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Compendium of Good Practices on Quality Infrastructure 2026

Rebuilding for the Future

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REBUILDING FOR THE FUTURE

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Foreword

The G20 Principles for Quality Infrastructure Investment were endorsed in 2019, calling for projects that are economically viable, socially inclusive, environmentally sustainable and resilient to natural disasters. These principles serve to underpin infrastructure investments that promote economic growth, broad societal well-being and environmental stewardship.

In that context, the OECD Development Centre published the first *Compendium of Good Practices on Quality Infrastructure* in 2024 with a focus on fostering resilience to natural disasters. Building on this, with the theme Building Back Better after natural disasters, the second edition of the Compendium draws from seven global case studies to distil actionable principles to guide reconstruction efforts.

The report is the result of collaboration with the World Bank, with financial support from the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of Japan. The report aims to inform actions that make nations and communities more resilient.

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Abbreviations and acronyms

ADB	Asian Development Bank
ANIN	National Infrastructure Agency of Peru
AI	Artificial intelligence
BBB	Building Back Better
BNPB	National Disaster Management Authority of Indonesia
DFIs	Development finance institutions
DRM	Disaster risk management
DRR	Disaster risk reduction
EC	European Commission
EM-DAT	Emergency Events Database
EWS	Early Warning Systems
FIDIC	International Federation of Consulting Engineers
GFDRR	Global Facility for Disaster Reduction and Recovery
GIS	Geographic information systems
ICT	Information and communication technology
IDB	Inter-American Development Bank
IFRC	International Federation of Red Cross and Red Crescent Societies
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
JICA	Japanese International Cooperation Agency
LAC	Latin America and the Caribbean
LDCs	Least developed countries
LTA	Land Transport Authority of Samoa
MDBs	Multilateral development banks

MLIT	Japanese Ministry of Land, Infrastructure, Transport and Tourism
NBS	Nature-based solution
NDBs	National development banks
NGOs	Non-governmental organisations
OECD	Organisation for Economic Co-operation and Development
PDNAs	Post-disaster needs assessments
PPA	Project partnership agreement
PPPs	Public-private partnerships
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
UNDP	United Nations Development Program
UNDRR	United Nations Office for Disaster Risk Reduction
VA	Vulnerability assessment

Executive summary

Building on the Sendai Framework for Disaster Risk Reduction 2015–2030 and the OECD Prevent-React-Rebuild (PRR) framework for infrastructure resilience, this report focuses on Building Back Better (BBB), a call to reduce pre-existing vulnerabilities of disaster-struck infrastructure by upgrading design standards, strengthening institutions, and improving land use, governance, and service delivery, rather than restoring assets and services to their pre-disaster condition.

This report defines rebuilding not only as an effort to repair or restore physical assets but a strategic development choice. Any rebuilding effort needs to be planned, financed and implemented to increase resilience and preparedness to future shocks and to foster sustainable development. While BBB inevitably raises the upfront rebuilding costs it is key to breaking the cycle of poor development and limited resilience.

When critical competitiveness-related infrastructure is damaged in the aftermath of a disaster, it is necessary to activate, in parallel with the emergency response, a systemic planning process to ensure that the resources mobilised for reconstruction address pre-existing development gaps, increase future resilience and amplify opportunities for transformation. In the case of infrastructure this implies shifting from asset replacement to life-cycle-based investments that enhance safety, reliability, inclusiveness and adaptability. It also means meeting development aspirations, such as social inclusion, industrialisation, innovation and increased local value addition. In practice, this requires:

- Putting people at the centre of rebuilding efforts. This includes community engagement and participation in risk assessment and needs identification and linking rebuilding to socio-economic development programmes.
- Activating targeted financial resources that go beyond the reaction and restoration phase. Financing mechanisms must be designed to support quality and resilience, not only speed.
- Enabling co-ordination of multiple actors, across levels of government and with the private sector. An effective governance system with capacity to update regulatory frameworks is essential to carry out effective rebuilding plans and implement them in an efficient and transparent way.

”Rebuilding right” matters because, even if investment needs are high, the cost of inaction is even higher. This is particularly urgent for developing countries where vulnerabilities are growing and infrastructure and socio-economic gaps remain deep. The report presents five actionable principles to build back better, drawing from global good practices and in-depth analyses of projects in Honduras, Indonesia, Japan, Malawi, Nepal, Peru and Samoa:

- Enable forward-looking planning, shifting from a temporary fix or restoration intervention to a structural upgrade, to support long-term sustainable development.
- Embed preparedness in rebuilding, with targeted interventions to enhance resilience to future shocks and by using multi-hazard and data-driven risk assessments.
- Activate targeted funding and partnerships to ensure the mobilisation of long-term financing beyond recovery funds.

- Ensure effective time management by sequencing actions to ensure rebuilding is an investment for better futures.
- Put people at the centre of rebuilding efforts, engaging communities to foster social cohesion and linking infrastructure planning to socio-economic development planning.

Development banks and development finance institutions play a key role in the realisation of BBB, by enabling long-term funding, facilitating matching funds from the private sector and by providing tools, skills and access to technologies and data. They can also trigger additional investments in complementary areas in support of government development programmes to ensure that rebuilding translates into concrete sustainable development outcomes.

1 Why Building Back Better matters for sustainable development

Building on the OECD Prevent-React-Rebuild framework, this chapter argues that post-disaster reconstruction of competitiveness-related infrastructure must be forward looking, risk informed and aligned with long-term development objectives. In line with the Sendai Framework for Disaster Risk Reduction 2015-2030, this chapter discusses why Building Back Better (BBB) matters for developing countries and clarifies that, to operationalise BBB, targeted financing and governance mechanisms must be put in place to ensure rebuilding is people-centred.

Introduction

The *Compendium of Good Practices on Quality Infrastructure* (hereafter "the Compendium"), introduced in 2024, is a technical report that presents concrete infrastructure projects in Africa, Asia, Latin America and the OECD, with a view to identifying global good practices. It is grounded on the principles that each context is unique and that knowledge-sharing and peer-learning enhance the quality and impact of public policy processes. It aims at identifying key challenges and needs of developing countries with a view to enhancing their capabilities and policies as well as to foster effective international partnerships for sustainable development.

The Compendium focuses on competitiveness-related infrastructure, defined as "assets, facilities and systems that have a direct effect on the economic performance and competitive capabilities of a given location. It includes transportation networks (roads, ports, airports, railways), energy facilities (power plants, grids), telecommunication networks and data centres" (OECD, 2024[1]). This is because competitiveness-related infrastructure plays a key role in enabling growth and sustainable development, having an economy-wide impact that extends well beyond the assets themselves. Competitiveness-related infrastructure assets are capital-intensive, long-lived and shape development trajectories for decades. It is essential that they are planned in a forward-looking way.

For developing countries, prioritising resilience is even more urgent, considering the persistent, if not growing, gaps that hamper sustainable development prospects. Reconstructing them to past standards risks entrenching structural bottlenecks, technological obsolescence and exposure to future shocks, with lasting consequences for economic performance (OECD, 2024[1]; OECD, 2024[2]; ITF, 2024[3]). By contrast, integrating resilience, quality and future-oriented standards into the rebuilding of competitiveness-related infrastructure supports both disaster risk reduction (DRR) and long-term economic transformation. Embracing resilience is not a luxury choice for developing countries: it should guide investments to close infrastructure gaps without locking into fragile, inefficient systems that would constrain industrialisation, trade integration and growth in an increasingly risk-prone environment.

This edition of the Compendium builds on the Prevent-React-Rebuild (PRR) framework, presented in the 2024 edition (OECD, 2024[1]), and focuses on analysing global good practices on Building Back Better (BBB). This chapter clarifies why BBB matters for sustainable development and why this concept is particularly important in the context of developing countries. Based on the in-depth review of 7 case studies (presented in Chapter 3) and discussed through an Expert Advisory Group (EAG), it argues that any rebuilding effort needs to be planned, financed and implemented in a way that increases resilience and preparedness to future shocks, while at the same time it should enable advancing on achieving local development aspirations.

This introductory chapter is structured in 3 sections. The first clarifies the rationale for making rebuilding forward looking. The second section gives an overview of international reference frameworks for BBB and the third section presents three keys for future-proofing rebuilding: people, finance and governance.

This chapter is followed by Chapter 2 that presents 5 global good practices for BBB, based on the review of the 7 case studies. Chapter 3 discusses in detail the 7 rebuilding processes from Honduras, Indonesia, Japan, Malawi, Nepal, Peru and Samoa, which have been chosen for this edition of the Compendium.

Rebuilding needs to be forward looking

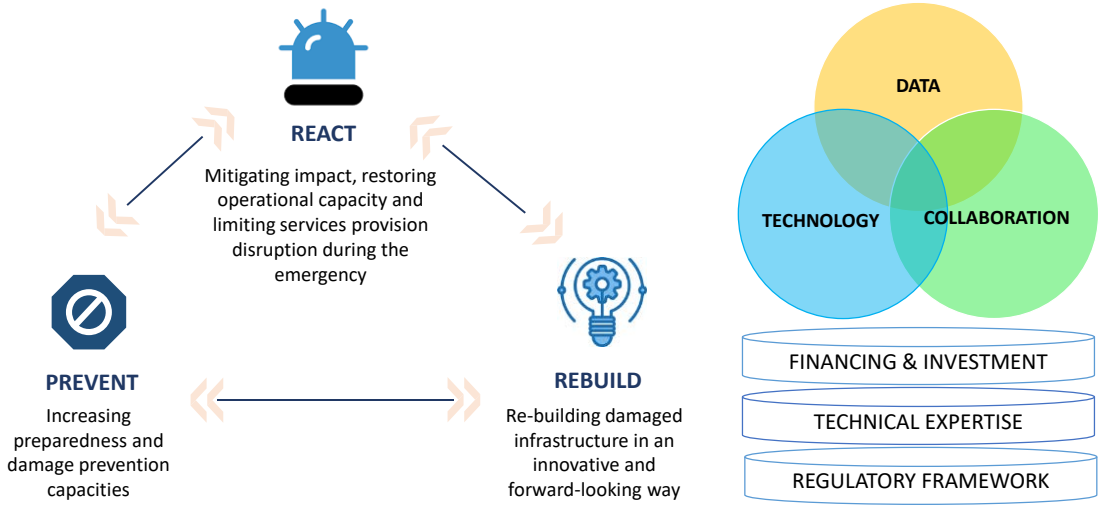
As the intensity and frequency of natural hazards increase, ensuring infrastructure resilience is crucial to achieve sustainable development and to avoid holding back developing countries in their development pathways (OECD, 2024[2]; OECD, 2024[1]).

The PRR framework guides governments in planning adequate actions to ensure infrastructure resilience to natural hazards (Figure 1.1). Each phase is distinct and interconnected, requiring targeted legal frameworks, technical capacities and financing tools. Actions taken during a phase should compound and contribute to achieving effectiveness in the other ones. Preventive actions should be implemented along the infrastructure asset life cycle and should be seen as productivity-enhancing investments to reduce costs and minimise future risks. Any rebuilding efforts should aim at increasing preparedness for future disasters (OECD, 2024[1])

In the aftermath of natural disasters, governments need to trigger actions both in reaction and in rebuilding. The reaction phase encompasses the emergency response, including mitigating impacts, restoring operational capacity and limiting service disruption during the emergency (e.g. immediate repairs). It focuses on people's safety first and then on restoring services when possible, or, if needed, on providing alternative temporary modes of service (e.g. replacement transport and electricity services while restoration is in process). This phase is often undertaken by targeted agencies and experts in co-ordination with local government and national authorities, and in the case of developing countries, it often involves a substantial mobilisation of foreign assistance and expertise.

In parallel to this phase, governments need to engage in the rebuilding phase. This involves the planning of how to rebuild the damaged infrastructure. This should be done in a forward-looking way to increase resilience to future hazards, augment preparedness capacity and support the overcoming of previous gaps in a way that is conducive to sustainable development. Implementation of the rebuilding phase is often delayed due to safety constraints, such as when affected areas have not been declared safe to access, debris needs to be removed, or risks from secondary disasters and expected natural hazards persist. Financial, technical and regulatory capacity gaps also tend to delay the implementation of the rebuilding phase.

Figure 1.1. The PRR (Prevent-React-Rebuild) framework for infrastructure resilience to natural disasters



Source: OECD (2024[1]).

Rebuilding needs to be forward looking:

- It needs to increase resilience, enhance preparedness to anticipated future shocks, and enable communities to reach their development aspirations.
- It requires systemic planning that goes beyond reparation and restoration and that enables a transformation of previous economic configurations (including spatial patterns where necessary), to achieve sustainable development. Such planning requires alignment with multi-level government strategies, substantively integrated with risk-informed and community-based assessments. This alignment and integration are essential to avoid the isolated rebuilding of individual assets, ensuring a life-cycle approach (Dehghani and Breteau, 2025[4]). This is particularly relevant for developing countries, which often lack adequate competitiveness-related infrastructure, and for which the costs of rebuilding what existed in the past would be even higher than for advanced economies in terms of missed development opportunities, inclusiveness, safety and resilience to future shocks.
- It requires placing equity and inclusion considerations at the core of infrastructure rebuilding. Equity and inclusion need to be a pre-condition for rebuilding investments, not an after-thought. The rebuilding effort should explicitly aim at reducing inequalities and addressing the needs of the most vulnerable groups. This is in line with the G20 Principles for Quality Infrastructure Investment, issued in 2019 in Osaka, which states that infrastructure should be inclusive enabling the economic participation and social inclusion of all, and with the G20 Disaster Risk Reduction (DRR) Ministerial Declaration, issued in Belém in 2025, which stresses the importance of reconstruction efforts that leave no one behind (G20 Osaka Meeting, 2019[5]; G20 Brazil, 2025[6]).
- Future-proofing rebuilding might require updates to the physical characteristics of infrastructure, its operational protocols, maintenance regimes and its location. It could also need the deployment of advanced or more efficient technologies and nature-based solutions, and it might entail changes to infrastructure design. These innovations require updates to legal frameworks and the establishment of adequate institutional mechanisms to ensure that planning is conducted in an inclusive and sustainable manner.

Rebuilding is challenging not only in reaching a shared agreement on “what” and “how” to rebuild but also in mobilising adequate resources and attracting private sector financing in situations of high uncertainty and operational risk. These challenges are particularly exacerbated in the context of developing countries, which in turn are also among the most exposed and vulnerable to natural hazards and tend to have limited fiscal and financial capacities as well as constrained government capabilities. Data, technology and collaboration, as presented in the PRR framework (OECD, 2024[1]), are key drivers of rebuilding. In particular, to BBB:

- **Data** are crucial, especially for preparedness through early warning systems, as well as post-disaster response and rebuilding planning. Geospatial and meteorological data enable BBB through hazard maps, evidence-based, community-informed risk assessments and data-driven simulations for rebuilding plans. One example is the Global Infrastructure Risk Model and Resilience Index (GIRI), launched in 2023 and developed by the CIMA Research Foundation in Italy, INGENIAR Risk Intelligence in Colombia, UNEP-GRID Geneva and the Norwegian Geotechnical Institute and managed by CDRI and the United Nations Development Programme (UNDP). It is a global disaster risk assessment tool for infrastructure assets across countries, sectors and types of disaster, including metrics derived from probabilistic models, such as the value of infrastructure exposed to hazards and the estimated average annual losses from disasters (CDRI, 2025[7]). The Samoa case study, described in detail in Chapter 3, further demonstrates the utility of vulnerability assessments in embedding resilience into post-disaster rebuilding planning. This evidence-based method systematically integrates climate-related variables into road infrastructure planning through climate sensitivity analysis that accounts for real-time road

conditions, historical data (hydrology information, sea-level trends, etc.) and identifies future vulnerabilities, thereby providing a robust empirical foundation for informed infrastructure decision-making.

- **Technology** is key to upgrading planning and technical solutions for competitiveness-related infrastructure. As technology advances, solutions not available in the past become viable to increase infrastructure resilience and to make infrastructure aligned with future economic development needs. For example, in Japan, the Fukushima Institute for Research, Education and Innovation, created in 2023 as part of the 2011 earthquake post-disaster reconstruction act, has developed robots and drones to track disaster- and accident-affected communities, informing recovery strategies and rebuilding plans (F-Rei, 2024[8]). While commercial research on resilient infrastructure technologies is a limited field, it is a growing one. Cumulative patent applications under the Patent Cooperation Treaty (PCT) for climate adaptation technologies in infrastructure (including, for example, adaptation at coastal zones and river basins, adapting or protecting infrastructure through thermal insulation and extreme weather resilient electric power supply systems) accounted for 0.73% of all applications during 2018-2022, up from 0.66% in 2003-2007, with their total number increasing more than sixfold[1] [authors' elaboration based on OECD (2025[9])].
- **Collaboration** lies at the cornerstone of BBB. As discussed in Chapter 3, in Nepal, for example, the 2015 earthquake recovery plan engaged over 250 national and international experts – spanning government, academia, civil society and the private sector – to plan actions in 23 economic and social sectors (Government of Nepal, 2015[10]). Regional collaboration is also pivotal for co-ordinated action, including data and good practices sharing. An example is the establishment of the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia in 2009. Created as a response to the 2004 Indian Tsunami, the initiative builds the capacities of member countries across Africa, Asia and the Pacific to generate and apply early warning information, improving data sharing, enhancing risk communication and supporting disaster-related research (RIMES, 2025[11]).

Ensuring that rebuilding is forward looking and increases preparedness to future shocks is an economic development imperative. Estimates indicate that economic damage from natural disasters is growing. Natural disasters caused, on average, 32% more economic damage during 2015-2024 than the previous decade, 2005-2014, according to the EM-DAT database (2025[12]).

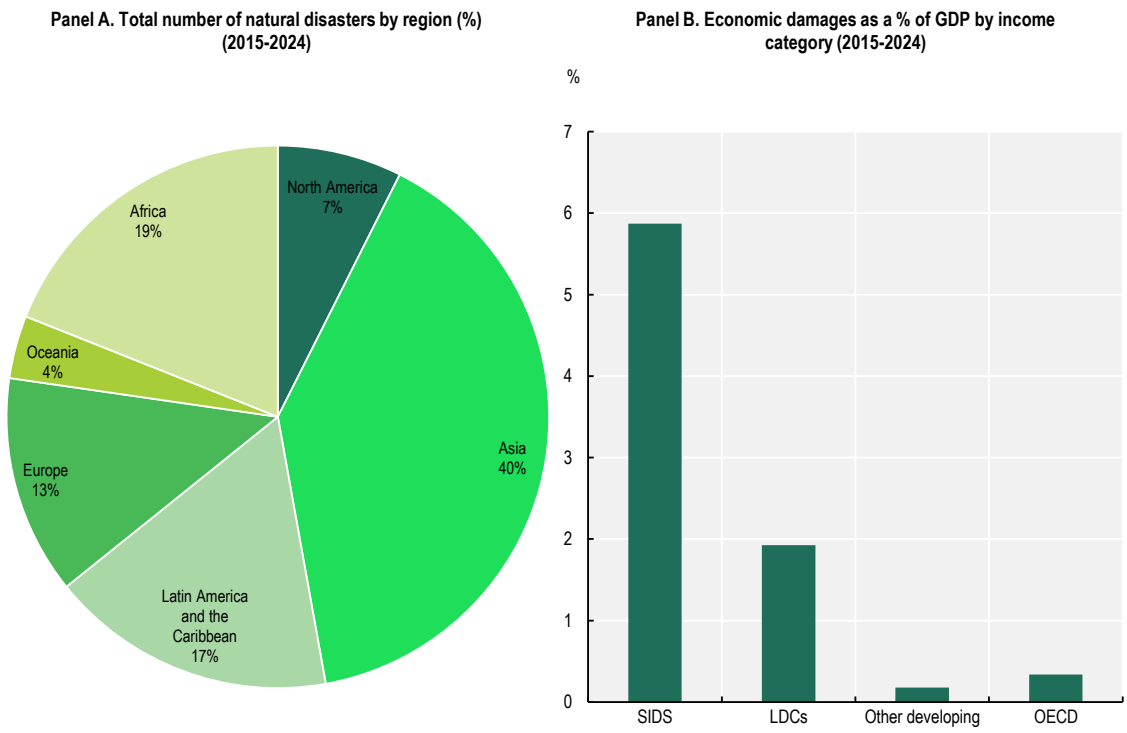
Developing countries are among the most vulnerable, due to their geographical risk exposure, the greater vulnerability of their infrastructure, as well as constraints in skills and fiscal resources. About 40% of disasters between 2015-2024 happened in Asia, followed by Africa (19%) and Latin America and the Caribbean (17%) (Figure 1.2 Panel A). In addition, the relative economic burden of disasters is often greater in Small Island Developing States (SIDS) and Least Developed Countries (LDCs), where disaster-related losses amounted to approximately 6% and 2% of GDP, respectively, compared with 0.3% in OECD countries from 2015 to 2024 (Figure 1.2 Panel B).

While BBB raises upfront rebuilding costs, it is necessary to break the cycle of poor development and limited resilience to future shocks. When countries do not assess rebuilding costs over the lifecycle, or integrate future disaster losses into infrastructure planning, they risk opting for solutions with lower initial costs over resilient alternatives, therefore increasing long-term costs (OECD, 2024[1]).

Future-proof infrastructure requires higher upfront investment but delivers significantly greater value over its lifecycle through avoided losses, reduced maintenance and continuity of economic activity (Box 1.1). Rebuilding that integrates resilience and that delivers on local development aspirations is crucial for sustainable development. Failure to BBB can result in inefficiencies in public spending. Poor rebuilding choices can also entrench inequality, undermine social cohesion and weaken trust in public institutions, thus further eroding development potential.

It is therefore pivotal to identify mechanisms to secure funding for BBB and to invest in planning tools that guarantee its efficiency, effectiveness and impact. A targeted approach is crucial to ensure that BBB is not dismissed as a costly and complex option in developing countries but rather seen as a necessary investment for sustainable development. In this context, international development finance institutions and multilateral and national development banks emerge as key players, as they bring the long-term, affordable financing needed to BBB and enable forward-looking planning that links rebuilding efforts to policies and investments for sustainable development. These institutions are particularly important given the limited integration of resilience considerations in national public funding mechanisms. In the transport sector, for example, 88% of 33 national public funding mechanisms, tracked by the World Bank in 2025 (Fanias, Xiong and Gall, 2025[13]), do not explicitly support resilience projects.

Figure 1.2. Developing countries tend to be among the most vulnerable to natural hazards



Note: Geographical and income classifications follow the United Nations classification system (2025[14]).
Source: Authors' elaboration based on EM-DAT (2025[12]) for disaster data and the World Bank (2025[15]) for GDP.

Box 1.1. BBB has higher upfront costs, but reduces future financial and economic risks

The World Bank (Hallegatte, Rentschler and Rozenberg, 2019[16]) undertook a pioneer study in 2019 to assess the cost of infrastructure disruptions and the economic benefits of resilient infrastructure in the power, water and sanitation, transport and telecommunication sectors. The study finds that resilient infrastructure investments are associated with extra costs, which are outweighed by long-term disaster losses mitigation (Table 1.1).

- In the energy sector, for example, incorporating more resilient design and materials against earthquakes (such as adequate anchorage, proper design and bracing) to solar energy facilities can reduce disaster damage probability by up to 88% while increasing investment costs by 15%, on average.
- In the transport sector, adapting railways to floods – through measures such as retaining walls, slope stabilisation and soil nailing – can increase investment costs by up to 50% while reducing damage probability by roughly 66%.
- In capital-intensive infrastructure sectors, higher construction costs are not uncommon, being often compensated by higher return on investment. This is the case of the rail sector, in which high volumes of freight or passenger transport could generate sufficient returns to support higher investment in quality infrastructure.

Table 1.1. Average incremental costs of resilient technologies in the energy and transport sectors

Average incremental cost to increase resilience by infrastructure type, disaster it adapts to and expected damage reduction

Infrastructure	Disaster	Damage probability reduction (%)	Average incremental cost to increase resilience (%)
Thermal power plants	Earthquake	90	20
	Storms	75	10
	Flood	N.A.	2
Solar power farms	Earthquake	88	5
	Storms	80	15
	Floods	N.A.	N.A.
Electricity transmission and distribution lines	Earthquake	50	2
	Storms	76	20
	Floods	N.A.	N.A.
Railways	Earthquake	58	25
	Storms	25	15
	Floods	66	50
Highway	Earthquake	85	5
	Storms	50	5
	Floods	90	3
Bridges (urban/highway)	Earthquake	87	10 / 20
	Storms	60/70	5
	Floods	68/33	5

Note: Estimates are made considering the implementation of new engineering and quality improvements to withstand earthquakes, storms and floods. The average incremental costs are obtained directly from the source. The damage probability reduction is obtained by calculating this rate based on the baseline probability versus the improved probability, obtained from the source.
Source: (Hallegatte, Rentschler and Rozenberg, 2019[17]).

