Resilient Infrastructure Good Practice Guide (RIG Guide)

Resilient infrastructure for resilient communities

2023

Australian Aid | Australia Pacific Climate Partnership

The Resilient Infrastructure Good Practice Guide (RIG Guide) was developed by the Australia Pacific Climate Partnership (Climate Partnership) with contribution and review from Engineers Without Borders Australia and Alexander and Lloyd Australia Pty Ltd, and through consultations with key stakeholders.

Contents

Cover: An Australian-funded school on South Tarawa that demonstrates good practice in resilient infrastructure, Kiribati.
Credit: Nicholas Harding, Kiribati Education Improvement Program.

Purpose

The purpose of this guide is to provide overarching principles and actions for development of infrastructure to ensure assets are resilient to climate and disaster risks for their life, based on inclusive design and stakeholder engagement, while also building broader community resilience, and where possible, supporting improved capacity of individuals, industry and governments.

Context

Pacific Island nations are highly vulnerable to the impacts of hazards such as tropical cyclones, earthquakes, tsunamis, volcanic eruptions, landslides, droughts, floods, storm surges, and coastal erosion. Climate change is intensifying weather patterns and associated disasters, as well as driving sea level and temperature rises, ocean acidification, and coral reef loss. These changes escalate the risks to infrastructure, causing impact, damage and failure to function of assets, compounding impacts to communities, economies and livelihoods.

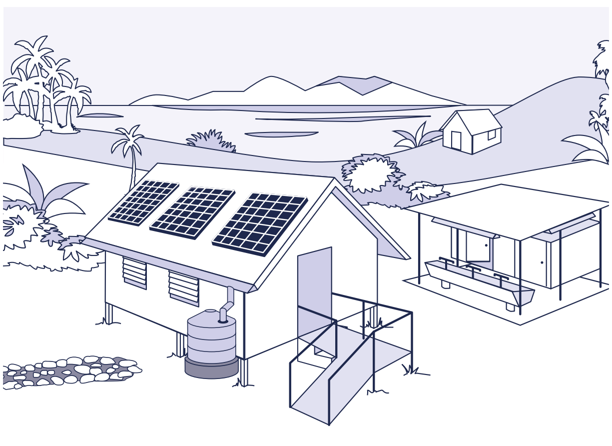
Scope

The Resilient Infrastructure Good Practice Guide (RIG Guide) is a set of principles and actions for use by practitioners working on infrastructure programs and projects.

Its use will ensure that infrastructure assets are planned and budgeted for, designed, built, managed and maintained to a level that appropriately reflects the climate and disaster risk, design working life, equitable access and structural design building importance level, and wherever possible promotes wider community resilience.

While the RIG Guide is applicable at any stage of the program or project cycle, its incorporation during project business case development and early concept stages of infrastructure development will achieve the greatest impact and increase the likelihood of achieving successful outcomes. Incorporation at a later stage of program or project cycle will generally be less effective and more costly. The RIG Guide includes both principles and actions that should be consistently applied at every stage of a program or project to ensure that variation creep does not divert project from the initial objectivity and decisions.

Imagine, for example, a school facility built to withstand tropical cyclones, in a location avoiding flooding and sea level rises with water harvesting for the school and local community. Or, imagine a market built to withstand earthquakes, allowing women farmers to continue to sell during a recovery period with safe accommodation and renewable energy for refrigerated storage of produce.



Principles for Resilient Infrastructure

1. Assess risk

Identify probable weather, climate and geological risk and social vulnerability prior to the design of a project, to allow stakeholders to make informed decisions.

Climate change, extreme weather and geo-hazards have the potential to result in a disaster if stakeholders, communities and infrastructure are exposed and vulnerable. Infrastructure development should therefore be informed by current and future projections of risks, social vulnerability and local knowledge. Comprehensive multi-hazard risk assessment, including climate change projections, allows the likelihood and impact of all hazards to be quantified; ensuring that location selection and designs are risk-informed. This includes risks to the asset, services and people who will build, operate and access them, incorporating vulnerability and capacity to adapt. A Risk Register is an integral part of the business case and concept design, and as a reference for the design working life of the asset.

2. Reduce risk

Reduce probable risks by ensuring development and implementation of climate and disaster resilient design criteria, design standards and management strategies.

Design standards and criteria are responsive to the risk assessment to reduce risk for the asset, service, the users and community. A holistic approach to increasing resilience requires that a risk reduction strategy does not unintentionally increase or shift risk to another stakeholder. For example, raising a health centre to avoid flooding and sea level rises can increase risk for people with disabilities unless accessibility is central to the new design. Technical understanding for decisions on risk reduction delegated to technical experts such as engineers will ensure that this understanding is integrated into the design. Collaborating with stakeholders requires appropriate consultation with representation from groups such as national government; civil society, users and community; asset operators and system managers; customers; employers and workers; finance and budgeting committees; and insurers and donors. Consultations may require separate focus groups within the community, based on contextual diversity.

