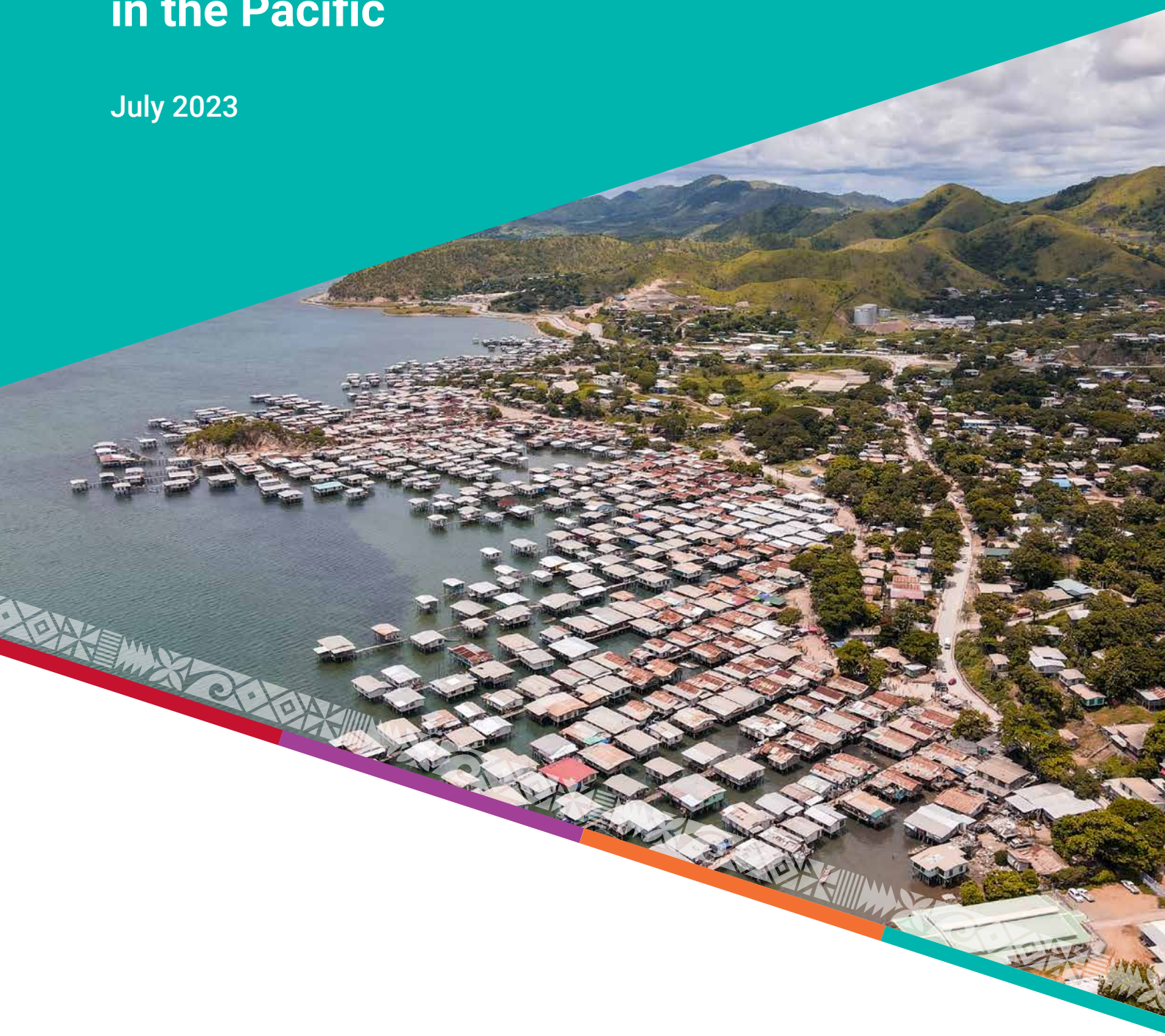
Midterm Review of the Sendai Framework for Disaster Risk Reduction 2015–2030

Thematic Report on Climate and Disaster-Resilient Infrastructure in the Pacific

July 2023



PRP PACIFIC RESILIENCE PARTNERSHIP STRONGER TOGETHER

Australian Aid

Midterm Review
SENDAI FRAMEWORK
FOR DISASTER RISK REDUCTION 2015-2030

UNDRR
UN Office for Disaster Risk Reduction

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Abbreviations and acronyms

Term	Definition
ACliFF	Asia-Pacific Climate Finance Fund
ADB	Asian Development Bank
AIFFP	Australian Infrastructure Financing Facility for the Pacific
AOSIS	Alliance of Small Island States
APCP	Australia Pacific Climate Partnership
APMCDRR	Asia-Pacific Ministerial Conference on Disaster Risk Reduction
CDRI	Coalition for Disaster Resilient Infrastructure
COSPPac2	Climate and Oceans Support Program in the Pacific Phase 2
CSIRO	Commonwealth Scientific and Industrial Research Organisation [Australia]
DFAT	Department of Foreign Affairs and Trade [Australia]
DRR	Disaster risk reduction
DWM	Disaster waste management
EIB	European Investment Bank
EU	European Union
FNBC	Fiji National Building Code
FRDP	Framework for Resilient Development in the Pacific
FSM	Federated States of Micronesia
G20	Group of 20 [countries]
GCA	Global Center on Adaptation
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEDSI	Gender equality, disability and social inclusion
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Reduction and Recovery

GGGI	Global Green Growth Institute
GoT	Government of Tonga
Gov4Res	Governance for Resilient Development in the Pacific Project
GPSS PR	Global Program for Safer Schools – Pacific Roadmap
IMF	International Monetary Fund
IRIS	Infrastructure for Resilient Island States
JICA	Japan International Cooperation Agency
J-PRISM	Japanese Technical Cooperation Project for Promotion of Regional Initiative on Solid Waste Management in Pacific Island Countries
MTR	Midterm Review
NBC	National Building Code
NDMO	National Disaster Management Office
NIIP	National Infrastructure Investment Plan
NRC	National Recovery Committee
OECD	Organisation for Economic Co-operation and Development
PACCSAP	Pacific–Australia Climate Change Science and Adaptation Planning [programme]
PacRIS	Pacific Risk Information System
PCCSP	Pacific Climate Change Science Program
PCR	Physical climate risk
PCRAFI	Pacific Catastrophe Risk Assessment and Financing Initiative
PCRIC	Pacific Catastrophe Risk Insurance Company
PDF	Pacific Disability Forum
PIC	Pacific island country
PIFS	Pacific Islands Forum Secretariat
PIPI	Pacific Infrastructure Performance Indicator
PNG	Papua New Guinea

PPP	Public-Private Partnership
PREP	Pacific Resilience Program
PRIF	Pacific Region Infrastructure Facility
PRP	Pacific Resilience Partnership
RCCAP	Regional Climate Consortium for Asia and the Pacific
RMI	Republic of the Marshall Islands
SAMOA Pathway	SIDS Accelerated Modalities of Action Pathway
SDGs	Sustainable Development Goals
SIDA	School Infrastructure Vulnerability and Damage Assessment
SIDS	Small Island Developing States
SIIP	Solomon Islands Infrastructure Program
SPC	Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
SWAP	Sustainable Waste Actions in the Pacific
TA	Technical assistance
TC	Tropical cyclone
TCAP	Tuvalu Coastal Adaptation Project
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UTS	University of Technology Sydney

1. Introduction

Objective of this report

Recognizing the countless efforts made to build resilient infrastructure in the past and at present, this synthesis report is intended as a "snapshot" to capture high-level trends in making Pacific islands infrastructure resilient to climate change and disasters. The report is not written as a sector technical report or a performance evaluation. Rather, it functions as a background information paper to inform relevant country governments, stakeholders, communities and institutions in preparation for the Sendai Framework Midterm Review in the Pacific, and the establishment of the technical assistance facility, Infrastructure for Resilient Island States (IRIS). By analysing the secondary data and information available in the Pacific, it aims to document good practices as evidence of Pacific resilience building, summarizes what is working, what challenges persist from the past seven years, and sets the scene for developing a pathway for improved implementation over the next seven years.

Background to Midterm Review of the Sendai Framework for Disaster Risk Reduction 2015–2030

Adopted by the United Nations in 2015, the Sendai Framework for Disaster Risk Reduction provides a blueprint for an all-of-society and all-of-state institutions engagement in preventing and reducing disaster risks. It advocates for the substantial reduction of disaster risk and losses in lives, livelihoods and health, and aims to achieve significant reduction of disaster risk across the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

In advance of the Sendai Framework reaching its midpoint in 2023, a midterm review was conducted in 2022 by the United Nations Office for Disaster Risk Reduction (UNDRR). In collaboration with countries and stakeholders, the review examined the progress and challenges experienced since 2015 and explored efforts to integrate disaster risk reduction into decision-making, investment, and behaviour.

The global midterm review included stakeholder consultations, regional forums, and written submissions. It resulted in a comprehensive collection of regional reports, national reports, thematic reports and literature reviews.

For the Pacific, the regional midterm review was led by the UNDRR Pacific Office and formed part of the broader Asia-Pacific review. The UNDRR Pacific Office supported Pacific island countries to undertake their own reviews as part of the National Voluntary Review process. The Pacific Office also coordinated reviews into key thematic areas of Gender Equality and Social Inclusion; Disability Inclusion; Climate and Disaster-Resilient Infrastructure; and Local, Indigenous and Traditional Knowledge.

To best understand these themes, the UNDRR Pacific Office worked with regional partners through the Pacific Resilience Partnership, and engaged a wide range of stakeholders including national and local governments, civil society organizations, development partners and financial institutions.

The findings and recommendations of these thematic reviews are designed to be practical and grounded in the real-world experiences of those living in the Pacific. They seek to provide a clear basis for discussion of the future of the Sendai Framework for Disaster Risk Reduction with a view to maximizing its effectiveness to 2030.

People accessing boat transport at the Bau Landing near Nausori, Fiji. Photograph: Australia Pacific Climate Partnership.