Source: Authors' elaboration based on Hallegatte, Rentschler and Rozemberg (2019[16]).

Reference frameworks for forward-looking rebuilding

The Sendai Framework for Disaster Risk Reduction (DRR) 2015-2030 places Build Back Better (BBB) as a core principle of post-disaster recovery (Box 1.2). Paragraph 33 of the Sendai Framework calls on States to "promote the incorporation of DRR measures into post-disaster recovery and reconstruction", explicitly endorsing BBB to reduce future disaster losses (United Nations, 2015[17]). The Sendai Framework places rebuilding beyond physical infrastructure engineering upgrades, and discusses reforms needed in terms of development policy, regulatory issues and financial tools. The Sendai recognises that post-disaster phases are critical moments to reduce future losses and overcome past vulnerabilities. Global climate frameworks and the 2030 Agenda for Sustainable Development are also in line with BBB.

Box 1.2. The Sendai Framework for Disaster Risk Reduction

The Sendai Framework 2015-2030, adopted at the 3rd United Nations World Conference on Disaster Risk Reduction (WCDRR) in 2015 in Sendai, Japan, is complemented by the 2019 G20 Principles for Quality Infrastructure Investment and replaces the 2005 Hyogo Framework for Action (2005-2015).

The Sendai Framework outlines four priorities for action:

1. understanding disaster risk;
2. strengthening disaster risk governance to manage disaster risk;
3. investing in DRR for resilience; and
4. enhancing disaster preparedness for effective response and to BBB in recovery, rehabilitation and reconstruction.

The Sendai Framework acknowledges the importance of combining physical reconstruction with policy, regulation and public awareness (and training) to make prevention, reaction and rebuilding indispensable elements to rebuild for sustainable futures.

Since its adoption, the Sendai Framework has also played a seminal role in shaping policy recommendations in several international organisations, including the United Nations Office for Disaster Risk Reduction (UNDRR), the World Bank (WB) and the Asian Development Bank.

Source: United Nations (2005[18]), Noy, Ferrarine and Park (2019[19]), Asian Development Bank (2024[20]), Hallegate, Rentscher and Walsh (2018[21]).

Over the past decade, the concept of BBB has evolved from a normative aspiration into a set of broadly agreed-upon principles embedded in global frameworks. BBB is defined as the integration of resilience, risk reduction, sustainability and improved performance into the recovery, rehabilitation and reconstruction of physical, social, institutional and economic systems after a disaster (UNDRR, 2024[22]).

Rather than restoring assets and services to their pre-disaster condition, the BBB approach calls for correcting pre-existing vulnerabilities by upgrading design standards, strengthening institutions and improving land use, governance and service delivery. For competitiveness-related infrastructure, this implies shifting from asset replacement to life-cycle-based investments that enhance safety, reliability, inclusiveness, adaptability to anticipated future shocks and responsiveness to development aspirations, such as, for example, social inclusion, industrialisation, innovation and increased local value addition.

BBB is not an optional characteristic of rebuilding, but a necessary condition for sustainable development. At the operational level, progress has been made through tools and programmes that enable the integration of BBB principles in rebuilding, for example, through the Post-disaster Needs Assessments (PDNAs) and

the Disaster Recovery Framework (DRF) (Box 1.3). These tools support planning investments in infrastructure, treating them not as isolated facilities, but as part of a complex economic and social system that can be rebuilt to achieve an improved development path with higher productivity and lower economic and social vulnerabilities.

Box 1.3. Post-Disaster Needs Assessments and Disaster Recovery Frameworks

Post-Disaster Needs Assessment (PDNA)

A PDNA is a globally recognised government-led methodology designed to evaluate post-disaster physical damages, economic losses and recovery needs. The standardised methodology was established through the 2008 Joint Declaration on Post-Crisis Assessments and Recovery Planning, jointly with the European Union (EU), United Nations Development Programme (UNDP) and the World Bank (UNDP, WB and EU, 2013[23]).

The primary purpose of a PDNA is to inform the formulation of comprehensive recovery strategies by the impacted countries and facilitate the mobilisation of financial and technical resources. The implementation of standardised PDNAs has allowed for the streamlining of the evaluation process and has become a useful tool for consolidating donor support.

PDNAs assess damages by sectors, including social ones (housing and settlements, education, health, culture and nutrition), productive sectors (agriculture, livestock, fisheries and forestry; industry, commerce and trade; tourism), infrastructure [water, sanitation and hygiene (WASH)]; community infrastructure; energy and electricity; transport and telecommunications and cross-cutting themes (employment and livelihoods; disaster risk reduction; governance; environment; gender, etc.)

In 2013, PDNA guidelines by sectors were published, including a specialised one on infrastructure (Quick and Demetriou, 2017[24]). The PDNA framework for infrastructure sector involves: 1) assessing physical and systematic damages on physical assets, supply chains and public services and identifying potential threats that may deteriorate conditions or trigger another disaster; 2) estimating the monetary value of damages, such as repair and reconstruction costs; 3) analysing the implications of government expenditure increase on rebuilding efforts; 4) co-ordinating cross-sectoral partners; and based on these findings, 5) developing an infrastructure recovery strategy. Crucially, it explicitly calls for a reassessment of reconstruction needs once governments have decided on what measures are needed to improve future infrastructure.

Disaster Recovery Framework (DRF)

A DRF is a government-led tool to conceive and plan the policy, institutional, financial and operational aspects of disaster recovery programmes, and outline outcomes to be achieved (GFDRR et al., 2017[25]). This idea was advanced globally by the WB's Global Facility for Disaster Reduction and Recovery (GFDRR), which, in collaboration with partners, published the first DRF Guide in 2015 (revised in March 2020). This guideline provided a practice-based, results-focused methodology for governments and partners to plan, prioritise, finance and implement BBB programmes in the aftermath of large-scale disasters. The DRF is ideally finished within a maximum of 45 days after the disaster occurs (GFDRR et al., 2015[26]; GFDRR et al., 2020[27]).

Source: Authors' elaboration based on UNDP, UE and WB (2013[23]), G20 Osaka Meeting (2019[5]), GFDRR, UN, EU and World Bank (2020[27]).

Three keys for Building Back Better: People, finance and governance

Translating BBB from principle to practice requires elevating infrastructure planning to the core of economic development planning.

While in the aftermath of a disaster that has damaged competitiveness-related infrastructure, the tendency is to prioritise fast reaction, people's safety and services restoration, the PRR (Prevent-React-Rebuild) framework guides governments to address rebuilding in a forward-looking way to ensure investments are planned in such a way as to minimise long-term costs and maximise sustainable development outcomes.

The case studies in this Compendium show how, in each context, specific mechanisms have been put in place to ensure that rebuilding is done in a forward-looking way. While each case exhibits different characteristics regarding the natural hazards faced, damage profiles, severity of human toll and affected infrastructure, three common factors emerge from all cases as critical in ensuring an effective rebuilding:

- **People.** Any rebuilding effort needs to put people at the centre of any decision. Managing the human factor is essential even when the planning exercise is about reconstructing a competitiveness-related infrastructure.

  Any rebuilding effort should be conceived as a development programme in a systemic and participatory way, rather than as a repair and reconstruction of a physical asset. This "human and community" factor is not only pivotal in the reaction phase, but also essential in the rebuilding and recovery strategy. To ensure rebuilding is forward looking, the planning needs to start from the people and the community. The adoption of this principle as a priority for competitiveness-related infrastructure planning is still incipient, despite its common application in development policy.

  To BBB, community engagement and participation in risk assessment and in needs-identification exercises are not collateral actions; they are core components of the planning exercise. It therefore requires planning social and economic development programmes as part of the physical assets rebuilding effort. It also encompasses the need to invest in capacity building to ensure resilience, by enabling community awareness and learning, and by activating training for infrastructure resilience design and project management. As discussed in Chapter 3, the experience of the rebuilding in Okuma town (Japan) and of five different bridge projects in Indonesia illustrate this point of ensuring that rebuilding is people-centred.
- **Finance**. Rebuilding requires activating targeted financial resources that go beyond the reaction and restoration phase. BBB implies higher upfront costs than traditional rebuilding but delivers superior development outcomes by reducing exposure to expected future shocks, mitigating risks and enabling the activation of new growth sources. This includes access to predictable mid- and long-term recovery financing in addition to emergency and fast-tracked financial support. Creating mechanisms to align and generate synergies between emergency funds and longer-term development budgets is essential to enable BBB. Without appropriate financial structures, BBB objectives are easily sidelined. Adequate financing, together with planning and project management capacities, is needed to ensure that rebuilding is forward looking and delivers on sustainable development.

  In this respect, more needs to be done to mobilise financing and technical support tools to ensure that BBB is implementable at the scale needed to achieve impact, especially in developing countries. Development assistance, given its nature, tends to prioritise funding for post-disaster reaction over long-term infrastructure investments. For example, from 2020 to 2023, Official Development Assistance (ODA) flows for short-term emergency measures (i.e. post-disaster emergency response, reconstruction relief and rehabilitation and disaster prevention and preparedness) were 70% larger than those for investments in energy, communication and transport (OECD, 2025[28]). It is therefore essential to identify how to bridge the financing gap for BBB. Development finance institutions, including national development banks, emerge as key actors to

turn BBB into a reality. They enable matching funds from the private sector to provide resources, tools and competencies, as well as access to technologies and data to plan interventions in a systemic way and can trigger additional investments in complementary areas in support of government development programmes. The rebuilding experiences of Honduras, Malawi and Samoa, discussed in Chapter 3, showcase the crucial role of international development finance institutions in enabling BBB.

- **Governance**. Updates in governance, through targeted institutions, dedicated co-ordination mechanisms, or reforms to legal frameworks, are needed to rebuild in a forward-looking way. While the co-ordination of multiple actors, across levels of government and with the private sector, is a common feature of any infrastructure project, BBB often entails deeper governance reforms to enable synergies between the emergency response and the reaction phase with the rebuilding effort.

  Institutional arrangements are needed to develop effective rebuilding plans and implement them in an efficient and transparent way. Mechanisms to update regulatory frameworks are essential to enable BBB, for example, through building codes and standards. Ensuring well-defined institutional mandates with clear legal responsibilities is essential to avoid fragmented efforts and to ensure transparency, accountability and stakeholders' engagement. It is also important to have in place adequate institutional capacities and tools to foster public trust and investors' confidence. Strengthening public sector capabilities at all government levels, supporting local government and building capacity, also through international partnerships, are critical components of ensuring effective governance for BBB.

  The cases of Indonesia and Nepal discussed in Chapter 3 provide interesting examples of governance reforms for disaster risk management and rebuilding which entailed first the creation of a temporary agency for managing the rebuilding phase, and then the conversion of this temporary institutional arrangement into a permanent body as the Indonesia's National Disaster Management Authority and the National Disaster Risk Reduction and Management Authority, with a view to increase preparedness to face the consequences of natural hazards (for details see Chapter 2).

Conclusions

Investing in competitiveness-related infrastructure is not just about building physical assets; it is about shaping future development opportunities. Rebuilding involves not only a technical planning exercise to repair or restore damaged assets, but also strategic development choices. Getting it right matters because investment needs are high and the potential future costs of failure are even higher.

Rebuilding efforts shape local and spatial development, institutional practices and social contracts for decades to come, thereby influencing long-term development patterns. Treating reconstruction as an opportunity to reduce risks and overcome structural weaknesses is essential for sustainable development in every country, and particularly in developing countries where development aspirations are high, vulnerabilities are growing, and infrastructure and socio-economic gaps remain deep. Chapter 2 presents five global good practices to make rebuilding forward-looking. Chapter 3 discusses in-depth seven rebuilding projects across the globe, identifying the lessons learned and opportunities for improvement.

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Notes

[1] This includes the following categories from the OECD dataset on patent diffusion database (OECD, 2025[9]): adaptation at coastal zones or river basin; adapting or protecting infrastructure or their operation (including structural elements or technology for improving thermal insulation, in transportation, extreme weather resilient electric power supply systems, planning or developing urban green infrastructure, and relating to heating ventilation or air conditioning technologies); assessment of water resources; information and communication technologies [ICT] supporting adaptation to climate change, e.g. for weather forecasting or climate simulation; irrigation water conservation; protecting water resources; water collection (rain, surface and ground-water); water conservation in thermoelectric power production.

2 Global good practices for Building Back Better

This chapter presents five global good practices to ensure that rebuilding after natural disasters is implemented with the view to Build Back Better (BBB). Based on the preparatory work carried out for this edition of the Compendium and learning from the seven case studies presented in Chapter 3, it discusses how forward-looking planning, embedding preparedness in rebuilding, activating target funding and partnerships, ensuring effective time management and making rebuilding people-centred are key to ensure that infrastructure rebuilding is not just an investment for reparation and restoration but a transformative one to deliver on sustainable development for the communities concerned.

Introduction

Ensuring that rebuilding efforts are forward looking requires careful consideration of the specific context. This process depends on a range of factors, including socio-economic factors, local economic development challenges and aspirations, geological characteristics and the origins of the disruption and the extent of the damage, whether infrastructure damage is systemic or isolated, and safety concerns linked to the post-disaster assessment.

While each rebuilding case is unique and each vision for the future calls for a transformation specific to the given place in question, a set of general principles nonetheless applies. When implemented effectively, these principles ensure that rebuilding is approached not merely as reconstruction, but as a transformative investment.

This chapter presents five guiding principles for Building Back Better (BBB) (Table 2.1). These principles are derived from the seven case studies discussed in detail in Chapter 3 and have been developed through an international peer dialogue process implemented in the framework of the preparatory work for this 2026 edition of the *Compendium of Good Practices on Quality Infrastructure*. These principles are not intended to be exhaustive; they have all equal importance and are interrelated.

Each section discusses the principle and concludes with a short box referring to how the principle has been implemented in given contexts, including in the seven case studies discussed in Chapter 3 (Table 2.2).

Table 2.1. Five global good practices for Building Back Better

	Enabling forward-looking planning
	Embedding preparedness in rebuilding
	Activating targeted funding and partnerships
	Ensuring effective time management
	Making rebuilding people-centered

Source: Authors' elaboration.

Table 2.2. Overview of the infrastructure projects discussed in this Compendium, selected countries, 2026

Countries	Case studies	Disasters	Infrastructure
Honduras	Embedding long-term planning for resilient road connectivity in Honduras after repeated storms	2020 Hurricanes Eta and Iota 2024 Storm Sara	Road
Indonesia	Rebuilding bridges in Indonesia	2014 Mount Kelud Volcano eruption 2017 Cyclone Cempaka 2018 Earthquake and tsunami in Central Sulawesi Province 2021 and 2022 Flash floods in West Nusa Tengara	Bridge
Japan	Rebuilding in Okuma Town, Japan, after the 2011 Great East Japan Earthquake: a people-centred and future-oriented approach	2011 Great East Japan Earthquake (Fukushima nuclear accident)	Town-wide
Malawi	Rebuilding road corridors and embedding resilience across their asset lifecycle in Malawi after Cyclone Freddy in 2023	2023 Cyclone Freddy	Road
Nepal	Adapting governance and tools for rebuilding in Nepal after the 2015 Gorkha Earthquake	2015 Gorkha earthquake	Road
Peru	Rebuilding river flood defences in Peru following the 2017 El Niño event	2017 El Niño	Water management
Samoa	Rebuilding and climate-proofing the road network following the Cyclone Evan in Samoa	2012 Cyclone Evan	Road

Source: Authors' elaboration based on the case studies presented in this chapter.

Enabling forward-looking planning

Build Back Better (BBB) requires transforming recovery actions from a temporary fix or restoration intervention into a structural upgrade to support long-term sustainable development. A key principle is to enable forward-looking planning. This requires moving beyond planning restoration and reparation interventions towards planning interventions for systemic transformation. Enabling forward-looking planning is a cornerstone of effective BBB approaches, as it shifts reconstruction from restoring what was lost to strategically investing in a more resilient, inclusive and productive future.

Rather than replicating pre-disaster competitiveness-related infrastructure as it was, including in terms of its spatial patterns, forward-looking planning uses the rebuilding phase to address long-standing structural weaknesses, such as inadequate connectivity, service gaps and limited economic diversification or innovation. To do so, the rebuilding phase updates the damaged infrastructure in ways that address challenges and reflect the development aspirations of the affected community.

Enabling forward-looking planning requires activating institutional, financing and partnership mechanisms in addition to those tailored to recovery and reaction with a view to identifying which development gaps can be addressed through the rebuilding phase. In practice, this is achieved by:

- **Co-ordination** across sectors, levels of government and stakeholders to enable integrated and long-term measures. Forward-looking planning aligns recovery investments with longer-term development, climate and social goals, ensuring coherence between immediate action and development ambitions. Public-private collaboration, community engagement and transparent governance mechanisms help ensure that plans are realistic, implementable over time and that they address existing development challenges.
- **Placing equity and intergenerational considerations** at the centre of rebuilding projects. Decisions taken today shape opportunities, risks and costs for future populations. BBB therefore requires assessing horizontal, vertical and intergenerational distributional impacts, protecting the most vulnerable and investing in capacity building and institutions that support achieving better futures for all. By linking resilience, sustainability and fairness, forward-looking planning turns rebuilding into a catalyst for sustainable development.
- **Community participation**. Forward-looking planning needs to be grounded on data-driven risk assessments and to be community-informed. A community-informed approach can be enabled by engaging local communities and local stakeholders, but it can take time, especially in the aftermath of a natural disaster when the urgency of immediate needs must be balanced against longer-term structural transformation. This engagement is a necessary step to ensure that rebuilding addresses structural imbalances and that it is not just a simple restoration and repair intervention.

  This is particularly important in developing countries where local development needs are high and the reconstruction phase could be turned into a real driver for change. Community participation empowers residents and local stakeholders, who often must undergo temporary relocation, by integrating local visions, aspirations and knowledge in the planning of rebuilding, complementing traditional technical assessments. Local insights on geography, historical hazard impacts and social vulnerabilities, as well as foreseeing scenarios on desirable futures enable the creation of tailored, relevant rebuilding plans that address the unique needs and ambitions of a given locality (OECD/UN-Habitat, 2026[1]). A community-informed approach also ensures that marginalised groups are included in the recovery, addressing disparities and preventing the reinforcement of existing social and economic vulnerabilities.
- **Balancing predictability with flexibility**. Forward-looking planning also requires balancing long-term views with adaptive planning mechanisms that integrate foresight and scenarios to factor in the flexibility needed for tomorrow (Box 2.1). Forward-looking planning requires stress-testing infrastructure, services and institutions against multiple future pathways, not only the most probable ones. Planning must be evidence-based, incorporate lessons learned, aligned with clear objectives and designed to remain adaptable as conditions evolve. This exercise of balancing predictability, which is necessary for long-term investments, with flexibility, enables policymakers and the private sector to prioritise options that deliver benefits today while preserving flexibility for tomorrow. Institutional capacities to update plans and adapt are as important as the plans themselves, and this adaptability needs to be integrated into the project planning life cycle.

Box 2.1. Enabling forward-looking planning

Malawi used forward-looking planning with a long-term time horizon to ensure that major transport projects – including both rebuilt infrastructure and new projects – integrate resilience and are aligned with national development goals. This planning exercise resulted in the National Transport Master Plan (2017-2037), developed in 2015 with support from the World Bank. It presents a 20-year portfolio of investment projects summing up USD 9 billion, which mandates Climate Risk and Vulnerability Assessments (CRVAs) for all major transport projects, the revision of design standards and the mainstreaming of climate risk into district planning. It relied on extensive stakeholder feedback from public and private sectors, civil society and international partners to develop future scenarios and concrete proposals for meeting increasing transport needs in a safer, lower-cost way and with resilience already embedded from the get-go. It is aligned with Malawi 2063, a national development blueprint articulating the vision of transforming the country into an inclusively wealthy, self-reliant, industrialised upper-middle-income nation by 2063, in which infrastructure, such as energy and transport, is listed as a key enabler.

Source: Authors' elaboration based on "Building Back Better: A case from Malawi", presentation by the Ministry of Transport & Public Works at the Second Preparatory Meeting of the Compendium of Good Practices in Quality Infrastructure in November 2025.

Embedding preparedness in rebuilding

Building Back Better (BBB) not only requires turning the recovery phase into a development driver by forward-looking planning but also requires that infrastructure rebuilding enhances preparedness and resilience to future natural hazards.

This means that rebuilding projects need to anticipate future risks, climate, demographic, technological, economic and social ones, and to integrate them into long-term investment and policy choices (Box 2.2). This requires:

- **Integrating multi-hazard and data-driven risk assessments as part of the rebuilding process.** Data-based and community-informed risk assessments are crucial for guiding decision-makers on how to improve future physical infrastructure design and implementation (e.g. through new materials, standards, increasing redundancies and adoption of nature-based or hybrid solutions, among others), on how to amend the way infrastructure is maintained, or even whether it would be more advisable to relocate assets to safer areas. In the road sector, for example, these assessments generally involve hazard exposure mapping, asset-level vulnerability assessments and system-level criticality and network effects analysis (Xiong et al., 2025[2]).

  Risk assessments should also be used to help prioritise actions and sequence decisions on rebuilding over time, contributing to cost effectiveness and effective time management of rebuilding interventions. Data-driven risk assessments can have multiple benefits that go beyond just managing physical assets or disaster risk. This information can guide urban planning and prioritise social and economic investments ensuring that the rebuilt competitiveness-related infrastructure contributes to sustainable development and resilience. Useful data involve enabling updated climate projections, using geospatial data and vulnerability mapping enabled by AI-driven satellite imagery to inform infrastructure design standards and site selection. Digital twin simulations of future climate scenarios can also help to inform decisions on possible infrastructure locations.
- **Supporting the updates of relevant standards and guidelines.** Data-driven risk assessments should also be used to update construction design, performance and safety standards. A risk

assessment could find that the parameters in building codes for seismic resistance, flood levels or temperature thresholds would need to change following lessons learned from a disaster, or land rezoning might be required. Through these assessments, lessons learned from previous disasters can also be codified and used to improve future preparedness. Estimates show that every USD 1 spent on improving building codes reduces disaster losses by USD 11 (World Bank, 2024[3]). For example, Japan introduced the world's first national seismic design code in 1924, establishing foundational principles for earthquake-resistant construction in Japan after the 1923 Great Kanto earthquake (Mw 7.9) that devastated Tokyo. Subsequent major earthquakes triggered progressive code enhancements, including a major one in 1981. As a result of these accumulated efforts, during the Great East Japan Earthquake (Mw 9.0) on 11 March 2011, modern code-compliant buildings sustained almost no damage to main structures (World Bank, 2018[4]; Fire and Disaster Management Agency of Japan, 2013[5]). The updating of standards and guidelines has also been crucial in the rebuilding processes in Honduras and Nepal (Box 2.2).

Standards and guidelines can function as operational protocols that support practical implementation and dissemination of legal frameworks, clarifying procedures such as prioritisation, approval, contracting, monitoring and inspection of construction work. Where such guidelines do not already exist, they should be developed as early as possible after a disaster to support co-ordinated and transparent recovery efforts. Putting in place pre-existing protocols and mechanisms that allow for review of relevant regulations after disasters and implementation of new ones is important. This means clearly pre-defined roles among executive, legislative and regulatory bodies, as well as formal co-ordination mechanisms among relevant agencies and stakeholders to carry out reviews.

- **Linking reconstruction budgets to national resilience strategies**. Successful practices link reconstruction budgets to preparedness and resilience benchmarks, in line with updated building codes and guidelines or with overall national resilience strategies. This approach has been applied, for example, in post-disaster transport and flood-control projects where reconstruction funds are disbursed upon the condition of putting measures in place to ensure that preparedness is embedded not only in physical assets but also in operational protocols, such as anticipatory maintenance and early warning systems. Another way to link reconstruction to national resilience strategy is to strengthen institutional organisation and capacity for reconstruction and disaster risk management. In several cases, as in Indonesia and Nepal, temporary agencies have been transformed into permanent institutions, thus increasing preparedness to future shocks (Box 2.2).

