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Issue brief

Lessons for Africa from Brazil on becoming more resilient to climate disasters

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Bottom lines up front

- Disasters triggered by extreme climate events are increasingly generating significant economic losses, infrastructure disruptions, and social pressures, particularly in developing regions where rapid urbanization and climate vulnerability intersect.
- Inadequate coordination, early-warning systems, disaster management, and crisis communication often amplify their impacts and delay recovery.
- Brazil's disaster monitoring and early-warning system lets decisionmakers assess the impact of disasters, identify triggering variables and effects, and enable future preventive actions—a model for developing nations across Africa.

Climate disasters as an economic risk

Climate disasters are increasingly among the most disruptive shocks affecting economies and societies worldwide (Alvalá and Barbieri, 2017; Moraes, 2023, 2026; Marengo et al., 2025). Extreme rainfall, floods, landslides, droughts, and storms are not only humanitarian crises; they also generate substantial economic losses, damage critical infrastructure, disrupt supply chains, and place significant fiscal pressures on governments (IPCC, 2021, 2022). In many developing regions, disasters can reverse years of economic progress, particularly when vulnerable communities and infrastructure systems are exposed to climate-related risks. Strengthening disaster risk governance—through effective prevention and disaster protection by means of monitoring systems, institutional coordination, and clear crisis communication—is therefore not only a matter of emergency response but also a central component of economic resilience and sustainable development.

These challenges are particularly acute in many African countries, where rapid urbanization, infrastructure gaps, and increasing climate variability are raising exposure to extreme events. Very few member states have attempted to develop an early-warning system with all the requisite details for effective disaster risk reduction (Maripe et al., 2022). The authors highlighted the need for all African Union member states to develop both the framework for and the

multihazard and people-centered early-warning system(s), in line with the Sendai Framework for Disaster Risk Reduction (SFDRR) and the Africa Plan of Action. Floods, droughts, and landslides frequently disrupt economic activity, damage transport networks and housing, and impose heavy reconstruction costs on governments already facing constrained fiscal space.[1] As climate change intensifies the frequency and severity of extreme weather events (Alcántara-Ayala, 2025; IPCC, 2021), improving disaster preparedness and risk management has become an essential priority for protecting economic development gains and strengthening long-term resilience.

Over the past decades, Brazil has developed an increasingly sophisticated disaster monitoring and early-warning system designed to reduce human and economic losses associated with extreme weather events (Alvalá et al., 2019; Moraes, 2023). The creation of the National Center for Monitoring and Early Warning of Natural Disasters (abbreviated as CEMADEN in Portuguese) has significantly strengthened the country's capacity to monitor climate disaster risks, provide early warnings, and support coordinated responses across different levels of government. Brazil's experience offers valuable lessons for countries seeking to strengthen disaster risk governance, particularly in regions where climate vulnerability and institutional capacity constraints coexist (Alvalá et al., 2023; Marengo et al., 2025).

Economic impacts of climate disasters

Climate-related disasters impose significant economic costs that extend far beyond their immediate impacts, generating prolonged disruptions to economic activity including supply chains and productivity (Shah and Baker, 2024; Haddad and Teixeira, 2015; Cavallo et al., 2013). The events also affect key sectors such as agriculture, tourism, and manufacturing. The cumulative effect is a loss of economic output that can slow national growth and undermine regional development.

Infrastructure systems are particularly vulnerable to extreme events (Hallegatte et al., 2019; Haddad et al., 2025). Roads, bridges, ports, electricity networks, pipelines, and water systems are frequently located in areas exposed to floods or landslides. When disasters damage these assets, the consequences ripple throughout the economy, interrupting trade, raising transportation costs, and delaying the delivery of goods and services. In many developing countries, where infrastructure networks are already limited, such disruptions can isolate communities and significantly hinder economic recovery.

Disasters also place considerable pressure on public finances (IMF, 2019; Haddad et al., 2024). Governments are often required to mobilize emergency resources for relief operations, reconstruction of damaged infrastructure, and support for affected households and businesses. These expenditures can strain already limited fiscal space, forcing governments to reallocate funds away from long-term development priorities such as education, health care, or infrastructure investment. In some cases, disaster-related expenditures contribute to rising public debt and long-term fiscal imbalances.

The economic impacts of disasters are rarely evenly distributed across regions (Hallegatte et al., 2017; IPCC, 2022; UNDRR, 2015; León et al., 2022). Vulnerable areas, such as rapidly growing urban centers, coastal zones, or regions with limited infrastructure, often experience disproportionately large losses. These spatial disparities can deepen regional inequalities, as disasters destroy local assets, reduce employment opportunities, and slow economic recovery in already disadvantaged areas.

For these reasons, disaster risk management must be understood not only as humanitarian and environmental issues but also as a critical component of economic policy. Investments in monitoring systems, early-warning capabilities, resilient infrastructure, and coordinated institutional responses can significantly reduce economic losses and accelerate post-disaster recovery. By strengthening these systems, governments can protect both lives and livelihoods while preserving the foundations of long-term economic development.

