WHITE PAPER

British Geological Survey

UK-Indonesia partnerships for advancing geohazard science for disaster risk assessment in Indonesia

UK-Indonesia partnerships for advancing geohazard science for disaster risk assessment in Indonesia

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Endorsements

The National Research and Innovation Agency of Indonesia (BRIN) is pleased to endorse the white paper, 'UK–Indonesia Partnerships for Advancing Geohazard Science for Disaster Risk Assessment in Indonesia.'

Indonesia is one of the most hazard-prone countries in the world and faces persistent risks from earthquakes, tsunamis, volcanic eruptions, and other geohazards. Therefore, advancing scientific knowledge and developing innovative approaches to disaster risk assessment and reduction are of the utmost importance.

This initiative, aligned with the Astacita program, is a significant step toward strengthening collaborative research between Indonesia and the United Kingdom. The white paper provides a valuable framework for leveraging complementary expertise, data, and technology from both countries. It also creates opportunities to promote joint training, capacity building, and knowledge exchange that will benefit both researchers and practitioners.

Equally important, the paper highlights the connection between science, policy, and societal practices. This ensures that research results advance knowledge, inform decision-making, and lead to practical actions that strengthen community resilience. By embedding scientific findings into policy and community-based initiatives, this collaboration will help ensure that disaster risk reduction strategies are inclusive, evidence-based, and sustainable.

BRIN strongly supports this initiative and looks forward to deepening collaboration with UK partners to enhance scientific capacity, foster innovation, advance science-driven policy, and contribute to global knowledge and practices in disaster risk reduction. Through sustained partnership, mutual trust, and shared commitment, this initiative has the potential to serve as a model for other international collaborations in tackling complex global challenges.

Professor Ocky Karna Radjasa

Chairman, Research Organization of Earth Sciences and Maritime, National Research and Innovation Agency (BRIN)

The Agency for Meteorology, Climatology, and Geophysics of the Republic of Indonesia (BMKG) welcomes this White Paper as an important milestone in advancing geohazard science and disaster risk assessment in Indonesia. As one of the world's most disaster-prone nations, Indonesia has long experience in confronting complex and cascading geo-hydrometeorological hazards. This document provides a timely roadmap to strengthen institutions, improve data integration, and embed disaster risk reduction into national development planning.

For BMKG, the White Paper holds both strategic and operational value. It reinforces our mandate in real-time monitoring, forecasting, and multi-hazard early warning services, while also enhancing coordination with national and local disaster management agencies. At the same time, it opens opportunities for research collaboration, capacity building, and international support, helping Indonesia move closer toward the vision of becoming a disaster-resilient nation by 2035 and contributing to the global Early Warnings for All initiative.

Dr Nelly Florida Riama

Deputy Head of Geophysics
The Agency for Meteorology, Climatology, and Geophysics of the Republic of Indonesia (BMKG)

As Indonesia's Geological Disaster Management authority under the Geological Agency, Ministry of Energy and Mineral Resources (ESDM), Center for Volcanology and Geological Hazard Mitigation or known as Pusat Vulkanologi dan Mitigasi Bencana Geologi (PVMBG) is committed to advancing geohazard science as a foundation for disaster risk reduction. Partnerships such as this UK–Indonesia collaboration are crucial to strengthen knowledge, build resilience, and enhance science-driven decision-making at both national and international levels.

Dr Priatin Hadi Wijaya, ST, MT

Head, Center for Volcanology and Geological Hazard Mitigation (PVMBG)

Executive summary

Indonesia is one of the world's most hazard-prone nations and experiences over 2000 disasters annually. Natural hazard disasters in Indonesia are responsible for hundreds to thousands of lives lost each year and cost the country US$1 to US$3 billion annually. Population growth, increasing urbanisation, embedded poverty and rising inequality mean these risks are rising.

Reducing disaster risk requires decisions to be grounded in the best available earth science and risk management skills. There are significant opportunities to advance geohazard risk science in Indonesia through:

- improved integration of hazard data
- wider institutional coordination
- increased resourcing and research budget allocation
- valorisation of local knowledge
- enhanced levels of community engagement

This White Paper, co-developed by Indonesian and UK multi-disciplinary hazard experts and disaster managers, presents a strategic roadmap to significantly reducing the impacts of geohazards by 2035 through interdisciplinary research, locally embedded solutions and equitable international partnerships. The paper is the outcome of a landmark geohazard solutions symposium, *'UK–Indonesia Solutions Symposium on Geohazard Science for Disaster*

Risk Assessment in Indonesia', held in Jakarta, Indonesia, in June 2025. The symposium brought together scientists, policymakers and practitioners to prioritise the geohazard challenges in Indonesia and co-design solutions pathways to them.

Key challenges

The main barriers to effective disaster risk reduction in Indonesia include:

- **Data gaps**: fragmented and often limited hazard, exposure and vulnerability datasets
- **Resource constraints**: limited funding and a lack of commitment to long-term resource allocation for geohazard research
- **Community engagement**: plans that need to account for diverse geographies and cultures for effective communication and building trust
- **Disaster response and recovery**: fragmented responsibilities and a lack of locally tailored approaches
- **Dynamic risk**: poor integration of multi-hazard interactions, including cascading and compounding risks, into current decision making

These challenges are compounded by institutional silos, inconsistent funding and fundamental knowledge gaps around hazard processes and the vulnerability and resilience of communities.