Technical understanding for decisions on risk reduction are to be delegated to technical experts such as engineers, who will ensure that this understanding is integrated into the design. A cost benefit analysis can identify the longer-term savings of resilient infrastructure from risk reduction in design.

Engage stakeholders to ensure national, community and traditional knowledge of climate and disaster risk is incorporated.

3. Design and plan for the life of the asset

Understand and design for the whole life-cycle of the asset to ensure exposure to weather, climate and geological risks can be reduced. Risk-reduction and resilience-building measures are to be sustained throughout the design life.

Take into account both the functional design of the asset and the risks predicted for the specified period. Plan for probable changes in climate and disasters for the design working life. Develop a plan for whole of life-cycle of the asset through analysis and in consultation with stakeholders.

Specific stakeholders should be involved in the decision-making about the asset design working life to ensure that the technical and resource capacity (material and financial) of those responsible for maintaining the asset are reflected in the design and ongoing management and resourcing arrangements.

It is essential that there is a clear understanding of the plan to management the level of operations and maintenance budget, operator skills, human resources, and the quantity, quality and cost of consumables required to meet the performance criteria.

4. Build performance and resilience

Holistically consider the local context and the different ways in which the asset will be used throughout its life to ensure maximum functionality, increased benefits and broader resilience for the whole community.

Identify ways for the asset to contribute to broader national and community climate and disaster resilience through seeking a diversity of perspectives. For example: use sustainable and low carbon materials and practices; integration of renewable energy to reduce energy costs and build energy security; ventilation, shading and passive climate control design to reduce energy consumption; water harvesting and vegetated wastewater systems to increase water security; and overnight accommodation to reduce travel for women and children.

Opportunities may exist for value adding through multi-purpose or out-of-hours use; and introducing the concept of 'Long life – loose fit', ensuring that the overall fabric of a building can be re-used and re-purposed if and when the original need or use is no longer relevant.

Ensure that the infrastructure does not cause harm to users and communities as well as the natural environment.

A physical asset is likely to have different requirements before, during and following a disaster, with implications for the importance level, typology and size of the asset, as well as access, building services and building systems required to accommodate all planned uses. Building type selection and performance levels are also determined by the national government codes, legislation, governance systems, site conditions, and local skills and expertise.

5. Be inclusive

Ensure accessibility, inclusivity and usability for all users and members of the community as well as build capacity.

Engage with stakeholders to identify needs, access to services, and design criteria to be inclusive to all people all the time. People at higher risk and those who are marginalised experience disproportionate impacts from disasters and climate changes, as well as disadvantage related to accessibility and usability of infrastructure. Holistically consider social inclusion to increase the resilience of at risk and marginalised people. Specific effort is made to engage the full diversity of the community early and throughout the process. People are provided the support they need to participate fully, reflect on past experiences and to effectively engage and express their needs. This is because even if people are physically present during consultations, barriers such as social norms and discrimination may prevent them from feeling comfortable to speak. Consultations may require separate focus groups within the community, based on contextual diversity.

Local expertise, knowledge and experience is used to complement external contemporary knowledge. Build partnerships with local communities, organisations and governments, across disciplines and sectors that are genuine and meaningful.

Wherever possible, build local professional and institutional capacity for assessing risks, climate and disaster resilient design, construction and maintenance. Strengthen government systems and policy (e.g. building codes) and industry capability to ensure an enabling environment for resilient infrastructure planning and implementation.

GOOD PRACTICE ACTIONS

These actions articulate good practice outcomes for programs and projects to build climate and disaster resilient infrastructure for resilient communities.

These actions have been put into general categories of project management and design. Project managers will need to ensure that all of the actions are undertaken. Technical experts such as engineers and architects will be engaged in the design as well as other project management actions.

Technical experts will also be engaged for identifying and assessing risks and other tasks such as stakeholder engagement and inclusion actions, however, this is included in project management as it is anticipated that this would be overseen by a project manager.

General examples have been provided to illustrate broad concepts. Targeted actions, specifications and designs will need to be developed for each project.

Project Management: General

Incorporate resilience in business case, budget, tenders and contracts

Climate and disaster resilience is built into the business case development stage to ensure its inclusion in the concept proposal.

The budget allows for actions to ensure climate and disaster resilience of assets, and accessibility and inclusion measures.

Tenders and contracts for contractors include the key elements of the RIG Guide to ensure that bids and agreements include the required elements for integrating climate and disaster resilience.