Box 2.2. Embedding preparedness in rebuilding

Supporting the updates of relevant standards and guidelines in Nepal and Honduras

In **Nepal**, after the 2015 earthquake, the National Reconstruction Authority (NRA) led the effort to create rules and manuals to guide reconstruction, as this information did not exist before. This was done in co-operation with key partners, notably international organisations like the World Bank, the United Nations Development Programme (UNDP) and the Japan International Cooperation Agency (JICA), as well as various local NGOs and community groups. The reconstruction manuals and standards were also developed with a focus on several key types of construction, including:

- Seismic-resistant design: To compile specific building techniques and materials to absorb and dissipate earthquake energy. This included recommendations to use reinforced concrete, proper wall bracing and well-designed foundations.
- Material specifications: The manuals provided detailed instructions on the quality of materials to be used, such as the type of stone, mud and timber, to ensure they meet safety standards. This was especially critical for traditional stone and mud mortar houses, which are common in rural Nepal.
- Retrofitting damaged structures: The guidelines also offered a pathway for homeowners to repair and strengthen partially damaged buildings instead of tearing them down, using specific techniques to make them more resilient.
- Community-based approach: The manuals were designed to be didactic (and user-friendly) enough to support rebuilding initiatives from local masons and community members, often with the support of engineers and technicians.

Honduras started, in 2024, an investment project to repair and rebuild the CA-4 and CA-13 highways that connect important production sites to the Puerto Cortés, Central America's largest port, with the objective of undertaking, at the same time, long-term resilience improvements and short-term investment needs. To do so, Honduras has complemented conventional reconstruction efforts with:

- Reforms to its national disaster management system (SINAGER), introducing the climate risk management dimensions into its transport policy and undertaking capacity building in the road sector to improve asset management and procurement processes towards better resilience management.
- The adoption of new forms of contracts for road procurement, a performance-based contract that incentivises private contractors to maintain minimum road performance standards over longer periods of time and to incorporate climate resilience and disaster preparedness to road operations.
- The integration of climate adaptation measures into project design standards, encouraging preparedness to respond to a range of future climate risks.

Linking reconstruction to national resilience strategies in Indonesia and Nepal

Indonesia's exposure to frequent disasters has prompted the country to implement permanent governance structures for disaster risk management and rebuilding. This governance was inspired by temporary structures, created in the country to respond to specific disasters during the 2000s, as in the case of Banda Aceh and Nias after the 2004 Indian Ocean Earthquake and Tsunami. The Aceh-Nias Rehabilitation and Reconstruction Agency was created in 2005, under the national government administration, and operated for five years to plan and co-ordinate reconstruction investments and mobilise financial resources. The lessons drawn from this experience and the need for a more proactive

post-disaster action inspired the creation, in 2008, of Indonesia's National Disaster Management Authority (*Badan Nasional Penanggulangan Bencana,* BNPB), through Presidential Regulation No 8 to co-ordinate the implementation of disaster risk reduction (DRR) policies at the national level covering prevention, emergency response, rehabilitation and reconstruction after disasters.

When **Nepal** was hit by the 2015 Gorkha Earthquake, there was no established national governance for disaster response. To implement a swift response, the country created the National Reconstruction Agency (NRA) in December 2015, designated to lead and manage the post-earthquake recovery. The NRA established Nepal's five-year Post-Disaster Recovery Framework, which detailed policy, institutional and implementation frameworks, and a rebuilding investment plan to respond to the earthquake. After learning from this disaster and with the experience gained from the 2015 response, the country decided to establish a permanent National Disaster Risk Reduction and Management Authority in 2017, ensuring institutional continuity of the country's disaster response governance and a continuous improvement of Nepal's DRR capabilities.

Source: Authors' elaboration based on "Good Practices on Private Housing Reconstruction in Nepal, after Gorkha Earthquake 2015", presentation by the National Disaster Risk Reduction and Management Authority, Nepal at the 1st preparatory meeting for the *Compendium of Good Practices on Quality Infrastructure 2026* that took place in June 2025, and based on "Transforming Infrastructure Through Resilience, Inclusion and Sustainability in Honduras", presentation by the National Secretariat of Infrastructure and Transport of Honduras at the 3rd preparatory meeting for the *Compendium of Good Practices on Quality Infrastructure 2026* that took place in November 2025.

Activating targeted funding and partnerships

Rebuilding for better futures requires activating targeted funding mechanisms that ensure the mobilisation of long-term financing beyond recovery funds to rebuild competitiveness-related infrastructure (in a forward-looking and modernised way). In contrast, common tools for funding infrastructure recovery after natural disasters (e.g. catastrophe bonds or aid grants for recovery) often fall short of addressing the transformative ambitions of Building Back Better (BBB), as the focus tends to be on dealing with the emergency and restoring service provision.

Targeted funding for rebuilding could involve mechanisms at the international, regional or national level and for private-public partnerships to mobilise funds in affected communities for long-term transformation. For this purpose, co-operation with the private sector, through funding and risk transfer instruments, can help leverage sufficient resources to meet investment needs. This should be in line with plans to increase preparedness or enhanced local economic development, including, for example, the use of improved construction materials or a relocation of the infrastructure to increase future preparedness and resilience.

While progress has been made in recent years in terms of creating innovative instruments for solidarity and shock absorption mechanisms, as for example the European Union Solidarity Fund introduced in 2022 to assist Member States in the event of catastrophes, these tools are not designed to drive systemic change and resilience as eligible expenditures are mostly linked to emergency responses and to what falls under the "reaction" pillar of the resilience cycle "Prevent-React-Rebuild". Investments linked to redesigning infrastructure with higher climate resilience standards, to assets' relocation and to transforming local economic development models fall out of what is eligible in most recovery funds and require targeted funding tools.

Development banks, national, regional and international ones, emerge therefore as critical actors to enable BBB by enabling long-term affordable financing with conditionalities linked to transformative and resilience-enhancing outcomes.

Development banks and international partners foster BBB in multiple ways, and notably by enabling:

- Funding linked to specific development impact outcomes, such as the use of improved design and materials, and implementing feasibility studies for asset modernisation or relocation, among others.
- Funding for local economic development programmes to turn infrastructure rebuilding into a transformative investment, such as programmes for local value addition or innovation.
- Technical assistance to plan, manage and build infrastructure in a forward-looking and resilient way, including by facilitating access to data and frontier technology for data-based risk assessment.

In developing countries, development banks and international partners also provide support in addition to financing, enabling a more holistic approach that is important for BBB through:

- **De-risking investment in countries hit by natural hazards** by providing guarantees and crowding in private investment, as countries' risk premiums and insurance costs tend to increase. For infrastructure rebuilding, project finance tools are often combined with risk sharing mechanisms to increase a project's profitability and mitigate investors' risk. This is particularly important as projects may not generate future revenues to cover investment costs. In this context, climate finance concessional programmes, insurance, guarantees and sovereign catastrophe risk pools can lower investors' financial and climate risk perception by decreasing capital costs and providing protection against default and rapid liquidity to countries after disasters. Through sovereign catastrophe risk pools, for example, countries pay premiums to access a collective insurance scheme that allows them to receive resources when a disaster occurs (OECD, 2025[6]). A concrete example is the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI) Insurance Programme, implemented in 2007 with Samoa (Box 2.3).
- **Facilitating access to data.** Funding from development banks and international partners often provides additional support, including expanding access to secure data, technical assistance for data analysis and interoperable data-sharing systems, which are crucial for resilient infrastructure construction and management. In this way, support for long-term transformation is amplified. For example, support can be crucial for access to a variety of data at spatial and temporal scales, including hazard, exposure, vulnerability, climate, environmental and socio-economic data, which are necessary for data-driven risk assessments. Access to these data can be limited, particularly for developing countries, where scarce resources prohibit investments in regular monitoring, or where access may be hampered by high prices. Partners can facilitate the use of collaborative platforms and standardised protocols to efficiently exchange data, reducing duplication and improving analytical quality. Open-access datasets further expand availability. An example is the Transport Data Commons (TDC) initiative, a coalition of more than 30 organisations working on transport, including the United Nations Economic Commission for Europe, the Asian Development Bank and the OECD International Transport Forum. Launched in February 2026, it is a global, open platform for accessible and high-quality transport data, such as indicators to support decarbonisation pathways in the sector (Transport Data Commons, 2025[7]).
- **Enabling effective digital infrastructure.** Development banks can support bridging structural gaps in digital infrastructure, therefore enabling BBB. The use of advanced monitoring data also requires good digital infrastructure. For example, creating Geographic Information Systems (GIS) data could require coverage with sensor networks, telemetry systems and mobile phone networks, among others. In the meantime, accessing datasets and processing them with advanced tools, including machine learning, also depends on fast internet and server capacity.
- **Updating policy frameworks to enable collaboration with qualified suppliers.** Partners can provide crucial assistance in simplifying and modernising relevant frameworks to ensure talent is available to support rebuilding. Complex contracts or co-operation agreements can prevent qualified suppliers and partners from participating, particularly when they operate cross-border and

lack familiarity with domestic legal frameworks. This is especially true for those that incorporate resilience technologies, if legal or procurement approaches do not mention resilience needs (Fanias, Xiong and Gall, 2025[8]). For example, engineers licensed in another country may find it difficult to practice legally in the disaster zone or to reach competitive prices for climate resilient solutions. In addition, overly complex terms may trigger long litigation processes and legal disputes, delaying efficient rebuilding. More flexible, simple and standard regimes can attract world-class specialists and promote further collaboration between parties. During post-disaster reconstruction, special derogations can be introduced to ensure that investments are made on time and with the required quality. The experience of Peru, which updated its framework to ensure better collaboration with qualified suppliers through a Government-to-Government (G2G) partnership with the United Kingdom, is illustrative in this respect (Box 2.4).

- **Capacity building for engaging in new techniques and improving the interpretation of data.** Training staff from relevant public and private sector bodies in analytical methods, modelling and GIS enhances their ability to apply risk assessments in rebuilding decisions. Simplifying the tools and ensuring interoperability across systems makes them more accessible and easier to integrate into existing processes. Development banks can engage in technical assistance and capacity-building programmes to ensure that risk assessment is used and translated into practical, actionable guidelines (Box 2.4). Partnerships between international organisations, national and local governments can also enhance targeted capacity-building programmes and effectively mobilise communities and the public sector at all levels of government. An example is the Africa Climate Resilient Investment Facility (AFRI-RES), a partnership, launched in 2017, between the African Union, the African Development Bank, the United Nations Economic Commission for Africa (UNECA) and the World Bank, with the support of the Nordic Development Fund (NDF). It supports governments, planners and private project developers in Africa in integrating climate change into project planning and design and attracting financing (World Bank, 2025[9]).

Box 2.3. The Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI) Insurance Programme: A tool to support Building Back Better

PCRAFI is a risk-layering and financial resilience instrument, combining catastrophe risk modelling, data and sovereign disaster risk financing (including insurance and contingency finance). Its core contribution to BBB lies in shifting the focus from ad-hoc recovery to anticipatory, rules-based preparedness. By ensuring rapid liquidity after disasters, it enables governments to plan recovery and avoid delayed, sub-optimal rebuilding driven by fiscal stress. Its key strengths are:

- **Speed and predictability of funding**: Rapid payouts reduce pressure to rebuild quickly at lower standards.
- **Incentive effects:** Risk assessment and pricing encourage better land-use planning, risk reduction and resilient infrastructure.
- **Integration with policy planning:** PCRAFI links financing with risk data and disaster risk management strategies, a core pillar of Building Back Better.
- **Avoidance of negative coping strategies:** Governments are less likely to divert long-term investment budgets or increase debt unsustainably aftershocks.

PCRAFI is a strong enabling mechanism for BBB, particularly on the financial resilience and institutional preparedness dimensions. Unlike purely ex post solidarity funds, it supports a forward-looking recovery model by ensuring that financing constraints do not undermine resilient reconstruction. While BBB is not PCRFAI's primary objective, the initiative creates the foundational conditions that make its pursuit feasible.

PCRAFI does not finance reconstruction directly and does not impose resilience conditionality on how payouts are used. On its own, it cannot guarantee that rebuilding will be greener, safer, or more inclusive. Those outcomes depend on national policies, standards and complementary investment instruments.

Source: The World Bank (2016[10]).

Box 2.4. Activating targeted funding and partnerships

In **Peru**, after the 2017 El Niño disaster, a comprehensive reconstruction programme with a focus on building resilient infrastructure was established through a G2G partnership with the government of the United Kingdom (UK), administered by the National Infrastructure Authority (ANIN). One of the most impactful measures from this G2G agreement was the adoption of the New Engineering Contract (NEC) system, an alternative public procurement framework that permits contract customisation according to the specific requirements of a given infrastructure project or supplier.

This new institutional arrangement operates through two complementary mechanisms: first, technical knowledge transfer from UK entities to ANIN strengthens infrastructure design capabilities, enabling more precise contract specifications for resilient technology implementation; second, standardised bilingual contracts featuring simplified structures and accessible language in English and Spanish, combined with streamlined bidding procedures, expand the supplier pool and facilitate the selection of providers demonstrating superior resilience-oriented solutions. Under this reformed framework, ANIN also enhanced contractual agility and flexibility, addressing longstanding challenges of incomplete infrastructure projects. Notably, the system replaces traditional litigation-based dispute resolution with performance-oriented mechanisms incorporating risk-sharing arrangements between contracting parties.

This integrated approach exemplifies how legal and institutional frameworks can be structured, through capacity building and knowledge development, to simultaneously advance infrastructure resilience, procedural efficiency and market competition within disaster recovery contexts. Nevertheless, updated legal and institutional mechanisms can increase the demand for public human and financial resources. In the case of Peru, new obligations associated with the NEC contract were reported to increase project costs in a context of federal budget constraints.

In **Samoa**, the Enhanced Road Access Project (ERAP), approved in 2013 with support from the World Bank, provided USD 32 million for nine years to restore damaged roads and bridges while improving design standards and sector management practices. This project was complemented by the Samoa Climate Resilient Transport Project (SCRTP), a USD 38 million, six-year initiative approved in 2018. It provides financial support through a combination of debt and grants to rebuild critical infrastructure and enhance the long-term resilience of Samoa's road sector through systematic improvements to transport infrastructure and institutional capacity. These projects were implemented by Samoa's Land Transport Authority (LTA).

In addition to physical investment in infrastructure, a critical component of the World Bank support to Samoa consists of technical assistance provision for institutional and regulatory reforms to integrate climate change considerations into road sector planning, development and management. Under the ERAP, Samoa also received grants to strengthen LTA's planning capacity, to revise maintenance and construction standards for roads and bridges and to update legal and regulatory frameworks. Under the SCRTP, project management and staff training programmes for the LTA were undertaken together with impact surveys to better assess the project's social impacts and additional support to improve road safety standards. In addition, another World Bank programme, the Pacific Resilience Programme (PREP), launched in 2015, included specific interventions to strengthen early warning and emergency management.

Integrating technical assistance into infrastructure credit programmes served as bridge financing to enhance sustainable development impact and build local capacity for undertaking investment programmes. For example, the World Bank supported the updating of the Climate Resilient Road Strategy (CRRS) in 2012 and of the Climate Vulnerability Assessment (VA) in 2013. Both tools provided

evidence-based frameworks that systematically compiled climate variables to inform road sector planning and project prioritisation. As strategic planning instruments, they support hazard identification, the climate-resilient design of infrastructure investments, prioritisation of investments and better assessing the benefits of the interventions to the country's resilience in the road sector.

Source: Authors' elaboration based on "ANIN Presentation", presentation by the National Infrastructure Agency of Peru at the 2nd preparatory meeting for the *Compendium of Good Practices on Quality Infrastructure 2026* that took place in July 2025 and "Rehabilitation of the West Coast Road, Samoa Project", presentation by the National Land Transport Authority of Samoa at the 3rd preparatory meeting for the *Compendium of Good Practices on Quality Infrastructure 2026* that took place in November 2025.

Ensuring effective time management

Effective time management in BBB is crucial, while rapid reaction is essential in the immediate aftermath of a disaster to save lives and restore basic services, rebuilding demands a different temporal logic.

Reacting requires different time management than rebuilding. Not differentiating the interventions risks hampering recovery and might contribute to perpetuating vulnerabilities, replicating pre-existing weaknesses and missing opportunities to improve resilience.

Managing time effectively, therefore, means sequencing actions appropriately, through pre-defined post-disaster protocols, to enable forward-looking planning and embed resilience in rebuilding. Prioritising damage assessments, risk analysis and stakeholders' consultations enables evidence-based and community-informed choices about when, what, where, how and whether to rebuild. Allocating time for building public understanding is equally important, as communities require time to reconcile their immediate needs with BBB.

The timeframes required to be factored in these steps in planning are not delays in responding to the disaster but are investments for better futures. They help ensure that reconstruction aligns with updated hazard information, climate projections and long-term development objectives, rather than responding solely to political or social pressure for rapid visible results. In extreme cases, a long time span needs to be factored in for safety concerns, as in the case of rebuilding in Fukushima Prefecture, Japan, after the 2011 Great East Japan Earthquake, followed by the Tsunami and the nuclear disaster (Box 2.5).

Effective time management therefore requires activating parallel measures to ensure, for example, that social and community concerns are considered when rebuilding can only take place after a long period of time. Emergency measures and reconstruction should be considered simultaneously under differentiated tracks. Temporary housing, for example, should be designed to meet the immediate needs of securing a place to live for those who lost housing, while reconstruction plans are developed with higher standards for long-term housing.

Effective time management in reconstruction requires adaptive planning frameworks that allow timelines to be revised as circumstances change. This is often guided by multi-year reconstruction plans, led by a dedicated agency and cross-ministerial government structures, including clear decision gates, procedures for continuous stakeholder consultation and mechanisms for transparent communication with affected communities about trade-offs between speed, safety and long-term resilience. The Fukushima experience underscores that incorporating time as a strategic variable, rather than a constraint, enables governments to balance urgency with quality, integrate preparedness into rebuilding and deliver infrastructure that supports sustainable recovery.

Box 2.5. Effective time management

Effective time management is a critical but often underestimated dimension of post-disaster reconstruction, as illustrated by the Fukushima nuclear disaster in Japan. In this extreme case, the scale and complexity of the shock required authorities to move beyond rapid rebuilding and adopt a phased, long-term reconstruction timeline aligned with safety, decontamination and social recovery objectives. Rather than prioritising speed alone, Japan sequenced actions – emergency response, temporary housing, environmental remediation, infrastructure rebuilding and economic revitalisation – according to evolving risk assessments and community readiness. This approach highlights that, in high-risk contexts, "rebuilding at the right time" can be more effective than building quickly.

A key good practice emerging from Okuma Town is the alignment of physical reconstruction timelines with social and economic policies, particularly when long-term displacement or relocation is unavoidable. Extended relocation periods were accompanied by targeted social protection measures, employment support, mental health services and investments in education and community facilities. Infrastructure rebuilding was synchronised with these policies to avoid creating assets disconnected from population needs or prematurely re-occupying unsafe areas. This integrated approach helped mitigate social fragmentation and economic decline, demonstrating the importance of embedding social policy planning into reconstruction timelines from the outset.

Source: Okuma Town (2017[11]; 2023[12]).

Making rebuilding people-centred

Disasters affect not only physical infrastructure but, above all, people and social networks. Engaging communities in rebuilding is a cornerstone of Building Back Better (BBB).

Making rebuilding people-centred places social issues at the core of economic planning through ensuring community engagement and fostering social cohesion. It helps affected people regain control, become active participants in their recovery and build resilience to future shocks. It means, in practice, having the affected community involved in reconstruction from the design and project formulation phase.

BBB needs to be based on a comprehensive understanding of local needs, capabilities and aspirations (Box 2.6). Road reconstruction, for instance, can gain from community inputs to identify critical access routes, minimise displacements and prioritise investments that improve local activities the most. It also requires factoring in social considerations in rebuilding, including enhancing local attractiveness to restore community confidence in returning to damaged areas. A pertinent example is the shifting aspirations of former Okuma Town residents in response to evolving circumstances following the 2011 Great East Japan Earthquake disaster. According to surveys conducted by the Reconstruction Agency, more than 67% of respondents were unwilling to return to the town in 2013 and merely 8.6% had expressed willingness to return, primarily due to radiation safety concerns and inadequate infrastructure reconstruction progress. By 2026, however, these figures shifted notably to approximately 55% and 19.1% (including those who had already returned), respectively (Reconstruction Agency of Japan, n.d.[13]). This trend illustrates how former residents' decisions evolved as rebuilding progressed, underscoring the importance of allowing adequate time for both physical rebuilding and community confidence restoration.

BBB means planning competitiveness-related infrastructure not only as physical assets, but also as a component of a local ecosystem that delivers sustainable development opportunities to people. It requires investing in people's well-being and social cohesion as part of territorial and local development planning.

In Japan, enhancing social capital has proven effective in supporting post-disaster population growth across all 47 prefectures between 1981 and 2012. This has been reflected in greater participation in voluntary organisations for disaster prevention and lower crime rates (Okuma Town, 2023[12]). In the case of the city of Kobe (Hyogo prefecture), community engagement has also played a role in creating local jobs in the service sector, more than compensating for job losses in industry, right after the 1994 Hanshin Awaji Earthquake (Shimada, 2017[14]). In this respect, investments to enhance local attractiveness are crucial; for instance, investing in education and health facilities can help promote an updated post-disaster image and bring populations back into damaged areas, as seen in Japan (Box 2.6).

BBB requires systemic planning and synchronising infrastructure reconstruction with people-centred policies and programmes, especially in contexts of prolonged displacement or relocation. Rebuilding prioritises local job creation and the use of local suppliers can accelerate economic recovery while strengthening the community ownership of the new infrastructure.

Box 2.6. Making rebuilding people-centred

Indonesia has established a disaster governance framework to co-ordinate short- and long-term responses at the national and local levels with a focus on integrating people's needs through community participation. The creation of the National Disaster Management Authority (*Badan Nasional Penanggulangan Bencana,* BNPB) in 2008 marked a shift from an ad-hoc disaster response to a permanent institutional capacity. In practice, the BNPB works together with local governments (provinces and regencies/cities) and regional disaster management agencies to ensure a co-ordinated multi-level action when a disaster occurs. One of the guiding principles of this co-ordination response is community participation set by the BNPB regulation No. 6, issued in 2017. In practice, this regulatory enforcement formalises approaches Indonesia has already been using to engage with provinces, regencies, cities and the communities impacted by natural hazards. For example:

- In 2016, during the reconstruction of the Sambong bridge in East Java Province, destroyed by the 2014 Mount Kelud Volcano Eruption, communities were actively involved in the project's inception phase, being part of early risk and needs assessments undertaken by the Malang Regency Regional Disaster Management Agency (*Badan Penanggulangan Bencana Daerah,* BPBD). This participatory assessment of potential risk and impact resulted in the inclusion of new design standards to secure population transport access needs and incorporated preventive measures, such as investments to increase resilience to potential future lava overflows.
- In 2022, during the Tuva bridge reconstruction in the Central Sulawesi Province, as a response to the 2018 Earthquake and tsunami, the project design was informed by community consultations through a series of public meetings to prioritise and test the project concept. The bridge was rebuilt with more resistant materials, replacing the original wooden structure with steel and reinforced concrete and was relocated to a safer location.

In **Japan,** Okuma Town, following the 2011 Great East Japan Earthquake, developed a strategic long-term reconstruction plan, not only focusing primarily on physical infrastructure restoration, but also on investment in talent development facilities. The earthquake was a magnitude 9.1 event, the strongest ever recorded in Japan, triggering a catastrophic tsunami that precipitated a major nuclear accident at the Fukushima Daiichi nuclear plant, located in Okuma Town and Futaba Town, Fukushima Prefecture.

Recognising that human capital development is fundamental for sustainable post-disaster recovery, Okuma Town's reconstruction plan involved the launch of two symbolic talent development facilities, the Okuma Incubation Centre (OIC) in 2022 and the Manabiya Yumenomori school (nursery school

through junior high school) in 2023, aiming to catalyse community revitalisation and local economy, and facilitate the displaced residents' return through education and innovation.

This Okuma Town's initiative exemplifies a people-centred approach to BBB wherein recovery is underpinned not merely by the restoration of built environments but by strategic investments in innovation capacity, educational opportunities and collaborative spaces for disaster-affected populations, while building a sense of community. Furthermore, both facilities function as a space for social integration and public engagement, while fostering knowledge creation and sharing, including for businesses through the OIC facilities.

Source: Authors' elaboration based on "Rebuilding bridges bridging resilience: Funding collaboration for post-disaster rehabilitation and reconstruction of bridges in Indo", presentation by the National Agency for Disaster Management (BNPB) of Indonesia at the 3rd preparatory meeting for the *Compendium of Good Practices on Quality Infrastructure 2026* that took place in November 2025 and "Regional 'Build Back Better' through Education and Human Resource Development", presentation by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan at the 1st preparatory meeting for the *Compendium of Good Practices on Quality Infrastructure 2026* that took place in June 2025.

Conclusions

Forward-looking rebuilding is a key pillar of ensuring infrastructure resilience to natural hazards. While rebuilding is inherently context- and time-specific, a set of broadly applicable good principles applies and, when implemented, significantly impacts the quality, effectiveness and efficiency of rebuilding planning, financing and implementation.