Strategic solution pathways

The symposium proposed solutions across four cross-cutting themes.

- **Multi-hazard assessment and warning systems**: develop integrated multi-hazard maps and early-warning systems using low-cost, community-based technologies
- **Dynamic risk and adaptation**: create interoperable and accessible data platforms encompassing time-dependent data on hazards, exposure and vulnerabilities and foster local knowledge exchange to close cultural and generational knowledge gaps
- **Emergency preparedness and community resilience:** embed locally relevant disaster risk reduction and risk literacy in education and community planning, utilising both formal and informal knowledge systems
- **Disaster response and recovery**: promote people-centred, 'build back better' recovery models supported by guidelines that link national and local practice

Recommendations

1. Establish a formal UK–Indonesia geohazard disaster resilience partnership as a basis to coordinate joint research, policy dialogue and technical collaboration between Indonesian institutions and UK research organisations
2. Invest in long-term, interdisciplinary research on dynamic multi-hazard risks
3. Adopt a national geohazard data and information policy to ensure consistency, transparency and integration with ongoing initiatives such as Indonesia's 'one map' policy
4. Strengthen workforce value and knowledge exchange via fellowships, joint PhD or Masters programmes, mobility schemes and community engagement platforms
5. Embed disaster risk reduction in national development planning by requiring multi-hazard risk assessments for infrastructure and urban planning projects

Why UK–Indonesia partnerships matter

This collaboration uniquely combines Indonesia's lived experience and local leadership with the breadth of scientific and technical geohazard expertise in both the UK and Indonesia. It builds on a history of successful research partnerships to understand geological hazards in Indonesia. Together, we can deliver scalable, evidence-based solutions, strengthen institutions and unlock international funding, paving the way for Indonesia to become a global leader in disaster resilience by 2035.

Introduction

Indonesia is one of the world's largest archipelago nations, comprising over 17 000 islands and over 54 000 km of coastline (World Population Review, 2025). With a population exceeding 281 million people (2024), it is also the fourth most populous country in the world (US Census Bureau, 2025). Geological hazards such as earthquakes, landslides, volcanic hazards and tsunamis are a potent threat to a large fraction of Indonesia's population and contribute to over 2000 disasters every year (World Food Programme, 2025). Natural hazard disasters in Indonesia are responsible for hundreds to thousands of lives lost each year and cost the country US$1 to US$3 billion annually (Khalil et al., 2021; Ministry of Finance, Republic of Indonesia, 2023). With a growing population and financial exposure, such losses are expected to increase. There is therefore an urgent need to increase knowledge and develop effective strategies to manage geohazard risks in Indonesia.

Effective disaster risk reduction (DRR) across the spectrum of geohazards, from landslides to tsunamis, depends on decisions grounded in the best available earth science. Yet significant knowledge gaps remain, particularly in understanding past hazardous events and how they shape future risk, and how lessons from the past can best inform effective hazard-management strategies. Addressing these gaps requires coordinated, interdisciplinary research, concrete actions and resource allocations, and sustained collaboration between countries with complementary strengths.

This White Paper, co-designed by multi-disciplinary experts from the UK and Indonesia, outlines a strategic pathway to advance geohazard science and disaster risk assessment in Indonesia. Our shared vision is clear: **by 2035, we aim to significantly reduce the impact of geological hazards in Indonesia** through interdisciplinary research, evidence-based policy, locally embedded solutions and equitable international partnerships.

We propose UK–Indonesia disaster risk research partnerships that utilise:

- The unique scientific and technological expertise of both countries
- Indonesia's lived experience of disaster risk and resilience strategies
- The strength of long-term research collaborations between UK and Indonesian researchers and institutions

This White Paper builds on a landmark symposium held on 10 to 12 June 2025, which was funded by the UK Foreign, Commonwealth & Development Office (FCDO). The symposium brought together a consortium of UK hazard and disaster specialists with over 50 Indonesian experts from academia, government and policy implementation to co-design a solutions pathway for geohazard disaster resilience in Indonesia. The symposium was organised by a team from the British Geological Survey (BGS) and the University of Birmingham in the UK and the National Research and Innovation Agency (BRIN), the Institut Teknologi Bandung (ITB), the Resilience Development Initiative (RDI) and the British Embassy in Indonesia.

Over three days, the delegates defined priorities and developed strategies to best support a cycle of effective disaster risk assessment and management across four key themes:

- Single and multi-hazard assessment and warning systems
- Dynamic risk and adaptation
- Emergency preparedness and community resilience
- Disaster response and recovery

The primary focus was on geological hazards such as earthquakes, landslides, tsunamis and volcanic hazards with the recognition that hydrological hazards are also a relevant component of geohazard risk in Indonesia, particularly in the context of multi-hazard systems and the impact of climate change on geohazards.

This White Paper is intended for policymakers, funders, researchers and institutions that are committed to collaboratively reducing disaster risk in Indonesia. Grounded in locally informed and co-designed solutions, this paper sets out strategic priorities and a shared vision for delivering evidence-based, resilient development in one of the world's most hazard-prone nations.