Institutional coordination and early-warning systems

Effective disaster risk management depends not only on scientific monitoring capabilities but also on strong institutional coordination among the agencies responsible for risk assessment, emergency response, and recovery. In many countries, disaster governance involves multiple actors including meteorological agencies, civil protection authorities, universities and research centers, local governments, and emergency services, whose responsibilities often overlap. Without clear coordination mechanisms, delays in information sharing and decision-making can significantly reduce the effectiveness of disaster response efforts (Alvalá et al., 2024a).

1. An International Monetary Fund article describes fiscal space as the "room in a government´s budget that allows it to provide resources for a desired purpose without jeopardizing the sustainability of its financial position or the stability of the economy." If it does not already exist, it must be created through taxation, external grants, reduced spending, or borrowing. See Peter Heller, *Finance & Development* 42, no. 2 (2005).

Early-warning systems play a critical role in reducing both human and economic losses from extreme events (Moraes, 2026). Advances in meteorological monitoring by observational networks, satellite observation, and meteorological, hydrological, and geological modeling have significantly improved the ability of decision-makers to anticipate floods, flash floods, landslides, droughts, risk of fire, and other climate-related hazards. When these monitoring capabilities are integrated into operational early-warning systems, authorities can issue timely alerts to the disaster response agencies, which in turn relay the information to local governments and the general public, enabling preparation. In addition, it is essential to include the goals of the Sendai Framework for Action (2015–2030), prioritizing actions aimed at promoting and disseminating science in school communities and civil defense and local communities, developing educational strategies for actionable and recommendations research, communication, and mobilization for risk management and reduction, from vulnerabilities to disasters, aiming to build sustainable and resilient societies (Alvalá et al., 2019; 2024b).

However, the effectiveness of early-warning systems depends not only on technological capacity but also on institutional arrangements that ensure information flows efficiently from scientific monitoring institutions to decision-makers and the public (Alcántara-Ayala and Oliver-Smith, 2019). In many developing countries, gaps remain between the generation of scientific data and its translation into actionable warnings. Communication failures, unclear institutional mandates and attributions, and weak coordination between national and local authorities can limit the impact of even the most sophisticated monitoring systems.

Strengthening institutional coordination therefore requires clear governance frameworks that define roles and responsibilities across agencies and levels of government. National monitoring institutions must work closely with civil protection agencies responsible for issuing alerts and coordinating emergency responses. At the same time, local governments play a crucial role in translating early warnings into concrete actions such as evacuations, infrastructure protection measures, and community preparedness.

The experience of Brazil illustrates how integrated monitoring and early-warning systems can strengthen disaster risk governance, as done through CEMADEN. Over the past decades, the country has developed a coordinated institutional framework linking scientific monitoring institutions, civil defense authorities, and local governments. This system allows real-time monitoring of climate-related hazards and facilitates the dissemination of early warnings that support timely decision-making and reduce disaster impacts.

The Brazilian experience: Disaster monitoring and risk reduction

Over the past decades, Brazil has significantly strengthened its capacity to monitor and respond to natural disasters by building an integrated system that combines scientific monitoring, early warning, and coordinated institutional action. This effort has been particularly important in a country frequently affected by extreme rainfall events, floods, landslides, and droughts, which generate substantial human and economic losses each year.

In 2011, a megadisaster severely impacted the mountainous region of Rio de Janeiro—one more in a succession of disasters in Brazil with significant socioeconomic and environmental impacts. Yet that year, a system was designed to ensure that Brazil had an early-warning system for the risk of landslides, floods, and flash floods. Leaders placed a priority on creating a multisectoral program aimed at managing the risks of geo-hydrometeorological disasters in an *integrated manner* including prevention. CEMADEN was created in 2011 and, in 2012, the National Plan for Risk Management and Responses to Disasters was implemented, prioritizing management in four axes: focusing on government action in prevention, included mapping risk areas; structuring a monitoring and warning system; structuring works; and in the medium term, strengthening civil defense bodies and supporting better urban planning with a view to avoiding the occupation of risk areas (Alvalá and Barbieri, 2017).

CEMADEN operates as a national scientific monitoring center responsible for analyzing meteorological, hydrological, and geotechnical data in real time to identify potential disaster risks. Using an extensive network of monitoring stations, satellite observations, and predictive models, the center continuously assesses conditions that may lead to floods, landslides, or other climate-related hazards.

When risks are identified, CEMADEN issues alerts to the National Civil Defense system and to state and municipal authorities responsible for emergency response and local preparedness. This structure allows scientific information generated at the national level to be rapidly translated into operational decisions at the local level. Early warnings enable authorities to mobilize emergency services, protect critical infrastructure, and, when necessary, evacuate populations exposed to imminent risks.

An important feature of the Brazilian system is the close collaboration between scientific institutions, government agencies, and local authorities. Monitoring activities rely not only on advanced technological infrastructure but also on partnerships with universities, research institutes, and meteorological services that contribute to improving hazard forecasting and risk assessment. At the same time, civil defense institutions at the state and municipal levels play a crucial role in implementing preventive measures and communicating warnings to communities.