2. Need for climate and disaster-resilient infrastructure

Pacific island countries are among the most exposed and vulnerable countries to both geophysical and hydro-meteorological hazards, with five of the 15 countries most at risk to disasters located in the region (Bündnis Entwicklung Hilft & Ruhr University Bochum – IFHV, 2021).[1] The PICs are also susceptible to very high relative economic losses due to disasters, with average annual losses ranging from 1 to 10% of Gross Domestic Product (GDP). In the case of Palau, Tonga, and Vanuatu, the average annual losses are estimated at more than 10% of GDP – 11.98%, 18.20%, and 20.67% respectively (UNESCAP, 2020).

Although the level of exposure is similar, their vulnerability differs as PICs have specific environmental, social and economic challenges that result in limited capacity to reduce vulnerability. The impact of natural hazards and climate change threaten their integrity, food security, water, health, infrastructure, livelihoods and economies and, more broadly, their populations and ecosystems.[2]

2.1 What is disaster risk reduction?

Disaster risk reduction (DRR) refers to the actions taken before a natural hazard event occurs to reduce the impact of such an event and avert disaster. Examples include developing building codes to ensure infrastructure can withstand cyclones and other hazards, implementing measures to divert flood water, strengthening social protection systems to facilitate timely assistance, planting drought-resilient crops, and increasing water storage capacity to maintain water supply in times of drought (DFAT, n.d.).

[1] Vanuatu is ranked 1st, Solomon Islands 2nd, Tonga 3rd, Papua New Guinea 9th, and Fiji 14th, as per the *WorldRiskIndex 2021*.
[2] Language adapted from the Declaration of the Fourth France–Oceania Summit, Paris, 26 November 2015.

2.2 Loss and damage

Infrastructure is one of the most affected sectors by disasters. Between 2011 and 2020, infrastructure accounted for about USD 1.45 billion or 37% of the total damage and losses of the major disasters that occurred in the Pacific.[3]

Climate change will likely increase disruption to infrastructure, especially from sea-level rise, storm surge and swells, since the rates of sea-level rise in the tropical Pacific between 1993 and 2009 were about four times the global average. Unsurprisingly, the PICs' highest adaptation costs will be coastal protection, with the costs going up to USD 329 million per year in Fiji (3% of GDP) and USD 58 million in the Marshall Islands (13% of GDP) (World Bank, 2017).

> The Asian Development Bank concludes the escalation in disaster losses underscores the urgency of addressing disaster risk adequately when planning and designing infrastructure in the region (ADB, April 2022). "Given the huge infrastructure investment requirements over the next 20 years, combined with the expected adverse impact of climate change, how and where investments are made will largely determine the region's ability to cope with disaster and climate risk for decades to come."

2.3 The Triple Dividend resilience framework

Infrastructure investment can also play a direct role in stimulating economies and maintaining employment, an objective compounded in the wake of the economic and social shocks resulting from the COVID-19 pandemic. The Asian Development Bank (ADB) describes the use of "the Triple Dividend resilience framework for planning, involving an assessment of benefits for their potential not only to reduce disaster losses but also to boost economic development and lead to wider co-benefits" (ADB, April 2022).

The Pacific Islands Forum Secretariat (PIFS) also communicated the Triple Dividend in its disaster risk submissions to Forum Economic Ministers in 2019 and 2020. This thematic review shares the same approach and further contributes to the collective focus on an "infrastructure-led recovery" and a "green recovery" across the globe (PwC, 2020). Infrastructure can also enable equal access to services for women, girls and vulnerable groups, helping to reduce gender-based inequalities (UNOPS, 2020), and encouraging a fully-inclusive approach from all stakeholders to deliver wider societal benefits.

The nexus between natural hazards and vulnerability is central to appreciating the scale of the damage caused by large disastrous events and resultant socio-technical impacts. Multilateral efforts to mitigate the impacts of weather and climate hazards have progressed over time. The Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation was a harbinger for the Hyogo Framework for Action, which emphasized building the resilience of communities and nations to the effects of disasters, and the Sendai Framework for Disaster Risk Reduction as the current flagship of unified effort (ASPI, 2020).

2.4 Sustainable Development Goals (SDGs)

UNDRR is finalising the Principles for Resilient Infrastructure to set a global standard to ensure resilience of infrastructure and to "de-risk" investments (UNDRR, 2022). The principles are aligned with, and will enhance, current global agreements, including targets of the SDGs, especially SDG 9 (United Nations Department of Economic and Social Affairs, 2015); global Target D of the Sendai Framework, which calls for substantially reducing disaster damage to critical infrastructure and disruption of basic services; the Paris Agreement (United Nations, 2015); and the Principles for Quality Infrastructure Investment of the Group of 20 (G20) countries (Global Infrastructure Hub, n.d.). The principles provide a global framework, key actions and guidance to enable a range of stakeholders – governments, donors, investors, owners, regulators, operators, designers and contractors, service providers, international organizations and others – to improve infrastructure resilience and contribute to positive economic, social and environmental outcomes.

[3] Analysis of the Post Disaster Needs Assessments (PDNA) available in the Pacific.

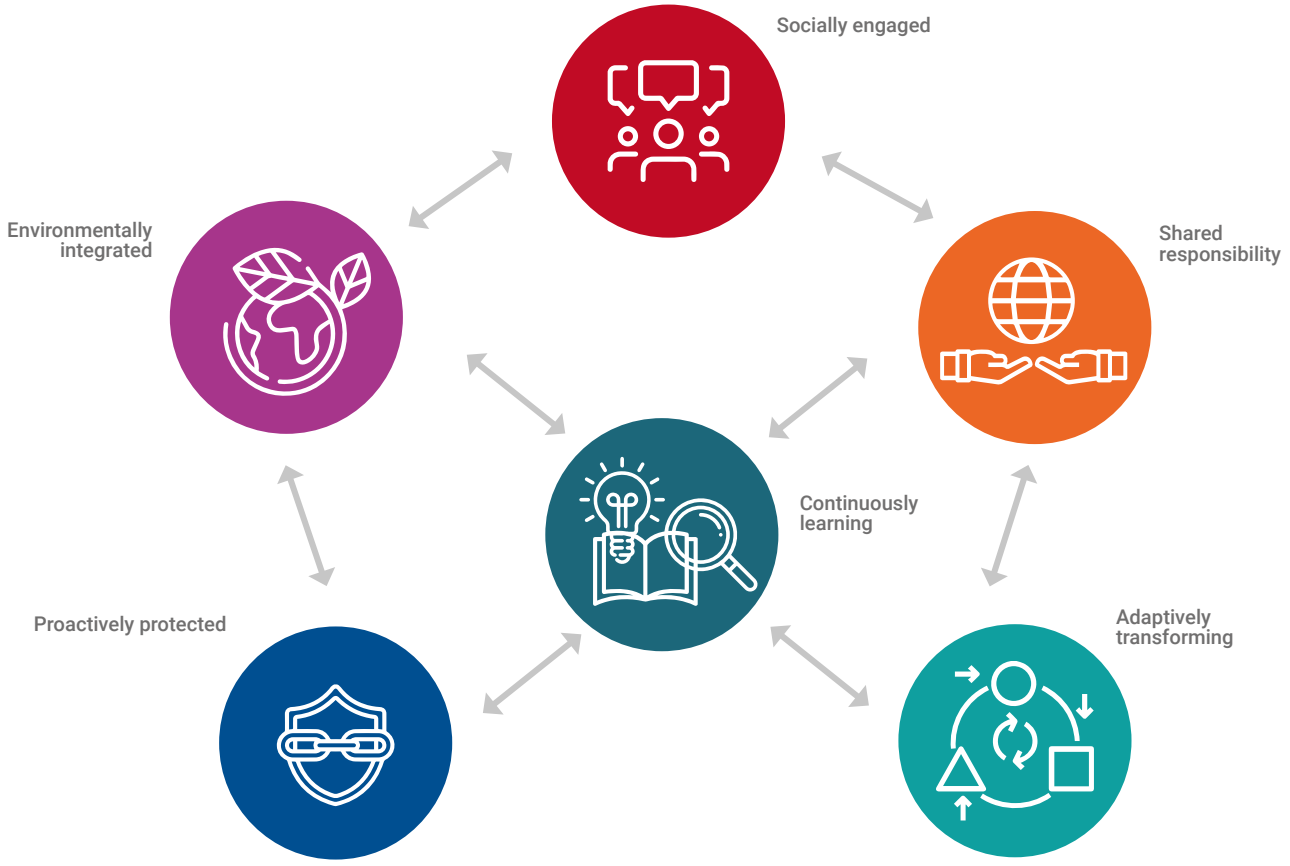
Developing a common understanding and framework for resilient infrastructure is critical to:

- Raise awareness and set an understanding of what "resilient infrastructure" constitutes.
- Form the basis for planning and implementation of infrastructure projects that take resilience as a core value.
- Communicate the desired outcomes of national infrastructure systems to establish resilience of critical services.
- Assist the public and private sectors in making risk-informed policy and investment decisions.

The six Principles for Resilient Infrastructure are:

1. **Adaptively transforming** – The goal is to adapt and transform to changing needs.
2. **Environmentally integrated** – The goal is to work in a positively integrated way with the environment.
3. **Protected by design** – The goal is to design infrastructure that is prepared for hazards.
4. **Socially engaged** – The goal is to develop active engagement, involvement, and participation with people.
5. **Shared responsibility** – The goal is to share information and expertise for coordinated benefits.
6. **Continuously learning** – The goal is to develop understanding and insight into infrastructure resilience

Figure 1. The six Principles for Resilient Infrastructure seek to to maximize positive economic, social and environmental outcomes from improving infrastructure resilience.



Infrastructure is critical for the Small Island Developing States (SIDS), as it has the potential to influence the achievement of up to 92% of all the targets of the SDGs.

The Principles for Resilient Infrastructure are being developed against the backdrop of both increasingly frequent and intense global disasters, as well as delayed efforts by developed countries to deliver on a commitment to provide USD 100 billion annually in climate finance to developing countries. The Organisation for Economic Co-operation and Development (OECD) estimates that in 2018 there was a USD 20 billion shortfall on that amount.

There is also limited funding directed towards disaster preparedness. Between 2010 and 2019, developed countries donated USD 133 billion in disaster-related Official Development Assistance but only USD 5.5 billion went towards measures to build resilience before disasters strike.