This Compendium highlights the value of exchanging experiences to identify lessons learned and innovative approaches to Build Back Better (BBB). By sharing knowledge and identifying best practices tailored to local conditions, countries can effectively address their unique challenges while benefiting from proven strategies implemented elsewhere. This chapter has demonstrated that while each country faces distinct socio-economic, environmental and institutional realities, some common principles and approaches can be universally applied to improve infrastructure resilience to natural hazards.

By fostering a culture of knowledge sharing and mutual learning, this chapter contributes to building a repository of effective strategies and tools. These can be adapted and implemented for different settings to enhance infrastructure resilience. In particular, five good practices have been identified:

- Enabling forward-looking planning
- Embedding preparedness in rebuilding
- Activating targeted funding and partnerships
- Ensuring effective time management
- Making rebuilding people-centred

These good practices provide actionable guidance for forward-looking rebuilding after natural disasters. They enable countries not only to restore disrupted infrastructure and regain access to essential services, such as energy and transport, but also to transform disaster events into development opportunities. By creating mechanisms that support BBB, these practices help activate investments that drive forward-looking change in affected communities, ultimately strengthening their long-term resilience to anticipated future risks.

In addition, to improve national and local governance in developing countries, international partnerships are vital for supporting the implementation of these good practices. Developing countries often face significant challenges due to limited financial resources, technical expertise and institutional capacity.

International partnerships can provide much-needed financial assistance, technical know-how and capacity-building support to help these countries overcome these barriers and effectively implement resilience-building measures. Increased collective efforts by the global community, including national and international development banks and financial institutions, are needed to enhance developing countries' resilience and promote sustainable development for the benefit of present and future generations worldwide.

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3 Rebuilding infrastructure for sustainable futures: Learning from concrete projects in Africa, Asia, Latin America and the OECD

This chapter examines seven concrete infrastructure projects from Honduras, Indonesia, Japan, Malawi, Nepal, Peru and Samoa, each offering valuable insights into effective strategies and practices for Build Back Better after natural disasters. It discusses long-term planning for resilient road connectivity in Honduras; bridge reconstruction in Indonesia; people-centred and future-oriented rebuilding in Japan; the reconstruction of road corridors and embedding resilience across their asset lifecycle in Malawi; adaptive governance frameworks and rebuilding tools in Nepal; river flood defence rebuilding in Peru; and climate-proofed road network rebuilding in Samoa. Through step-by-step analysis of these infrastructure projects, this chapter provides valuable in-depth lessons for governments, the private sector and civil society on implementing forward-looking rebuilding.

Introduction

Making rebuilding forward looking, with a view to Build Back Better (BBB), is highly context specific and requires co-ordinated measures towards a transformative change. To address this challenge, concrete case studies from seven countries – Honduras, Indonesia, Japan, Malawi, Nepal, Peru and Samoa – are examined, in Chapter 3, within the framework of the three pillars of prevention, reaction and rebuilding.

This chapter delves into detailed descriptions of these case studies, covering a multitude of different disaster events and geographies, a wide range of infrastructure projects and national policies. The cases span various categories such as roads, bridges and water management, while also emphasising talent-development initiatives. They offer a comprehensive analysis of post-disaster infrastructure rebuilding across Africa, Asia, Latin America and the Caribbean and OECD countries (Table 3.1).

Table 3.1. Overview of the infrastructure projects discussed in this Compendium, selected countries, 2026

	Honduras	Indonesia	Japan	Malawi	Nepal	Peru	Samoa
Infrastructure	Road	Bridge	Town-wide	Road	Road	Water management	Road
Disaster	2024 Storm Sara; 2020 Hurricanes Eta and Iota; Recurrent floods in the Sula Valley	2014 Mount Kelud Volcano eruption; 2017 Cyclone Cempaka; 2018 earthquake and floods in Central Sulawesi	2011 Great East Japan Earthquake (Fukushima nuclear accident)	2023 Cyclone Freddy	2023 Cyclone Freddy	2017 El Niño	2012 Cyclone Evan
Rebuilding project	Rehabilitation of rural and secondary roads in the northern and eastern regions	Rebuilding bridges across the country	Reconstruction of Okuma town, Fukushima Prefecture	Rebuilding critical road corridors and bridges	Rebuilding critical road corridors and bridges	Upgrading flood defences for two ravines near the city of Trujillo in Northern Peru	Strengthening overall road network resilience by rebuilding damaged roads
Co-ordination entity for rebuilding	Secretariat of Infrastructure and Transport (SIT)	National Agency for Disaster Management (BNPB)	Reconstruction Agency/Municipality of Okuma	Ministry of Transport and Public Works	Ministry of Transport and Public Works	National Infrastructure Authority (ANIN),	Land Transport Authority (LTA)
Total investment	USD 517 million	USD 1.5 million	USD 245.4 billion[1]	USD 100 million	USD 100 million	USD 351 million	USD 38 million
Duration	7 years	Up to 2 years	22 years[2]	5 years	5 years	3 years	6 years
Governance for implementation	Central government in co-ordination with a development finance institution	Provinces in co-ordination with BNPB Co-operation with the private sector and international organisations.	Okuma town, in co-operation with Fukushima Prefecture and National Reconstruction Authority	Central government in co-ordination with a development finance institution	Central government in co-ordination with a development finance institution	Central government through a government-to-government co-operation agreement with foreign partners	Central government in co-ordination with a development finance institution

Results and impact	Road reconstruction, coupled with reforms in governance.	Reconstruction of 5 bridges, with integrated DRR measures and governance reforms.	Repopulating the Okuma municipality; promotion of new innovative and industrial activities.	Upgrade of roads and bridges. Climate resilience embedded into infrastructure planning, design and management.	Upgrade of roads and bridges. Climate resilience embedded into infrastructure planning, design and management	River flood protection and infrastructure modernised with updated resilient standards. Reform of contract systems.	Recovered and upgraded roads, including the country's primary economic corridor.

Note: DRR: Disaster risk reduction.
1. The estimated investment in nationwide rebuilding during the initial five-year "Intensive Reconstruction Period".
2. Okuma Town's rebuilding planning period was initially set up for 5 years from 2012, extended to 2034, 22 years from the initiation year.
Source: Authors' elaboration based on the government's official sources and peer review during the three Preparatory Meetings for this edition of the Compendium.

Each of the following seven sections presents one case study. Taken together, they provide practical insights into how different countries have approached infrastructure rebuilding based on real-life scenarios. Based on that, the chapter identifies good practices and lessons learned, shedding light on effective strategies and practices that can be applied across different contexts. All case studies follow a similar structure, presenting the location, the context, the challenges to be addressed and the key elements of the rebuilding initiative together with results, success factors and good practices.

Embedding long-term planning for resilient road connectivity in Honduras after repeated storms

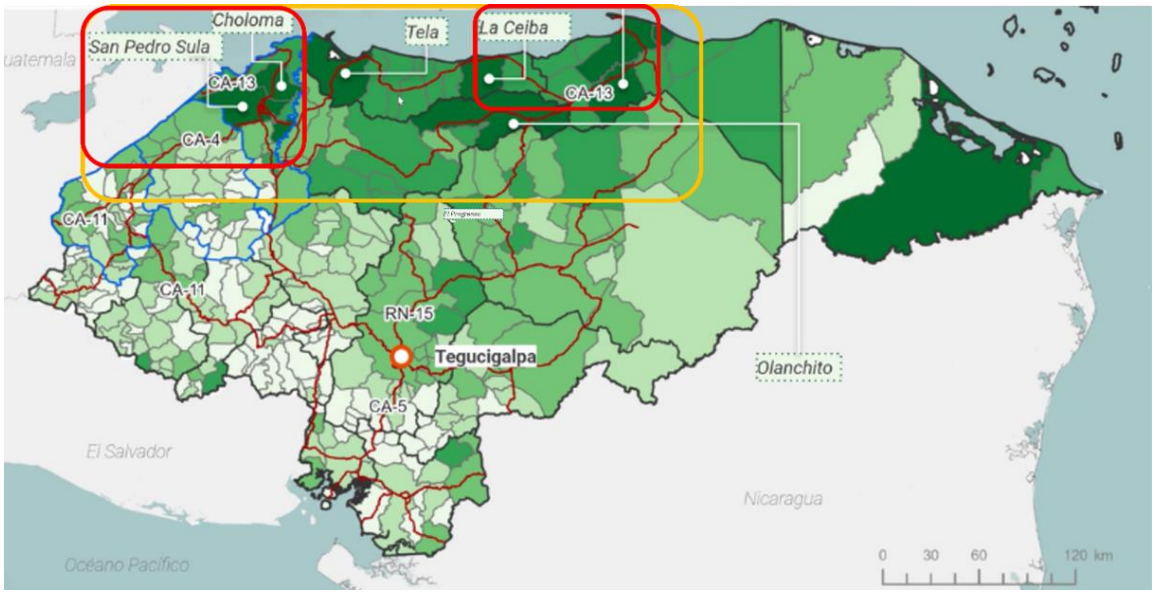
Honduras, one of the most climate-vulnerable countries in the world, has faced repeated devastating disasters that destroy key infrastructure. To secure reliable access to the country's major economic hubs and strengthen inclusion and accessibility across rural areas, the government launched a rebuilding strategy, with the support of the World Bank, that combines resilient road construction with innovative maintenance contracts. This case study highlights three investment projects in Northern Honduras that, together, unfold a comprehensive connectivity strategy through road rebuilding. These projects show how developing countries can build back better by strengthening governance and embedding long-term planning into infrastructure design and management, ensuring that transport investments deliver lasting connectivity, redundancy and inclusive access for rural communities and national trade routes.

Location and background information

Honduras is extremely vulnerable to storms and floods from its mountainous terrain, fragile soil conditions and exposure to both Pacific and Atlantic weather systems. Between 1998 and 2011, annual losses due to climate-related hazards were equivalent to around 1.8% of GDP (World Bank Group, 2023[1]). The most catastrophic event in recent history, Hurricane Mitch in 1998, affected 90% of the territory and caused damage equivalent to 81% of GDP (ECLAC, 1999[2]). In a nation with nearly 10 million people and a GDP per capita of only USD 3 426.4 in 2024 (World Bank, 2025[3]), these recurring disasters strike hardest where resources are already scarce. Rural, Indigenous and Afro-descendant communities, already marginalised by profound inequality, bear the heaviest burden when storms and floods hit. These vulnerabilities are compounded by chronic social pressures, including land disputes, drug trafficking and violence.

Recent successive storms and floods, hitting especially northern and eastern Honduras, demonstrate that the country's transport network, the backbone of its economy, cannot withstand the climate shocks that now arrive with alarming frequency (Government of Honduras, 2025[4]). In total, from 1999 to 2024, disasters in Honduras have impacted more than 4 million people and affected the transport sector heavily. The government reported the destruction of 113 roads and 21 bridges, as well as damage to 99 roads (4 500 km) and 29 bridges. Honduras' northern region, including the Sula Valley (the main industrial hub in the country) and coastal areas in eastern Honduras (known for agricultural and fishing production) were particularly affected (Figure 3.1). Recurrent flooding in these regions has impacted economic transportation corridors, including the CA-4 road corridor, which connects the Sulla Valley to Puerto Cortés port (which handles 80% of Honduras' exports) and to Guatemala. Damages increased in 2020, when two Category 4 hurricanes, Eta and Iota, struck the area within two weeks of each other, impacting the access to the port. In addition, the 2024 Storm Sara hit Honduras's coastal areas across the Atlántida and Colón departments, damaging 58 roads, including the CA-13 La Ceiba-Puerto Castilla corridor, which connects the city of La Ceiba and coastal areas to Puerto Castilla, Honduras' second most important port. This extensive infrastructure damage underscored the necessity of rehabilitation with rigorous maintenance protocols.

Figure 3.1. Honduras hazard vulnerability in the project areas



Note: Red rectangles represent the transport project areas; green indicates the degree of hazard (the darkest green indicating higher vulnerability) and the orange rectangle depicts the emergency recovery project area. The areas represented in the picture are those related to the three projects listed here as case studies.
Source: Elaborated by the World Bank.

Main challenges to be addressed

Transport infrastructure rebuilding programmes in Honduras face major challenges, including:

- **Urgent need to strengthen the resilience of road transport infrastructure:** In Honduras, transport networks are among the most exposed public assets to floods and landslides, making road failure a primary transmission channel through which disasters disrupt trade, mobility and access to services, particularly in rural areas (World Bank Group, 2023[5]; IBRD/World Bank, 2016[6]). While extreme events cause major disruptions, the scale of losses is largely amplified by chronic weaknesses in asset management, including outdated hydrological design standards, insufficient drainage and persistent maintenance backlogs (IBRD/World Bank, 2016[6]). These deficiencies accelerate infrastructure deterioration during both exceptional and routine rainfall events, leading to network-wide disruptions and major economic consequences even from moderate storms. In Honduras, 27% of the firms identified transport as a major constraint to their activities in 2018, a figure higher than the Latin American and Caribbean average of 15% in the same year (Government of Honduras, 2025[4]). Meeting reconstruction needs requires investment at levels far beyond past capital spending, underscoring the urgency of scaling up financing, institutional co-ordination and technical capabilities.
- **Fiscal and institutional constraints pose challenges for disaster response and reconstruction:** Limited fiscal space forces trade-offs between urgent social spending and long-term sustainable infrastructure, leaving critical road assets chronically underfunded. Weak inter-agency co-ordination and limited technical capacity slow procurement and project execution, while governance challenges and security risks complicate operations on the ground.
- **The mountainous conditions and ecological degradation increase local infrastructure vulnerability:** Honduras is a mountainous country, with more than 75% of its territory covered by mountains (UNIDO and ICSHP, 2022[7]). Deforestation and loss of ground cover directly weaken slope stability and hydrological regulation, increasing the likelihood of landslides, erosion and

structural failure of roads and bridges. In Honduras, floods and landslides linked to degraded upstream watersheds are identified as the main causes of recurrent damage to rural and secondary roads (IBRD/World Bank, 2016[6]; IPCC, 2022[8]; FAO, 2018[9]; FAO, 2020[10]). To prevent erosion and preserve ecosystem services vital for infrastructure sustainability, action is needed to promote forest restoration and biodiversity protection, thereby decreasing infrastructure vulnerability.

Key elements of the rebuilding strategy

Honduras's rebuilding strategy is gradually shifting its focus over time from emergency response to systemic resilience, building on more than a decade of reforms that established the foundations for resilience planning (Table 3.2). The Secretariat of Infrastructure and Transport (SIT), especially since the 2000s, has focused on programmes that translate long-term resilience planning into inclusive investments. The devastation caused by recurrent disasters in Honduras' northern and eastern regions revealed the country's dependence on vulnerable infrastructure networks.

Table 3.2. Tools for scaling up transport infrastructure resilience in Honduras, 2001–2024

Type of Instrument	Programmes for scaling up transport infrastructure resilience
Policy & Institutional Reforms (developed with the support of the World Bank)	**2017 – PPCR Phase I & SPCR** Mainstreamed climate adaptation into national planning and cross-sectoral co-ordination. **2020–2022 – Cat DDO I & Cat DDO II** Enhanced fiscal resilience and disaster risk management through rapid financing and policy reforms.
Investment Operations (financed by the World Bank)	**2001–2015 – Road Reconstruction & Improvement Projects (I & II)** Rehabilitated 600 km of roads post–Hurricane Mitch; established the Road Fund (Fondo Vial) and piloted community micro-enterprises for maintenance. **2008–2023 – COMRURAL I–III (Integrating Innovation for Rural Competitiveness)** Strengthened agricultural value chains and rural livelihoods with community-based micro-enterprises for maintenance with rehabilitation of 600 km of roads destroyed by Mitch. **2019–2020 – Water Supply Strengthening Project in Tegucigalpa and Water Security in the Dry Corridor** Strengthened water infrastructure and watershed resilience to droughts and floods. **2020 – Emergency Recovery & Resilience Project** Restored critical connectivity after Eta and Iota; introduced community participation in prioritisation. **2024 – Honduras Sustainable Connectivity Project** Aims at building a new CA-4 to CA-13 road corridor, biodiversity safeguards and increased rural resilience. **2025 – Resilient Management for La Ceiba–Puerto Castilla Corridor** 174 km under resilience-linked Contracts of Rehabilitation and Maintenance (CREMA) and disaster-readiness and rehabilitation of 13 bridges.
Parallel Initiatives (other partners):	CABEI (CA-13 Corridor); IDB (Rural Communities); Adaptation Fund (Ecosystem Restoration); GCF (Ecosystem-Based Adaptation).
Analytics & knowledge	**2024 – GFDRR ASA on Rehabilitation of Unpaved Roads** Developed climate-smart technical guidelines and a national catalogue of interventions for rural and unpaved roads, informing future design standards and prioritisation.

Note: PPCR: Pilot Program for Climate Resilience; Cat DDO refers to Catastrophe Deferred Drawdown Options; COMRURAL: Rural Competitiveness Project; CABEI: Central American Bank for Economic Integration; IDB: Inter-American Development Bank; CGF: Green Climate Fund; GFDRR ASA: Global Facility for Disaster Risk Reduction and Recovery's advisory services and analytics.
Source: Authors' elaboration based on official information.

Many rural communities, often isolated and economically dependent on agriculture, faced prolonged isolation, reinforcing the need for resilient, all-weather roads and bridges that safeguard access to markets, schools and health services. Early efforts since the 2000s under the Pilot Program for Climate Resilience (PPCR Phase I, 2017) and the Strategic Program for Climate Resilience (SPCR, 2017), led by the Ministry of Environment (MiAmbiente) in Honduras, helped mainstream climate adaptation into public investment and strengthen co-ordination across water, agriculture and urban sectors (Table 3.2). These programmes financed capacity building, community consultations, risk mapping and vulnerability assessments, leading

to other initiatives such as the Tegucigalpa Water Supply Strengthening Project (2019) and the Water Security in the Dry Corridor Project (2020). In addition, Honduras published a national catalogue of interventions for unpaved and rural roads with support from the Global Facility for Disaster Reduction and Recovery (GFDRR). Collectively, these initiatives have advanced data-driven planning and cross-sectoral collaboration, setting the stage for more integrated resilience investments in infrastructure. These initiatives were complemented by broader support from international partners, including the World Bank, the Central American Bank for Economic Integration (CABEI) and others.

Improving rural accessibility and securing reliable, year-round connectivity to Honduras's main trade hubs has emerged as a core priority of the country's infrastructure agenda. Reflecting a sustained national commitment to resilient transport infrastructure and with World Bank support, this agenda combines governance reforms, climate-smart construction and the rehabilitation of storm-damaged economic corridors, operationalised through the following three projects:

- **The Honduras Tropical Cyclones Eta and Iota Emergency Recovery Project (2020) to restore rural and secondary roads and bridges:** This six-year project invested USD 150 million for the reconstruction of critical infrastructure, restoring connectivity and basic services for affected communities across the departments of Atlántida, Colón, Yoro, Cortés and Santa Bárbara (which suffered the heaviest losses). The measures include:
  - **Reconstruction and rehabilitation of rural and secondary roads**: The project prioritises critical transport infrastructure that connects isolated rural communities to markets, schools and health services. By integrating improved drainage systems and slope protection, the investments also reduce flood risk and ensure all-weather access, benefiting over 200 000 people.
  - **Rebuilding small and medium-sized bridges and culverts:** Damaged crossings are being replaced using modern hydrological standards and higher elevation designs, ensuring resilience against future extreme rainfall and safeguarding connectivity and food security during floods.
- **The Honduras Sustainable Connectivity Project (2024) to create an alternative route to Puerto Cortés and improve regional integration:** This USD 187 million 7-year project, approved to restore and improve these connections, epitomises a resilient transport project that introduces cutting-edge construction techniques, reduces transport costs, enhances trade reliability and opens Atlantic access to El Salvador. The main activities include:
  - **Construction of a redundancy, i.e. a flood-free alternative route for road transport:** Construction of a new 46 km road linking the CA-4 road corridor with the CA-13 road corridor, creating a reliable alternative road that bypasses the congested and flood-prone Sula Valley and securing uninterrupted access to Puerto Cortès in case of disasters.
  - **Increasing feeder road resilience:** Upgrade of 41 km of existing unpaved feeder roads in four municipalities (Quimistán, Azacualpa, Nueva Frontera and Macuelizo), selected through climate risk screening and participatory processes and also based on their proximity to the corridor. These roads enhance rural connectivity in a region where agriculture employs about 60% of the workforce.
- **The La Ceiba–Puerto Castilla Corridor Project (2025) to rehabilitate, upgrade and maintain road infrastructure:** This 6-year project invests USD 176 million (USD 100 million from the World Bank/International Development Association (IDA) and about USD 76 million from the Spanish Agency) to restore, upgrade and modernise the La Ceiba-Puerto Castilla road corridor, a vital lifeline for the eastern and northern regions of Honduras, linking agricultural zones, fishing communities and tourism hubs. It embeds resilience across the entire asset lifecycle, including the following dimensions:
  - **Rehabilitation, upgrade and maintenance of 174 km of the corridor**: The Project will include rehabilitation of the existing road, the addition of third lanes on ramps and road duplications, including road safety improvements and integrating climate-resilient features, to

be defined after a road safety audit, following performance-based contracts (PBC) best practices. In a PBC, contract payments are tied to measurable outcomes over time, including road condition, drainage effectiveness and disaster readiness.

- **Reconstruction of 13 bridges**: Bridges are being rebuilt to 100-year flood standards, using updated precipitation data and modern design parameters. These bridges are expected to safeguard connectivity for people and goods year-round, ensuring that supply chains, markets and essential services remain accessible even in the face of increasingly frequent and intense storms.

Results, success factors and good practices

Honduras' experience suggests that progress toward more sustainable reconstruction is possible when long-term planning is deliberately incorporated into recovery efforts, even amid recurrent shocks and institutional constraints. The scale of disaster losses, combined with limited institutional capacity and fiscal constraints, has exposed the limits of short-term repairs and underscored the need for more durable approaches to prevention, management and adaptation. Recent efforts to introduce forward-looking planning and network analysis into infrastructure design, linking financing and performance to risk management and connecting infrastructure to environmental and social objectives, mark important steps toward reducing vulnerability. Sustaining and scaling these reforms will be critical for enabling Honduras's reconstruction to evolve into a more resilient and inclusive infrastructure system over time. In particular, the following elements stand out as good practices and success factors:

- **Embedding long-term performance in road contracts to promote continuous resilience and asset maintenance.**

  The La Ceiba–Puerto Castilla Corridor project introduced the Rehabilitation and Maintenance contract (CREMA), a performance-based contract (PBC) model in which payments are tied to measurable outcomes over time, including road condition, drainage effectiveness and disaster readiness (including measures to reduce flood and landslide risks). For a country long accustomed to emergency repairs, the planned introduction of CREMA represents a major mindset shift toward structured and accountable maintenance, which is a key factor for the resilience of road infrastructures, often overlooked. Under this new framework, contractors are responsible for keeping roads open and reliable throughout the contract period, with payments linked not only to surface conditions. These multi-year contracts will institutionalise and enhance the effectiveness of preventive maintenance while ensuring continuity of services before, during and after future natural hazards.

- **Strengthening resilience governance and investing in capacity building.**

  Honduras has begun modernising the Secretariat of Infrastructure and Transport (SIT) through the introduction of digital asset management tools, improvements in procurement practices and the gradual incorporation of resilience-focused planning standards. By embedding these measures within ongoing infrastructure investment projects – rather than treating them as stand-alone reforms – the approach seeks to build institutional capacity and improve governance practices alongside physical reconstruction, while recognising that consolidation will depend on sustained implementation over time.

  Honduras also reformed national and local offices to integrate disaster risk management into fiscal management and expand municipal emergency plans. In addition, CREMA contracts also promote better environmental practices in the private and public sectors by requiring contractors to publish Climate Resilience and Risk Management Plans, linking disbursements to measurable resilience indicators and Emergency Action Plans, establishing clear protocols for warnings, evacuations and rapid response.

- **Diversifying finance to scale up resilience.**

  Honduras accessed loans and grants from multiple funding sources (including development banks) and layered rapid-response financial tools to finance post-disaster response, governance improvements and long-term investments. This approach has enabled overcoming financial constraints and responding quickly to urgent needs while simultaneously embedding resilience into future infrastructure.

  In addition to World Bank conventional loans, Honduras also accessed the World Bank Catastrophe Deferred Drawdown Option (Cat DDOs), a contingent credit line that provides immediate liquidity after disasters. The Cat DDOs funded emergency responses against disaster losses and disaster risk management reforms for the Secretariat of State in the offices of National Risk and Contingency Management (COPECO) and of National Risk Management System (SINAGER), including the design of disaster risk financing strategies and municipal emergency plans.