Build a capable team

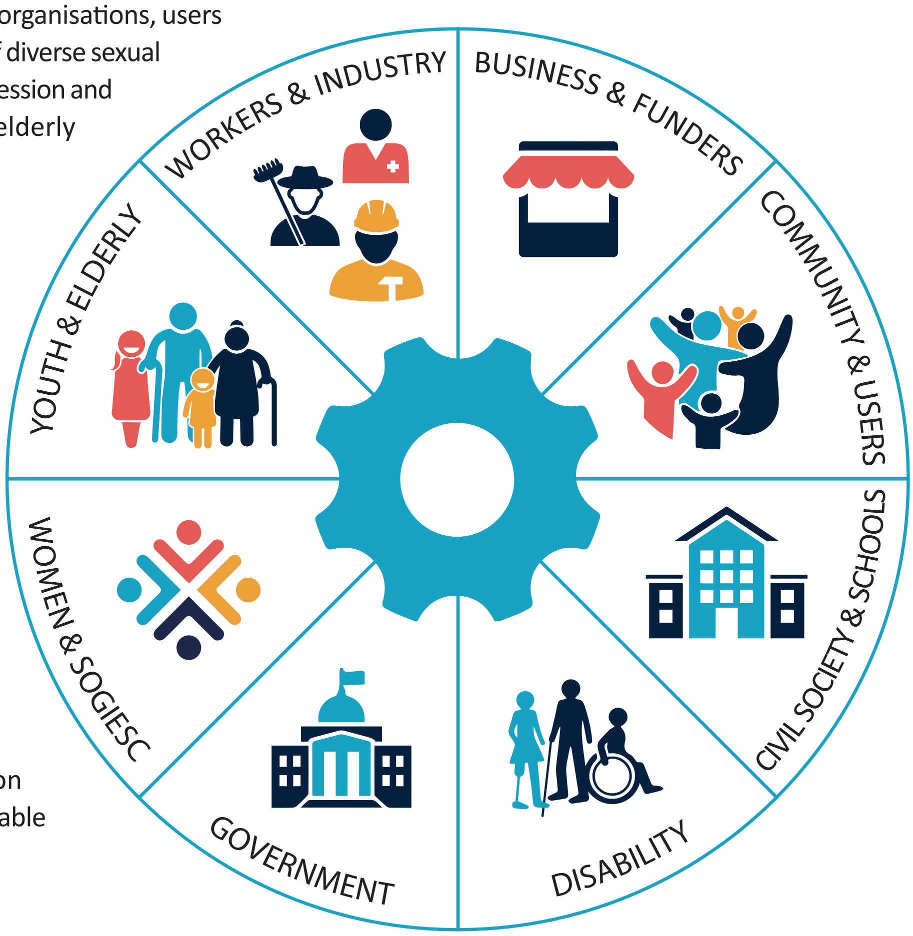
Engage a diverse team of practical and experienced expert practitioners with skills and capability to provide international best practice and local experience. In additional to technical and project management capabilities, specific expertise may be needed for actions such as risk assessment, life cycle analysis, design, stakeholder engagement and gender equality and social inclusion.

Consult with stakeholders and users early and throughout the process

Consult stakeholders early in the process to inform risk assessment and reduction, operational life, location, design criteria and specifications and for integration of gender and social inclusion, safety, protection, and resilience building actions. Stakeholders are consulted to assess usage requirements and to inform building location (at the selected site), typology, components, design and appropriate maintenance to ensure outcomes are achieved and sustained. Stakeholders will be specific to each project, however, they may include (but not limited to) national government agencies, funders, businesses, civil society, schools, industry and worker groups, community groups and organisations, users and communities, women and people of diverse sexual orientation, gender identity, gender expression and sex characteristics (SOGIESC), youth, elderly and people with disabilities.

Ensure meaningful participation

Engage those who will use or are affected by the infrastructure in meaningful participation and decision-making. Specific effort is made to engage the full diversity of the community. People are provided the support they need to participate fully, reflect on past experiences and to effectively engage and express their needs. This is because even if people are physically present during consultations, barriers such as social norms and discrimination may prevent them from feeling comfortable to speak.



Project Management: Assess risk

Access risk information

Expert practitioners access best available current, historical and future weather and climate (e.g. tropical cyclones, mean and intensity rainfall, temperature, regional and local wind, humidity, tidal conditions, sea level rises, and ocean acidification); geological hazards (e.g. earthquakes, tsunamis, landslide and volcanic activity); and topographic and geotechnical information to conduct the risk assessment. Up to date climate change projections are obtained for the design working life of the asset. Additionally, where appropriate and achievable for further inform designs, downscaled site-specific climate change and hazard modelling for the design working life are undertaken to quantify the risks of high impact hazards (e.g. extreme rainfall, flood events and sea level rises).

Conduct a climate and disaster risk assessment

The multi-hazard risk assessment is based upon site-specific studies of hazards (to asset, service, user and community), including climate change projections for the design working life, vulnerabilities based on physical, social and economic factors, exposure, and capacity. Residual risk is understood at each phase of a project. The findings are recorded in a risk assessment and are applied to derive design criteria to address risk specified in design documents.

A Risk Register establishes a reference for the design working life of the asset.

Where appropriate and achievable, a Site-Specific Topographic and Geotechnical Report is prepared. Local topographic maps will be required. There may be reports and maps available from previous projects or studies, but if not a survey and general geotechnical summary should be prepared.