In its recent report, *Disaster-resilient infrastructure – Unlocking opportunities for Asia and the Pacific*, ADB (April 2022) presents 16 Opportunities to Build Infrastructure Resilience, alongside the primary stakeholder groups at which each opportunity is targeted and the barrier faced by those stakeholders that the opportunity is expected to address (see Annex 2).

The 2022 report of the United Nations Environment Programme, *International good practice principles for sustainable infrastructure* (2nd edition), is a normative framework that policymakers can follow to help integrate sustainability into infrastructure planning and delivery, and to achieve the SDGs and the objectives of the Paris Agreement. The OECD has estimated that an annual average of USD 6.9 trillion in climate-compatible infrastructure investment is required over the next decade to meet global development needs.

3. Overarching trends and developments since 2015

The Pacific remains one of the most vulnerable regions in the world to climate change and natural hazards. The World Risk Index in 2021 found five Pacific island countries, including Papua New Guinea (PNG), are among the top 15 most at-risk countries, with Vanuatu, Solomon Islands, and Tonga ranked first, second, and third, respectively (Bündnis Entwicklung Hilft & Ruhr University Bochum – IFHV, 2021).

Frequent low-impact disaster events create significant fiscal burdens for governments in the Pacific and impede development in the region. Less-frequent, higher-impact events inflict acute damage on communities, infrastructure, and economies, further exacerbating fiscal burdens and slowing the development process (ADB, 2018).

3.1 From disaster and climate impacts to actions

A number of other natural-hazard-related communiqués and declarations were released in 2015[4], each emphasizing greater attention, resources and capacity to build a Pacific that is more resilient to the impacts of climate change and other disaster risks.

> Those concerns were testified during the 2015–2016 cyclone season, when eight fully developed cyclones wrought havoc across large parts of the eastern Pacific Ocean. One of the storms, Tropical Cyclone (TC) Winston, a Category 5 system that impacted Fiji, was the strongest storm event on record in the Southern Hemisphere and the most costly, causing damage and losses estimated at more than USD 1 billion (Bolatagici, 2016; Mansur et al., 2017).

[4] Lifou Ministerial Declaration on Climate Change in April 2015; the Nuku'alofa Ministerial Declaration on Sustainable Weather and Climate Services for a Resilient Pacific and the Polynesian Leaders' Taputapuatea Declaration on Climate Change in July 2015; and the Smaller Island States Leaders' Port Moresby Declaration on Climate Change and the Suva Declaration on Climate Change in September 2015.

A small propeller airplane just landed on a remote airstrip overgrown with palms, Levuka, Ovalau Island, Fiji. Photograph: Maloff/Shutterstock.com.

These events further influenced the urgent prioritization of several key principles important to equitable responses to DRR; for example, expanded concepts that linked human and environmental security, regional cooperation in building resilience, and strengthened information sharing and the further development of early warning mechanisms, assessments and other advice, all of which remained central to Pacific Islands Forum discussions for the rest of the decade.

3.2 Defining infrastructure resilience

Through engagement with member states, the UNDRR has recognized that one of the key gaps in the infrastructure resilience arena is a shared view of:

- what infrastructure is in scope
- the extent of resilience
- the scale and ambition for resilience
- the definition of resilience
- what can be done to improve infrastructure resilience, while assisting in raising awareness and setting a common basic understanding, but not a one-size-fits-all approach to resilience.

From economic to social infrastructure

While the scope of the term "**infrastructure**" was traditionally applied, particularly among the international donor and development finance institutions, to public sector economic infrastructure (energy, telecommunications, transport, solid waste management, and water and sanitation services), for the purpose of DRR it now typically embraces all of the social infrastructure, including physical public facilities and services required for the operation of a society (education, health, community, cultural, and governance facilities), and increasingly the housing stock, plus the business sector.

The Pacific's geographical spread, coupled with small populations, narrow-based economies, and limited natural resources, also make the region more vulnerable to external shocks, which can in turn impact economic growth and increase poverty. To successfully manage the nexus of risks going forward, United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) found that a coherent and systematic approach is needed, alongside inclusive approaches, and long-term cooperation between governments, international development partners, and regional organizations. The Sendai Framework's priority areas are suitably aligned with this approach, particularly with its broad focus on sudden and slow-onset disasters, natural or human-made, and including biological hazards and risks.

A transformed "riskscape" in the Pacific

The UNESCAP report in 2021, *Resilience in a riskier world: Managing systemic risks from biological and other natural hazards*, found the intersection between the COVID-19 pandemic and the existing dangers of climate change and natural disasters has transformed the "riskscape" in the smaller islands of the Pacific, as well as in Asia (UNESCAP in PRIF, 2021). While the Pacific has made progress over the past two decades in achieving the SDGs related to disaster risk reduction (Goal 1, Goal 9, and Goal 11), and to good health and well-being (Goal 3), most countries in the region are still ill-prepared for the convergence of such complex overlapping crises (UNESCAP in PRIF, 2021).

> As reported by the Pacific Region Infrastructure Facility (PRIF) in its *Annual Report 2021*, "the coronavirus (COVID-19) pandemic has been the most severe economic shock to the Pacific region to date, with an impact across all countries but particularly those which are tourism-dependent" (PRIF, December 2021).

"While widespread, and considered a regional 'disaster', the impact has been mixed, with smaller countries largely able to insulate themselves from the health impacts in 2021 but not the significant economic downturn from border closures. Larger countries and economies, such as PNG and Fiji, have been impacted by both COVID-19 and the economic downturn following travel restrictions. By the end of 2021, the Pacific recovery was yet to begin, with new COVID-19 variants emerging." (PRIF, 2021)

4. Trends, activities and case studies, clustered by Sendai Framework Priorities

The following initiatives, programmes and case studies provide a snapshot of the trends and developments, risks, challenges and opportunities, with regard to the infrastructure component of DRR, and present a significant response to the Sendai Framework over the past seven years. Within the parameters and scope of this report, these are selected as leading examples, and are not intended as a comprehensive or exhaustive review.

4.1 Priority 1: Understanding disaster risk

Policies, strategies and regulatory frameworks need to be based on evidence of risks and on a clear understanding of the vulnerabilities of national infrastructure systems. One of the key gaps is the lack of understanding of what "resilient infrastructure" actually means and entails in terms of policy, planning, and practical measures, which public and private sectors can refer to when planning and managing infrastructure policies and projects (UNDRR, 2022).

At the strategic level, the quest for appropriate regional monitoring and evaluation systems, including benchmarking of performance improvements, is addressed, for example, in the evolving frameworks adopted by the Pacific Infrastructure Performance Indicators (PIPIs), developed by the Pacific Community (SPC) and the PRIF. Recommendations include specific indicators, for example, in identifying development of climate-resilient infrastructure, and a focus on condition and maintenance of key economic infrastructure (SPC & PRIF, 2021).

At the project level, donors and international finance institutions report a definite shift in requests from PIC governments to include projects in their infrastructure investment portfolios that provide a heightened level of climate and disaster resilience, with risk assessments, and that take into account best available risk metrics, climate and geoscience data, and technical and design standards.

Disaster and climate risk information and management

The Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI), a regional flagship initiative of the World Bank, aims to provide PICs with disaster and climate risk information and associated tools for enhanced risk management to inform development planning and financing decisions. For example, it strengthened the Pacific Risk Information System (PacRIS), one of the largest collections of geospatial information for the Pacific. The database contains detailed, country-specific information on assets, population, hazards and risks.

More spatially granular information about climate and disaster risk – taking future demographic, economic, and climate scenarios into account, and expressed in decision-relevant socioeconomic terms – is identified by ADB to improve decision-making. "Approaches to overcoming existing barriers to risk information include the use and standardization of open-source data, and the application of dynamic adaptive policy pathways to account for future uncertainties." (ADB, April 2022)

The Regional Climate Consortium for Asia and the Pacific (RCCAP) portal, funded through an ADB technical assistance programme, provides the latest information about climate change for 14 Pacific countries and Timor-Leste. Climate data is presented in a set of technical reports produced by Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Secretariat of the Pacific Regional Environment Programme (SPREP). Launched in October 2021 as part of Next Generation Climate Projections for the Western Tropical Pacific, these reports describe observed and projected climate changes for: Cook Islands, Fiji, Federated States of Micronesia, Kiribati, Marshall Islands, Niue, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor-Leste, Tonga, Tuvalu and Vanuatu (RCCAP, 2021).

Through the Pacific Climate Change Science Program (PCCSP), Pacific–Australia Climate Change Science and Adaptation Planning (PACCSAP) programme, and Pacific Climate Change Science and Services Outreach Project, the Australian Government provides additional tools and knowledge to 15 PICs to enhance their capacity to deal with a changing climate (Australian Government, n.d.).

Climate and disaster information services, such as long-range weather forecasts and geohazard mapping, are improving in the Pacific. However, much of this scientific knowledge is not available to businesses, governments and communities in formats that are meaningful and useful. Improving access to climate and disaster information for improved decision-making is needed to build resilient livelihoods, plan and protect critical assets, and keep people safe.

The Australia Pacific Climate Partnership (APCP) is working to promote the integration of climate change and disaster risk management into Australian aid investments in the Pacific.

For example, Australian Infrastructure Financing Facility for the Pacific (AIFFP) projects are supported by the latest climate projections and seismic hazard advice from APCP (with the support of Australian science agencies such as the Bureau of Meteorology and Geoscience Australia). Such practices should be expanded to all PIC infrastructure projects to make them resilient to climate change and disaster events.

A number of studies have focused on the impending risks posed by specific threats, such as sea-level rise in the Pacific. For example, in 2022, ADB published *Sea-level change in the Pacific islands region*, which reviews available evidence to explore the strengths, weaknesses, and uncertainties associated with various sources of information on sea-level rise in the Pacific islands (ADB, July 2022), and PRIF published *Guidance for managing sea level rise infrastructure risk in PICs*, which explains the infrastructure risks associated with climate change induced sea-level rise and offers practical guidance on how to approach sea-level rise planning through the concept of dynamic adaptive pathways when considering infrastructure developments (PRIF, 2022a).

Development partners' technical assistance (TA) programmes are also responding to the need to understand the associated risks involved and the need for appropriate technical solutions and implementation guidelines.