- **Mainstreaming environmental and spatial planning into reconstruction.**

  Roads that are part of the Honduras Sustainable Connectivity project also cross adjacent areas to the 234 km² Cusuco National Park, part of the Mesoamerican Biological Corridor, which provides water for the city of San Pedro Sula (at the core of the Sulla Valley and the country's second most populated city). The reconstruction project integrates a biodiversity and watershed management and protection plan to enhance the long-term stability of the corridor. It considers landscape restoration, biodiversity monitoring, community-based tourism, nature-based solutions and micro-basin management to promote resilience and environmental protection as infrastructure expands. This reflects a forward-looking planning approach in which transport corridors are synchronised with their ecological surroundings, rather than isolated and imposed upon them.

- **Partnering with local communities.**
  - Honduras is promoting initiatives for inclusive community engagement**.** Feeder roads and local interventions will be selected through participatory processes, ensuring that the voices of the local population, including women, indigenous and afro-descendant communities, are considered. Proactive actions supporting the local development agenda, fostered by the projects, also include measures to promote women's entrepreneurship, prevent gender-based violence (GBV) and integrate community priorities into project design. In the Honduras Emergency Recovery and Resilience Project, participatory planning mechanisms were implemented to enable local communities to contribute to site selection and oversight of road maintenance. This approach increases accountability, local ownership and provides employment opportunities, particularly for vulnerable groups.
  - Honduras is also piloting innovative ways to combine public works and social protection with resilience. The Jobs for Urban Youth Through Public Works Pilot Project, implemented in 2024 with the World Bank, provided training for 750 people and short-term employment for 120 people through the public works scheme for urban infrastructure upgrading (World Bank, 2023[11]). The initiative targeted local youth aged 18 to 30, who also benefit from the upgrade of existing infrastructures towards a climate-resilient one. This initiative demonstrates how post-disaster reconstruction can simultaneously address youth unemployment and strengthen infrastructure. Its lessons inform future corridor projects, ensuring that reconstruction also serves as an entry point for local employment and long-term economic opportunity.

Rebuilding bridges in Indonesia

Indonesia is exposed to a wide range of disasters, including floods, earthquakes and volcanic eruptions. Bridges connecting isolated communities are especially vulnerable and, when damaged, can cut off vulnerable populations from basic services and hinder market access and transport. This case study focuses on the rebuilding of four bridges in Indonesia, damaged by a set of disasters occurring from 2014 to 2022: the Sambong bridge in Malang Regency, East Java Province, the Mojorejo bridge in Gunung Kidul Regency, Yogyakarta Special Region Province, the Tuva suspension bridge in Sigi Regency, Central Sulawesi Province and the Amanah bridge in West Lombok Regency, West Nusa Tenggara Province. The four rebuilding cases included infrastructure modernisation with a view to increasing resilience and were grounded on effective public-private collaboration, local community participation and improved co-ordination mechanisms between national and local governments.

Location and background information

Indonesia is particularly exposed to natural hazards. Its tropical climate and equatorial position result in heavy rainfall, alternating with severe droughts during dry seasons. In addition, its location at the convergence of three tectonic plates (the Indo-Australian, Eurasian and Pacific plates) increases the incidence of earthquakes and volcanic eruptions. This geographic vulnerability exposes the country to a wide range of hazards: between 2000 and 2024, 30% of the reported disasters stemmed from geophysical hazards, including earthquakes, tsunamis and volcanic activity and the other 70% are related to hydrometeorological hazards, such as floods, storms and landslides [Authors' elaboration based on (EM-DAT, 2025[12])]. These disasters take a high toll on the country's economy. From 2017 to 2024, the country suffered losses and damage totalling USD 15.3 billion, which represents roughly 1% of its national GDP annually (Government of Indonesia, 2025[13]). They also have a significant impact on infrastructure, with an estimated 75% of infrastructure assets located in disaster-prone zones (Government of Indonesia, 2025[13]; Pacific Disaster Center, 2020[14]).

This case study will discuss the rebuilding of four different bridges after the following disasters:

- **The Mount Kelud volcano eruption in 2014.** The volcano is located in East Java, Indonesia and its last eruption, in 2014, led to 7 deaths, about 100 000 evacuees and damage to buildings and transport infrastructure caused by the volcanic ashes, triggering damage and losses of approximately USD 28 million (Government of Indonesia, 2025[13]).
- **The cyclone Cempaka in 2017.** The disaster hit primarily Java and Bali, leading to 19 deaths, around 15 000 displaced people and damage and losses of approximately USD 15 million across more than 3 500 houses, 28 roads and 22 bridges (Government of Indonesia, 2025[13]; Adinet, 2017[15]).
- **The earthquake, tsunami and liquefaction in the Central Sulawesi Province in 2018**. The 2018 earthquake had a magnitude of 7.5, making it the largest recorded since 2005, leading to over 2 000 deaths and damage of approximately USD 782 million, including disruptions to the transport network, caused by associated tsunamis, landslides and liquefaction (Government of Indonesia, 2025[13]; Government of Indonesia, 2018[16]). Only 37% of the roads were in good condition in 2019, a number 30% lower than the one reported in 2017, one year before the disaster (Government of Indonesia, 2025[17]).
- **The flash floods in the West Nusa Tenggara Province in 2021 and 2022 (West Kalimantan Island).** The floods caused damage and losses of approximately USD 6.7 million (Government of Indonesia, 2025[13]). After the floods in 2022, only 14% of the roads in the province were in good condition, versus a rate of 35% in 2020 (Government of Indonesia, 2025[17]).

Main challenges to be addressed and elements of the rebuilding strategy

Bridges are particularly important for Indonesia, given its unique geography. A sprawling archipelago of over 17 000 islands and home to 70 000 rivers, the country had over 19 000 bridges as of 2023. However, around 28% of them, in the same year, were reported as collapsed, damaged or in critical condition (World Bank, 2025[18]). In fact, between 2014 and 2024, an average of 365 bridges (or 2% of the total) were damaged annually across Indonesia (Government of Indonesia, 2025[17]). Insufficient and non-resilient bridge infrastructure can result in severe isolation for many districts and communities, preventing access to basic services, such as education, health and economic opportunities and markets.

This case study centres on four bridge-rebuilding projects following the disasters mentioned above, each distinguished by unique characteristics, including the type of bridge, the nature of disaster damage and the specific challenges encountered during the reconstruction process (Table 3.3).

Table 3.3. Rebuilding four bridges in Indonesia after natural disasters: a brief overview

	Sambong bridge	Mojorejo bridge	Tuva suspension bridge	Amanah bridge
Location	Malanga Regency, East Java Province	Gunungkidul Regency, Yogyakarta Special Region Province	Sigi Regency, Central Sulawesi Province	West Lombok Regency, West Nusa Tenggara Province
Reconstruction year	2016	2019	2022	2025
Disaster	Mount Kelud Volcano Eruption (2014)	Cyclone Cempaka (2017)	Earthquake and tsunami (2018)	Flash floods (2021 and 2022)
Main rebuilding challenge	Reconnecting the communities across five villages surrounding the Sambong River that were isolated after the disaster	Reestablishing the connection of farmers to the main markets	Reconnecting rural communities that ended up being isolated from main urban centres.	Re-establish the connection of vulnerable communities to the main urban centres.

Source: Authors' elaboration based on the Government of Indonesia (2025[13]).

The following paragraphs present more details about the four bridge-rebuilding projects:

- **The Sambong bridge**, damaged in 2014 by the Mont Kelud Volcano Eruption**,** was critical to connect small communities located on opposite sides of the Sambong River at the Pandansari Village in Malang Regency, East Java Province. During the Mount Kelud volcanic eruption, the bridge was washed away by volcanic lava and remained closed for two years, isolating these communities, cutting off local mobility and access to services. Safe crossing without the bridge remained possible only when the waters were low.

  In 2016, the local government of Malang Regency implemented a USD 602 000 project to rebuild the Sambong bridge. The project was funded with grants from Indonesia's central government to the Malang Regency, processed in collaboration between Indonesia's Ministry of Finance and its National Disaster Management Authority (*Badan Nasional Penanggulangan Bencana,* BNPB) through their Rehabilitation and Reconstruction Funding Mechanism, approved in 2008 to regulate post-disaster financial transfers to local governments. The project introduced a risk-assessment phase as part of the bridge rebuilding planning, in which the regency government conducted a risk assessment in consultations with the local community in Pandansari village, which lies within the primary zone exposed to volcanic mudflows from Mount Kelud. This participatory risk assessment led to the inclusion of new design standards to secure population transport access needs and to the adoption of preventive measures as investments to mitigate damage from potential future lava overflows.
- **The Mojorejo bridge**, destroyed in 2017 by Cyclone Cempaka, is a small-scale bridge, with capacity for both passenger vehicles and trucks, linking isolated communities to main urban areas

and playing an important role in connecting local producers to main markets. After the cyclone, the bridge collapsed, and it remained closed for two years. In 2019, the Government of the Gunungkidul Regency implemented a USD 715 000 project, funded by grants from the central government to the Gunungkidul Regency, to rebuild it.

The bridge-rebuilding was planned to improve transport and increase safety. The traffic capacity was doubled after the rebuilding process, with the construction of a new two-lane bridge. It improved the service to the user, allowing more vehicles to pass simultaneously while reducing congestion and the risk of road accidents.

- **The Tuva suspension bridge**, destroyed in 2018 by the Central Sulawesi Province earthquake, tsunami and liquefaction, was one of the damaged transport infrastructure assets in the region. It is a pedestrian and light-vehicle suspension bridge that connects the Tuva village communities to larger districts, ensuring access for rural producers to sell their harvest products. The bridge was unusable and stayed closed for three years. In 2022, the Government of the Central Sulawesi Province implemented a USD 161 000 project to rebuild the Tuva suspension bridge through risk-informed design.

  The bridge was rebuilt with more resistant materials, replacing the original wooden structure with steel and reinforced concrete. It was also relocated to a safer location with lower flood risk. This project is part of the Programme for Earthquake and Tsunami Infrastructure Reconstructive Assistance (PETRA) led by the United Nations Development Programme (UNDP) and funded by the KfW, Germany's Development Bank. The PETRA was launched in 2019 to support investment in post-disaster recovery in the provinces of Central Sulawesi and West Nusa Tenggara in Indonesia (UNDP, 2024[19]; 2024[20]).
- **The Amanah bridge**, destroyed in 2022 by flash floods, was a pedestrian wooden bridge serving as a vital lifeline for isolated communities in West Lombok Regency. The floods damaged the bridge structure, forcing its closure for three years and cutting off access for vulnerable populations. In 2025, the LAZ DASI (*Lembaga Amil Zakat Dompet Amanah Sejahtera Indonesia*), a local non-governmental organisation, implemented a USD 6 000 project to rebuild the Amanah bridge by:

  Updating building standards and replacing the old wooden bridge with a steel bridge capable of supporting loads up to 1 tonne, improving flood resistance and pedestrian safety. It also enabled expanding the use of the bridge beyond pedestrians to include bikes, motorcycles and other small-scale vehicles, thereby increasing its connectivity capacities.

  The rebuilding required collaboration among diverse public and private actors, including the LAZ DASI, a local non-governmental organisation that led the reconstruction in partnership with the government of the West Nusa Tenggara Province and the Bank Nusa Tenggara Barat (NTB) Syariah, the public regional Islamic development bank of West Nusa Tenggara.

To guide these four bridge rebuilding cases, Indonesia has a governance and policy framework for disaster management and reconstruction based on:

- National Disaster Management Authority (*Badan Nasional Penanggulangan Bencana,* BNPB), with Presidential Regulation No. 8 of 2008 (Government of Indonesia, 2008[21]), was set up in 2008. Before the establishment of BNPB, Indonesia relied on temporary governance structures to respond to specific disaster events, as in the case of Banda Aceh and Nias after the 2004 Indian Ocean Earthquake and Tsunami. The Aceh-Nias Rehabilitation and Reconstruction Agency, for example, was created in 2005 under the national government administration and operated for five years to plan and co-ordinate reconstruction investments and mobilise financial resources (World Bank, 2012[22]). However, the frequent occurrence of natural hazards in Indonesia prompted the country to develop a more permanent structure for disaster risk reduction (DRR), emergency response and rebuilding. The BNPB now co-ordinates the implementation of DRR policies at the national level, while local governments (provinces and regencies/cities) are also mandated to

establish their Regional Disaster Management Agencies (BPBDs) to implement DRR activities in their respective jurisdictions. For lower levels of local governments (districts and villages), there is no mandate to implement a BPBD. Together, the creation of BNPB and the BPBDs represents a strategic shift, in which an emergency response-only approach is replaced by a disaster management cycle view that covers prevention, emergency response, rehabilitation and reconstruction (ADRC, 2025[23]; ADPC and UNDRR, 2020[24]).

- Constantly updated national policies and planning instruments for disasters. Following BNPB's creation, the government published two National Disaster Management Plans, for 2010-2014 and 2015-2019, articulating strategies to mainstream DRR financing and post-disaster recovery and reconstruction (BNPB, 2016[25]). These plans were followed by the implementation of Indonesia's first long-term disaster management plan, the "Master Plan for Disaster Management 2020-2044", approved by the Presidential Regulation No. 87, published in 2020 (Government of Indonesia, 2020[26]; BNPB, 2024[27]). This 25-year master plan is structured in five stages of five years each, with guidelines for disaster management and provisions for periodic policy review and monitoring, control and evaluation. It is the reference framework for disaster management planning across all BPBDs in the country.

  Established co-ordination mechanism across levels of government. Since the 2010s, Indonesia's post-disaster rehabilitation and reconstruction plan explicitly emphasised co-ordination between the national and subnational authorities to restore and upgrade livelihoods and critical infrastructure. In 2017, the country issued specific guidelines for planning and implementation of post-disaster action through the BNPB Regulation No. 5, which sets out policy principles and procedures and defines responsibilities across all government levels (BNPB, 2017[28]). Publishing a recovery plan, immediately after a disaster and in co-ordination among national, provincial, district and municipal authorities, is one of the regulation's mandatory requirements. Recent disasters illustrate this approach. In 2018, for example, a USD 2.4 billion recovery plan for the Central Sulawesi earthquake was prepared and implemented jointly by national and local authorities, covering investments in housing, transport, water and sanitation and other facilities (The United Nations Sustainable Development Group, 2019[29]). In 2017, Cyclone Cempaka caused up to USD 15 million in losses in the Yogyakarta Special Region Province, including damage to houses, roads and bridges, which required a rapid rebuilding taskforce led by the regional disaster agency in co-ordination with BNBP (Government of Indonesia, 2017[30]).

Results, success factors and good practices

The analysis of these four bridge-rebuilding cases in Indonesia enables the identification of the following good practices:

- **Effective mechanism for matching funds and resource transfer between national and local levels of government.**
  - According to Indonesia's Disaster Management regulations, national and regional governments jointly bear responsibility to enable disaster management funds (BNPB, 2007[31]). Permanent transfers from the national government budget to national and local disaster management agencies are a key funding source for this purpose and are prioritised according to the needs of the BNPB and local agencies in alignment with the National Disaster Management Plan (BNPB, 2024[27]). When a disaster strikes, national "on-call" and "contingency" funds can also be mobilised by local governments.
  - To regulate the budget allocation from the central government to provinces and regencies/cities, the government approved in 2008 the Rehabilitation and Reconstruction Funding Mechanism (Government of Indonesia, 2025[13]). It sets official procedures for the demand and prioritisation of grants from the national budget to provinces after natural

disasters. The first step to access these non-permanent transfers is the preparation of a "Post-disaster Rehabilitation and Reconstruction Plan" (R3P) by BNPB and by the local disaster agency. Once this plan is validated, funding request proposals can be submitted to BNPB. Once BNPN approves it (after a financial and technical viability analysis), the agency sends the demand to Indonesia's Ministry of Finance, which consults its director of budget and fiscal balance before issuing a grant agreement with the provinces.

- The Indonesian government also established the Disaster Pooling Fund through its Presidential Regulation No. 75 of 2021 (Government of Indonesia, 2024[32]). Administered by the BNPB, the fund became operational in April 2025 and aims to mobilise additional financial resources from private and public sources as well as national and international donors. These resources are pooled into a single fund with multiple purposes. These resources are used for investments across the entire disaster cycle, channelling resources to pre-disaster investment, emergency response, rehabilitation and reconstruction and disaster-related insurance schemes. This structure ensures that disaster financing is timely and effective while reducing the national fiscal strain (BNPB, 2024[27]; Indonesian National Disaster Management Authority, 2023[33]; The Jakarta Globe, 2025[34])

- **Ensuring community participation and resilience**
  - Indonesia's disaster management regulation requires community participation in infrastructure reconstruction. The BNPB Regulation No. 6, issued in December 2017, governs post-disaster action and includes local community participation among its guiding principles (BNPB, 2017[35]). It explicitly mentions the need to involve communities in the design, implementation and result monitoring of post-disaster interventions. In practice, it formalises approaches that Indonesia has long used to engage local communities in reconstruction. In 2016, during the reconstruction of the Sambong bridge in East Java Province, for example, the local population was actively involved in the project's inception phase, participating in early risk and needs assessments.
  - Indonesia engages local communities from the design to the implementation of reconstruction programmes through consultation, information collection and financial incentives. One example is the reconstruction of the Tuva Bridge in Central Sulawesi Province, carried out in 2022 through the UNDP PETRA Program. The project design was informed by community consultations through a series of public meetings to prioritise and test the project concept. During the implementation phase, the community was further engaged through a cash-for-work programme that employed local workers in reconstruction. This initiative was implemented under the UNDP PETRA Program, which has also led cash-for-work programmes in other areas in the Central Sulawesi Province following the 2018 earthquake, employing a total of 3 500 local workers (UNDP, 2024[20]).

- **Mainstreaming local development into national infrastructure planning.**
  - Promoting bridge reconstruction in small and isolated communities contributes to strengthening national integration and reducing the development gaps between major islands and more remote regions. The bridge reconstruction initiatives presented in this case study received technical or financial support from Indonesia's central government and align with a national post-disaster recovery vision that integrates local development. In the aftermath of the 2018 Central Sulawesi earthquake, for example, the reconstruction of the Tuva suspension bridge (presented in this case study) was not an isolated initiative. Indonesia's Ministry of Public Works and Public Housing has also conducted a specific programme to rebuild 12 bridges in the region, with a focus on reducing isolation from rural and vulnerable communities (Government of Indonesia, 2023[36]).

Rebuilding in Okuma Town, Japan after the 2011 Great East Japan Earthquake: a people-centred and future-oriented approach

The 2011 Great East Japan Earthquake was the strongest earthquake ever recorded in Japan's history, with a magnitude of 9.0 Mw. The earthquake triggered a tsunami, which led to a major nuclear accident at the Fukushima Daiichi nuclear plant, located in Okuma Town and Futaba Town. This made the rebuilding of Okuma Town particularly challenging, as the entire city was fully uninhabitable until 2019, following an evacuation order issued immediately after the accident and some areas remain inaccessible. The rebuilding experience of the town offers lessons about the importance of forward-looking infrastructure planning and of matching it with investments in social policies to restore community confidence, enhance social capital and the town's attractiveness, while offering opportunities for industrial diversification and innovation opportunities.

The strongest earthquake recorded in Japan's history

Japan is one of the countries most exposed to earthquakes in the world. The country is positioned over four tectonic plates (Pacific, North American, Eurasian and Philippine) and on average, one major earthquake with intensity greater than 6 Mw (momentum magnitude scale) happens every 16 months (National Centers for Environmental Information, 2025[37]). About 18% of severe or extreme earthquakes worldwide between 2003 and 2013 occurred in Japan and surrounding areas (Japan, 2021[38])

The Great East Japan Earthquake, on 11 March 2011, was the strongest earthquake ever recorded in Japan's history, with a magnitude of 9.0 Mw. It was followed by a tsunami that triggered a major industrial accident at the Fukushima Daiichi nuclear plant, which accounted for roughly 10% of Japan's installed nuclear energy capacity.

The disaster severely affected the Tohoku region of northeastern Japan, particularly the prefectures of Iwate, Miyagi and Fukushima, impacting its population and damaging infrastructure. Overall, 19 782 people died and economic damages, including infrastructure and housing, supply-chain disruptions and electricity outages, reached up to USD 285 billion (or roughly 5.2% of the country's GDP in 2010) (ECB, 2011[39]; Reconstruction Agency of Japan, 2026[40]).

In Japan, disaster management, including rebuilding, involves all government administrative levels (national, prefectural and municipal), in line with the Basic Act on Disaster Management (Act No. 223 of 1961). Under this framework, municipalities act as the primary bodies for undertaking disaster response and reconstruction, leveraging their proximity to affected populations and comprehensive understanding of local contexts. When disaster strikes, municipalities are responsible for handling warnings, evacuation orders, shelters and rescue operations, among others, while they develop and implement recovery strategies based on local priorities and knowledge during the reconstruction phase. Prefectural governments occupy an intermediary position, responsible for regional-scale interventions, inter-municipal co-ordination and supplementation of administrative capacity. The national government articulates overarching policy frameworks while providing targeted financial, technical and human capital support calibrated to municipal implementation capacities and locally determined priorities.

Main challenges to be addressed

This case study focuses on lessons learned from rebuilding Okuma Town, which was severely impacted by the 2011 Great East Japan Earthquake and the associated nuclear accident. The rebuilding efforts in Okuma Town faced three main challenges:

- **Suspending rebuilding to address safety issues linked to the nuclear plant industrial disaster primarily caused by the tsunami.**

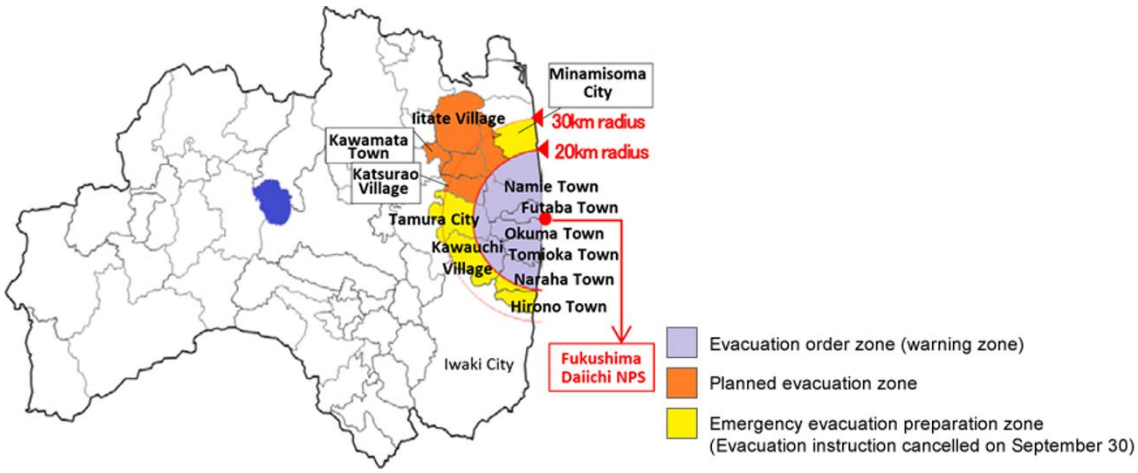
  Located in Fukushima Prefecture, Okuma Town was home to about 12 000 people and of the Fukushima Daiichi Nuclear Power Station, owned by Tokyo Electric Power Company. With a pre-

disaster population of 11 505 residents as of 11 March 2011, Okuma Town recorded 144 fatalities attributable to the disaster as of October 2025 (Okuma Town, 2025[41]).

The earthquake and its associated tsunami in March 2011 hit the town and caused extensive damage to basic infrastructure. It also severely damaged the Fukushima Daiichi Nuclear Power Station, leading to hydrogen explosions at three nuclear reactors and scattering a large amount of radioactive substances. The power plant was fully decommissioned in 2014 (Tokyo Electric Power Company Holdings, n.d.[42]). As a result of this incident, Japan's share of nuclear energy in total electricity generation declined from 32% in 2010 to 2% in 2012 (Arikawa, Cao and Matsumoto, 2014[43]).

A major challenge was to relocate people and re-establish safety. Due to the magnitude of the disaster and safety concerns arising from potential exposure to radioactive materials, mandatory evacuations and displacements took place in parts of Fukushima Prefecture. On 12 March 2011, an evacuation order was issued to isolate a 20 km-radius area from the Fukushima Daiichi Nuclear Power Station (Figure 3.2). This area was classified as a "no-entry zone", necessitating the complete evacuation of the Fukushima Prefecture's municipalities of Tomioka, Okuma and Futaba, as well as partial evacuations of Tamura and Minamisoma cities, Naraha and Namie towns and Kawauchi and Katsurao villages (Fukushima Prefectural Government, 2025[44]). In total, 160 000 people had to leave their homes and move to different towns and all economic activities within the exclusion zone had to be suspended. This unprecedented evacuation enabled the national government to make a large-scale decontamination effort to restore environmental safety levels sufficient for future reconstruction in Okuma Town and surrounding municipalities.