Incorporate local and traditional knowledge

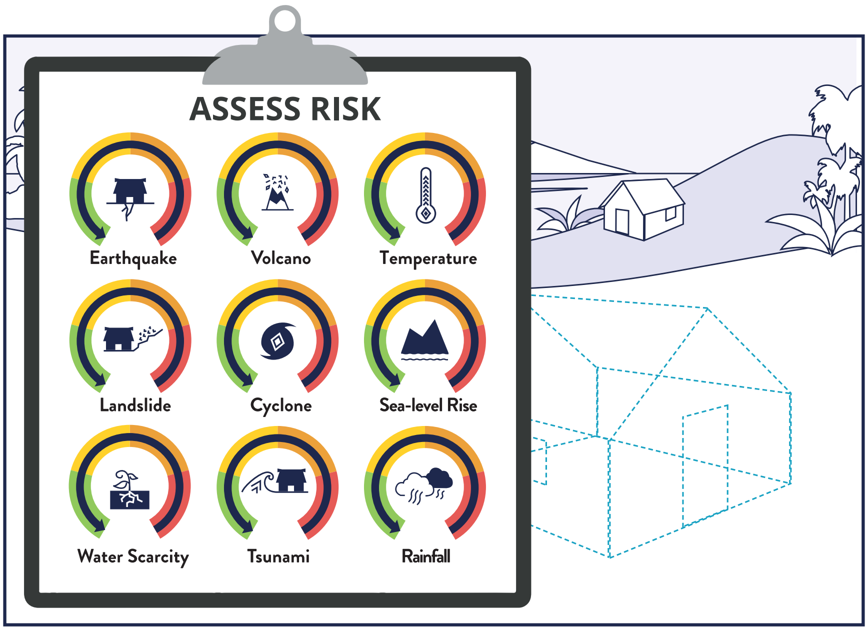
Regional, national, community and traditional knowledge, understanding and experience of past site-specific disaster events is incorporated in risk assessments, including longer-term indirect impacts, and interaction with other drivers of change.

Build capacity

Wherever possible, capability is built locally to assess and identify risks. Individual professional capability is strengthened through skills transfer, training and mentoring.

Conduct an environmental impact assessment

An environmental and social impact assessment provides an opportunity to consider and reduce environmental impacts and risks as well as avenues to address climate change and disasters.

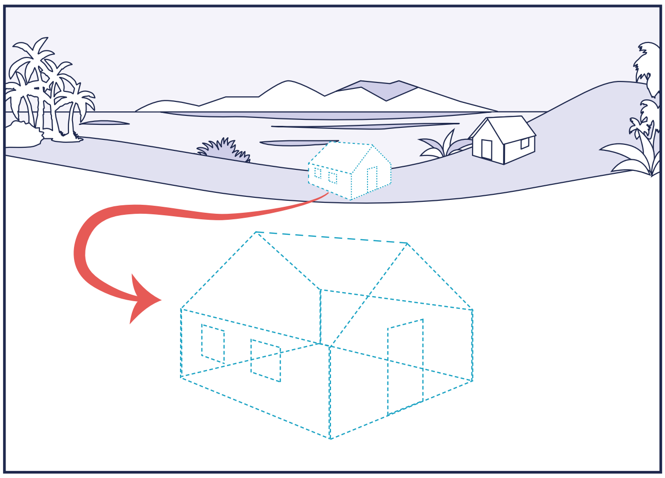


Project Management: Reduce risk

Consider alternative locations

Site selection, site layout and off-site mitigation measures are considered and/or adopted to reduce or mitigate site-specific risks, with approval sought from relevant stakeholders.

Are the likely risks of the site selected able to be mitigated through design or are there alternative locations available with more acceptable levels of risk?



Project Management: Plan and design for life of the asset

Design working life defined and incorporated

Design life is defined to apply climate change projections to an appropriate time period and plan for likely hazards and risks as well as maintenance. Specific stakeholders are involved in the decision-making about the asset design life to ensure that the technical and resource capacity (material and financial) of those responsible for maintaining the asset are reflected in the design and ongoing management. There is clear understanding on the level of operations and maintenance budget, operator skills, human resources, and the quantity, quality and cost of consumables required to meet the performance criteria.

Plan for whole of life

A whole of life cycle analysis allows for consideration of the environmental impact of the asset through its life cycle. Plan for whole of life-cycle of the asset through analysis and in consultation with stakeholders.

Project Management: Build performance and resilience

Apply design and building codes

National building codes and Standard Building Designs (if available) are adapted and supplemented with additional design specifications and international standards where appropriate to mitigate likely weather, climate and geological risks, with comprehensive site-specific adaptations for local risks and to include international accessibility standards.

Donors and international funding organisations may require higher standards than local building standards.

Determine importance level

The structural design building importance level is determined and is consistent with design standards associated with its functional use, operational life, risk level, and economic replacement cost. The importance level will determine the appropriate engineering used in the asset. This is why it is important to define the climate change projections that are used, and how and to what level to address climate and disaster risks.

