Date of Submission	15 May 2026

IPL Project Annual Report 2025

January 2024 to 31 December 2024

1 Project Title: Development of Community-based Landslide Early Warning System in Indonesia (IPL 158)

2 Main Project Fields: Landslide Monitoring and Early Warning and the Implementation of Landslide Mitigation

3 Name of Project leader:

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Core members of the Project: Names/Affiliations: (4 individuals maximum)

a. Prof. Teuku Faisal Fathani: Executive Director of the Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG), Indonesia (tfathani@bmkg.go.id)
b. Dr. Hendy Setiawan - Center for Disaster Mitigation and Technological Innovation (GAMA-InaTEK), Geological Engineering Dept. Universitas Gadjah Mada.
c. Dr. Fikri Faris - Center for Disaster Mitigation and Technological Innovation (GAMA-InaTEK), Civil & Environmental Engineering Dept. Universitas Gadjah Mada.
d. Dr. Rozaqqa Noviandi - Center for Disaster Mitigation and Technological Innovation (GAMA-InaTEK), Civil & Environmental Engineering Dept. Universitas Gadjah Mada.

4 Objectives: (5 lines maximum)

- Community empowerment with respect to community-based disaster risk reduction in landslide vulnerable areas, by integrating technical and social system.
- Improvement of awareness, preparedness, and resilience of the community in facing disasters in order to create resilient villages, which is the root of the nation's resilience.
- Promotion of a global standard on landslide early warning system.

5 Study Area: (2 lines maximum): at 120 districts located in 34 provinces of Indonesia.

6 Project Duration (1 line maximum) : 2009 – 2025

7 Report

1) Progress in the project: (30 lines maximum)

The community-based landslide monitoring and early warning system (EWS), which was initiated and supported by ICL, has been developed in Indonesia since 2007. This EWS is designed to enhance disaster preparedness and response capabilities through a structured approach to risk reduction, utilizing coordinated efforts from various stakeholders. Annual monitoring and evaluation are conducted systematically to ensure continuous improvements, addressing challenges encountered during implementation and strengthening the system's overall effectiveness.

A critical aspect of this activity is multisectoral coordination, involving the central and local governments, universities, private sectors, and local communities. This collaboration facilitates resource mobilization, data sharing, technical expertise, and community engagement, ensuring the program's long-term sustainability and effectiveness. The system's strategic framework emphasizes integrated monitoring technologies, real-time information flow, and command-based response mechanisms, enabling timely warnings and preventive actions.

Between January and December 2025, the landslide EWS was successfully implemented across several provinces in Indonesia, supported financially by District Governments (BPBD) and private-sectors, including geothermal, mining, and exploration companies. As part of a comprehensive disaster preparedness strategy, evacuation drills were conducted in each location, reinforcing community resilience and emergency readiness.

Recognizing the broader necessity for multi-hazard risk reduction, the scope of the early warning system has been expanded from landslides to include flooding, debris and lahar flows, volcanic eruptions, and tsunamis. The continuous refinement and expansion of Indonesia's community-based landslide EWS emphasize the importance of proactive disaster risk management. By combining technological innovation, cross-sector collaboration, and strategic emergency preparedness initiatives, this system contributes significantly to risk reduction efforts at both local and national levels.

Since November 2025, the previous team leader for this project has been appointed as the head of the BMKG. Since then, BMKG will support the implementation of the multi-hazard early warning system throughout Indonesia. The EWS covers not only landslides but also floods, extreme weather, cyclones, forest fires, earthquakes, and tsunamis.

2) Planned future activities or Statement of completion of the Project (15 lines maximum)

This landslide monitoring and early warning device will be further developed, by implementing it in several pilot sites supported by BMKG and other countries. Its technical performance and its impact on local communities will be thoroughly evaluated, and the results of these evaluations will be used to enhance the system's performance. Furthermore, the International Standard of Guidelines for the Implementation of Community-based Landslide Early Warning System (ISO 22328-2:2024) initiated

by Universitas Gadjah Mada, The Indonesian Authority for Disaster Management (BNPB), Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) and Indonesia Standardization Agency (BSN) has been published and will be implemented in other countries. For additional details, please refer to: https://www.iso.org/standard/83417.html

3) Beneficiaries of Project for Science, Education and/or Society (15 lines maximum)

Various potential beneficiaries of the project include academic institutions, government agencies, and private-sector partners, collectively strengthening international partnerships and fostering effective cooperation among related institutions. In addition, the integration of the landslide monitoring and early warning systems is a critical objective. Currently, several institutions operate independent systems that lack interoperability, underscoring the necessity for a unified approach. Establishing a national framework to manage all landslide monitoring systems in Indonesia is imperative. Such a framework would serve as a platform for integrating systems at the national, provincial, and district levels, thereby promoting consistent practices in disaster management and facilitating improved data sharing and technical collaboration. Ultimately, this integrated approach is expected to contribute to more effective risk reduction outcomes, benefiting science, education, and society as a whole.