Figure 3.2. Evacuation designated zones in Fukushima, after the Great East Japan Earthquake as of 22 April 2011



Note: A purple semicircle indicates the evacuation order zone (no-entry zone), with mandatory and immediate displacements, up to a 20-km radius from the Fukushima Daiichi Nuclear Power Station. Orange areas had a relocation plan to be set. Yellow areas were advised to prepare to evacuate (Evacuation instruction cancelled on 30 September 2011).
Source: (Fukushima Prefectural Government, n.d.[45]).

- **Managing population return after prolonged displacement.** Rebuilding Okuma meant not only restoring and rebuilding physical infrastructure but also navigating the return of its evacuated population after an exceptionally prolonged absence, necessitating the rebuilding of social capital. The period of the no-entry zone, when installed, was indefinite. Between December 2011 and August 2013, the national government re-implemented a classification system that split areas into "difficult-to-return", "restricted residence," and "preparation for lifting" (Reconstruction Agency of

Japan, 2024[46]). In Okuma Town, restrictions were lifted in certain areas only in 2019 and during those eight years of no-entry, the population had already settled in other cities and the town's older buildings had been severely affected by the disaster and needed major interventions to restore them.

As of 2025, 98% of the Fukushima Prefecture's area, measured in square kilometres, has reopened (Fukushima Prefectural Government, 2025[47]). The closed areas include parts of the municipalities of Futaba, Okuma, Namie, Minamisoma, Tomioka, Iitate and Katsurao closer to the nuclear power station that have remained "difficult-to-return zones" due to radioactive fallout as of March 2025 (Fukushima Prefectural Government, 2025[48]).

- **Identifying new sources of competitiveness and attractiveness for the town, restoring confidence in safety and reinventing the city's image beyond the nuclear disaster.** Rebuilding in Okuma Town had to consider the need to make it an attractive place for its inhabitants to live after several years of displacement and also activating new drivers of growth and diversification of local development opportunities (Shimada, 2024[49]). This diversification effort was also necessary to reinvent the city's image beyond the nuclear activity and update it to be more appealing. The city strategy focused on innovation, education, economic diversification and improved connectivity with other regions in Japan as key components of the rebuilding strategy.

Key elements of the rebuilding strategy

Japan has a well-established framework for rebuilding, including regularly updated regulatory frameworks, building codes and disaster-related measures that complement the 1961 Basic Act on Disaster Management, the national law that regulates central and local governments' roles in disaster management and establishes disaster management plans. However, due to the unprecedented scale of the seismic and nuclear disaster in the devastated Tohoku region, including Okuma Town, the new Act (Act No. 76 of 2011) was enacted to develop dedicated BBB governance mechanisms.

Although Okuma Town had established a nuclear disaster recovery plan in 1962 that assigned evacuation responsibilities to the prefectural government, the framework proved inadequate for the scale of the disaster as the prefectural plan covered only a 10-km radius around the nuclear facility. This limited scope meant that comprehensive inter-jurisdictional co-ordination for Okuma Town had not been previously planned (Cabinet Office of Japan, n.d.[50]; Okuma Town, 2017[51]).

Following two weeks of intensive cross-municipal co-ordination, the town's leadership launched its strategic collective relocation initiative on 25 March, establishing operations in Aizu-Wakamatsu city within the same prefecture on 5 April 2011. This relocation created a temporary community base 100 km from the original site, encompassing not only the immediate evacuation of 2 100 residents but also that of municipal administrative functions, educational institutions and residential infrastructure.

Designing the relocation as a medium- to long-term settlement that would enable residents to settle down rather than a tentative emergency measure, the town selected the relocation destination prioritising the availability of school facilities, the municipality's capacity to accommodate all residents seeking relocation, its accessibility to medical services and its distance from the Fukushima Daiichi Nuclear Power Plant and proximity to Okuma Town (Okuma Town, 2017[51]). This community-oriented long-term relocation enabled Okuma to maintain its institutional continuity and support rebuilding efforts remotely throughout the eight-year evacuation period until partial town resumption in 2019.

Managing rebuilding in the Tohoku region, including Okuma Town, required co-ordinating efforts between the national, prefectural and municipal levels. To this end, the Reconstruction Agency was established in February 2012.

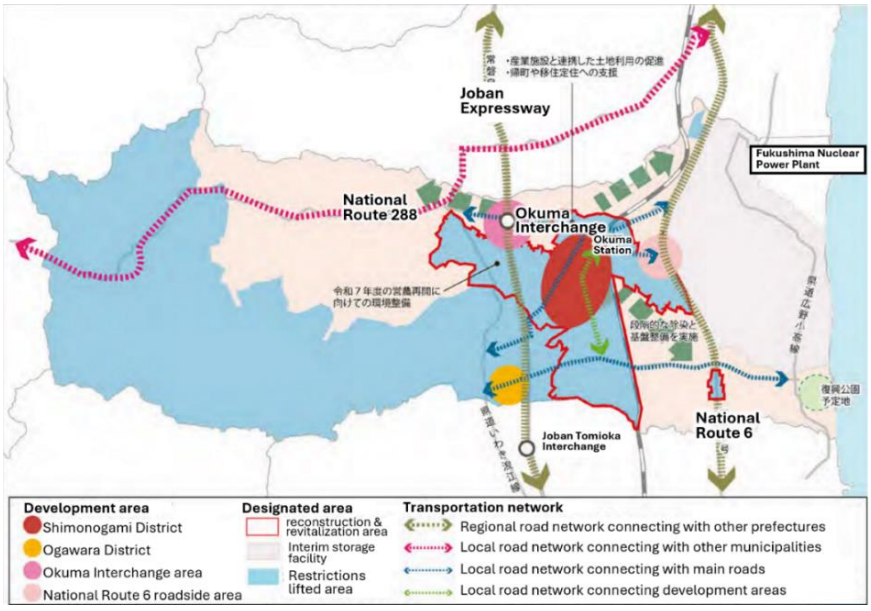
Rebuilding involved an important investment of JPY 19 trillion (approximately USD 245.4 billion) during the initial five-year "Intensive Reconstruction Period", financed through a diversified revenue portfolio encompassing public expenditure rationalisation, divestment of national-owned assets, reforms to special

accounts and civil service compensation structures, enhanced non-tax revenue streams and temporary taxation mechanisms (Reconstruction Headquarters in Response to the Great East Japan Earthquake, 2011[52]). This fiscal architecture incorporated a vertical transfer mechanism in which the national government provided targeted grants to municipalities, enabling local-level capital formation and reconstruction.

In August 2011, Fukushima Prefecture launched a long-term reconstruction plan combining rebuilding of competitiveness-related infrastructure to promote the recovery of the region and ensure a safe return of the population to the area. It was accompanied by orders to lift the imposed access restrictions and measures to attract the population back to the isolated towns. Foreseeing ten years from 2011, the prefecture established "The Vision for Revitalization of Fukushima Prefecture" (Fukushima Prefectural Government, 2011[53]), which led to the formulation of strategic actions and projects for its realisation as "Plan for Revitalization in Fukushima Prefecture" (Fukushima Prefectural Government, 2011[54]). Currently, 99% of the planned infrastructure investments have been implemented, including roads, trains, a port, housing facilities, schools and hospitals (Fukushima Prefecture, 2025[55]).

The municipality of Okuma also drafted a blueprint outlining strategic objectives for future community development in October 2011 and in the following year, the local authority adopted its inaugural five-year reconstruction plan, with subsequent revisions implemented in 2015 and 2023 (Figure 3.3) (Okuma Town, 2023[56]; 2011[57]). The recent plan outlines six urban development initiatives for the period 2024-2034, with a focus on infrastructure, social welfare, learning environment, business incubation, social engagement and sustainability.

Figure 3.3. Blueprint for reconstruction toward 2034 in Okuma town, Fukushima Prefecture



Source: Authors' elaboration based on "Third Reconstruction Plan for Okuma town" in December 2023 (Okuma Town, 2023[56]).

The latest plan adopted a "zoning approach" with the designation of four areas, under the special zoning framework of the Act No. 76 of 2011, to mobilise intergovernmental technical and financial support and plan reconstruction and future urban development (Figure 3.3) (Okuma Town, 2023[56]; n.d.[58]):

- **The Ogawara District**, fully reopened in April 2019, is home to most social development initiatives, including the Okuma Town Hall (opened in May 2019), public housing, retail establishments, community centres, medical clinics and schools.

- **The Shimonogami District**, which lifted its evacuation order in June 2022 and is located in the town centre, was primarily designated for local businesses and start-ups fostering research and development, new technologies, while providing employment opportunities.
- **The Okuma Interchange (IC) area,** which was intended to streamline traffic flow and boost connectivity to other regions.
- **The National Route 6 roadside area,** which was identified as the new business district area where the successful incubated firms in the Shimonogami District could relocate, benefitting from improved transport and accessibility.

Results, success factors and good practices

As of 31 January 2025, Okuma Town's registered population stood at 9 915 people, consisting of 7 798 evacuees residing within Fukushima Prefecture and 2 117 evacuees located outside the prefecture and 878 residents physically in the town (Okuma Town, 2025[59]). While the town holding the nuclear power plant experienced a 14% registered population decline relative to pre-disaster levels (Okuma Town, 2025[41]), this once-abandoned municipality has been steadily regaining residents and revitalising its community through the following critical success factors:

- **Effective time management with a long time-horizon**
  - The time management of the rebuilding in Okuma Town had to be tailored to the unique safety needs associated with the nuclear power plant disaster. This means that while a success factor is usually rebuilding speed with assured quality, a major lesson in this case has been to effectively account for safety issues in time management. The approach included an immediate housing relocation plan, implemented two weeks following the disaster and the formulation of a long-term vision to future-proof the community in the same year as the disaster (2011) and a reconstruction plan that was developed and periodically revised (2012, 2015, 2023), allowing actions to be adapted to evolving circumstances. Given constrained land availability due to radioactive contamination, Okuma Town's reconstruction plan also strategically designated four functionally differentiated development zones to implement phased reconstruction efforts synchronised with the progressive lifting of access restrictions, including redesignating certain difficult-to-return zones as areas where residents willing to return can live after prioritised decontamination measures (Okuma Town, 2024[60]) and visualised the progress that fostered confidence among prospective returnees. Key milestones included: the initiation of educational facility design and the improved transportation accessibility to the town in 2019, coinciding with the complete lifting of restrictions in the Ogawara District and Okuma Interchange area; the launch of an innovation hub in 2022, immediately after the evacuation order in Shimonogami District was lifted; and completion of the educational facility in 2023. These interventions were enabled by the fiscal mobilisation framework established under Act No. 76 of 2011, which provided vertical financial transfers from the national government to municipalities.
  - Timely actions with a long-term vision have been essential for moving forward and fostering residents' hopes for Okuma Town's recovery and the rebuilding of its residents' lives.
- **Investment in forward-looking talent-development facilities as drivers of local revitalisation**
  - The extensive and prolonged housing displacement following the 2011 disaster created barriers to residents' return to the local community. The long-abandoned areas generated uncertainties about the future and hesitancy among former residents to return, creating a critical challenge for community revival.
  - Recognising that human and social capital are fundamental to sustainable recovery, Okuma Town established the public educational facilities (nursery school through junior high school) and the Okuma Incubation Centre (OIC), leveraging participatory planning methods involving younger residents and professionals. It aimed to create compelling reasons for current and

prospective residents and visitors to remain in, relocate to and visit the community (Box 3.1). This focus on human and social capital is key in the recovery strategy for the whole province of Fukushima. In recent years, the launch of the Fukushima Institute for Research, Education and Innovation (F-REI) has aimed to support reconstruction by developing local talent in emerging research areas that can benefit from the region's experience in rebuilding.

- The effectiveness of these measures is evidenced by measurable outcomes: school enrolment grew from 9 students to 90 between 2022 and 2025, and the OIC's network expanded to encompass 140 affiliated entities during the same timeframe. These talent-incubating interventions have contributed to a steady increase in both returnees and new residents, demonstrating that sustainable revitalisation requires the cultivation of knowledge ecosystems that can drive long-term economic resilience.

- **Increasing regional transport connectivity**
  - The town's complete shutdown created cascading effects on regional connectivity. The Joban Tomioka Interchange on the Joban Expressway, a critical link for the region to major economic centres such as Sendai city and Tokyo, closed accordingly, severing Okuma's access to regional economic networks and talent pools, hindering economic recovery (East Nippon Expressway Co., Ltd., 2025[61]). While this interchange reopened in February 2014, its location outside Okuma Town's jurisdiction limited its utility for transporting removed soil and other materials and thus local economic recovery.
  - To accelerate reconstruction efforts, increasing regional transport connectivity was a major priority. The Okuma Interchange construction project was initiated in June 2017 jointly by Okuma Town and East Nippon Expressway Co., Ltd on the Joban Expressway (Reconstruction Agency of Japan, 2017[62]), beginning operations in March 2019 with an investment of JPY 3.7 billion (approximately USD 30.7 million) (East Nippon Expressway Co., Ltd., 2019[63]; Ministry of Land, Infrastructure, Transport and Tourism of Japan, 2015[64]).
  - Direct access to the Joban Expressway connected Okuma Town to metropolitan economies and labour markets, addressing the talent attraction challenges inherent in post-disaster recovery. The improved mobility flows to and from the town synergised with the school and the OIC, creating an integrated ecosystem that facilitates knowledge exchange, supports business development and enables residents to access broader employment and educational opportunities while maintaining residence in Okuma.

Box 3.1. Investing in education and knowledge infrastructure to increase attractiveness in Okuma Town, Japan

The Manabiya Yumenomori School in Okuma town opened in 2023 in the Ogawara District. With an investment of approximately JPY 5.6 billion through a national grant from the Reconstruction Agency of Japan, the facility consolidated former educational institutions from nursery school (daycare) to junior high school into a brand-new single facility, departing from the standardised school-facility design. However, the facility was redesigned through participatory planning involving students, teachers, local and regional educational leaders and experts, spatially seamlessly connecting classrooms and recreational areas to foster cross-generational interaction and collaborative learning. Beginning with merely nine students when the school reopened in 2022 in the relocated town, the enrolment has grown to 65 in October 2024 and 100 in November 2025. The interactive school facility design has played a key role in attracting people back to the city.

A former elementary school building was transformed into the Okuma Incubation Centre (OIC). The OIC opened in July 2022 as a facility to support startups. As of March 2025, only three years after its

launch, 140 entities are affiliated with the OIC, of which 76% are startups and SMEs. The number of users accessing the OIC has increased 252% from 5 213 to 18 379 since the first operation year. Many of the registrants leverage its collaborative environment for R&D and business development, working on diverse projects, such as renewable energy, automobiles, agriculture, healthcare and education.

Figure 3.4. Exterior of the Manabiya Yumenomori School

Source: Provided by the Government of Okuma Town.

Source: Authors' elaboration based on "Regional 'Build Back Better' through Education and Human Resource Development", presentation by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of Japan at the 1st preparatory meeting for the Compendium of Good Practices on Quality Infrastructure 2026 that took place on 24 June 2026.

Rebuilding road corridors and embedding resilience across their asset lifecycle in Malawi after Cyclone Freddy in 2023

Cyclone Freddy in 2023 devastated Malawi's southern region, particularly the Lower Shire Valley, washing away bridges and roads and isolating entire communities. In response, the Government of Malawi launched the Resilient and Strategic Transport Operational Enhancement (RESTORE) Project, funded by the World Bank, to rebuild critical road corridors with climate-resilient standards. The cyclone was not an isolated event but part of a pattern of recurrent shocks, underscoring the urgency of moving from reactive recovery to proactive resilience. RESTORE was designed to link emergency recovery to long-term development while demonstrating the importance of climate-informed design, integrating vulnerability assessments into planning and embedding resilience across the lifecycle of transport asset management. Another innovation was the project's strong governance framework and inclusive community engagement, which ensured that rebuilding efforts were both technically sound and socially equitable.

Location and background information

Malawi is one of the most climate-vulnerable countries in Africa, facing frequent floods, storms and droughts. Since 2010, it has endured 16 major flooding events, multiple storms and droughts, with transport infrastructure repeatedly affected. About 17% of Malawi's road network (4 350 km) is highly vulnerable to flooding, with up to 83% of the network likely to face disruptions, representing an annual value at risk of over USD 160 million – 1.3% of the country's GDP (World Bank Group, 2022[65]). With a population highly dependent on rain-fed agriculture and limited adaptive capacity, climate disasters in Malawi quickly translate into economic shocks and human suffering. Transport infrastructure plays a central role in connecting farmers to markets, students to schools and patients to health centres. When roads are cut off by floods, entire districts can remain isolated for weeks, undermining food security and livelihoods.

The road sector in Malawi remains highly vulnerable to natural hazards with substantial climate-related losses, as seen in the case of Cyclone Freddy in 2023. The cyclone caused severe damage across Malawi, with the transport sector bearing a disproportionate burden, accounting for 62% of total losses (Government of Malawi, 2023[66]). The Lower Shire Valley, a critical agricultural region serving as the nation's food basket, was particularly impacted due to its geography, which is prone to flooding in its flat lowlands and wetlands around the Shire River. The cyclone destroyed bridges and roads in the Lower Shire, effectively severing community connectivity, disrupting regional trade corridors and compounding pre-existing food insecurity challenges. The scale of these losses underscored the urgent need to enhance resilience in Malawi's core road networks. Economic damage exceeded hundreds of millions of dollars, while the loss of connectivity impeded the delivery of humanitarian aid to affected populations. Furthermore, the Lower Shire Valley exemplified the critical nexus between infrastructure resilience and national food security: while the region serves as a vital supplier of maize, sugar and other staples to the national economy, fertile soils and flat terrain render it susceptible to catastrophic flooding. Consequently, building back better in this valley surpasses transport considerations and also contributes to a national imperative linked to food security by ensuring the distribution of local agricultural production.

Main challenges to be addressed

The 2023 Cyclone Freddy revealed that post-disaster reconstruction demands far exceeded previous scales of investment, with damage to roads accounting for over half of total disaster losses. The magnitude of reconstruction needs, after Cyclone Freddy, required scaling up investment and co-ordination across agencies to levels rarely seen before in Malawi's infrastructure sector. The fundamental challenge was to overcome the systematic vulnerability of Malawi's road transport network to climate shocks, due to:

- **Fragility of existing road infrastructure:** In Malawi, only 26% of the national road network is paved (Government of Malawi, 2017[67]). This includes the majority of main roads (21.7% of the

total network), which have been paved; secondary and tertiary roads remain predominantly unpaved. In addition, factors such as inadequate drainage systems, under-capacity of roads and bridges and poor maintenance exacerbate poor road conditions, often rendering entire sections inaccessible and preventing community connectivity.

- **Fiscal constraints leading to the use of low-cost infrastructure solutions and poor maintenance:** Road maintenance operations and investments face severe budgetary limitations, with current expenditure levels falling considerably below the necessary thresholds to sustain infrastructure over time. Malawi's transport sector needs investments of roughly USD 450 million per year in the coming 20 years, a number more than ten times larger than the country's 2014 transport budget (Government of Malawi, 2017[67]). This financial gap resulted in the past in the reliance on low-cost, structurally inadequate design solutions that prove unsustainable under recurrent climatic stress, perpetuating a cycle of degradation and emergency intervention.
- **Limited institutional capacity in the transport sector:** The transport sector exhibits significant institutional capacity bottlenecks, including a fragmented public governance for disaster response and effective resilience planning. Critical knowledge gaps are also reported among the transport sector personnel when it comes to both technical and managerial capabilities, impeding strategic resilience implementation, thus necessitating comprehensive technical capacity development interventions.
- **Weak data and asset condition monitoring systems to anticipate and prevent disaster risks:** Malawi faces a fundamental absence of robust data and infrastructure performance monitoring systems for disaster risk management (DRM). For example, as of 2025, only 28 out of the 100 existing weather stations to monitor climate conditions were fully operational (WMO, 2025[68]). This gap limits the government's capacity for anticipatory risk reduction and proactive disaster prevention.

Key elements of the rebuilding strategy

Malawi's approach to road infrastructure development has undergone a substantial policy reorientation in recent years, with resilience as a foundational element (Government of Malawi, 2025[69]). Whereas the pre-existing disaster governance framework predominantly emphasised low-cost solutions that could not withstand recurrent shocks, its current one has increasingly pivoted toward risk-informed infrastructure planning and investment. In January 2021, Malawi's National Planning Commission launched Malawi 2063, a national development blueprint plan articulating the vision of transforming the country into an inclusively wealthy, self-reliant, industrialised upper middle-income nation by 2063, in which infrastructure, such as energy and transport, is listed as a key enabler. Malawi 2063 explicitly calls for a competitive and climate-resilient infrastructure base to stimulate domestic investment, attract foreign direct investment (FDI) and boost productivity. This long-term vision is operationalised in the transport sector through specific sectoral frameworks co-ordinated by the Ministry of Transport and Public Works, including the 2015 National Transport Policy and the National Transport Master Plan (2017–2037) (Malawi National Planning Commission of Malawi (NPC), 2020[70]; 2021[71]; Government of Malawi, 2017[72]). The National Transport Master Plan (2017–2037) presents a 20-year portfolio of investment projects summing up USD 9 billion and integrates resilience by mandating Climate Risk and Vulnerability Assessments for all major transport projects, the revision of design standards, the review of the National Transport Policy to strengthen the call for resilience and initiatives to mainstreaming climate risk into district planning and the review of the National Transport Policy to strengthen the call for resilience.

In this context, the Ministry of Transport and Public Works of Malawi launched the Resilient and Strategic Transport Operational Enhancement (RESTORE) Project, with support from the World Bank, to enhance climate-resilient and safe transport connectivity in the Lower Shire by 2030. The initiative will improve

access to resilient and sustainable road transport through physical investments in the Lower Shire Valley and institutional reforms, including:

- **The upgrade of 150 km of roads to resilient standards.** The project will rebuild and improve 90 km of the M1 Road (Thabwa–Chikwawa–Bangula), a vital trade corridor that serves main agriculture hubs, including the Chikwawa district in the Lower Shire Valley. The intervention follows new climate-resilient standards, like elevated alignments, drainage and safety features. This intervention reduces flood risks and ensures all-weather connectivity. As part of the project scope, Malawi will also upgrade 60 km of the S152 Road (Thabwa–Chitseko–Seveni) – that connects rural communities to main service hubs in the Lower Shire Valley – with resilient design standards, improving rural access and trade opportunities. In addition, other interventions are also expected to improve watershed and catchment management, including erosion control, sediment removal and riverbank stabilisation to protect transport assets.
- **The replacement of vulnerable bridges.** It includes four bridges along the M1 and one major crossing on the S152, both updated with modern, climate-resilient designs to safeguard lifeline connectivity.

Results, success factors and good practices

The RESTORE Project demonstrates how proactive design, stakeholder engagement and institutional reforms can transform disaster response into an opportunity for resilience. Although the resulting reconstruction projects are at the preparation or early implementation stages and results are not available, the following elements stand out:

- **Utilisation of vulnerability assessments and data-driven tools for effective decision-making**
  - The RESTORE project relied on a detailed Road Vulnerability Assessment (VA) tool to guide investment prioritisation, having as a reference the impact of Cyclone Freddy (2023) and other previous climate disasters. It mapped hotspots of erosion and flooding, such as under-capacity bridges and low-lying sections of the M1 and S152 roads, to ensure resources were allocated to the highest-risk areas. In practice, the VA focused on identifying the sections of the M1 and S152 roads most at risk. Given the complex hydrology of the Shire River and its tributaries, hazard analysis used multiple return periods (1/20, 1/100, 1/400 years) to assess both current and future risks while structural inspections of bridges, culverts and embankments evaluated their ability to withstand high water flows and sedimentation. Findings highlighted critical vulnerabilities on the M1 and S152 roads, with inadequate culverts and bridges contributing to erosion and flood risk. This evidence-based approach also unveiled implementation risks and avoided the pitfalls of politically driven, low-impact investments.
  - The VA applied forward-looking climate resilience projections to redesign key road segments using a multi-resolution exposure mapping approach. At the macro level, the project design examined the Shire basin's hydrological connections, while regional analysis focused on flood extents in tributaries and confluence areas. Locally, high-resolution flood hazard maps using Digital Terrain Models (DTMs) simulated inundation depths and velocities at specific road segments, pinpointing structural weaknesses. Based on these projections, embankments were raised, culverts enlarged, and bridges reinforced with standards able to withstand 50- to 100-year flood events. This ensures roads remain passable even during severe weather, significantly reducing disconnection days for local communities. The project also used GIS-based flood modelling to evaluate interventions. By embedding resilience into the engineering standards themselves, Malawi is shifting from reactive repairs to preventive, long-term protection of infrastructure.
  - The VA also informed a Cost-Benefit Analysis (CBA) to monetise the costs and benefits of the selected interventions and better reflect the dynamic conditions of the Shire and Ruo River

valleys. The VA relied on a CBA that considered various design and hazard return periods, integrated climate scenarios into capital and operating expenditures. Selecting and monetising losses – direct, indirect, tangible and intangible – was challenging, but five key benefit layers were chosen: land use/cover, population, health/education/accidents, trade logistics and emergency relief. Additional benefits included reduced greenhouse gas emissions and lower O&M costs under a “no intervention” scenario. Data sources included nightlight data, satellite imagery, census data and local traffic information, all visualised in a GIS environment. By quantifying benefits such as avoided flood damage, reduced transport disruptions and lower greenhouse gas emissions, RESTORE built a strong case for investing in resilience. This analytical rigor improved prioritisation attracted donor confidence and created accountability mechanisms for future results monitoring with donors and other partners.