Set performance requirements from the outset

Performance requirements and design working life of the asset are specified in the Functional Design Brief and Conceptual Designs, including its mechanical, electrical, water, wastewater, sanitation, access, stormwater, rainwater collection, hygiene, security, monitoring and communications systems before, during and after disaster events. Emergency supply systems are included at this time. Performance is extended to materials and sub-components.

Design: Reduce risk

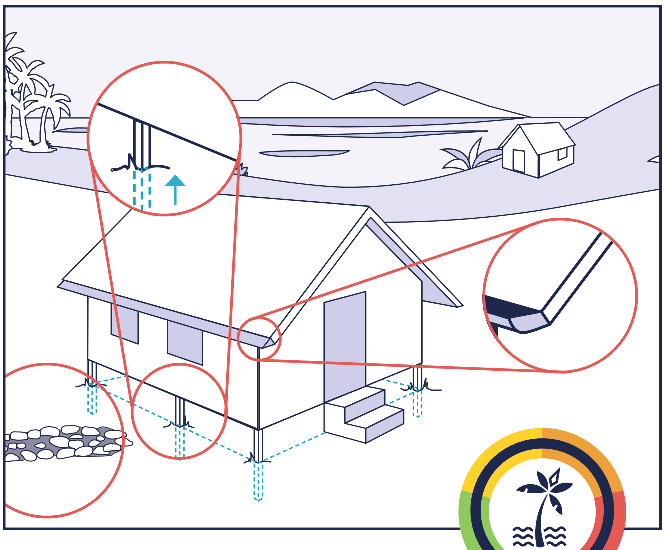
Adopt risk reduction design standards and criteria

Risk reduction design standards and criteria (e.g. for maximum wind speed or flood event) are expressed in a consistent format such as Annual Exceedance Probability (AEP) and adopted in the design and construction of the built infrastructure to manage, accommodate and absorb probable weather, climate and geological risks, in line with the purpose (importance level), amenity and design working life.

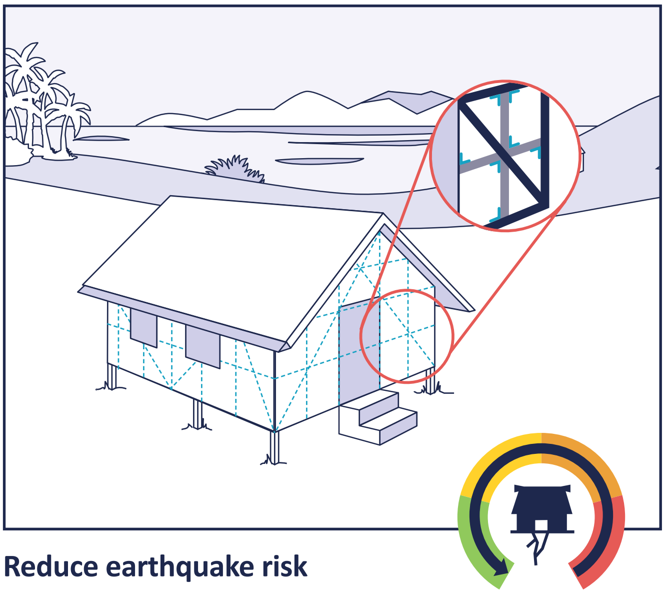
Building criteria safety factors are specified in the design to manage probable climate and disaster risks that will impact on amenity in the design working life.

Plan for future climate and disasters

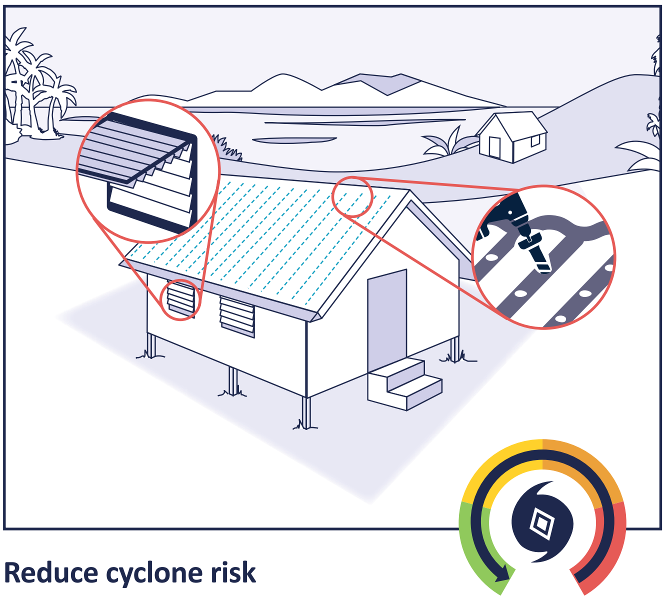
Design standards and criteria reduce risk and increase resilience of the asset for projected changes in climate change and disasters over its design working life.