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Challenges and priorities

In 2022, the British Geological Survey (BGS) and the Indonesia-based Resilience Development Initiative (RDI) co-hosted a two-day, virtual workshop to identify the priority research needs for understanding geological hazards to support disaster risk assessment in Indonesia (Lutfiananda et al., 2022). These included:

- improved hazard assessments
- more comprehensive coverage of baseline geological data
- enhanced collaboration and interdisciplinary working
- a key role for community engagement and education
- clear understanding and evaluation of institutional roles and responsibilities
- a particular need to understand and address multi-hazard processes and exposure in Indonesia

This provided the foundation for the 2025 geohazard solutions symposium, which built on the previous workshop by first defining the key geohazard challenges and priorities, then shifting the focus to explore solution pathways to address these and work towards achieving our shared vision.

The overarching challenge for geohazard research and disaster risk management in Indonesia is to build capacity to reduce impact from geological hazards. We can break this down to

identifying the key challenges and barriers, helping us prioritise the most effective solution pathways.

Based on the symposium discussions, we identified that underlying many of the challenges is the lack of a sustainable nexus between science, policy, and societal practice. The absence of an ecosystem for knowledge co-production and learning impedes the development of robust institutional knowledge and is the root cause of many of the barriers to coordinated disaster risk assessment for geological hazards. These barriers include social and institutional barriers, policy and governance barriers, scientific and technical barriers, and cultural and everyday knowledge barriers.

- **Social and institutional barriers**, such as social inequality, influence exposure and vulnerability to hazards, lead to gaps in community engagement and inadequate integration of local knowledge and lived experience within hazard planning.
- **Policy and governance barriers** include bureaucratic hurdles arising within fragmented national and local institutional roles and responsibilities, a lack of integration of DRR into local or national development plans, and the absence of a robust science-policy-societal practice nexus that inhibits the flow of knowledge and the building of institutional knowledge. These barriers are compounded by gaps in funding mechanisms for disaster resilience and limited institutional capacity for multi-stakeholder collaboration and long-term planning.
- **Scientific and technical barriers** include fragmented and non-standardised hazard data, risk maps, information systems and early-warning frameworks; hazard assessments that poorly reflect multi-hazard mechanisms, time-dependent and cascading risks; geographical gaps in baseline data, real-time data collection and monitoring; and gaps in the interoperability of hazard management systems
- **Cultural and everyday knowledge barriers** include limited recognition of community-based everyday knowledge and cultural practices that shape disaster perception; the unique traditions, beliefs and geographical adaptations of each community, which are crucial for understanding and integrating local disaster awareness into planning.

These barriers combine in limiting current capacity to reduce geohazard impact. Underpinning them all is a poor science-policy-societal practice nexus, which perpetuates siloed initiatives and fragments the institutional knowledge necessary for long-term resilience. Addressing these barriers is critical to advancing the following four key themes that form essential components to effective DRR:

1. Data availability
2. Communication and community engagement
3. Disaster response and recovery
4. The dynamics of risk

Data availability

The challenges around data include gaps in:

- knowledge about existing geological hazards
- exposure and vulnerability datasets and databases
- accessibility and management of these resources

These gaps are spatially variable and more pronounced outside Java, particularly in more isolated parts of Indonesia, such as small islands and eastern Indonesia. Data is needed at sufficient resolution to enable meaningful analysis of future hazard scenarios. The data gaps include, for example, knowledge of historical volcanic activity, gaps in nearshore and high-resolution bathymetry, gaps in real-time data collection, and spatially variable monitoring coverage.

Underpinning these technical gaps are governance challenges, which include:

- institutional fragmentation, where data acquisition by different agencies creates silos that prevent a unified risk picture
- inconsistent implementation of the '*Satu Data Indonesia* (One Data Indonesia)' policy (Cabinet Secretariat of the Republic of Indonesia, 2019), limiting standardised and synchronised data sharing across ministries and levels of government, and
- insufficient mechanisms to ensure the integrity and integration of diverse datasets, which is a critical requirement for accurate multi-hazard risk assessment

Consequently, efficient and versatile data sharing and interpretation is hindered by a lack of interoperability across hazard monitoring and communication systems, and a lack of standardized risk maps and early warning frameworks across different geohazard types. Included in the challenge of data availability is the systematic collation and coverage of social knowledge of events, passed down through generations and lived experience, and how this is captured and integrated with scientific knowledge.

Communication and community engagement

Indonesia is culturally and socially diverse, with over 17 000 islands and over 600 languages. Clear and systematic communication of geological hazards and associated risks must overcome these geographical and cultural challenges in order to build capacity and ensure communities can prepare for, respond to and recover from hazard events and disasters. Communication barriers may be amplified in more isolated communities with limited physical and technological connectivity to centralised hazard management networks.

Part of developing effective communication strategies requires community engagement to build trust between community groups, scientists and authorities, and to build community resilience. This also requires disaster risk communication strategies that are contextual to specific social and cultural conditions, avoiding 'one-size-fits-all' approaches in hazard communication. The challenge is how to address community engagement gaps and develop balanced and informed public perception of hazards and risk, and to integrate different community groups in disaster preparedness to help reduce vulnerability.