One example is a 2021 ADB knowledge and support programme, Building Coastal Resilience through Nature Based and Integrated Solutions, to enhance resilience of coastal communities, cities, infrastructure, and ecosystems.[5] With additional financing from the Global Environment Facility (GEF) and the Asia-Pacific Climate Finance Fund (ACliFF), this programme will support the assessment, preparation, knowledge sharing, research and policy advice for the implementation of an innovative coral reef financing and insurance model in four project countries.

The Australian Government is supporting long-term climate change monitoring in the Pacific, for example, through a technology transfer programme under the Climate and Oceans Support Program in the Pacific Phase 2 (COSPPac2), which monitors long-term sea-level data, among other tools and data such as water storage outlook models. The support includes installation and maintenance of high-tech tide gauges and related data management systems, which enables real time sea-level rise data and more accurate projections to strengthen local capability in resilient infrastructure planning.

Case study: Tonga

In the case of the Hunga Tonga–Hunga Ha'apai eruption in January 2022, the event triggered a tsunami across the entire Pacific, which was detected in real time, since the Tonga Meteorological Service had been closely monitoring unusual volcanic activity using the data from the Nuku'alofa tide gauge station. This led to a series of tsunami alerts and warnings over radio and social media, which elevated awareness, and contributed to public preparedness and early action based on pre-planned evacuation strategies.[6]

In 2017, PRIF published a review of affordable engineering options, with recommended technical guidelines, for coastal protection structures, such as sea walls, in PICs, with the objective of adding to the existing knowledge by researching appropriate geotechnical solutions, while attempting to maximize the use of local materials and labour, and minimize the need for imported materials and equipment (PRIF, February 2017; PRIF, November 2017).

[5] See ADB TA-6742 REG: Building Coastal Resilience through Nature-Based and Integrated Solutions – Terms of Reference.
[6] See http://cosppac.bom.gov.au

Rarotonga Hospital is the largest hospital in the Cook Islands. National Building Codes help ensure key public buildings can withstand natural disasters. Photograph: ChameleonsEye/Shutterstock.com.

The availability is often limited of suitably detailed and localized data that is relevant at the project level, which requires the project evaluation and design processes to include risk data assembled by specialist consultants, contracted alongside environmental impact assessments and social safeguards, drawing on all available data sources at local, regional and international levels.

A good example of such a detailed, localized infrastructure risk assessment is the World Bank's Global Program for Safer Schools (GPSS), which invests in improving the safety and resilience of school infrastructure at risk from natural hazards. The GPSS – Pacific Roadmap (GPSS PR) provides TA to the Government of Tonga (GoT) Ministry of Education and Training in the form of detailed risk assessment, including a hazard and exposure assessment of all primary schools (95 schools) and a vulnerability assessment of schools with sufficient information available on classroom buildings, food halls/canteens, halls, libraries, toilets and utility buildings (295 buildings). Hazard data was obtained from a range of sources, which formed the basis of a desk-based risk assessment, followed by a 'ground truthing' exercise (a School Infrastructure Vulnerability and Damage Assessment (SIDA) of 24 primary schools on Tongatapu, Vava'u and Eua), undertaken by Arup and the GoT in May 2019, to validate existing hazard exposure and vulnerability data, and to collect new data.

Prior to undertaking any physical interventions that reduce risk, it is recommended that additional assessments be carried out that consider site-specific hazard exposure and building vulnerability for schools identified as requiring mitigation. These assessments would help to validate this desk-based risk assessment and enable accurate mitigations to be designed and costed.

ADB also reports that localized DRR information is a priority, since climate risk assessments are now mandatory in the project evaluation and planning processes. However, the geophysical risk factors tend to receive less attention and need to be integrated on a more systematic basis. There is also a lack of post-disaster hazard impact data, which is valuable to compare modelling with historical data.

> The importance of using local knowledge and community observations is now widely acknowledged, and countries are now requesting more resources deployed to raise community awareness and technical capacity by introducing technical training programmes within all project-specific disaster risk assessments.

Despite evident progress made by major donors and large infrastructure projects, there is still a significant gap between what is known about hazards, vulnerabilities and exposure, and the application of integrated approaches to mitigate risks at local levels. For example, climate and disaster risks are rarely understood and applied in the social sector, especially in housing. Such a trend is reflected in the low (non-life) insurance penetration – for example, in Fiji, 6% of households have property insurance and, in Samoa, 10% of households have cyclone insurance (Lucas, 2015).

There are, however, considerable barriers to the uptake of disaster insurance in PICs, including affordability, inadequate disaster risk mitigation measures, insufficient baseline information, limited availability of reinsurance, consumer awareness and cultural issues, lack of trust, inadequate building codes and certification mechanisms, lack of public asset registers, aid dependence, and weak pay-out distribution mechanisms.

Pooling risk across multiple countries can reduce costs significantly. The Caribbean Catastrophe Risk Insurance Facility was the first multinational parametric catastrophe insurance instrument, established in 2007. It is a not-for-profit risk pooling facility owned by and operated for Caribbean governments, and offering parametric insurance against earthquakes, cyclones, and excess rainfall events. The facility has been in operation long enough to have generated significant evidence of success, and it is widely cited as a model with potential to be emulated elsewhere (CCRIF SPC, n.d.). The Pacific Catastrophe Risk Insurance Pilot Program (World Bank, n.d. b; see Innovative Financing Mechanisms under section 5.3) and African Risk Capacity (n.d.) are two other widely cited examples. These programmes have only been operating for a few years, but there is some evidence that they are also broadening coverage and distributing compensation for insured risks successfully (Lucas, 2015).

Identifying issues to improve understanding of disaster risk

Gaps and challenges	Opportunities and actions
• While climate impact risk assessments are now mainstreamed within most PIC governments and international development agencies' project investment and design processes, the assessments to cover the full range of specific disaster risk requirements need to be more comprehensive, integrated, or systematic. • There is no one single reference source or data repository for climate projections, and geological and other disaster hazard risks.	• There is a need to use information on geohazards and climate projections for the lifespan of the asset. • Recognize the critical importance of awareness-raising among local communities, and engage with relevant stakeholders to foster common understanding of disaster and climate risks and resilience. • Prioritize infrastructure investments that select low-risk locations when feasible.

Further support is required to:

- Strengthen the capacity of national/regional technical agencies to use and maintain the PacRIS database.
- Update risk information and underlying data, including risk exposure databases.
- Expand the reach and access to the data-sharing platform through the SPC Geoscience Programs.
- Develop country risk atlases and other knowledge products to effectively communicate risk information to policymakers and decision-makers to assess their exposure to natural hazards and impacts of climate change.

4.2 Priority 2: Strengthening disaster risk governance to manage disaster risk

The primary objective is to mobilize and align all support for Pacific governments to better integrate climate change and disaster risks into key sector policies and budgets. For example, the Fiji *Climate Change Act 2021* recognized the power of the Minister to make regulations and develop policies for the construction of sustainable, low-emission, energy efficient and climate-resilient infrastructure and buildings; and emphasized proper risk assessments and building codes to make public infrastructure and physical assets resilient to climate change.

> However, governance today is often ill-equipped to deal with complexity and long-term risks. It is alternative modes of decision-making that enable more anticipatory and future-fit governance for development.

To enhance the resilience of infrastructure through strengthened governance, there is also a need to understand the performance of existing infrastructure, its exposure, current regulatory environment, challenges and barriers, coordination across various stakeholders and options to integrate resilience. This process also requires that common understanding of "critical infrastructure resilience" is built, based on certain criteria that can serve as a compass for governments, the private sector, and other stakeholders (UNDRR, 2022).

Regional support for disaster risk governance

In 2016, the Pacific Island Forum leaders endorsed the regional *Framework for Resilient Development in the Pacific (FRDP) 2017–2030* (SPC et al., 2016). Recognizing that building resilience has to be an inclusive, genuine and active multi-stakeholder partnership, leaders in 2017 endorsed a set of governance arrangements for the Pacific Resilience Partnership to support and facilitate effective implementation of the FRDP. Regional cooperation, particularly among Pacific Islands Forum Officials Committee, SPC and SPREP Governing Councils, is key to the successful implementation of the FRDP.

The UNDP Governance for Resilient Development in the Pacific Project (Gov4Res) promotes risk-informed development, including green public finance management, climate budget tagging, and risk screening toolkits for developing local proposals (UNDP, n.d.). These practices should be expanded and made available to improve infrastructure climate and disaster resilience.

Strengthening national governance systems

The World Bank, in June 2015, approved USD 32.29 million in International Development Association grants and credits to support the Pacific Resilience Program (PREP) – a series of projects to strengthen Pacific island countries' resilience to extreme and disastrous events. The programme initially provided assistance to Samoa, Tonga, Marshall Islands and Vanuatu, as well as SPC and the Pacific Islands Forum Secretariat. This assistance:

- strengthened early warning and preparedness
- retrofitted key public assets to meet international resilience standards
- created a framework for smarter investment in resilience activities
- improved financial resilience by enabling access to an immediate injection of funds for post-disaster recovery.

> The PREP also helps to consolidate and avoid duplication of resilience initiatives across the Pacific, and to effectively train local institutions, civil society groups, village communities, community volunteers and groups in disaster risk management and climate resilience.

Role of National Disaster Management Offices (NDMOs)

Over many years, national offices have been established in many PICs to address disaster recovery strategies, while also acting as the government agency responsible for coordination of preparation, planning and responses to emergencies and disasters, and to coordinate disaster risk management and climate change adaptation into sectoral plans, policies and budgeting. These include those listed below:

- American Samoa: Territorial Emergency Management Coordination
- Australia: National Emergency Management Agency
- Cook Islands: National Disaster Management Office
- Fiji: National Disaster Management Office
- Federated States of Micronesia: National Disaster Management Office
- Nauru: National Disaster Management Office
- New Caledonia: La Direction de la Sécurité Civile et de la Gestion des Risques
- New Zealand: National Emergency Management Agency
- Niue: National Disaster Management Office
- Northern Mariana Islands: Homeland Security and Emergency Management
- Palau: National Emergency Management Office
- Papua New Guinea: National Disaster Centre
- Republic of the Marshall Islands: National Disaster Management Office
- Samoa: National Disaster Management Office
- Solomon Islands: National Disaster Management Office
- Tonga: National Emergency Management Office
- Tuvalu: National Disaster Management Office
- Vanuatu: National Disaster Management Office.