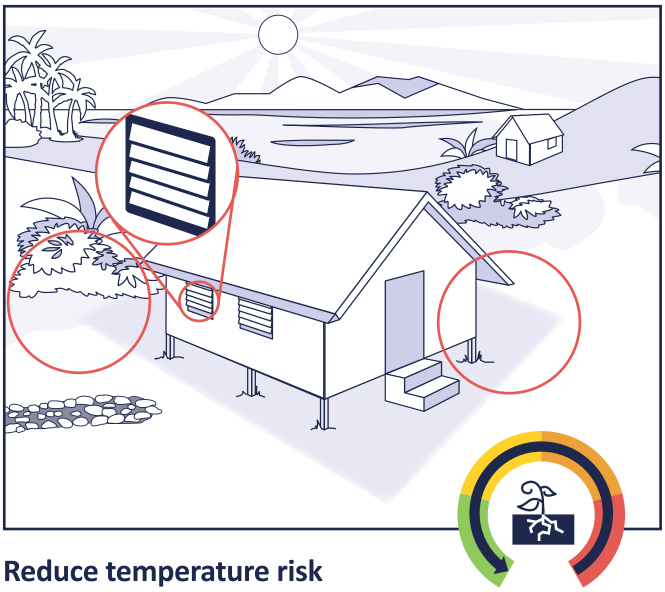
Reduce flood risk



Reduce earthquake risk



Reduce cyclone risk



Reduce temperature risk (passive cooling)

Design: Build performance and resilience

Enhance community resilience

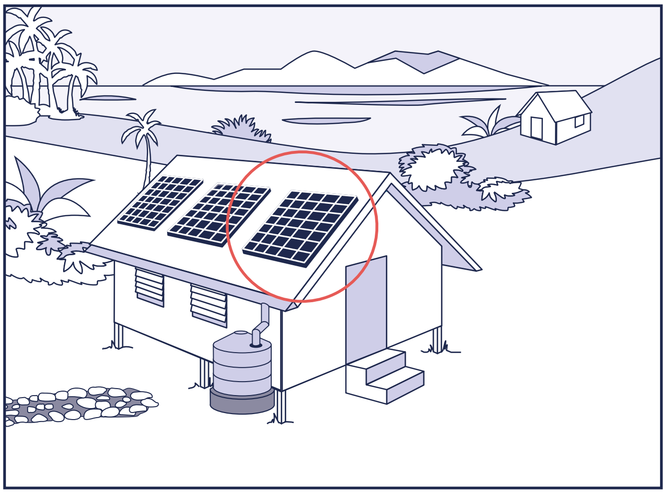
The asset and the site (including technologies and building services) contribute to broader community or national climate and disaster resilience. For example: renewable energy, passive climate control and shading to reduce energy costs and build energy security; water harvesting and vegetated wastewater systems to increase water security; overnight accommodation to reduce travel for women and children; new opportunities for local businesses, support for jobs and skill development and improved access and communications.

Ensure accessibility, inclusivity and usability for all users and members of the community

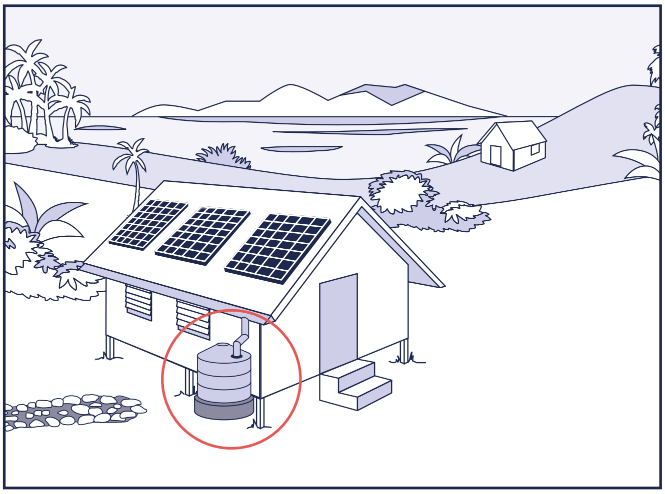
All relevant spaces of the asset are designed and constructed to ensure accessibility and usability (of all users) at all times including before, during and following a disaster event (incorporating universal and inclusive design principles), including consideration of access to and from infrastructure (via roads, pathways, and jetties, for example).

Do no harm and embed safety and security in design

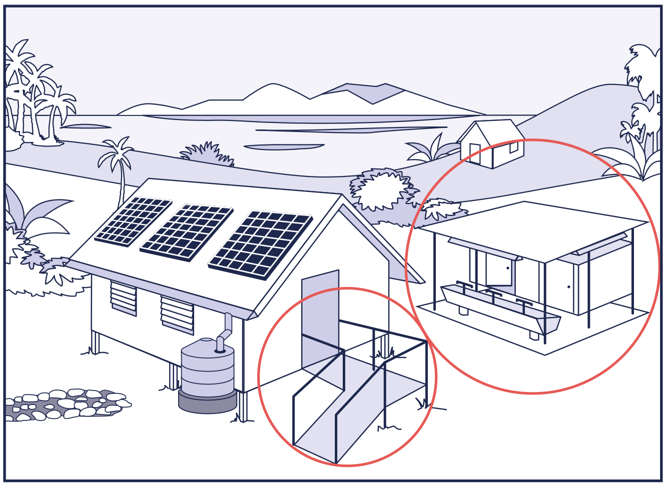
The design and construction of the asset avoid exacerbating existing inequality. Safety and security criteria cause no harm to the people and environment as specified in designs.