Disaster response and recovery

Operationally, disaster response efforts must maintain critical infrastructure and provide access to healthcare, clean water and food. However, this is very dependent on the local context. For example, infrastructure (including support capacity and access to materials for recovery) on small islands may differ significantly from large islands, or provision of certain food may be culturally inappropriate in some locations. As with communication and engagement, there can be no one-size-fits-all to disaster preparedness planning, response and recovery.

A resilience-focused and 'build-back-better' approach to recovery ensures that post-disaster actions not only meet immediate needs but also enhance future adaptive capacity. This ensures that rebuilding efforts systematically reduce underlying risk factors and prevent the reproduction of vulnerability.

Another challenge for disaster response and recovery is the fragmentation of institutional responsibilities for different geological hazards, alongside limited institutional capacity for multi-level and multi-stakeholder collaboration and long-term planning.

Dynamics of risk

Disaster risk is dynamic, incorporating multi-hazard complexity (for example, cascading events and compounding hazards), transboundary hazards and impacts, and changes in hazards, exposure and vulnerability over space and time as events unfold.

A key aspect of this that was repeatedly discussed during the 2025 symposium is the need to incorporate multi-hazards into disaster risk assessment and planning. The temporal and spatial dynamics of hazard events need to be built into preparedness and recovery plans, considering related changes, exposure and vulnerability as hazard events evolve. Land-use plans should incorporate the understanding of risks and potential future threats, and incorporate recommendations for addressing them. The local context of vulnerability (social; political; economic; physical; systemic), vulnerable groups (women; children; elderly; disabled; carers, etc.) and the factors that can influence the social vulnerability of these groups all need to be understood as well.

Priorities

The priority for advancing geological hazards research for disaster risk management and exploring solution pathways must be addressing these challenges and barriers. We need to:

- embrace new innovative technologies for hazard and risk assessments (for example, artificial intelligence) sustainably
- embed DRR in education
- establish centres of excellence
- promote knowledge sharing
- build consistent funding mechanisms for DRR

A more integrated hazard-management framework would also provide the basis for effective, national-scale assessment and management of dynamic risk and multi-hazard challenges, filling the gaps within currently fragmented structures (for example, national coverage by multi-hazard maps by 2035).

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Solutions for advancing geohazard disaster risk reduction

Building on the identified barriers to effective geohazard disaster risk assessment in Indonesia, collective discussions at the symposium proposed several solution pathways. These were not intended to be exhaustive or exclusive, but they did provide a set of priorities that emerged across the symposium that focused on proposed ways for geohazard science to address the disaster risk assessment challenges in Indonesia.

The solutions are organised across four themes:

- Single and multi-hazard assessment and warning systems
- Dynamic risk and adaptation
- Emergency preparedness and community resilience, and
- Disaster response and recovery

Hazard assessment and warning systems

Within this theme, covering both single and multi-hazards, solution pathways focused on gaps in baseline geohazard knowledge, practice and operations. These gaps inhibit effective multi-hazard assessment and the development and implementation of early-warning systems.

Establishing risk and hazard assessment for multi-hazard events was identified as a priority. Given the complexity and variety of Indonesia's environment and hazard landscape, triaging is required to determine the highest-risk areas, priorities in terms of both risk and vulnerability (social, physical and community), and for addressing varied multi-hazard types and pathways. This approach may not be viable on a national scale. Pilot-scale projects were advocated that could establish and demonstrate effective approaches that integrate current single-hazard assessment and management approaches alongside multi-hazard evaluation.

Multi-hazard solutions require a forum to connect and exchange knowledge within cross-disciplinary expert and stakeholder teams that span affected communities, interagency researchers and practitioners, and local government. This is a necessary component of generating integrated multi-hazard assessments. It is also important to establish the inclusion of risk and potential losses as part of an investment and prioritisation model. Outputs from this framework may involve multi-hazard maps or other formats and should define mitigation measures that directly inform regulation, guidelines, standards and planning, hazard monitoring and management structures. Mitigation measures should also include approaches for establishing long-lasting communication and education mechanisms for building community resilience.

Given the scale of the geohazard challenges in Indonesia**, early-warning systems require low-cost, accessible and sustainable technologies that are integrated across multiple hazard types**. These must deliver on agency responsibilities and remain effective on decadal timescales. The systems should be simple to maintain and operate, and capable of rapid deployment.

Baseline knowledge of risks remains a knowledge gap that requires addressing through (multi-)hazard mapping approaches. Monitoring and warning systems require development in conjunction with local stakeholders for effective management. Open-source and low-cost technologies may hold strong potential, including the use of geophysical tools and installation of instruments, for example low-cost seismometers and earthquake early-warning systems (EEWS) in community buildings such as schools, stations and hospitals. The latter can play a role in community awareness and education, forming part of an effective response capability and fostering community engagement with hazard warning systems.

Dissemination and communication for preparedness and response remain a challenge; approaches should consider multiple mechanisms of dissemination (for example, telephone; radio; sirens) embedded through scenarios and drills. Research is also needed in this area to understand community and individual behaviours and responses to early-warning systems in different societal and cultural contexts, aiming to reduce vulnerability.

Funding of effective early-warning systems remains a major challenge, for training (for example, local hazard management and implementation systems) and community or stakeholder engagement as well as the technologies themselves. These are of equal importance in an effective system. Innovative financing may be required to support such initiatives; suggestions proposed at the symposium included taxation routes, crowdfunding, corporate social responsibility routes, tourism levies and *zakat* — an Islamic obligation for individuals to give away a portion of excess wealth each year to charitable causes.