- **Risk-informed and inclusive planning through multi-stakeholder engagement**
  - The RESTORE Project's VA involved key stakeholders such as the Ministry of Transport and Public Works of Samoa, the Department of Water Resources of Samoa, the National Road Authority, local district councils and international partners like the World Bank and Japan's Disaster Risk Management programme. Their collaboration ensured the VA followed international climate resilience standards while integrating local priorities and capacities. The project is Malawi's first practice to fully integrate climate resilience into asset management across the lifecycle.
  - Furthermore, unlike traditional road projects that prioritised motorised traffic, RESTORE explicitly considered the needs of pedestrians, school children and women traders. Markets were upgraded with secure stalls, storage and sanitation facilities. Footpaths, pedestrian crossings and school safety zones were incorporated into road designs. This broadened the project’s benefits beyond transport efficiency to social inclusion and equity, giving vulnerable groups a greater voice and protection in resilience planning.
- **Leveraging institutional reforms and capacity building**
  - The project introduced comprehensive training programmes for engineers, technicians and university students, moving beyond ad-hoc sessions to structured knowledge transfer. One example was specific capacity-building initiatives for local officials and engineers to ensure the best use of the newly introduced climate risk assessment tools and methods to diffuse their utilisation. Financial support from the Global Center on Adaptation (GCA) – an international organisation founded by the Netherlands, the United Nations Environment Program, Japan and the Philippines to accelerate action on climate change adaptation – helped update design standards and foster systematic capacity building, ensuring that resilience is embedded not just in individual projects but across the transport sector.
  - RESTORE deployed a new Road Asset Management System (RAMS), managed by Malawi’s Roads Authority, to enhance the management of transport infrastructure by integrating climate resilience information. RAMS provides a data-driven approach to asset monitoring and maintenance, supporting long-term resilience and efficiency in road management. The system organises and provides real-time road asset performance data and information, which allows the prioritisation and optimisation of budget allocation for maintenance works and resilience monitoring.

Adapting governance and tools for rebuilding in Nepal after the 2015 Gorkha Earthquake

The 2015 Gorkha Earthquake in Nepal was a devastating one, inflicting a high human toll and large economic damage. Nepal reacted quickly, putting in place a national rebuilding plan that mapped the investments needed to ensure recovery and adapted its governance and tools to switch from short-term recovery to long-term rebuilding. This case study focuses on the elements of this governance reform and zooms in on two major reconstruction projects: seismic reinforcement of the Sindhuli Road, a major transport artery across the country and the implementation of an inclusive housing reconstruction programme. It highlights the critical roles of international co-operation, local capacity building in resilient reconstruction techniques and ensuring social inclusion and community empowerment.

Location and background information

Nepal is vulnerable to seismic hazards, experiencing at least six significant earthquakes since the 1930s that were classified as major or strong in severity, i.e. with a magnitude greater than 6.9 Mw. In 1934, an 8.1 magnitude earthquake devastated the Kathmandu valley, killing one-third of its population. Subsequently, major earthquakes in 1980, 1988, 2011 and 2015 continued to inflict severe damage on both the economy and communities. This is because the country lies at the boundary of the Indian and Eurasian tectonic plates, making it prone to seismic activity (Government of Nepal, 2015[73]).

The Gorkha Earthquake struck Nepal in April 2015 with a magnitude of 7.8 Mw, claiming many deaths and severe physical infrastructure damage across the country. With its epicentre about 80 km northwest of the capital, in Barpak village, Gorkha District, the disaster affected 31 out of Nepal's 75 districts (14 severely damaged), including the greater Kathmandu metropolitan area. The earthquake's impact was devastating: 8 962 people died, while one third of the country's population was otherwise affected. About USD 7 billion of economic losses were recorded (equivalent to 29% of the 2015 national GDP). In terms of infrastructure, about 50% of the damage was recorded in housing and 34% in competitiveness-related infrastructure, including transport and energy systems (Government of Nepal, 2015[73]). Moreover, industries were affected, notably the tourism sector, followed by commerce and agriculture. These disruptions threatened to deepen Nepal's socioeconomic inequality. While approximately 20% of the population lived below the poverty line in 2022 (World Bank, 2025[74]), before the disaster, this figure stood at 25.2% (FY 2010-2011). The disaster was estimated to push an additional 2.5%-3.5% of the population into poverty in FY 2015-2016 (Government of Nepal, 2015[73]).

In response, the government of Nepal announced a USD 8.4 billion five-year post-disaster recovery plan equivalent to 34.4% of the country's 2015 GDP (National Reconstruction Authority of Nepal, 2016[75]). The recovery activities prioritised housing and social sectors (including health, education, social protection and culture), which accounted for 44.9% and 28.6% of the identified needs, respectively (Table 3.4).

Table 3.4. Nepal's reconstruction plan after the 2015 earthquake: Financing requirements by sector

Sector	Total investment (USD million)	Share of total (%)
Housing	3 762	44.9
Health, education, social protection and cultural heritage	2 397	28.6
Agriculture, commerce & industry and *tourism*	388	4.6
Competitiveness-related Infrastructure *(Communications, electricity & renewable energy and transport)*	448	5.3
Other infrastructure	212	2.5
Other investments	1 170	14
Total	8 377	100

Note: Categories in the original plan have been aggregated to improve readability and identify competitiveness-related infrastructure investments as a group.
Source: Authors' elaboration based on National Reconstruction Authority (2016[75]).

Main challenges to be addressed

Given the magnitude of the damages, Nepal needed to achieve two critical objectives: reconstructing housing at scale with seismic resilience for affected populations and strengthening competitiveness-related infrastructure, particularly transportation networks, to withstand future hazards while supporting economic recovery. These imperatives demanded substantial investments, governance reforms and technical capacity building and Nepal had a fragmented disaster governance framework compounded by fiscal constraints, underdeveloped logistical systems and insufficient engineering skills at the local level:

- **Fiscal and governance constraints.** To close infrastructure gaps, Nepal needed to invest 8.2%-11.8% of GDP per year until 2020 (Asian Development Bank, 2015[76]). The post-disaster investment needs imposed significant additional fiscal burdens and required complex co-ordination of domestic and external funding sources. Nepal successfully secured pledges and agreements from 24 donors (excluding technical assistance), including bilateral and multilateral partners, development banks and development agencies, to finance its reconstruction efforts (National Reconstruction Authority of Nepal, 2016[77]). Furthermore, the pre-existing disaster governance framework, driven by the Natural Calamity Relief Act of 1982, emphasised emergency response but lacked multi-year and cross-sectoral rebuilding mechanisms.
- **Logistical challenges due to landlocked geography and inadequate infrastructure**. Nepal's geographical isolation makes it more difficult to undertake reconstruction efforts. In addition, the country suffers from poor infrastructure: the country ranked 132nd out of 147 countries for infrastructure provision and quality in the 2015 Global Competitiveness Index (Sapkota, 2015[78]). Road networks, in particular, those important for carrying out reconstruction quickly are often limited and inefficient. As a result, access to affected populations was challenging, delaying the delivery of materials and substantially increasing the overall cost and complexity of rebuilding operations.
- **Insufficient engineering skills for resilient reconstruction at the local level**. The shortage of a qualified and trained workforce equipped with knowledge of resilient construction techniques had amplified the disaster's initial impact and complicated reconstruction. Housing demonstrated vulnerability due to low-strength construction materials – including stone, mud and unreinforced bricks – which lack seismic resistance. For transportation infrastructure, while some roads had earthquake- or flood-resistant structures, these proved inadequate for a 7.8 Mw earthquake, as for example with the Sindhuli Road, a 160-km highway connecting Kathmandu with the Eastern Terai region (JICA/Nippon Koei Co., Ltd., 2018[79]).

Key elements of the rebuilding strategy

The five-year post-disaster recovery plan, managed by Nepal, reformed its disaster governance to better respond to the needs and challenges emerging from the 2015 Earthquake and unveiled a targeted reconstruction investment plan. Key measures included:

- **Adapting disaster governance to deal with a long-term rebuilding challenge**: Nepal created a new government authority, the National Reconstruction Agency (NRA), in December 2015, designated to lead and manage the post-earthquake recovery. The following year, based on the Post Disaster Needs Assessment (PDNA), the agency established Nepal's 5-year Post-Disaster Recovery Framework (PDRF), which detailed policy, institutional and implementation frameworks and a rebuilding investment plan.

  The disaster also catalysed the creation of a holistic legislative framework for disaster risk reduction (DRR) and disaster risk management (DRM). Although the Natural Calamity Relief Act of 1982 was already in place, it focused exclusively on disaster response and lacked long-term post-disaster recovery mechanisms. In response, the nation enacted the Disaster Risk Reduction and Management Act in 2017 (subsequently amended in 2019), replacing the previous legislation to enable overall disaster management. This new Act aims to implement co-ordinated and effective DRR and DRM actions to public, private and individual resources, natural and cultural assets, as well as physical structures from both natural and human-induced disasters. The Act established the National Disaster Risk Reduction and Management Authority (NDRRMA), under the Ministry of Home Affairs, as a central co-ordinating body, absorbing the NRA's former responsibilities. Additionally, it also formally established the Disaster Management Fund – a centrally managed collective financial resource designated exclusively for disaster response and management operations, overseen by the Auditor General.

  Governance transformation extended to housing as well. In August 2020, the Ministry of Urban Development (MoUD) updated the Nepal National Building Code (NNBC) 105: 1994 Seismic Design of the Buildings in Nepal primarily to incorporate findings from the 2015 earthquakes and enhance building resilience. This marked the first-ever revision of the building code since its inception. Compliance with this building code is enforced by the Housing Recovery and Reconstruction Platform (HRRP), launched in December 2015 to facilitate technical co-ordination for the NRA, MoUD, the Ministry of Federal Affairs and Local Development, Central Level Programme Implementation Units and other government authorities and partner organisations.
- **Reinforcement of roads to withstand major earthquakes.** The reconstruction of the 160-km Sindhuli Road exemplified this priority, serving as a backbone of the nation's transportation and logistics connecting the capital Kathmandu with the Eastern Terai region near the Indian border (JICA/Nippon Koei Co., Ltd., 2018[79]). This project was particularly emblematic, as the entire 160 km stretch was inaugurated in March 2015 – just months before the earthquake – following a 20-year construction programme. However, just one month after the road's completion, the earthquake caused road cracks and partial collapse at 25 locations along the route. While 12 of these were urgently repaired starting in June 2015 to ensure continued access for relief supply transportation, ongoing torrential rains threatened to accelerate erosion and significantly increase collapse risk beyond the road's design resilience (Ishimoto, 2023[80]).

  Given the circumstances, Nepal's PDRF positioned the highway rebuilding as one of the priority recovery programmes, undertaken by the Ministry of Physical Infrastructure and Transport of Nepal in co-operation with Japan International Cooperation Agency (JICA) through official development assistance (ODA). With a total investment of JPY 1.081 billion (JPY 4 million from Nepal and JPY 1.077 billion from Japan), the road reconstruction project began with preparatory surveys in 2017 and was completed in early 2021. This intervention included restoration and resiliency improvements, especially in slope stabilisation and retaining walls to reinforce prevention against

landslide or soil movement capable of withstanding earthquakes, comparable to the 2015 earthquake magnitude (Ishimoto, 2023[80]). In addition, JICA provided technical assistance to Nepal's road department officials in concrete materials and bridge design, strengthening institutional capacity building for sustainable road maintenance.

- **Implementing a community-driven and inclusive housing reconstruction programme.** Given the type and scale of damages, about half of Nepal's post-earthquake reconstruction investments went into private housing. In support of this policy, the Nepal Earthquake Housing Reconstruction Multi-Donor Trust Fund (MDTF) was developed in October 2015, administered by the World Bank, initially with the support of the US Agency for International Development (USAID), the Swiss Agency for Development and Cooperation (SDC) and the governments of Canada and later the United Kingdom, which joined in November 2016. Nepal has also received financial support from neighbouring countries, like India and the People's Republic of China. The majority of MDTF resources are assigned to co-financing the World Bank's Earthquake Housing Reconstruction Project for Nepal (EHRP), initiated in January 2016, which cumulatively resulted in the rebuilding of about 90% of the almost 800 000 damaged houses.

  EHRP is characterised by a homeowner-driven approach, in which communities lead the rebuilding process with technical and financial support from the government and partners to help the affected residents rebuild resilient housing units themselves. The approach allows beneficiaries the discretion to determine the typology and size of houses according to their needs.

  To build local capacity, the World Bank trained about 4 000 masons across 12 districts and provided orientation on seismic-resilient reconstruction to 57 140 houseowners. At NRA's request, JICA also conducted training for 711 house owners and 282 masons between October 2015 and June 2016 (JICA et al., 2019[81]). The Technical Working Group established by NRA developed comprehensive standards, guidelines and manuals for homeowners, masonry and inspection engineers to facilitate resilient reconstruction.

  Each beneficiary received USD 3 000 in three instalments based on reconstruction progress: the first tranche upon enrolment, the second at an intermediate stage and the third upon satisfactory completion verified by NRA-qualified engineer inspection to ensure compliance with building codes and technical guidelines. These activities and associated documentation were digitised and managed through a centralised Management Information System (MIS), developed for NRA and relevant ministries. The system enhanced efficiency, transparency and accountability while facilitating grant disbursements through integrated banking information.

  This project also emphasised women's engagement and empowerment in reconstruction. Although women represent only 10% of the 54 000 Nepal's trained masons, they comprised 20% of the 755 masons and 8% of over 3 600 engineers employed for the housing rebuilding activities. Additionally, while all beneficiaries received financial benefits through their bank accounts, 70% opened new bank accounts to receive the grants, with 30% of these new account holders being women, contributing to financial inclusion.

Results, success factors and good practices

Although the country suffered from financial constraints and governance limitations as well as inadequate infrastructure and shortages of qualified human resources, Nepal's successful reconstruction stemmed from three core components:

- **Governance update to address long-term rebuilding.**
  - Despite the absence of pre-existing frameworks, Nepal quickly reframed new national governance structures for disaster prevention, response and reconstruction. The NRA, created in 2015, published comprehensive rebuilding investment plans embracing BBB principles and co-ordinated multiple reconstruction projects. As reconstruction needs diminished, the

NDRRMA succeeded the NRA in 2017, ensuring institutional continuity and long-term disaster preparedness.

- Critically, the central government executed emergency measures in parallel rather than following a typically linear process. The National Planning Commission of Nepal urgently consolidated the PDNA just within six weeks after the disaster, providing an essential foundation for the government's rebuilding strategy. Facing significant funding gaps, Nepal secured USD 4.1 billion in pledges at the International Conference on Nepal's Reconstruction (ICNR), just three months after the disaster. Furthermore, the MDTF, administered by the World Bank, was created in October 2015 to channel development assistance from Switzerland, Canada, the United Kingdom and the United States – even before the legislative funding scheme, the Disaster Management Fund, was launched.

- **Increasing future preparedness by updating guidelines and investing in training and compliance inspection.**
  - Training homeowners and engineering personnel in resilient construction standards and methods efficiently decentralised rebuilding efforts while fostering community resilience. The government published at least nine manuals and catalogues, including design catalogues for earthquake-resistant housing reconstruction, training manuals for engineers and construction workers and technical inspection guidelines for housing reconstruction. Building on these resources, Nepal organised comprehensive training programmes for construction workers, engineers and architects. In total, around 3 600 professionals were trained on advanced concepts in earthquake-resistant design and construction, technical inspection rules and techniques to correct damaged structures. Furthermore, third-party expert oversight and inspections ensured compliance with technical standards, thereby strengthening overall structural resilience and quality assurance.
  - International development assistance equally played a pivotal role by disseminating international resilience practices and strengthening the capacity of the local construction sector. Nepal had the financial support of 28 development partners (including technical assistance) while 445 national and international NGOs contributed to reconstruction initiatives. The post-disaster reconstruction of the Sindhuli Road benefited from the financial and technical support of JICA, which also helped transfer engineering capability to improve the road's earthquake resistance.

- **Prioritisation of social inclusion to reduce gender disparities.**
  - The owner-driven housing reconstruction initiative, awareness initiatives and orientation sessions exemplify an all-level-of-society participation model in Nepal's rebuilding taskforce. House owners were mobilised to engage with reconstruction efforts through technical and financial assistance, following new building and resilience regulations. These initiatives were incentivised by government cash transfers, which were provided to homeowners in return to adhere to the national housing reconstruction programme. Through this embedded system, the community would be able to deepen their understanding of prevention against disruptions, while increasing the individual's resilience literacy.
  - This approach deliberately addressed gender inequality, fostering community inclusion and achieving notable progress in the male-dominated construction sector. Recognizing that 26% of households among the over 715 000 eligible beneficiaries identified in the 14 most-affected districts were headed by women, the MIS facilitated equitable access to housing grants for marginalised and vulnerable groups, especially women. This initiative resulted in many of the eligible female beneficiaries opening bank accounts, advancing financial inclusion and economic empowerment.

Rebuilding river flood defences in Peru following the 2017 El Niño event

Peru is frequently hit by heavy rainfall and flooding due to El Niño. The coastal city of Trujillo, in the La Libertad region, a local agricultural and logistics hub and the third most populous city in Peru, suffered from heavy disruptions during the 2017 and 2023 El Niño events. Peru's National Infrastructure Authority (ANIN), which operates under the Presidency of the Council of Ministers, oversees the national infrastructure reconstruction response to natural disasters aligned with the objectives outlined in the country's 2050 National Development Strategic Plan. As part of this response, the agency presented in 2023 a package of integrated solutions to upgrade the flood defence infrastructure for two seasonal ravines near Trujillo (San Carlos and San Idelfonso), including the use of nature-based solutions and the construction of tunnels, dikes and dams to manage water flows. Rebuilding physical infrastructure was accompanied by reforms in public procurement tailored to post-disaster reconstruction needs and with international partnerships tailored to capacity building in project management and engineering to improve resilience and prevention capacity.

Location and background information

The Peruvian coast along the Pacific Ocean receives heavy rainfalls and is prone to flooding due to its exposure to the El Niño phenomenon. El Niño is a naturally occurring climate event that raises sea surface temperatures when warm Pacific waters are pushed toward the South American coastline by usually strong winds. These elevated temperatures trigger heavy rains and tend to occur every year. As a result, regions exposed to the Pacific winds in Ecuador and in Northern Peru – such as Cajamar, Lambayeque and La Libertad – experience heavy rains and flooding, despite their normally arid conditions.

Extreme El Niño episodes have become more frequent since the 1980s and are projected to double in the 21st century (IPCC, 2019[82]). During the 2017 El Niño, Peru's north-central region experienced one of the most severe rainfall events in its meteorological record, with precipitation exceeding the 90th percentile of historical data between January and March, accompanied by sea surface temperatures reaching 5-6 °C above average (French et al., 2020[83]). More recently, in 2023, a strong coastal El Niño of comparable magnitude, ranking among the five strongest recorded since 1950, similarly hit northern Peru, resulting in severe flooding, river overflow and significant disruption to transportation infrastructure. Historically, such events disproportionately affect agricultural and fishery activities, with production declining by an estimated 11% and 70%, respectively, during each disaster period (IMF, 2024[84]).

The 2017 and 2023 coastal El Niño disruptions considerably affected the Peruvian GDP and caused extensive infrastructure damage, especially in the northern region, including the department of La Libertad. In 2017 alone, estimated damage for the whole country reached USD 3.1 billion, equivalent to 1.5% of the national GDP (Banco Central de Reserva del Perú, 2017[85]). Up to 11 761 km of roadways and 481 bridges were damaged (Congreso de la República, 2017[86]). Peru's northern region was particularly affected, including La Libertad, where 1.9 million individuals (23% of the population) were impacted and numerous economic activities and competitiveness-related infrastructure sustained flood damage. This was particularly the case in the city of Trujillo, the capital of the department, home to almost 800 000 people – the third most populous city in Peru – and a hub for agriculture (sugar, asparagus and avocados) and mining logistics.

Main challenges that needed to be addressed

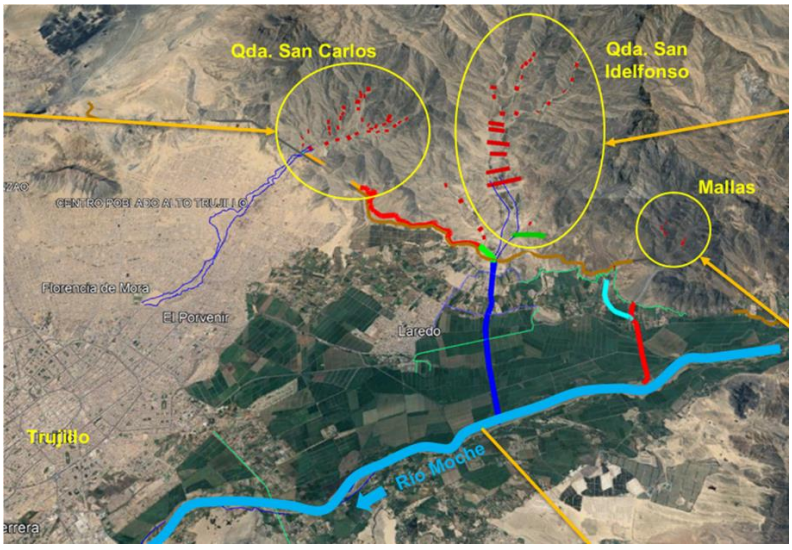
Upgrading flood defences around the city of Trujillo faces the following challenges:

- **Overcoming fragmented governance structures for infrastructure development.** Enhanced policy co-ordination between sub-national and national governments is essential for a more effective infrastructure investment and for reducing project implementation delays. As of December 2024, 87% of paused public investments in Peru were under municipal or regional government jurisdiction (Government of Peru, 2025[87]). Moreover, in 2023, 72% of public entities in the country

lacked disaster risk reduction (DRR) plans despite the previous publication of a national DRR policy (Government of Peru, 2023[88]). Co-ordinated responses are particularly critical to advancing El Niño reconstruction efforts: while local and regional governments face financial constraints that impede project implementation, these entities possess comparative advantages in identifying local needs, providing technical support and operating facilities following reconstruction completion.

- **Integrating topographic risks into flood prevention planning.** Trujillo is located in a coastal valley in Peru, at the foothills of the Andes. The city is surrounded by two seasonal ravines (San Carlos and San Idelfonso), natural watercourses formed by erosion that carry water from the nearby mountainous areas to lower elevations, leading to extreme flooding during periods of heavy rains (Figure 3.5). These flows must be effectively redirected to the city's main river, the Moche River, necessitating interventions at high elevation.

Figure 3.5. San Carlos and San Idelfonso ravines in Trujillo city, La Libertad



Source: National Infrastructure Agency of Peru, presentation at the 2nd preparatory meeting for the Compendium of Good Practices on Quality Infrastructure 2026 that took place on 10 July 2025.

Key elements of the rebuilding strategy

The rebuilding of flood defences in Trujillo formed part of a nationwide effort to manage recurring flood impacts and extreme precipitation events, particularly in its northern region.

In 2017, Peru issued the Comprehensive Plan for Reconstruction with Changes (*Plan Integral de Reconstrucción con Cambios,* PIRCC*)*, announcing investments of approximately USD 6.8 billion, for the period 2017 to 2020, in housing, education, health, sanitation, transportation and agriculture across 13 regions and 292 municipalities. PIRCC introduced important changes with respect to the previous practice of managing reconstruction in Peru, adopting a comprehensive, nationwide plan (instead of an approach that was commonly centred on project-based rebuilding) and making it legally binding for all levels of government. It institutionalised oversight with the establishment of the Authority for Reconstruction with Changes (*Autoridad para la Reconstrucción con Cambios*, ARCC). The ARCC ceased its operations on 31 December 2023, and was succeeded by the National Infrastructure Authority (*Autoridad Nacional de Infraestructura*, ANIN), which operates under the country's Presidency of the Council of Ministers.