Case study: Fiji

The Fiji NDMO has published a *National Disaster Risk Reduction Policy 2018–2030* (Ministry of Disaster Management and Meteorological Services, 2018), which represents a major contribution to the achievement of Target E of the Sendai Framework, with a strong, integrated and inclusive approach to mainstreaming DRR investment into all relevant policies, plans and practices. It is also populated with a number of Success Stories that illustrate positive and practical delivery of the policy objectives at national and local level.

Coordination across multiple ministries

However, NDMO offices, and the responsibility for climate and disaster risk strategies across national government, typically sits within different line ministries, with varying resources, capacity and ability to coordinate, integrate and streamline policies and actions across multiple government departments. Meanwhile, national infrastructure investment planning is mostly the domain of ministries of infrastructure, aid coordination and planning, finance and others, within the context of national and provincial strategic development plans.

To improve coordination of national planning processes, since 2010 the PRIF has assisted PIC governments to develop 10-year strategic infrastructure development frameworks, mostly titled National Infrastructure Investment Plans or NIIPs.[7] So far, 11 PICs have implemented NIIPs, with several entering their second or third iterations; recent examples include Cook Islands, Palau and Tonga. The prioritization framework

[7] See https://www.theprif.org/national-infrastructure-investment-plans for National Infrastructure Investment Plans (NIIPs).

Afonotele Elementary School campus in Afono village, American Samoa. Photograph: J nel/Shutterstock.com.

methodology ranks prospective projects using a multi-criteria analysis, taking account of other relevant frameworks and strategies, to focus on project investments that best align with the development priorities of the individual countries. In the case of Tonga, PRIF is now supporting the government to update the NIIP in light of the damages and recalibration of infrastructure priorities since the January 2022 volcano and tsunami disaster.

Considerations of climate change adaptation and disaster risk reduction are now prominent in these and other project planning processes, and it is likely that climate resilience and sustainability will become an increasingly integral criteria for donor funding over the short and medium terms. In the case of Cook Islands and Tonga, dedicated sections on climate change, and natural disaster risks and resilience are included, and in sector-by-sector assessments specific attention is often given to cyclone shelters and coastal protection. Another notable feature, for example, in the Cook Islands NIIP, is the full list of climate change and disaster resilience projects and the articulated "expectation that climate change and resilience will be integrated into national policies, planning, and programs across various sectors, in addition to international or bilateral development aid policies and programs. Any climate change-related initiative by any stakeholder can be potentially financed through international climate financing provided it meets the country's priority areas, as elaborated upon in the Cook Islands Climate Change Country Program" (PRIF, June 2021).

Resilient infrastructure investment planning

To further support PICs to develop country-specific systems and frameworks for prioritizing infrastructure investments, PRIF has recently published a *Guideline to preparing National Infrastructure Investment Plans*, which details best practice approaches and methodologies throughout the investment planning process. Significantly, it includes a full account of "How does the plan help you build resilience?" (PRIF, July 2022).

Pacific countries have different national institutional and governance arrangements, and local and provincial government structures based on geographical, social and political frameworks, so there is rarely a single focal point in terms of DRR governance. During the recovery phases especially, different departments and national/provincial governments take charge of sectors and levels of intervention, including schools, hospitals, social infrastructure, and humanitarian relief issues.

Case study: Vanuatu

In Vanuatu, the National Recovery Committee (NRC) (formerly the Cyclone Pam Recovery Committee) was established as a permanent structure by the Government Act Order No. 154 of 2018, responsible for oversight and governance of recovery projects funded by donor partners and the Government of Vanuatu. The Department of Strategic Planning and Aid Coordination under the Prime Minister's Office is the Secretariat for the NRC.

A recently approved Green Climate Fund (GCF) project in Vanuatu is regarded as an innovative project, as it will be implemented by local government and community organizations, following extensive consultations with communities living with the effects of climate change. The project will allow increased access to climate information and early warning data, support climate-resilient agriculture and fisheries, and improve economic opportunities for vulnerable communities. More than 200,000 people will benefit across the country and it has been hailed as game changing for one of the world's most climate-affected countries.

Identifying issues to strengthen DRR governance to manage disaster risk

Gaps and challenges	Opportunities and actions
• Incorporate climate and disaster resilience considerations in all planning and budgeting. • More investment is required in capacity building and supporting PIC governments to develop project pipelines that prioritize climate and disaster-resilient infrastructure, and implement these with both donor and private financing.	• PRIF is implementing the NIIP infrastructure planning programme, which integrates climate change, asset management, cost-benefit indicators, and budget parameters into infrastructure planning in most PICs. • Integrate NIIPs with national strategic development plans. • Integrate technologies that deliver resilience into existing buildings; e.g. water harvesting, and solar energy.

4.3 Priority 3: Investing in disaster risk reduction for resilience

For small island states, climate and disaster resilience is more than merely a budgetary safeguard – it's an economic imperative. Losses from major disaster events can easily exceed 100% or more of GDP for these particularly vulnerable countries, and set back development goals by decades or more. TC Pam in 2015 led to estimated economic losses in Vanuatu of USD 450 million or approximately 64% of GDP. On average, Vanuatu is expected to incur USD 48 million per year in losses due to disaster events (World Bank, 2016).

Existing infrastructure systems and the services they provide are increasingly being affected by disasters with a natural hazard origin as well as human-made hazards, and from the impacts of climate change. In the aftermath of these disasters, governments must divert public funding to rebuild instead of investing in new infrastructure to make up for existing deficits. This creates an "infrastructure trap" – vicious cycles of repeated climate shocks that risk halting economic growth and disrupting or even reversing progress towards the SDGs. Evidence shows that infrastructure disruptions impose significant costs in low and middle-income countries, and that investing in disaster risk reduction activities could avoid future losses significantly.

Systemic resilience

UNDRR has proposed the idea of a "Net Resilience Gain", to generate a strong economic case for resilience, and to match the "net zero" approach to greenhouse gas emissions. All infrastructure investments must be driven by a commitment to make a positive impact on systemic resilience of infrastructure and protect the ongoing supply of critical services. The introduction of new assets, and the decommissioning of old or damaged assets, results in changes to systemic resilience, as do changes in skills, abilities, aging of assets, and exposure to hazards.

Ensuring infrastructure resilience is a transnational issue, not confined to infrastructure organizations. The wider natural environment, society, technology, regulation, finance, and investment, all have an impact. The UNDRR work on Principles for Resilient Infrastructure highlights the value of taking a systemic perspective, especially the effect on resilience from the dynamics of structural changes to infrastructure.

Opportunities for resilient economic recovery

Investment in infrastructure development has long been viewed as an important part of economic recovery following a crisis, stimulating recovery efforts and resulting in job creation and revitalization of communities. Considering that governments around the world are now planning to invest heavily in infrastructure to expedite their recovery from the post-pandemic economic slowdown, it is imperative to ensure that such investments result in an inclusive, blue, green and resilient recovery.

To strengthen resilience for PICs, the Global Facility for Disaster Reduction and Recovery (GFDRR), a multi-donor partnership established in 2006, administered by the World Bank Group, has been developing targeted initiatives to bolster disaster preparedness and resilient recovery capacity, especially through innovative financial protection instruments (World Bank, n.d. a).

In October 2020, ADB announced that it would elevate its ambition to deliver climate financing to its developing member countries from USD 80 billion to USD 100 billion during the period 2019 to 2030. ADB's Strategy 2030 includes enhancing adaptation and resilience in responding to the climate change threat and addressing COVID-19 recovery.

While significant international climate finance is now flowing to the Pacific, the skills to deliver such programmes have mostly been sourced externally. To support local skills and capacity building, donors are increasingly providing assistance across different development sectors – in community resilience, energy, climate information services, policy and governance – with effective training and local community awareness programmes. The Vanuatu Skills Partnership, with Australian Government support, is helping the Ministry of Education and Training build the skills ni-Vanuatu need to adapt to climate change and move towards clean, affordable low carbon growth in tourism, agribusiness, handicraft and construction sectors. Women and men attend the ministry's Skills Centres for training courses in priority skills areas (for example, training for tour and bungalow operators to develop disaster action plans), and to access renewable energy (Vanuatu Skills Partnership, n.d.).

> It is also becoming evident that the public sector, especially in developing countries, cannot cater alone to the huge demands of infrastructure investments. The private sector must therefore play a pivotal role in addressing this gap.

De-risking infrastructure projects to stimulate private sector investment

If the economic recovery is to be stimulated through investment in infrastructure, it is vital that the risk profile of projects is further reduced so projects will be insurable and delivered in a timely and cost-effective manner. De-risking infrastructure projects, and taking a portfolio approach in managing risks, are envisioned to result in:

- affordable insurance premiums
- increased financial resilience after disasters
- improved construction and insurance business-enabling environment in the region
- facilitating participation of local contractors deemed too small and risky by insurers.

Moreover, a comprehensive de-risking solution has the potential to mobilize institutional private sector investments to co-finance infrastructure projects in the Pacific (PRIF, 2022b). The Global Center on Adaptation (GCA), the World Bank, African Development Bank, Asian Development Bank, European Investment Bank, European Bank for Reconstruction and Development, and other partners, have launched the *Knowledge Module on PPPs for Climate-Resilient Infrastructure* to help countries draw the private sector into financing climate-resilient infrastructure. In many sectors, there are government-supported advisory facilities that provide technical assistance and analytical support to help countries embed capacity to assess and integrate climate resilience into Public-Private Partnership (PPP) projects.

Innovative financing mechanisms

There are also many programmes and initiatives to develop innovative financial mechanisms and instruments that encourage building resilience into the infrastructure sector, including various adaptation, climate finance and catastrophic risk insurance approaches. These include the Pacific Catastrophe Risk Insurance Company (PCRIC), which developed from a pilot insurance programme launched by the World Bank in 2013 under PCRAFI (PCRIC, n.d.).