Dynamic risk and adaptation

This theme identified the need for an integrated multi-hazard system and approaches that effectively address cultural and generational knowledge gaps.

Harmonisation and integration of current knowledge is needed to identify gaps, with oversight by an agency responsible for information management and communication. Such an approach would enable comprehensive coverage and information accessibility, which can be promoted through open-source approaches and map-based formats.

Short-term approaches to establishing an integrated multi-hazard system must first collate existing datasets across all relevant organisations, including legal frameworks. Coordination and integration of data types across disciplinary areas, to ensure effective interoperability, is essential to developing an effective system that goes beyond the sum of its parts.

In the medium term, societal data and early-warning approaches should both be included within this system. They will enable effective vulnerability and risk assessments and scenario simulations, which in turn can inform management, planning and regulation.

The long-term output of these short- and medium-term approaches could be an **open-source multi-hazard app that is useable by both professionals and the public**, drawing on datasets that span all geohazards on a national scale. It is essential that these build on and can connect to existing applications and websites, such as InaRisk and Magma Indonesia, to ensure their interoperability.

As with the previous theme, **effective communication to build resilience** was identified as essential. Using mini-funds to support influential voices (for example, from politics; education; public life, etc.) could deliver effective knowledge-sharing and awareness-raising events. The target of this would be two-fold: addressing cultural and generational knowledge gaps in a versatile framework, and learning from communities living with geological hazards.

In the short-term, this approach requires education and community engagement that can then build into funding routes and materials for dissemination across a variety of networks, both formally (for example, DRR established within school teaching) and informally (for example, social media). Such an approach should consider local- to national-level communication routes. For instance, this could combine the establishment of village-level resilient systems with outputs such as a 'National Geohazard Day' or a centre for disaster memory and resilience, which would facilitate events that span generations and bring together experts and communities.

Emergency preparedness and community resilience

Early-warning systems and education were again identified as key solution priorities. **Early-warning systems must not only be effective, affordable and sustainable in order to have longevity and widespread coverage; they must also trigger appropriate and immediate responses** within the context of a complex hazard environment and a diverse Indonesian culture. Approaches need to be versatile in terms of drawing on evolving technologies (for example, artificial intelligence modelling) and continual improvement of high-resolution baseline geological datasets, in order to move towards near real-time systems. Such systems need to be planned on a local scale in conjunction with community stakeholders, both to build community resilience and ensure that designs meet local needs, establishing a framework for capacity building and effective early response. Co-financing models, such as collaboration with the

community and private sectors benefiting from the system, may also be effective in maintenance of and engagement with early-warning systems.

Education approaches that combine both formal and informal methods provide an effective way to enhance resilience and trigger continuous action, knowledge sharing and co-production. This requires input across multiple stakeholders, including:

- academic researchers
- media
- at-risk communities
- local and national government
- policymakers
- private sector organisations
- civil society (for example, faith-based groups)
- international organisations

Knowledge sharing and co-production could draw on a range of approaches, incorporating local knowledge, art, non-degree training, museums and infographics, social media, artificial intelligence, and production of 'starter kit' information for tourists and migrants.

The success of such efforts should be monitored and evaluated to establish a continuous cycle of action, reflection and development that aims to maintain awareness and enhance resilience and preparedness.

Disaster response and recovery

In this theme, recognition that there is no one-size-fits-all approach is essential to developing appropriate measures in a complex and diverse society.

The proposed approaches identified the need for **national-level guidelines that could be integrated with local-level procedures**, considering both single and multi-hazard risk. Guidelines and protocols must bridge gaps between government, scientists and local communities, and consider how local needs can be heard, acknowledged and recorded. Approaches could include platforms for sharing views and standardised surveys, to ensure that hazard understanding and community knowledge and needs are evaluated in a way that is consistent, comprehensive and can account for societal diversity.

Disaster recovery should take a 'build back better', people-centred approach, with recovery prioritising the implementation of resilient housing and infrastructure and enabling sustainable community self-recovery. Such a method requires the identification of local resources and the capacity for rebuilding, which could be assessed ahead of events for a range of scenarios. This should include assessment of building types and infrastructure performance, taking lessons from ongoing events and via post-event surveying.

Following infrastructure damage, short-term coordination needs to be combined with the long-term implementation of building codes, permits and controls. Communication to communities should be tailored and could consider the use of mandatory apps and testing effective local communication methods. Knowledge on evaluating effective, low-cost mitigation actions should also be drawn from other countries and disciplines.

A disaster resilience roadmap

This section outlines a roadmap toward reducing the destructive effects of geological hazards in Indonesia. Co-developed by Indonesian and UK experts, the roadmap is a shared commitment towards building a disaster-resilient nation by 2035. UK–Indonesia partnerships underpin this roadmap, combining deep local knowledge with international collaborations in research and innovation. These partnerships are essential for delivering inclusive, science-based solutions to complex multi-hazard risks.

Long-term vision (2035)

Vision (2035)

By 2035, we aim to significantly reduce the impact of geological hazards in Indonesia.