4) Results: (15 line maximum, e.g. publications)

Research papers published in journals or presented at conferences

1. Erzagian, E., Fathani, T.F., Wilopo, W. & Noviandi, R. (2026) Influence of weathering grades on landslide occurrences in the tropical volcanic region of Kulon Progo, Indonesia. Earth Surface Processes and Landforms, 51(5), e70294. https://doi.org/10.1002/esp.70294
2. Pratama, G.M.; Gomi, T.; Noviandi, R.; Ritonga, R.P.; Fathani, T.F.; Wilopo, W. Land Cover and Land Use Controls on Landslide Morphometry and Occurrence in a Heterogeneous Mountain Watershed. GeoHazards 2026, 7, 31. https://doi.org/10.3390/geohazards7010031
3. Erzagian, E., Fathani, T.F. & Wilopo, W. Statistical landslide susceptibility zonation: kulon progo mountains, Indonesia. *Environ Earth Sci* **84**, 601 (2025). https://doi.org/10.1007/s12665-025-12519-3
4. Syariefudin, M.H., Erzagian, E., Setiawan, N.I., Setiawan, H., Fathani, T.F., Wilopo, W. (2025). Slope Stability Analysis Using the Slope Mass Rating (SMR) Method on Provincial Road Section, Kebumen Regency, Central Java Province, Indonesia. In: Abolmasov, B., *et al.* Progress in Landslide Research and Technology, Volume 4 Issue 1, 2025. Progress in Landslide Research and Technology. Springer, Cham. https://doi.org/10.1007/978-3-031-89836-5_18
5. Tanto, N.A., Setiawan, H. & Wilopo, W. Designing Underground Mine Support Systems in Weak Rock Zones at Pongkor Gold Mining, Bogor Regency, West Java Province, Indonesia. *Indian Geotech J* **56**, 658–671 (2026). https://doi.org/10.1007/s40098-024-01150-x
6. Wilopo W, Fathani TF (2024). Correlation of Liquefaction with Excess Pore Water Pressure in Langkat, North Sumatra. Intl Journal of GEOMATE. 2024. Vol. 26/No. 114/PP.117-125. https://doi.org/10.21660/2024.114.4150.

7. Al Rahman MH, Fathani TF, Wilopo W (2025). Excess Pore Water Pressure Ratio Comparison from Empirical and Numerical Methods to Determine Liquefaction Potential in Palu, Central Sulawesi, Indonesia. The Open Civil Engineering Journal. 2025. Vol 19. https://doi.org/10.2174/0118741495372949250114055629.
8. Aini I, Wilopo W, Fathani TF (2024). Development of Peak Ground Acceleration Using a Non-Linear Approach to Evaluate Liquefaction Potential in Sei Wampu Bridge, Langkat, North Sumatra, Indonesia. ASEAN Engineering Journal. 2024. Vol.14/No. 3/PP 41-52. https://doi.org/10.11113/aej.v14.20606.
9. Farid M, Mase LZ, Fathani TF (2024). The Investigation of Subsurface Beds using Microtremor and Geo-electric Methods in A Liquefied Area in Bengkulu City After The Bengkulu-Mentawai Earthquake. Indonesian Journal on Geoscience. (2024). Vol. 11/No. 3/PP. 377-390. https://doi.org/10.17014/ijog.11.3.377-390.
10. Prasetyaningtiyas GA, Mase LZ, Rifa'i A, Fathani TF, Listyawan AB, Azhom MN (2024). The Influence of Rainfall Variation on Slope Stability: Case Study of Wanayasa Street Slope, Banjarnegara, Indonesia. Transportation Infrastructure Geotechnology. 2024. Vol. 11/Issue 4/PP. 2406-2424. https://doi.org/10.1007/s40515-024-00376-9.
11. Azifah, G.B., Fathani, T.F. & Setiawan, H. Seismic microzonation studies in the Southern part of Progo River, special Region of Yogyakarta, Indonesia. Geoenviron Disasters 12, 6 (2025). https://doi.org/10.1186/s40677-025-00310-2
12. Heykal M, Ismanti S, Setiawan H (2024). Comparison of site classification using SPT and seismic downhole survey to evaluate liquefaction severity: A Case study in Serang-Panimbang Section III Toll Road Project. IOP Conference Series: Earth and Environmental Science. 2024. Vol. 1416/Article No. 012014. doi:10.1088/1755-1315/1416/1/012014
13. Priyanto N, Faris F, Setiawan H (2024). Liquefaction potential and severity analysis on road embankment in Serang-Panimbang Toll Road Section 3. E3S Web of Conferences. 2024. Vol. 576/Article No. 03005. https://doi.org/10.1051/e3sconf/202457603005.
14. Hardwiyanto S, Wilopo W, Setiawan H (2024). Slope stability of tunnel outlet portal at Budong-Budong Dam, Central Mamuju, West Sulawesi, using limit equilibrium method. AIP Conference Proceedings. 2024. Vol. 3110/Article No. 020016. https://doi.org/10.1063/5.0205006.
15. Andikasari LY, Syahbana AJ, Damayanti C, Atmojo HT, Mase LZ, Faris F (2024). Scenario Seismic Hazard Analysis of the Mataram "Fault": An Initial Study of Geophysical Approach. BIO Web of Conferences. 2024. Vol. 131/Article No. 04004. https://doi.org/10.1051/bioconf/202413104004.
16. Prasetya AR, Faris F, Rahardjo AP (2024). Seismic Vulnerability Assessment Using the HVSR Method at Yogyakarta International Airport Underpass, Indonesia. International Journal of GEOMATE. 2024. Vol. 26/No. 114/PP. 25–33. https://doi.org/10.21660/2024.114.4082
17. Saputri ANAE, Ismanti S, Fathani TF (2024). Numerical Study on the Liquefaction Potential Analysis Using Constitutive Models for Sand and Silt in Mamuju, West Sulawesi. The Open Civil Engineering Journal. https://doi.org/10.2174/0118741495358612241024091912