Accurately integrating physical climate risks (PCRs) in investment decision-making is challenging, both at the onset in relation to an asset's design, structure and initial investment, and over the life cycle of an asset as it is potentially refinanced and sold to other investors. In addition, transferring PCRs to insurers may not be a long-term viable option as risk probability and materiality rise – the cost of insurance may become prohibitive for specific risks and there is no certainty that the insurance market will continue to insure against certain hazards over the long-term. There is no currently recognized methodology for assessing PCRs at the asset level or incentives to report on such risk exposure.

> Developing a methodology to quantify the economic, social and financial benefits of incremental investments in resilience will provide a substantial and critical incentive for the financial markets and services to embed resilience upfront. The challenges, opportunities and implications should be addressed by a range of industries and sectors – engineering, data analysis, rating agencies and governments.

The International Monetary Fund (IMF) has developed a Public Investment Management Assessment Framework, which includes climate change and COVID-19 aspects, and which was adapted by PRIF to assess public investment management systems with PIC governments, focusing on infrastructure investments that increasingly consider climate risk exposure.

Case study: Tonga

Tonga is one of the PICs that has advanced policy and institutional reforms that enable access to climate and disaster risk finance. The government created a Resilient Development Finance Division within the Ministry of Finance, and Tonga is one of two PICs that has a national disaster risk finance strategy, which translates policy frameworks into action and identifies funding opportunities to build resilience against climate change and disaster risks.

Nature-based solutions

With stronger demands from all stakeholders to focus investments in "green infrastructure", there is growing awareness and attention paid to nature-based solutions, and approaches that create synergies between climate mitigation, adaptation, and social and ecological outcomes. Nature-based solutions can be cheaper and more sustainable than engineered solutions, and can offer benefits to local communities by unlocking potential for local economic development, often developing tourism potential. Improvements to coastal protection, for example, can often use plants, reefs, sand, and natural barriers to reduce erosion and flooding, while maintaining natural shoreline processes. Nature-based solutions are increasingly adopted for floods and storm surge management and managing drought conditions in combination with flood defences.

Opportunities for social inclusion

Applying a gender and socially-inclusive approach is also increasingly recognized and integrated in all infrastructure investments. Donors and international finance institutions have revised and adopted policies that enhance gender-responsive planning and management in infrastructure projects across the region. PRIF published a *Review of gender and infrastructure in the PRIF agencies* (PRIF, 2016) and *Inclusive infrastructure in the Pacific: Study on gender equality and social inclusion* (PRIF, July 2022b) to inform the practices of the development partners operating in the Pacific islands, by focusing attention on identifying and addressing gender equality and social inclusion in infrastructure throughout the project life cycle.

At the local level, a number of programmes are providing gender-positive enabling environments and opportunities to develop inclusive communities and workplaces. For example, the Markets for Change (M4C) project in Fiji is a UN Women project in partnership with the United Nations Development Programme (UNDP). It is a six-year initiative aimed at ensuring that marketplaces in rural and urban areas in Fiji, Solomon Islands and Vanuatu are safe, inclusive and non-discriminatory environments, promoting gender equality and women's empowerment. Market vendors are predominantly women, and marketplaces offer important venues to effect women's social and economic change, with secure, productive and sustainable work opportunities for women.

Gizo Market in Solomon Islands, for example, was designed to withstand wind speeds of a Category 5 cyclone and resist sea-level rises, with the market site raised above 2055 sea-level rise projections. With Australian Government support, and working closely with the women producers, the architects were provided specifications to meet women's needs and disability access, as well as current climate projections. The design includes a sea wall to protect the market and reinforced beams to withstand high wind speeds. Other design features include sustainable water supply and sanitation facilities, ramps for disability access, and an affordable, secure, clean energy supply.

The Tuvalu Coastal Adaptation Project (TCAP), supported by the Green Climate Fund, is designed to enhance coastal protection on the islands of Funafuti, Nanumaga and Nanumea. With a strong focus on inclusion, and gender equality considerations built into its initial design, and an ongoing Gender Strategy and Action Plan, women's participation in the project is assured. TCAP is also seeking to create short- and medium-term jobs for local labour, especially youth and women, during the construction phase, and further jobs will also be created after construction, with monitoring and maintenance needs to be filled by local labour (financed by island administrations).

Improving women's access to sustainable energy is essential to equitable and sustainable development across the Pacific, and the focus of *Gender equality and sustainable energy: Lessons from Pacific Island countries and territories*, a report by SPC, UN Women, and Women Count (June 2022). To promote women as key and informed users, decision-makers, and engineers of the region's sustainable energy solutions, the report recommends:

- improving women's and girls' access to technical education and professions
- ensuring women's equitable access to productive and financial resources
- broadening off-grid access to solar power

The coastlines of Tuvalu are among some of the most low-lying in the Pacific. Photograph: Australia Pacific Climate Partnership.

- increasing clean energy in the mix supplying the grid
- involving more women in energy decision-making
- improving the availability of data on gender and energy.

Improving infrastructure access for people with disabilities is the focus of a PRIF research report, *Improving accessibility in transport infrastructure projects in the Pacific islands*, in partnership with the Pacific Disability Forum (PDF) and PIFS. The report covers all modes of transport – aviation, road and maritime – and includes assessment of the current situation; technical guidelines related to design and construction of accessible infrastructure, and screening tools for assessing and auditing accessibility features (PRIF, ca. 2016).

Identifying issues to investing in DRR for resilience

Gaps and challenges	Opportunities and actions
• Developing infrastructure that strengthens community resilience and delivers socioeconomic and environmental co-benefits is a growing trend but requires significantly more investment.	• Leverage the potential of the public and private sectors working together to finance resilient infrastructure. • Scale up initiatives that support local employment in construction, maintenance and community engagement. • Further develop the concept of "net resilience gain", similar to Net Zero, whereby all infrastructure investments, not just those specifically targeted at enhancing the resilience of that system, must demonstrate that they enhance the systemic resilience of infrastructure and not damage the wider context (UNDRR, 2022).

4.4 Priority 4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction

Considerable studies were conducted in recent years with the aim of improving the resilience of infrastructure to disasters in the Pacific region, but most have targeted post-disaster reconstruction protocols, post-disaster assessment and recovery frameworks, strengthening capacity for recovery planning, and monitoring and disaster insurance provision.

National Building Codes (NBCs)

The role of building codes in adapting building requirements to prepare for future disasters and foster resilient Pacific communities is increasingly recognized. They provide minimum standards for safety, health, and general welfare, including structural and mechanical integrity, sanitation, water supply, light, ventilation, means of egress, fire prevention and control, and energy conservation. However, many PICs still have outdated, incomplete or unlegislated building codes, which are complex and expensive to enforce. Most Pacific countries have adopted Australian or New Zealand building standards when necessary and often on an informal basis. Challenges range from the high costs of construction materials to the lack of a skilled labour force needed for quality control, compliance and enforcement.

In 2021, PRIF completed a *Regional diagnostic study on the application of building codes in the Pacific*, which examined the National Building Codes of 13 PICs and assessed each country's capacity to apply their codes. As a result, the report recommends regional and national responses to strengthen building codes and standards. It also provides valuable information to guide future initiatives in building code updates, administration, management, compliance, and enforcement for PICs to ensure shelter and access to basic services (PRIF, August 2021). Case studies of building code and standards guidance were published for Solomon Islands, Fiji and Vanuatu.

Improving National Building Codes and Standards in the Pacific, is follow-up TA that seeks to:

- Coordinate across Pacific countries and partners to support the sharing of NBC best practice, leverage lessons learned and support regional initiatives.
- Support national efforts to improve NBCs, strengthen legislation and regulatory frameworks, and build capacity for the application and enforcement of codes, specifically responding to requests from Federated States of Micronesia, Kiribati and Nauru for technical support to initiate the development of an NBC or improve the existing NBC.

Case study: Fiji

ADB is supporting the revision of the Fiji National Building Code (FNBC), with a detailed review and assessment of the existing code, which is to include recommendations on how to incorporate disaster and climate resilience features, and strengthen government policies for the development of a resilient and safe building stock. The TA will review legal and institutional arrangements, recommend improvements in compliance enforcement and prepare an FNBC awareness and promotion strategy. Also included will be a new FNBC section on sustainability, based on the sustainability work currently being undertaken by the Global Green Growth Institute (GGGI) under the 2021 Fiji Low Emissions Climate Resilient Development Program. Fiji Ministry of Infrastructure and Meteorological Services and the Fiji National Disaster Management Office will also work to incorporate this into the FNBC. The sustainability section will:

- Address anticipated climate change impacts, including guidance on the management of sea-level rise and flood plain planning.
- Enhance resilience in the building sector.
- Promote resource efficiency (energy and water).
- Consider opportunities for integrating provisions on social inclusion/gender.

Case study: Solomon Islands

A focus on quality, nation-building infrastructure is a feature of the Solomon Islands Infrastructure Program (SIIP), Australia's flagship 10-year SBD 1.5 billion partnership with the Solomon Islands Government to create local economic opportunities through a large pipeline of infrastructure projects, launched in 2021 (SIIP, n.d.). Like many other Pacific nations, a largely unregulated approach to safeguard public buildings and structures led to poor quality infrastructure, which is unsustainable, unsafe or both. Technical assistance has been provided to modernize the National Building Code, which will soon be legislated to become a legally-binding regulation.

A range of contextual influences included the local environmental conditions, the availability of building materials, the sophistication of local construction delivery systems, building affordability and, most importantly, the capability of the local construction industry. With a plan to update the code every five years, new sections may be added, such as those relating to natural hazards, which encourage more climate-resilient infrastructure over time. It is important to recognize the need for an incremental approach to enable local industry and regulators to adjust to, and achieve compliance with, new regulations and standards. Complementary national technical training and awareness programmes are essential to ensure adoption of suitable skills and enforcement capacity.