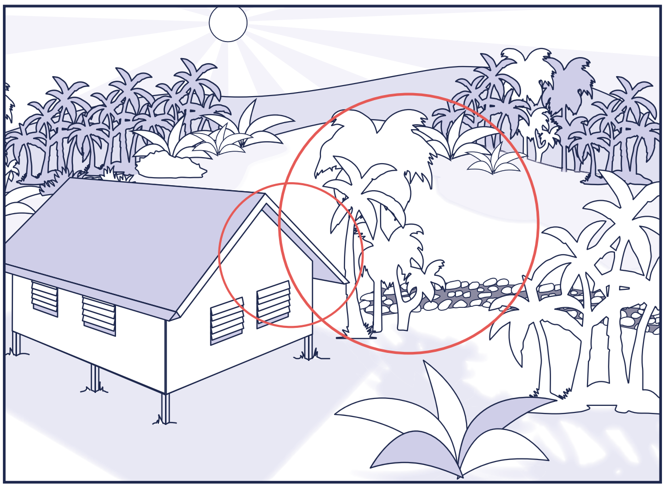
Renewable energy



Water harvesting



Accessibility, inclusivity and usability



Energy efficiency (shading and insulation)

Design: Build performance and resilience

Integrate sustainable and low carbon materials and practices

Practices are integrated into the asset design and maintenance regimes to increase nature-based solutions and reduce energy consumption, such as recycling, vegetated wastewater systems, reflective paint, ventilation, and renewable energy.

Materials and practices are used that are sustainable and low carbon to reduce emissions, such as choosing local materials that require less transport, using technologies and materials that have lower embedded greenhouse gas emissions and support national emissions reduction targets.

Minimise environmental impact

Sites are designed/managed and developed with materials that are sourced to protect vulnerable built and natural assets from the impacts of construction, operation, disasters and climate change (e.g. assets such as coral reefs and lagoons, waterways, shorelines and ecosystems, and other infrastructure).

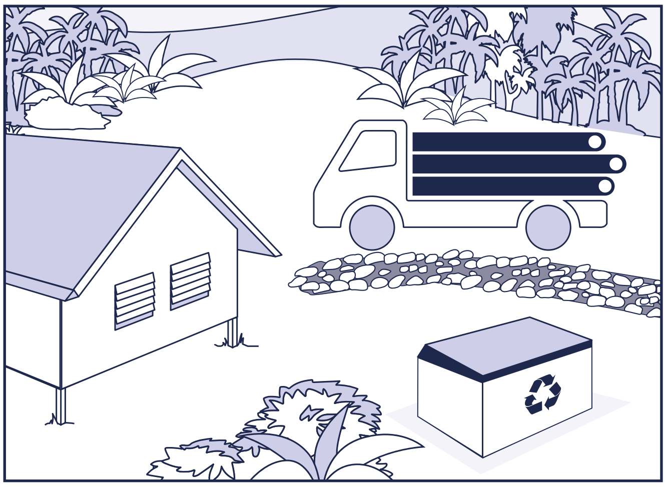
Design operating and maintenance requirements

The need for maintenance is reduced through appropriate and quality material selection, construction strategy, and construction quality. The ability for local trades and skilled professionals to maintain and repair the asset and the local availability of consumables and replacement fittings and fixtures is considered.

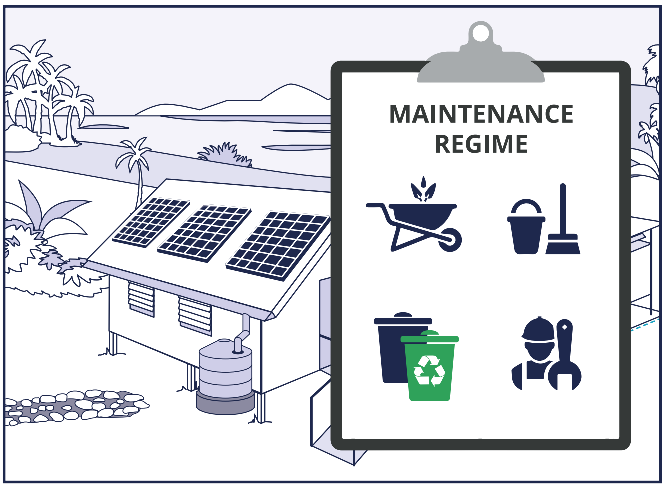
Maintenance regimes to reduce risks are resourced through the project term, with strategies in place to secure ongoing resourcing, training and peer support.

Incorporate local and traditional knowledge

Design, construction and maintenance is considered with regional, national, community and traditional level knowledge, understanding and experience of site use and management.