- **Informed & prepared society**
- **Evidence-based policy**
- **Zero casualties**
- **Risk maps & multi-hazard warning**
- **Sustainable capacity & investment**

Indonesia aspires to become a global leader in disaster resilience by 2035. The country will have comprehensive multi-hazard risk maps that inform planning, investment and community preparedness that will cover all regions of the country in granular detail and will be regularly quality checked and updated. Communities and institutions across the nation, from urban centres to remote islands, will have a high level of geological hazard and disaster risk knowledge, and be empowered to take protective action. This will be supported by improved disaster literacy and inclusive education, integrating intergenerational knowledge and cross-community education.

Existing regulations, such as the *Rencana Induk Penanggulangan Bencana* (Disaster Management Master Plan) 2015–2045 (Badan Nasional Penanggulangan Bencana (BNPB), 2018), and *Perpres* (Presidential Regulation) No. 87 / *Tahun* (Year) 2020, govern actions on disaster-resilient development (Hadi, 2020). However, these can be further strengthened and expanded to include multi-hazard processes and time-dependent risks. Together, these can ensure that national development policy decisions are backed by evidence demonstrating social, environmental and economic benefits in addition to long-term DRR.

A well-trained and funded disaster management workforce will ensure rapid, coordinated responses and long-term risk reduction. Policies would include how to best support vulnerable groups through social protection measures, such as integrating geological hazard data with scenarios and potential impact assessments on vulnerable groups.

Advanced multi-hazard early-warning systems (MHEWS) will cover the entire country. Cross-sectoral policymaking will integrate the latest findings from geoscience and social science research with local knowledge. This vision is one where zero casualties and significantly reduced economic losses from geological hazards are not only goals, but expectations.

Priority outcomes (two to five years)

To achieve these goals, a series of coordinated outcomes need to be prioritised in the next two to five years. These include institutional, technical and community-level changes that will drive improvements in DRR across Indonesia.

Strengthening institutions and national coordination

A key priority is strengthening nationally mandated, expert bodies for geological hazard assessments. The Geological Agency, through the *Pusat Vulkanologi dan Mitigasi Bencana Geologi* (Centre for Volcanology and Geological Hazard Mitigation), is responsible for producing the official national hazard maps for earthquakes, volcanoes, landslides, liquefaction and tsunamis. However, updating and delivering these maps requires significant resources and close collaboration between academic and government institutions, for example:

- the National Research and Innovation Agency (BRIN) for continuous research and methodology development
- the National Center for Earthquake Studies (PuSGeN) for the updated active fault sources
- the Meteorology, Climatology and Geophysical Agency (BMKG) for earthquake and real-time tsunami hazard information

In addition to improving the spatial and temporal resolution of these official single-hazard assessments, an inter-agency framework is required that can effectively understand and plan

for the realities of time-dependent hazards in the context of realistic multi-hazard systems. The framework would ensure coordination that crosses single-hazard boundaries (for example, hazards at the land/sea interface).

Additionally, closer partnerships should be developed to understand the exposure and vulnerability to both individual and multi-hazards. Hazard maps and exposure and vulnerability information must account for physical, social and systemic vulnerabilities and be updated regularly to support dynamic and locally relevant risk assessments. This will necessarily require consistent and harmonised data and information at the national level, with granular detail. To deliver this outcome, cross-organisational and cross-sectoral coordination mechanisms must also be strengthened. A clearer understanding of institutional roles, improved information flow and dedicated procedures for risk communication will encourage more efficient disaster risk governance. The goal is to make the multi-hazard approach to disaster risk management the norm, rather than the exception.

Integrated data infrastructure and early warning systems

Improved data sharing across ministries and sectors is essential. An integrated, real-time data platform must be developed to support access to multi-hazard data across scales and sectors. A national rollout of MHEWS is also essential. These systems should be designed to reach both urban and remote communities, and should be supported by the clear communication of hazard maps and scenarios. Research will also explore methods for assessing compound and cascading hazards and integrating them into spatial planning and national development strategies. A joint programme to support interoperability and cross-institutional integration of datasets will be critical.

Demonstrating and localising impact

Pilot case studies will demonstrate the value of DRR approaches and help identify 'hard-to-reach' populations, local champions and effective community practices. These studies will focus on understanding how:

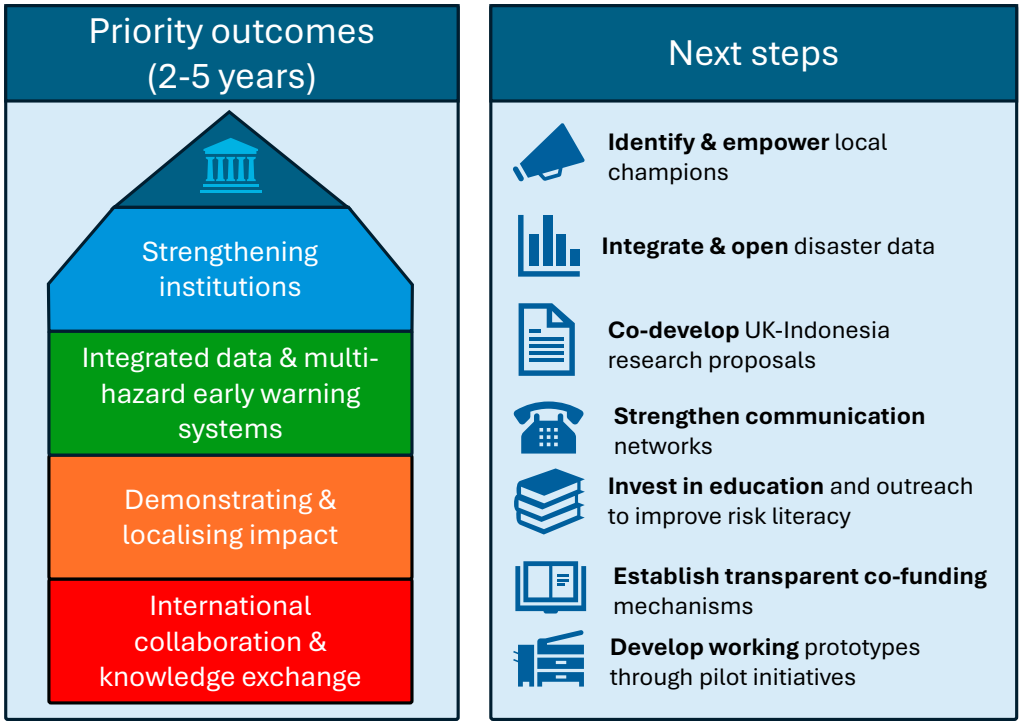
- communities have experienced past events
- vulnerability has changed
- interventions can be sustainably implemented

Inclusion and trust-building will be central, ensuring communities actively shape and benefit from decision-making processes. Local authorities, non-governmental organisations and DRR forums will be empowered through training and collaboration. Pilot programmes in multi-hazard-prone areas, such as Bandung, Sukabumi, Ambon, Palu, Ternate and the new capital, Ibu Kota Nusantara (IKN), could be used to test and refine strategies for integrated multi-sectoral governance, and offer scalable models for national implementation.

International collaboration and knowledge exchange

A creative option to address the science-to-implementation gap could be through the establishment of a Centre for Geohazard Solutions. This centre would bring together those Indonesian government ministries responsible for hazard assessment with academic stakeholders from both Indonesian and UK universities and research institutes. The centre would

be mandated as the bridge between scientific innovation, policy and practice for disaster risk solutions in Indonesia. It would engage with global platforms such as the United Nations Office for Disaster Risk Reduction (UNDRR) and the International Science Council to help position Indonesia as a leader in integrated geohazard science. This would strengthen international partnerships and open access to global funding and scientific resources.

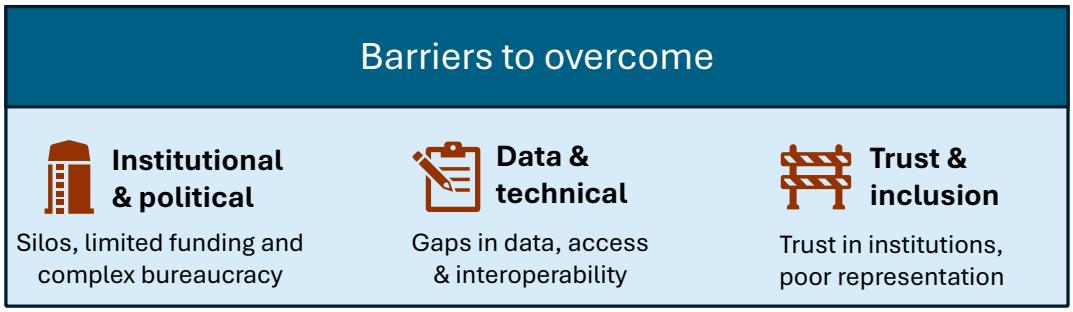


Next steps

A number of actionable steps can be initiated now to advance the roadmap.

1. Develop pilot projects to both illustrate the approach and test effective engagement strategies. These could target high disaster-prone areas and expand existing programmes to engage provincial and regional Disaster Management Agencies (BPBDs) and community actors to identify local champions and empower grassroots leadership.
2. Integrate and open disaster data, linking it with National Disaster Management Agency (BNPB) systems and developing a data-sharing framework that encourages collaboration and open access for all stakeholders.
3. Develop joint research proposals, particularly around multi-hazards, compounding and cascading hazard and risk, early warning and DRR, drawing on UK–Indonesia interdisciplinary teams.
4. Strengthen communication networks between science, media and policy stakeholders to improve risk literacy and public trust.
5. Invest in education and outreach, including curriculum development, intergenerational education (with bespoke modules for vulnerable groups) and awareness programmes for youth and young scientists.

6. Create transparent co-funding mechanisms and connect with the existing disaster management funding, such as the Indonesia Disaster Risk Financing Strategy for long-term DRR investment.
7. Develop prototypes, such as a mobile multi-hazard museum and MHEWS pilots, that showcase innovation and inclusivity.



Barriers to implementation

Whilst the roadmap is ambitious, progress will be shaped by how well the following barriers are addressed.