Resilient housing programmes

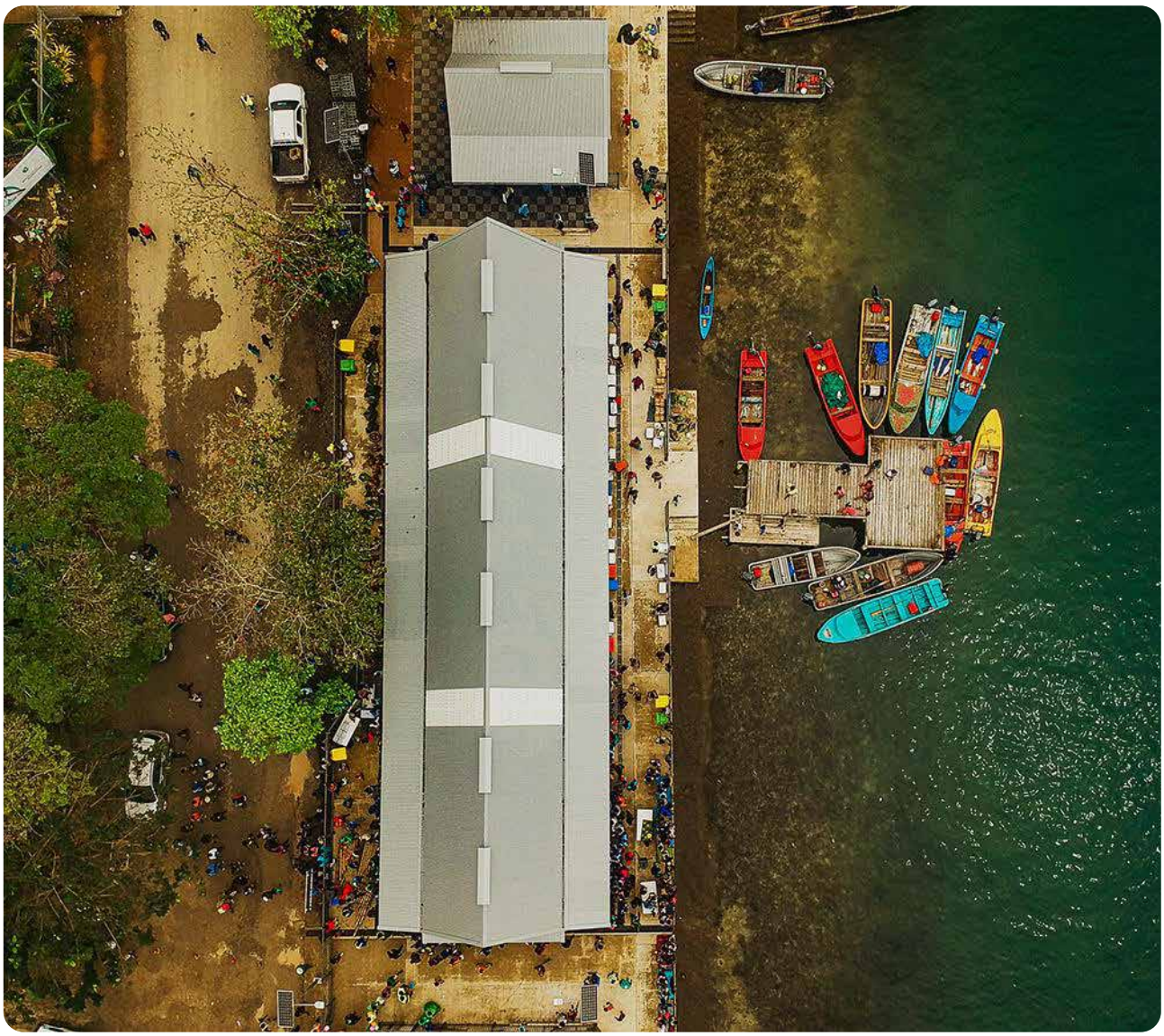
The Pacific Shelter Cluster[8] prioritizes provision of support to country-level clusters across the Pacific according to their specific needs, particularly following disaster events (Global Shelter Cluster, 2020). Shelter Cluster assessments following the 2016 Category 5 Tropical Cyclone Winston in Fiji indicated that much of the housing damage[9] was experienced by low-income households and came from the limited use of appropriate structural design principles (Habitat for Humanity Fiji et al., 2019). Reasons for this include lack of access to appropriate building technologies, materials and skills, compounded with the complex logistics required to transport materials and tools to affected island communities. Furthermore, the NBC (which requires structures to withstand the design wind speeds of a Category 3 storm) is not enforced in rural and informal communities, nor does it represent affordable or localized construction methods.

The New Zealand Government supports the construction of resilient housing in remote Fijian communities through a programme with Habitat for Humanity NZ and Fiji, as part of the Partnership for International Development's four-year Stand Strong project. Recommendations prescribe a best practice, community-centred approach, which promotes resilience with appropriate, affordable and accessible shelter support (Habitat for Humanity Fiji et al., 2019). Support to source locally-available materials with reliable suppliers, payment methods, and resilient supply chains, reinforces existing capacities and locally-identified solutions to meet these challenges and decrease reliance on externally-purchased material supply chains.

The *Fiji Shelter Handbook* (Shelter Cluster Fiji, 2019) is the first of three national shelter guidelines for Fiji, Vanuatu and Solomon Islands that are being published under the Australian Humanitarian Partnership Disaster READY programme, which aims to increase knowledge of disaster-resilient construction techniques and methodologies, and safer shelter practice, as well as the capacity of responding stakeholders to deliver better coordinated, more efficient and safer disaster response and recovery construction.

[8] The Shelter Cluster is an Inter-Agency Standing Committee coordination mechanism that supports people affected by natural disasters and conflicts with the means to live in safe, dignified and appropriate shelter. In Fiji, the Shelter Cluster is led by the Ministry of Housing and Community Development, and co-led by the International Federation of the Red Cross and Red Crescent Societies and Habitat for Humanity Fiji.

[9] According to Habitat for Humanity Fiji et al. (2019), 30,000 homes were damaged or destroyed by TC Winston in 2016, representing the greatest loss to Fiji's housing stock by a single event.



Gizo Market, Solomon Islands, from the air. Much important infrastructure in the Pacific is located immediately on the coastline. Photograph: Australia Pacific Climate Partnership.

Planning for post-disaster solid waste management

To assist in dealing with the generation of large volumes of solid waste following disastrous events like tropical cyclones, floods and earthquakes, a number of Pacific regional programmes support PICs to mainstream disaster waste management (DWM) through preparedness, response, recovery and reconstruction. Waste is often a challenge requiring an immediate response; for example, roads blocked by bulky waste, power lines down, stranded plastic and other debris pollution, and asbestos materials, all posing a significant health risk to the public, response workers and the environment.

Having developed Regional Disaster Waste Management Guidelines, the J-PRISM II programme, funded by the Japan International Cooperation Agency (JICA), in partnership with SPREP, implements projects to reduce damage to infrastructure, strengthen regional DWM capacity and promote “Build Back Better” following disasters (SPREP, n.d.). Similarly, the Disaster Waste Regional Project by the European Union (EU)-funded PacWastePlus programme, also hosted by SPREP, is designed to guide participating countries to establish structured disaster waste planning and management activities to reduce vulnerability and contribute towards protecting communities’ livelihoods, health, cultural heritage, socioeconomic assets, and ecosystems, thus strengthening disaster resilience (SPREP & PacWaste Plus, 2020).

Identifying issues to enhance disaster preparedness for effective response

Gaps and challenges	Opportunities and actions
• Disaster waste management issues are not typically included in operational plans of NDMOs. • Compliance with National Building Codes is complex, challenging and expensive to enforce. • There are high costs and lack of suitable building materials.	• Expand support for the revision of National Building Codes, and address the gaps in capacity for compliance, enforcement, education and community awareness, as outlined in the PRIF Regional Diagnostic Study. • Extend the coverage and application of Pacific Shelter Cluster guidelines to improve resilience in the housing sector. • Include DWM in sectoral infrastructure Post-Disaster Needs Assessments.

5. Fostering regional and international cooperation – two examples

The Sendai Framework acknowledges that developing countries require continued international support, with enhanced capacity and resources, through cooperation, coordination and global partnerships for development, to strengthen their efforts to reduce disaster risk. Vulnerability to the impacts of climate change and disasters requires the urgent strengthening of international cooperation and ensuring genuine and durable partnerships at the regional and international levels to support developing countries to implement the present framework, in accordance with their national priorities and needs.

5.1 Example 1: Infrastructure for Resilient Island States

The Coalition for Disaster Resilient Infrastructure, with support from member countries and partner organizations, such as the Governments of Australia, United Kingdom, India, USA, Japan, and agencies such as the EU, UNDP, UNDRR, World Bank and ADB, has established IRIS, a dedicated initiative co-created by SIDS that will provide technical support on multifaceted issues related to infrastructure systems to promote disaster and climate resilience in SIDS.

Aligned with the policy direction of the SIDS Accelerated Modalities of Action (SAMOA) Pathway, and with the collaboration of the Alliance of Small Island States (AOSIS), the goal of IRIS will be to support SIDS in achieving sustainable development through a systematic approach to resilient, sustainable, and inclusive infrastructure.

The CDRI is a partnership of national governments, UN agencies and programmes, multilateral development banks and financing mechanisms, the private sector, and knowledge institutions, which aims to promote the resilience of new and existing infrastructure systems to climate and disaster risks in support of sustainable development. CDRI works to support the coalition members to promote disaster-resilient infrastructure for reducing economic losses and improving well-being of communities in the face of disaster risks. For the Pacific region, Australia and Fiji are current members (CDRI, n.d.).

5.2 Example 2: Pacific Region Infrastructure Facility

PRIF is a leading example of an effective infrastructure donor coordination mechanism and a proven model for effective regional cooperation. Established in 2008, and supported by the major multilateral development agencies active in the Pacific, including ADB, World Bank, European Investment Bank (EIB), EU, and the government aid agencies in Australia, Japan, New Zealand, and the United States of America (USA), it provides technical assistance to 13 PIC governments, cooperation with regional organizations, a donor coordination platform, and knowledge-sharing benefits across all practitioners, project developers, planners and other stakeholders.

Avoiding duplication of effort, researching technical reports, developing guidelines, and enabling rationalization, prioritization and alignment of project pipelines, are some of the strategic and practical benefits to the donor agencies and PIC governments alike. The PRIF has been able to play a unique and effective role in supporting development of, and catalysing support for, climate and disaster-resilient infrastructure, through its focus on best practice, sharing of knowledge, and the provision of specialist technical assistance to increase local infrastructure policy, planning and management capability.