ANIN currently oversees the national infrastructure reconstruction response to natural disasters, including investments in disaster-resilient infrastructure. The agency operates in alignment with the objectives

outlined in the 2050 National Development Strategic Plan (*Plan Estratégico de Desarrollo Nacional al 2050*), launched in 2023 by Peru's Council of Ministers and by the National Centre for Strategic Planning (*Centro Nacional de Planeamiento Estratégico,* CEPLAN). The Plan highlights the need to address the "permanent vulnerability to disasters due to poor disaster risk management in the territories" and proposes policy actions to repair post-disaster damage, incorporate resilience into infrastructure projects and introduce disaster risk management in decision-making at all levels of government. To advance on these objectives, ANIN currently manages 234 projects in its portfolio totalling USD 12.3 billion across sectors such as health, education, agriculture, river flood protection and transport.

In the city of Trujillo, ANIN implements an integrated resilience-enhancing solution to upgrade the flood defences. The agency is taking the lead in executing the reconstruction, with financing from the national government and in collaboration with relevant ministries and with the regional government of La Libertad, which identifies needs, provides technical support and will be responsible for maintenance. With an estimated total investment of USD 351 million in the San Carlos and San Ildefonso ravines, the project relies on two components as an integrated solution (Government of Peru, 2025[89]):

- **Construction of river flood defences and dikes:** The project, as of July 2025, had already delivered 17.2 km of river defences, including 61 transverse dikes of varying lengths, designed to impede and redirect water flows while reducing flow velocity and 14.6 km of conveyance channels to redirect riverine overflows toward designated lower-risk areas, with enhanced drainage infrastructure. The dikes have been designed by incorporating both data on historical water flows and estimations through specialised modelling on the potential changes caused by climate change. In addition, a 1 510-meter tunnel in the San Idelfonso ravine and five mesh barriers from steel to retain the sediment were built.
- **Nature-based solutions:** Reforestation initiatives in upper watershed areas have been undertaken to achieve slope stabilisation, enhanced rainfall infiltration and sediment retention, thereby reducing erosion and sediment transport to downstream watercourses. These measures reduce hydraulic pressure on rebuilt infrastructure and decrease the likelihood of flooding during heavy rains.

According to ANIN, the project is expected to be completed in December 2026, and its engineering design and specifications were published in 2023. Upon completion, it will be transferred to the public water operator of La Libertad, which will undertake future operations and maintenance.

The investments to upgrade flood defences in the city of Trujillo were complemented by additional municipal government efforts for better-informed DRR measures. After the 2017 El Niño event, the implementation of an Early Warning System (EWS) had been identified as a critical need by local governments. In 2022, the EWS became operational, supported by development co-operation, namely the SECO (Swiss State Secretariat of Economic Affairs) and the GIZ (German Agency for International Cooperation). The EWS enables SEDALIB (*Servicio de Agua Potable y Alcantarillado de La Libertad*) to obtain hydrological and operational data through a telemetry system that provides continuous real-time monitoring. Additionally, a web-based platform facilitates access to operational information from the local potable water treatment plan. This information enables water utility personnel to conduct analytical assessments, generate monitoring reports and develop preventive action proposals. Trujillo also implemented a DRR plan for the period 2018-2021, updated in 2023.

Results, success factors and good practices

The upgrading of flood defences in the San Carlos and San Ildefonso ravines aims to reduce the vulnerability of the city of Trujillo and the surrounding region to flooding. The project has included a comprehensive approach, combining a web of structures to manage water overflow (tunnels, dikes, dams) with updated designs and materials and nature-based solutions. At the same time, Peru has undertaken institutional reforms to facilitate responding to disasters and rebuilding. These reforms were designed to

address the lack of domestic technical expertise to implement up-to-date standards and to improve project origination and governance to accelerate post-disaster investments. The development partner, the United Kingdom, has also been crucial for capacity building:

- **Reforming procurement practices to allow contractual flexibility and collaboration with contractors**
  - Peru has carried out a public procurement reform for post-disaster reconstruction. The previous procurement law – Law No. 30225 on State Contracting and its Regulations, approved in 2016 – enforced budgetary expenditure controls through strict technical documentation, multilayered approval processes and disbursement procedures that were often inflexible. Moreover, it only allowed for formal arbitration processes. As a result, many infrastructure investments have been delayed. A public report indicates that as of December 2024, 2 476 public investment projects were paused nationwide, with more than 60% attributed to strict contractual obligations within public procurement systems, including contractor non-compliance, delays in financial resource disbursements, insufficient technical documentation and disputes and controversies requiring arbitration (Government of Peru, 2025[87]). A new legal framework was created in 2024 with Law No. 32069 on General Public Procurement.
  - The new Law has allowed ANIN to deploy new contractual modalities across infrastructure projects, including the one in Trujillo. One of these is the New Engineering Contract (NEC) modality, developed through a Government-to-Government (G2G) partnership with the United Kingdom. The NEC comprises a suite of standardised contracts designed to manage projects throughout their full lifecycle and customisable to be tailored to the specific requirements of each type of supplier for infrastructure projects, to prevent costly contractual disputes. In Peru, this framework facilitates accelerated project execution while maintaining quality assurance standards for post-disaster reconstruction. One of the benefits of the NEC is the possibility of adopting performance-based agreements that replace prescriptive and rigid contractual frameworks.
  - In addition, the NEC allows a collaborative contract administration approach that emphasises proactive risk prevention and resolution. Adversarial litigation and formal legal disputes have been superseded by early warning mechanisms and compensation event procedures that allow negotiated settlements between contracting parties. This framework establishes co-operative planning and risk management processes wherein both parties define performance objectives that remain adaptable through proactive dispute resolution protocols and risk-sharing mechanisms.
  - The implementation of the NEC has also facilitated increased participation by qualified international suppliers offering advanced resilient solutions by reducing barriers to competitive bidding. The prescriptive procurement regulations mandated under Peru's national procurement law were replaced by standardised contractual instruments with accessible language and streamlined structures in both English and Spanish. Concurrently, bidding procedures were simplified with more agile protocols. This framework enables the application of multiple evaluation criteria in supplier selection, thereby facilitating the procurement of enhanced resilience solutions and promoting competitive tendering in the market.
- **Technology and know-how transfer and capacity building through international partnerships**
  - The bilateral G2G agreement with the United Kingdom has facilitated systematic knowledge transfer to ANIN in climate-resilient infrastructure design within the El Niño context. Technical co-operation included investments in schools, hospitals, river flood protection, drainage projects and EWS. British engineers collaborated with Peruvian counterparts to integrate resilience standards into project origination processes based on climate risk assessments, multi-hazard analytical frameworks and material specifications. In flood defence projects in

Trujillo, for example, British engineers provided technical support in project design for climate resilience, for example, by ensuring the calibration of structures for extreme precipitation scenarios.

- Skills and knowledge transfer to Peruvian public officials in long-term infrastructure projects management constitutes a central component of the bilateral agreement. More than 9 000 public officials received training in project management methodologies, digital technologies – including Geographic Information Systems (GIS) and NEC contract administration. The training also included climate risk modelling and resilient urban planning. Furthermore, the UK Delivery Team (UKDT, a multidisciplinary consortium of British firms) works as a programme management office, supporting and overseeing the design and execution of works.
- In addition, the government of Peru has implemented training programmes for workers involved in the reconstruction activities, thereby increasing the spillovers derived from public infrastructure investments. The integrated resilience infrastructure project in Trujillo certified 650 workers with the support of Peru's National Training Service for the Construction Industry, representing the largest workforce certification programme associated with infrastructure projects in the country.

- **Enabling national scaling up of reconstruction by developing a standardised project design process**
  - The bilateral partnership of Peru with the government of the UK encompassed the development of standardised project designs for each prioritised sector of intervention, aimed at replicating them in different municipalities and regions in Peru. The gully protection investments in Trujillo were not isolated, but part of a larger programme to implement integrated solutions in different locations to increase resilience to natural hazards in the country. As of July 2025, ANIN's portfolio had 109 projects for integrated solutions in 9 regions and more than 35 municipalities (Government of Peru, 2025[89]). Collectively, at least 17 river basins are covered by flood mitigation projects, built after multi-hazard assessments to identify optimal solutions, including retention barriers, warning systems and nature-based solutions.

Rebuilding and climate proofing the road network following Cyclone Evan in Samoa

The tragic incident at the Lano Ford, a river crossing in Samoa's Savai'i's North Coast Road, where a bus was washed off during a flash flood due to Cyclone Evan in 2012, killing two children, served as a pivotal event for Samoa to institutionalise investments aimed at mainstreaming resilience and reducing climate risks, such as floods and landslides. This event highlighted the urgent need to better address climate risks through comprehensive vulnerability assessments and investment in transport infrastructure during the rebuilding process. These assessments were crucial for supporting investment prioritisation, engineering designs and asset management practices, ensuring that transport infrastructure, such as roads, bridges and fords are designed to withstand extreme weather conditions and protect road users and communities.

Location and background information

Samoa, a small Pacific Island Country (PIC) with a population estimated in 2025 at around 232 000 people, comprises two large islands, Upolu and Savai'i and eight smaller ones, totalling approximately 2 935 km². Samoa faces increasing frequency and intensity of extreme weather events like heavy rainfall, strong winds and storm surges, which severely damage infrastructure and economic assets, affecting livelihoods. Notable disasters include Cyclones Ofa (1990), Val (1991) and Evan (2012), which caused flash floods. The impacts of Ofa and Val involved 21 fatalities and economic losses up to USD 500 million, about four times Samoa's GDP (World Bank, 2018[90]). Cyclone Evan's damage and losses to transport, housing and tourism were estimated at USD 204 million, 28% of Samoa's 2011 GDP. Additionally, Samoa experiences high seismic activity, as evidenced by the tsunami on 29 September 2009, which resulted in 143 deaths and affected nearly 5 300 people, mainly on Upolu's southern, eastern and southwestern coasts.

Main challenges to be addressed

Samoa's coastal areas are particularly vulnerable to recurring disasters. Amid this context, rebuilding and pivoting on risk-informed governance are required to overcome the following obstacles:

- **Locational vulnerability of coastal road network to sea-level rise, storms and torrential rains:** Samoa's road network faces escalating vulnerabilities at the intersection of geography, natural hazards and climate change. With approximately 75% of the population living within 1 km of the coast and critical transport infrastructure concentrated in coastal zones, the country's infrastructure is acutely vulnerable to climate-driven hazards (Government of Samoa, 2025[91]). The combination of rising sea levels, intensifying typhoons and increasingly frequent extreme rainfall events poses a direct threat to the road network upon which Samoa's economic development depends.

  The country's primary economic corridor, the West Coast Road (WCR), that connects the Faleolo International Airport to the capital, Apia, along Samoa's northern coast (Figure 3.6) exemplifies this case. This vital artery sustains daily commuting, freight transport, tourism, market access and essential public service delivery. Yet, it is at risk of sea-level rise and recurrently affected by storm surge and torrential rainfall, resulting in flooding and road closures that sever communities and disrupt economic activity. The escalating frequency and severity of these disruptions demand innovative, climate-resilient infrastructure solutions to safeguard Samoa's connectivity and economic future.
- **Structural vulnerability of critical water crossings:** Samoa is made up of nine islands, with 75% of the population living in the main island, Upolu, followed by Savai'i (with more than 20%) (Figure 3.6) (FAO, 2016[92]). This geography presents transportation challenges with a road network unable to connect different islands but vital to connect the population, goods and services to ports. In this context, the road network, including water crossings, is pivotal. Two critical water

crossings, Afega Crossing on WCR and Lano Ford on North Coast Road, have long had safety and connectivity risks that compromised road network resilience.

Figure 3.6. Savai'i and Upolu islands in Samoa: location of the Faleolo International Airport and municipalities of Saleologa and Apia in Samoa

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Key elements of the rebuilding strategy

In the wake of recent disasters, Samoa's Cabinet approved a plan in 2013 to reinforce the climate resilience and longevity of the nation's road infrastructure (World Bank, 2018[90]). Furthermore, the Government of Samoa, through the Ministry of Natural Resources and Environment, established its National Disaster Management Plan 2017-2020 (NDMP) and Samoa National Action Plan for Disaster Risk Management (2017-2021) under the Disaster and Emergency Management Act 2007, addressing prevention, reaction and rebuilding (Government of Samoa, 2017[93]; Disaster Management Office of Samoa, 2016[94]). The NDMP provides a comprehensive policy framework for disaster risk management, outlining operational procedures at the local, national and regional levels. For the transport sector specifically, the NDMP establishes clear objectives to ensure safe, secure and viable transportation modes and infrastructure assets. This includes conducting comprehensive risk assessments and developing practical technical standards for road and drainage planning, design and construction, alongside resilience measures for all transport modes. These standards ensure that infrastructure is designed proactively to prevent climate and disaster risks.

The World Bank has continuously supported Samoa in the transport sector since 2013 to promote "reconstruction plus resilience" in rebuilding efforts. The Enhanced Road Access Project (ERAP), approved by the World Bank in 2013 after Tropical Cyclone Evan, restored damaged roads and bridges on both of Samoa's main islands while improving design standards and sector management practices. It also reinforced institutional and regulatory frameworks to boost local capacity and investment sustainability, including technical assistance for construction standards and axle-load limit reforms. In addition, the Pacific Resilience Program (PREP), launched by the World Bank in 2015, included specific interventions in Samoa to strengthen early warning and emergency management and set up disaster risk financing instruments that speed post-disaster response and reconstruction allocations. Together, these investments and reforms translate Samoa's climate-resilience goals into practical tools and financing and enabled the origination of the Samoa Climate Resilient Transport Project (SCRT):

- **Samoa Climate Resilient Transport Project (SCRTP):** To accelerate these efforts, the SCRTP was approved in 2018. The USD 38 million of financial support by the World Bank through debt

and technical assistance grants has strengthened the resilience and functionality of its road network as a lifeline for economic and social connectivity. Its objective is to improve the climate resilience of Samoa's road network and, in the event of an eligible crisis or emergency, to provide an immediate response. The SCRTP is implemented by Samoa's Land Transport Authority (LTA), a public trading body established through the Land Transport Authority Act 2007, responding to the Ministry of Public Enterprises and founded in 2008 to plan, design, supervise and maintain national roads and implement policies for the sector, which also leads day-to-day technical co-ordination and project management. The LTA also works in tandem with the Ministry of Works, Transport and Infrastructure (MWTI)'s Transport and Infrastructure Sector Co-ordination Division and the Ministry of Finance's Centralized Technical Services Support Unit to align designs, procurement and approvals across government systems. On the technical side, LTA manages and directs the design-and-supervision consultants, ensuring that climate-resilient engineering is grounded in site-specific disaster risk diagnostics, such as hydrological survey and hydraulic modelling.

The following two selected interventions make up the backbone of SCRTP:

- **Rehabilitation of the West Coast Road (WCR) and the Afega water crossing**: Between 2015 and 2024, approximately 24 km of the WCR (and its Afega bridge) was upgraded with a suite of flood-risk mitigation measures that harden the corridor against extreme rainfall, coastal inundation and high-water tables. Based on the Vulnerability Assessment (VA) and Climate Resilient Road Strategy (CRRS), the project raised the road's minimum elevation to 2.24 m (enough to be above the highest foreseen sea level in 2038 even under extreme climate conditions) and comprehensively upgraded its hydraulic performance (including installation and/or replacement of twelve drainage outfall channels to improve both longitudinal and cross-drainage and reduce surface flooding and impounding). To buffer coastal flooding and scour, 2 095 meters of coastal revetment were also constructed or replenished, complemented by new vegetated coastal scour protection along the same reaches.

  The retrofit is also addressing a critical overtopping point at the Afega bridge, a critical bridge along the West Coast Road. This crossing's inadequate freeboard has led to repeated overtopping during storm events and remains the last low point on the WCR that has not yet been raised to climate-resilient standards. Its vulnerability creates a critical weak link in Samoa's primary economic corridor, threatening to sever the airport-capital connection during extreme weather events. The Afega crossing is soon to be replaced with a six-cell box culvert designed to accommodate a 1-in-50-year flood, significantly increasing hydraulic capacity and freeboard and adding bank and bed protection to manage high flows – thereby reducing closure risks and maintaining access during severe weather. Together, these measures materially lower flood hazard across the WCR by combining elevation gains, drainage capacity and coastal and riverine protections in a coherent, climate-resilient retrofit.
- **Rehabilitation of the Lano Ford at the Savai'i's North Coast Road**: The Lano ford is located at the Savai'i's North Coast Road, which is the main road along the east side of the Savai'i Island, connecting Salelologa and its ferry terminal with the northern areas of Savaii. The Lano ford is a low-lying river crossing prone to flash flooding that has previously resulted in fatalities. Its current design leaves communities and travellers exposed to life-threatening conditions during heavy rainfall, while also disrupting access to essential services and economic activities on Savai'i.

  The Lano ford will be replaced with a high-capacity 6-cell multi-cell box culvert (6 × 4.0 m × 2.65 m), designed for a 1-in-100-year event and shifted slightly downstream/seaward to improve hydraulic performance and the approach alignment. This core enhancement is paired with robust scour and flood-protection works, including about 50 m of 2 m-high upstream

gabion walls, downstream riprap raised, streambed clearing and shaping and bank/bed protections to safely convey high flows.

The design also upgrades approximately 100 m of asphalted approaches on both sides of the ford, adds V-drains at the embankment toes, catchpits and additional cross-culverts to improve local drainage and relocates utilities to reduce outage risks. User-safety and inclusive access are thus reinforced with guardrails, road markings and warning signage (including edge markers for flood conditions) and a 1.5 m pedestrian path with railings on the crossing. Together, these measures transform the ford from a vulnerable and exposed point into a climate-resilient river crossing that reduces flood hazard, limits scour and debris risks and sustains safe access for communities along the corridor.

Results, success factors and good practices

The Samoa Climate Resilient Transport Project (SCRTP) finances priority road works and safeguards, including road rehabilitation, slope stabilisation and replacement of critical water crossings to address flooding, storm surge and landslide risks. The LTA, with support from the World Bank, has also upgraded sector planning and risk management instruments to guide climate-proof designs and maintenance prioritisation. The following describes the selected good practices that are driving Samoa's strategy to address the urgent needs to promote systemic infrastructure resilience in rebuilding:

- **Promoting innovative engineering designs:**
  - The WCR adopted a hybrid "gray-green" coastal and drainage solution, combining nature-based solutions and conventional technologies. Hard revetments paired with new vegetated coastal scour protection help dissipate wave energy and increase resilience. Upgraded longitudinal/cross drainage with twelve new outfall channels and pollution-control features (swales, earthen ditches, catchpits) also slows, filters, and safely discharges runoff away from villages and reefs.
  - Safety-by-design was embedded into the engineering: road safety and access audits informed the WCR's detailed design and post-works refinements, including replacing hazardous driveway culvert headwalls with drivable end walls (a first-of-its-kind approach in Samoa) and specifying edge markers and warning signs for water crossings to maintain safe connectivity during storms.
  - As part of the SCRTP, Samoa has also planned a new future slope stabilisation design for the East Coast Road (ECR) to significantly reduce the current risk of landslips and rockfalls and their resulting hazards along the road, through careful assessment, investigation, design and construction supervision of localised slope stabilisation initiatives and targeted drainage improvements. Samoa used site-specific geotechnical investigations to prioritise unstable cut slopes and tailor measures – such as barrier fencing and other stabilisation systems – to reduce landslides/rockfall, keep drains clear and prevent closures.
  - The Afega and Lano ford water crossings advanced from conventional concept design to value-engineered, climate-informed culvert solutions: Hydrology/hydraulic analysis led to the installation of multi-cell box culverts with a 2-meter raised carriageway at Afega, upstream/downstream erosion protection, guardrails, footpaths and a temporary culverted bypass to maintain traffic during works; their designs also integrate safety features (edge markers/signage) for severe weather operations.
- **Adopting a risk-informed and collaborative rebuilding planning.**
  - In late 2017, the Government of Samoa, through the LTA, adopted and updated its VA and CRRS, prepared under the Enhancing the Climate Resilience of the West Coast Road Project (CRWCR), approved by the World Bank in 2012. Both instruments now serve as strategic planning tools to inform identified hazards, the climate-resilient designs of infrastructure

investments, as well as prioritised areas for investments within the transport sector. In practice, these tools are evidence-based, compiling climate-related variables to support road sector planning in project prioritisation standards updates and climate-screened designs. The VA, for example, emphasises updated hydrology information, sea-level trends and climate sensitivity analyses to assess uncertainties and inform policy and decision-making.

  - Led by designated co-ordination and technical units within LTA, the rebuilding planning process encompassed effective collaboration across institutions, such as Ministries and Agencies, to ensure harmonised co-ordination of technical resources and expertise and project implementation. Within this collaboration framework, Samoa has clearly defined institutional roles: the Ministry of Finance, as the executing agency, provided overall leadership, fiduciary oversight and co-ordination, ensuring alignment with national priorities and timely decision-making; the Ministry of Works, Transport and Infrastructure played a role in technical planning and implementation; while the Ministry of Natural Resources and Environment and the Ministry of Lands and Survey provided critical inputs on environmental safeguards, land matters and regulatory compliance. In addition, the Ministry of Women, Community and Social Development ensured community engagement, social inclusion and responsiveness to local needs. The co-ordination between different agencies was backed by inter-agency consultations, clear communication channels and a shared commitment to project outcomes.
  - These collaborative implementations strengthened LTA's institutional capacity to plan, implement and manage projects and assets in partnership with multiple stakeholders.

- **Improving data-driven asset management practices for decision-making:**
  - SCRTP upgraded the Samoa Asset Management System (SAMS) hardware, software and workflows to enable data-driven infrastructure planning. SAMS monitors real-time road conditions in Samoa, tracking variables to assess resilience, safety and performance to inform maintenance prioritisation, capital investment decisions and the upcoming ten-year road master plan. The integration of a national crash database with SAMS, combined with improved access to cadastral data, enables LTA to prioritise safety hotspots alongside climate risks while streamlining surveys and right-of-way decisions. Supported by an LTA-MWTI data-sharing memorandum of understanding, these systems shift the sector from reactive repairs to programmatic, climate-informed asset management.
  - SCRTP is enabling LTA to build a climate resilient driven investment pipeline by using the uptake of SAMS and the updated VA/CRRS. These tools are used to identify, justify and sequence resilient projects. Ultimately, it aims to support the allocation of budgets, mainstream climate risk into project selection and portfolio management, rather than isolated designs and decision making.

- **Leveraging local knowledge for technical capacity building**
  - Collaborating with experienced local and international practitioners was critical in constructing climate resilience solutions tailored to vulnerabilities in Samoa. Specifically, LTA personnel have been exposed to best practices through training and consultancies. International consultancies have provided face-to-face trainings as part of their contractual agreements with Samoa and local capacity has been developed through continued WB engagement with the Government of Samoa.
  - Technical capacity building programmes were undertaken by Samoa to ensure that project outputs are impactful for the population. It includes construction techniques and project management. For example, hydrological modelling, road asset management techniques and new technologies have been introduced through the VA. These programmes also helped leverage local expertise through hands-on experience in constructing climate-resilient solutions to vulnerabilities specific to the Samoa context. For example, the SCRTP has supported the design of drainage structures that also improve road safety and cost benefit assessments were

introduced to reduce water crossing solution costs without compromising climate resilience requirements.

Conclusions

The seven infrastructure projects discussed in this chapter exemplify different ways to ensure that rebuilding after natural disasters delivers on Building Back Better.

The case studies present the main elements of rebuilding initiatives, demonstrating how post-disaster action can go beyond reparation and restoration and serve as a transformative investment to deliver on sustainable development. Integrating prevention measures and rebuilding investments for disaster risk reduction is pivotal. Chapter 2 of this Compendium summarises the lessons learned from these case studies into five actionable global good practices:

- Enabling forward-looking planning
- Embedding preparedness in rebuilding
- Activating targeted funding and partnerships
- Ensuring effective time management
- Making rebuilding people-centred

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Rebuilding for the Future

Building on the OECD Prevent-React-Rebuild (PRR) framework for infrastructure resilience, this report focuses on Building Back Better as a strategic development choice rather than a mere restoration of damaged assets. It argues that reconstruction must be systematically planned, adequately financed and effectively governed to enhance resilience to future shocks while advancing sustainable development objectives. The stakes are particularly high for developing countries, where infrastructure deficits and socio-economic gaps amplify long-term costs of inadequate rebuilding. Drawing on concrete case studies from Honduras, Indonesia, Japan, Malawi, Nepal, Peru and Samoa, the report distils five actionable principles to guide reconstruction efforts after natural disasters to ensure they deliver on Building Back Better.

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