed several technical and institutional challenges, including limited long-term seismic monitoring data, inadequate integration of rainfall-triggered instability assessments with seismic hazard evaluations, and the absence of detailed rockslide susceptibility zoning for reservoir margins. Furthermore, the increasing frequency of extreme climate events emphasizes the need to integrate climate-induced hazard conditions into reservoir-induced seismicity and landslide risk assessments.

8.10. Accordingly, the “Ditwah Cyclone” event demonstrated the urgent requirement for comprehensive hazard zoning, continuous seismic and geotechnical monitoring, advanced early warning systems, and multidisciplinary disaster risk reduction strategies for the Kotmale Reservoir area.

9. **Future Work Plan/Expected Results:**

The proposed work plan is designed to provide a comprehensive, multi-disciplinary approach to assessing and zoning of potential rockslides induced by seismicity in the Kotmale reservoir area, with a strong emphasis on collaboration, capacity building, and the integration of advanced technologies. Works study of the area, collecting compressive data base on geomorphology, geology, seismographic data, geotechnical investigation data (old data and ongoing data), hydrological characteristics of the Kotmale reservoir area.

Year 2025 to 2026

- Comprehensive review report of findings, identify data inventory and gaps.
- Detailed surveys for geological mapping and geomorphological analysis. Seismic hazard analysis using historical data and probabilistic models.
- Technological Collaboration: Establish a network of engineers/practitioner/policymaker from both Sri Lanka and international institutions to facilitate ongoing collaboration and information exchange.
- Publication of finding at the Open Access Book Series P-LRT – 2026.

Year 2027 to 2028

- Data integration and analysis using GIS and specialized software.
- Development of landslide susceptibility maps.
- Scenario analysis of potential landslide events under different seismic conditions.
- Technological Collaboration: Establish a network of engineers/practitioner/policymaker from both Sri Lanka and international institutions to facilitate ongoing collaboration and information exchange.
- Publication of finding at the Open Access Book Series P-LRT – 2027/28

Year 2029 to 2030

- Resource Development: Create educational materials and resources, such as manuals and online platforms, to support ongoing learning and capacity development.
- Human Resource Training: Implement programs to train human resources in stakeholder institutions, including universities and technological centers, focusing on landslide and seismic risk management.
- Stakeholder Engagement: Organize regular meetings and workshops with stakeholders to review progress, share findings, and refine strategies.
- Publication of finding at the Open Access Book Series P-LRT – 2029/30.

12. **Project Beneficiaries:**

- a. Residents/Farmers: Kotmale Training Center, People living in and around the Kotmale reservoir area who are directly at risk from landslides and seismic activity. Enhanced risk assessment can help them prepare for and mitigate potential disasters.

- a. Disaster Management Center (DMC): This agency will benefit from the assessment by gaining detailed information to improve disaster preparedness and response strategies.
- b. National Building Research Organization (NBRO): This organization can use the findings to enhance its research on landslides and integrate the data into broader national risk assessments.
- c. Ministry of Irrigation and Water Resources: Responsible for the Kotmale reservoir, this ministry can use the assessment to protect the reservoir infrastructure and ensure water resource management is not compromised by landslides.
- d. Universities and Research Centers: These institutions can benefit from the data and findings for further research in geology, seismology, and disaster management. It can also provide opportunities for academic collaborations and advanced studies.

1. References

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