PRIF is now in its 14th year, nearing the end of its current fourth phase, with USD 12.6 million funding over four years. The PRIF Coordination Office is based in ADB's Pacific Liaison and Coordination Office in Sydney.

6. Looking ahead to 2030

The ADB estimated that the Pacific region requires USD 3.1 billion annually to fully address its infrastructure needs. Similarly, other estimates indicate the infrastructure shortfall in the Pacific, including Timor-Leste, to be USD 46 billion from 2017 to 2030, or approximately USD 3.2 billion annually. As a percentage of GDP, the Pacific requires greater levels of infrastructure investment compared with other regions (PRIF, ca. 2022).

> In light of COVID-19, the Lowy Institute considers that the Pacific is facing "a lost decade of development", with projected increases in the number of people in poverty and youth unemployment, a downward pressure on budgets, and an increased likelihood of social and political disturbance (Rajah, 2021).

International commitments for the Pacific COVID-19 response were estimated at USD 3.3 billion in October 2021 (equalling 10% of the region's GDP), but this has not matched the scale of the crisis (Rajah, 2021). Beyond addressing the immediate needs, the Lowy Institute argues for a multiyear recovery and rebuilding programme, in which infrastructure would play a critical role. They estimate that, to avoid a prolonged crisis, another USD 3.5 billion in international funding is needed per year in addition to existing commitments (Rajah, 2021).

Climate change (and related weather uncertainty) has become a major existential threat and an ongoing global security issue. It represents a constellation of risk exposures that threaten human and environmental security as well as socioeconomic stability on multiple levels; it is a significant threat multiplier. While the occurrence of climate/weather disasters cannot be prevented, the severity of the destruction that they bring can be limited; this is a central tenet of the Sendai Framework and a central issue examined in this report. Similarly, the emergence or re-emergence of infectious disease, while less difficult to prevent, is obviously as devastating, as experienced globally over the past 12 to 24 months. In the case of PICs, reducing their vulnerability to climate-driven disasters and the effects of pandemic disease is critically important. Sustained and coordinated effort is needed (ASPI, 2020).

6.1 Future-proofing economies and communities

Indeed, the very word "**resilient**", in the context of equipping infrastructure, communities, institutions and economies with the means to withstand elevated and predicted climate change impacts and other physical, biological and other natural hazards, is a term now almost universally applied by all major donors, development partners and governments when designing, investing, procuring and implementing infrastructure projects, especially in high risk, vulnerable regions like the Pacific islands.

For example, the pipeline of 16 Green Climate Fund and 11 Adaptation Fund implemented and completed projects to date in the Pacific all address very specific national and/or regional climate mitigation and adaptation, coupled with disaster-resilient infrastructure and community needs. Indeed, in 9 of 11 Adaptation Fund projects, the terms "resilience", "adaptive capacity", "vulnerability" and other disaster-related concepts

are included even in the project titles. Similarly, all GCF projects are funded on the basis of their capacity to deliver climate mitigation, adaptation and cross-cutting benefits, which build resilience in the infrastructure sector (UNDP et al., 2021).

In the *Special report: A Pacific disaster prevention review* (ASPI, 2020), edited by Dr Paul Barnes, the several authors from PNG, Solomon Islands, Tonga, Vanuatu, Samoa, Fiji, Nauru and Kiribati give their thoughts on what would progress DRR into the future, following comments by Dr Robert Glasser, former Special Representative of the UN Secretary-General for Disaster Risk Reduction and Head of the UNDRR.

6.2 Localising the Sendai Framework to community level

Since an additional consideration is the usability of the Sendai Framework when incorporating local knowledge and skills and promoting collaboration and the inclusion of local capabilities and culture, the ASPI report also explores some generic themes and options to enhance the 'fit' of the Sendai Framework to local needs. For example, this includes "recognising the importance of engaging effectively with local private sectors and wider civil society in supporting DRR efforts and risk communication outcomes, because community recovery rests on a viable economy", and "acknowledging and documenting traditional knowledge supportive of self-protection and risk communication that can increase community and regional resilience" (UNDP et al., 2021).

To contribute to this agenda, the PRIF 2021 study on *Enhancing procurement practice and local content in Pacific infrastructure* considered how local content in infrastructure projects in the Pacific might be enhanced, focusing on the 13 PRIF member PICs. It aims to contribute to a greater understanding of the social and economic costs and benefits of local content in the delivery of infrastructure in the PICs and to identify opportunities for improving procurement practices to facilitate local content in infrastructure delivery (PRIF, ca. 2022).

Case study: Tonga

Following the Hunga Tonga–Hunga Ha'apai volcanic eruption in January 2022, which resulted in tsunami waves that damaged 600 structures in Tonga, including at least 300 residential buildings, some on nearby islands, a total of 1,525 persons from 317 households were displaced. Initial assessments, made in light of the Tonga COVID-19 lockdown restricting entry for foreign construction firms and engineers, indicated a strong demand for domestic contractors to implement the rapid response aid programmes that included prefabricated temporary housing to support those families who had lost their homes.

Clearly, therefore, an essential element to deliver resilient infrastructure is developing a sustainable local capability to design, build and maintain it. One of the levers available in the local capacity building toolbox is procurement methodology – in the case of the Australian Government's approach, a Social Procurement Policy covers all aspects of sustainable procurement outcomes – quality, safeguards, gender equality, disability and social inclusion (GEDSI), and local content. It applies across all of Australia's aid programme for infrastructure investment, and includes:

- optimising employment of the local workforce
- procuring goods and services locally (physical works delivery and other ancillary services)
- investment in training the local workforce and local supplier development.

The importance of local contractor participation is emphasized in tender evaluation criteria, which are designed to give weighting to this element, and with a requirement to submit a Local Contractor Participation Plan to incentivize local job creation.

6.3 Policies fit-for-purpose for Sendai Framework and beyond

It is a function of the Sendai Framework MTR to examine and interpret these and other experiences of the past seven years, particularly in the context of recent and ongoing post-disaster actions, assessments and the evolution of disaster risk management programmes. PIC governments, development partners and all other stakeholders will learn from the lessons and determine how these activities influence and inform improved policies and approaches, to ensure disaster risk reduction, disaster preparedness and response are "fit-for-purpose" over the next seven years and "beyond Sendai".

It will be critically important to further integrate and promote resilience into both social and economic infrastructure sectors at the core of disaster preparedness, and further refine the concepts of "Build Back Better" in recovery, rehabilitation and reconstruction.

The Outer Island Renewable Energy Project (OIREP) increased the reliability, efficiency and affordability of power in nine of Tonga's outer islands, including the island of 'Eua where a solar farm was installed. Photograph: Johnny Lillis/OIREP.

7. Annexes

Annex 1. Summary of opportunities to build disaster-resilient infrastructure

The figure below is from: Asian Development Bank. (April 2022). *Disaster-resilient infrastructure – Unlocking opportunities for Asia and the Pacific.*

Figure 2: Opportunities to Build Infrastructure Resilience across Asia and the Pacific

Setting objectives for disaster resilience (Section 3)			
Barrier: Objectives are set with a focus on preventing asset-level loss and damage after a disaster → **Opportunity 1:** Broaden disaster resilience objectives			✓
Barrier: Resilience investments are not consistently coordinated with development strategies → **Opportunity 2:** Integrate resilience objectives into long-term development strategies	✓	✓	
Assessing disaster risk and potential impact (Section 4)			
Barrier: Application of risk assessments to infrastructure projects is limited → **Opportunity 3:** Develop a shared understanding of critical infrastructure risks	✓	✓	
Barrier: Quantitative analysis is insufficient → **Opportunity 4:** Promote the use of standardized, replicable approaches to making decision-relevant risk assessments	✓	✓	
Barrier: Up-to-date, high-quality data are sparse and data access is restricted → **Opportunity 5:** Use open-source data, risk models, and software in conducting high-level risk assessments			✓
Prioritizing infrastructure resilience investments (Section 5)			
Barrier: Hard engineering solutions are often prioritized → **Opportunity 6:** Consider the use of nature-based solutions when building, upgrading, and maintaining infrastructure			✓
Barrier: Resilience benefits are shared across stakeholders and difficult to quantify → **Opportunity 7:** Conduct stakeholder engagement and multi-criteria assessments to compare investment options		✓	
Barrier: Infrastructure has a long lifetime and climatic and socioeconomic circumstances are uncertain → **Opportunity 8:** Use dynamic adaptive policy pathways to manage future uncertainty	✓		
Operating and maintaining infrastructure to promote resilience (Section 6)			
Barrier: Maintenance is de-prioritized in favor of capital spending → **Opportunity 9:** Prioritize asset maintenance to avoid costly repairs	✓	✓	✓
Barrier: Critical service delivery is disrupted after disasters → **Opportunity 10:** Develop well-coordinated emergency response plans	✓	✓	✓
Scaling up financing for resilient infrastructure and disaster response (Section 7)			
Barrier: Climate finance is heavily focused on mitigation efforts → **Opportunity 11:** Increase use of climate finance for resilience	✓	✓	
Barrier: Further private financing is needed to meet resilience needs → **Opportunity 12:** Mobilize private financing for resilience investments	✓	✓	
Barrier: Risk transfer options and benefits are not clearly understood → **Opportunity 13:** Enhance the use of risk transfer instruments to improve disaster response	✓	✓	
Barrier: Deployment of funds post-disaster can be inefficient → **Opportunity 14:** Make finance conditional on disaster recovery planning	✓	✓	
Designing institutions to support infrastructure resilience (Section 8)			
Barrier: Mismanagement of risk ownership creates moral hazard or inequitable burden sharing → **Opportunity 15:** Encourage risk ownership through risk-sharing arrangements and enforcement	✓	✓	✓
Barrier: Priorities differ and decisions are decentralized → **Opportunity 16:** Set up governance structures to guide coordination between government, infrastructure operators, and financiers	✓	✓	✓
Target audience	National government	Sectoral ministries	Infrastructure owners/operators

Source: Vivid Economics.

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Banban Primary School's new classrooms on the island of Santo, Vanuatu, withstood the Category 5 TC Harold, and were used as an evacuation centre sheltering some of the school students and their families. Photograph: Alex Bortoli.