Disaster analysis includes aspects such as hazard, vulnerability, and the degree of exposure of populations, especially large urban populations. In Brazil, for vulnerability and exposure, CEMADEN works closely with the Brazilian Geological Survey and the Brazilian Institute for Geography and Statistics (IBGE). The hazard component includes the weather and climate components, which depend on monitoring and modeling outputs as well as interaction with meteorological services given the importance of weather/climate forecasting. A hazard is not a disaster; the impacts of the hazard on vulnerable and exposed populations represent a *risk of a disaster*. Therefore, a weather forecast is not the same as a forecast of risk of a disaster triggered by weather/climate extremes. These institutional arrangements have contributed to strengthening disaster preparedness and reducing economic losses associated with extreme events. By providing timely information and enabling coordinated responses, both monitoring and the early-warning system help limit infrastructure damage, reduce disruptions to economic activity, and improve the effectiveness of emergency interventions.

Brazil's experience illustrates how investments in scientific monitoring and institutional coordination can enhance national disaster risk governance. For countries facing growing exposure to climate-related hazards, particularly in regions undergoing rapid urbanization, the development of integrated monitoring systems and clear coordination mechanisms can play a critical role in reducing both human and economic impacts of natural disasters.

Policy lessons for African countries

The growing economic and social impacts of natural disasters highlight the need for stronger disaster risk governance across many African countries. As climate variability increases and urban populations expand in vulnerable areas, governments face rising exposure to floods, droughts, landslides, and other extreme events. While each country faces unique institutional and environmental conditions, the Brazilian experience offers several lessons that may help strengthen disaster preparedness and resilience.

First, scientific monitoring should be integrated into disaster governance systems. Effective risk management begins with reliable information. Investments in meteorological monitoring, hydrological observation networks, and geotechnical risk assessment can significantly improve governments' capacity to anticipate hazards. National monitoring centers capable of integrating different sources of environmental data can play a critical role in identifying emerging risks and supporting early-warning systems.

Second, institutional coordination must be strengthened across levels of government. Disaster risk management often involves multiple agencies with overlapping responsibilities, including meteorological services, civil protection authorities, emergency response units, and local governments. Clear institutional arrangements are necessary to ensure that risk information is rapidly transmitted from scientific monitoring institutions to authorities responsible for emergency response and local preparedness.

Third, early-warning systems must be linked to local response mechanisms. These systems are most effective when they are connected to operational response structures at the municipal or community level. Local authorities must have the capacity to translate warnings into concrete actions, including evacuation procedures, protection of infrastructure, and communication with affected communities.

Fourth, disaster risk management should be integrated into economic and infrastructure planning. Investments in transport networks, energy systems, housing, and urban infrastructure should incorporate risk assessments that account for exposure to extreme weather events. Strengthening the resilience of infrastructure systems can significantly reduce economic losses and accelerate recovery following disasters.

Finally, effective communication systems are essential for building public trust and preparedness. Additionally, community participation is fundamental, both to increase awareness and distinguish perceptions about the risks they face, going beyond a static understanding of the physical environment (Ferreira et al., 2026). Timely and credible communication allows communities and businesses to respond appropriately to warnings and reduces the spread of misinformation during crises. Governments should therefore invest in communication protocols that ensure consistent messaging between monitoring institutions, civil protection authorities, and the public.

Taken together, these lessons highlight the importance of moving beyond reactive disaster response toward more proactive systems that combine scientific monitoring, institutional coordination, and economic resilience. By strengthening these components, governments can reduce the human and economic costs of disasters while protecting the foundations of long-term development.

Of course, maintaining a state-of-the-art early-warning system also requires the active involvement of researchers from universities and research centers. In Brazil, for instance, the Climate Crisis and Disasters Resilience Research Center at the University of São Paulo aims to foster resilience, innovation, and sustainable practices in the face of the climate crisis, disasters, and their impacts.

Conclusion

Climate disasters are becoming an increasingly significant source of economic disruption in many developing regions. Beyond the immediate humanitarian consequences, extreme weather events damage infrastructure, interrupt economic activity, and place substantial fiscal pressures on governments. As climate change intensifies the frequency and severity of weather and climate extreme events, the risk of disasters will also increase if adaptation or mitigation measures are not implemented. Strengthening disaster risk governance has become an essential priority for protecting development gains and promoting long-term economic resilience.

The experience of Brazil demonstrates how investments in scientific monitoring, early-warning systems, and the combination of institutional coordination and clear disaster governance can significantly improve disaster preparedness and reduce both human and economic losses. Integrated monitoring systems that link scientific analysis with operational decision-making enable governments to anticipate risks, issue timely warnings, and coordinate responses across multiple levels of government.

For African countries facing growing climate-related risks, strengthening disaster governance will require sustained investments in monitoring infrastructure, improved coordination among national and local institutions, and effective crisis communication systems. By adopting proactive approaches to risk management, governments can reduce the economic costs of disasters while enhancing resilience and safeguarding the foundations of sustainable development.

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