Institutional and political

- Fragmentation and silos across institutions, sectors and disciplines
- Limited funding, short political cycles and inconsistent prioritisation of DRR
- Complex bureaucratic structures that can delay action
- Combined with a diverse political party landscape, differences in authority between central and local governments make coordination complex

Data sharing and technical constraints

- Gaps in hazard, exposure and vulnerability data coverage and interoperability
- Difficulty accessing, updating and using data across agencies
- High resource demands for real-time monitoring and early-warning systems

Social and cultural factors

- Potentially low public trust of national institutions, particularly in areas with indigenous practices
- Insufficient representation of social sciences and local knowledge in risk assessments
- Barriers to participation from vulnerable and marginalised groups
- The diversity of cultural contexts across Indonesia makes it challenging and time-consuming to design bespoke or customised disaster risk communication

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Recommendations

The UK–Indonesia collaboration provides a unique opportunity to combine global scientific excellence and rich local expertise to address the urgent need to deal with geological hazards. This partnership is not only instrumental in shaping research and policy but also in strengthening institutions, scaling solutions across diverse hazard contexts and unlocking funding for DRR solutions.

Building on the symposium outcomes and the co-developed roadmap, we propose the following five recommendations to accelerate progress toward our 2035 vision for geohazard disaster resilience in Indonesia. These recommendations are designed to be actionable, sustainable and rooted in the strength of UK–Indonesia research partnerships.

Establish a formal UK–Indonesia geohazard disaster resilience partnership

Create a permanent framework to coordinate joint research, policy dialogue, and technical collaboration between Indonesian institutions (such as BMKG, BNPB, BPBD, BRIN, the Geological Agency, the Geospatial Information Agency (BIG), the Ministry of National Development Planning/National Development Planning Agency (BAPPENAS), research centres and universities) and UK research organisations.

- Establish a bilateral Centre for Geohazard Solutions to bridge science, policy and practice, bringing together scientists, policymakers and disaster managers to exchange knowledge, share best practices , and identify needs and opportunities for furthering disaster risk science in Indonesia
- Conduct regular meetings and updates to promote research progress and to invite wider stakeholders involved
- Promote shared research agendas aligned with Indonesia's national DRR priorities
- Develop mechanisms to mobilise international funding and sustain long-term collaboration beyond individual projects and political cycles

Invest in long-term, multi-hazard risk science

Fund long-term interdisciplinary research programmes that advance the science of dynamic disaster risk, with direct links to policy and practice.

- Expand current single-hazard mapping to include multi-hazards and their time dependencies at national and local scales
- Support pilot projects in highly exposed regions (for example, Bandung; Palu; IKN; Ternate) and others if funding allows, to demonstrate applied solutions
- Develop innovative, low-cost monitoring and early-warning technologies that are co-designed and implemented with local communities
- Expand research on societal vulnerability, cultural dimensions and risk behaviour to complement geophysical monitoring and modelling
- Promote strategies to collaborate and share knowledge and expand partnerships with regional partners across south-east Asia, which could include (amongst others) research centres such as the Earth Observatory Singapore, PHIVOLCS in the Philippines, the Disaster Management and Humanitarian Affairs unit of the Association of South-east Asian Nations (ASEAN) Secretariat, ASEAN Coordinating Centre for Humanitarian Assistance on Disaster Management (AHA Centre).

Create a national geohazard data and information policy

Adopt a national framework for open, consistent and trusted data to underpin disaster risk management. Where appropriate, these datasets should be integrated with Indonesia's existing 'one map' policy (Shahab, 2016; Cabinet Secretariat of the Republic of Indonesia, 2024), managed by BIG.

- Establish a platform that connects hazard, exposure and vulnerability data across academia, ministries and local government
- Mandate more regular updates and quality assurance of official hazard maps and risk datasets
- Promote transparency and accessibility of these datasets, enabling use by policymakers, communities and the private sector
- Integrate indigenous knowledge and post-event impact information into a unified risk knowledgebase

Strengthen human capital and knowledge exchange mechanisms

Build a resilient disaster risk knowledge ecosystem by connecting scientists, practitioners and communities.

- Launch knowledge exchange and mobility schemes for young and early-career researchers, including fellowships, joint Masters and PhDs, and secondments between the UK and Indonesia
- Support community engagement platforms, such as village-level DRR forums, mobile multi-hazard museums and disaster memory initiatives
- Provide training for professionals, volunteers, local governments and BPBDs to improve the interpretation and use of hazard data, and to develop risk assessment and disaster risk management strategies
- Promote intergenerational education and develop risk literacy programmes embedded in schools, universities and informal networks, drawing on arts, media and local culture
- Encourage investment in the development of knowledge management platforms and training on good practice in disaster risk management

Embed disaster risk reduction in national development planning

Reprofile DRR as a core component of sustainable development, infrastructure and education policy.

- Require multi-hazard risk assessments and resilience strategies for all major infrastructure and urban planning projects
- Strengthen commitment to research on disaster mitigation and development of building codes, permits and control in seismically active locations, such as along the Sumatra and Semangko faults, Cimandiri and Lembang faults, Palu-Koro Fault, etc.
- Introduce cross-governmental DRR working groups that link the ministries responsible for education, health, infrastructure, finance and environment
- Integrate risk modelling into risk financing instruments, such as risk pooling, disaster insurance and adaptive social protection
- Accelerate the implementation of DRR into school curricula and professional training to foster intergenerational knowledge transfer
- Design inclusive investment models (co-financing; tourism levies; corporate social responsibility; faith-based voluntary financing, including *zakat*) to ensure sustainable funding for DRR
- Promote 'build back better' and self-recovery standards that strengthen resilience and reduce long-term vulnerabilities

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