Local sustainable materials, recycling station



Maintenance regime

Project Management: Reduce risk

Build capability

Wherever possible, individual professional capability is built locally to design, and construct and maintain infrastructure through skills transfer, training and mentoring.

Institutional capability is strengthened through support for policy, resourcing, training and communities of practice.

Resource maintenance

Maintenance regimes to reduce risks are resourced through the project term, with strategies in place to secure ongoing resourcing training and peer support.

Understand performance after event

Post-disaster assessments include evaluation of built asset performance against design criteria and resilience rating (e.g. wind speed, and inclusion). This is to cover individual systems, components and the asset as a whole. The Risk Register should be re-evaluated against the stated risk and mitigation measures.

Community preparedness

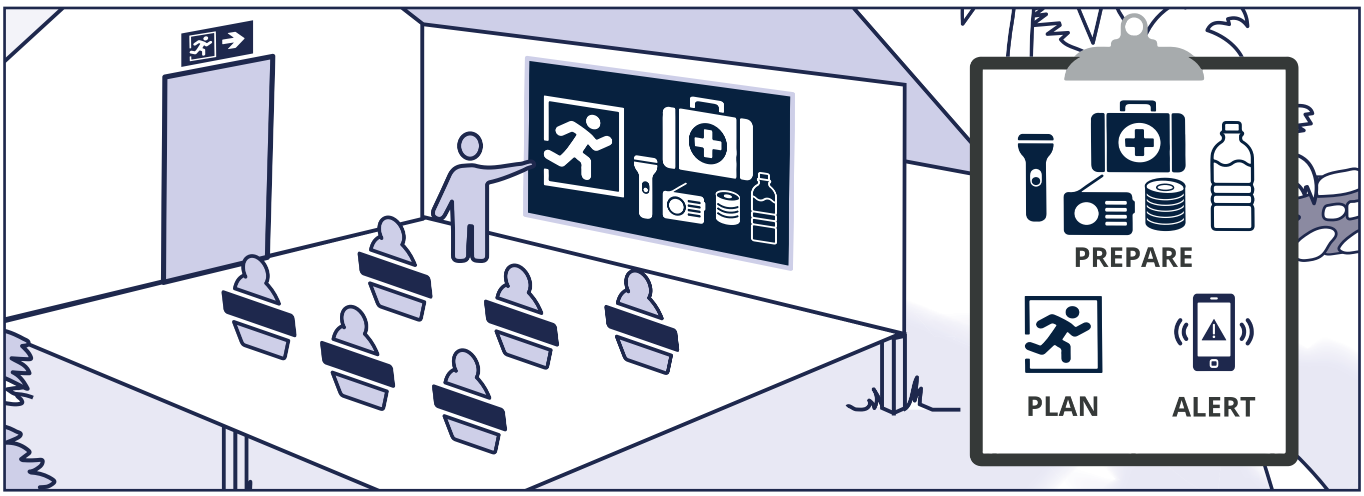
A Disaster Management Plan is established and managed with community involvement to reduce risk, prepare for, respond to and recover from a disaster.

Community preparedness is increased through emergency planning, supplies and education to raise awareness of what to do when a disaster occurs (e.g. planning, evacuation routes, and safe places).

Governance structures for disaster management include a diversity of people in decision making and support for their participation.

Manage residual risk

Residual risks to the infrastructure (that are not mitigated through the design, construction and maintenance) are managed, where possible through risk financing for example insurance.



Disaster management

Definitions

Climate change - A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use (Intergovernmental Panel on Climate Change (IPCC) (2022) *Assessment Report 6, Working Group 2, Annex 2: Glossary*).

Design working life - Duration of the period during which a structure or a structural element, when designed, is assumed to perform for its intended purpose with expected maintenance but without major structural repair being necessary (Definition may change in different jurisdictions and under different regulations. This definition is taken from AS/NZS 1170M:2002, 1.4.23).

Disaster management - The organization, planning and application of measures preparing for, responding to and recovering from disasters (United Nations International Strategy for Disaster Reduction (UNISDR) (2009) *Terminology on Disaster Risk Reduction*).

Disaster risk - The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity (UNISDR (2009) *Terminology on Disaster Risk Reduction*).

Exposure – The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas (UNISDR (2009) Terminology on Disaster Risk Reduction).

Hazard – A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation (UNISDR (2009) Terminology on Disaster Risk Reduction). Hazards include biological, environmental, geological, hydrometeorological and technological processes and phenomena (Sendai Framework for Disaster Risk Reduction 2015–2030).

Resilience - The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management (UNISDR (2009) Terminology on Disaster Risk Reduction).

Vulnerability – The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards (UNISDR (2009) Terminology on Disaster Risk Reduction).

About us

The Climate Partnership is supporting the Australian Government to integrate climate and disaster resilience in Australia's aid program in the Pacific.

The Climate Partnership provides technical advice, expertise, and resources to aid program managers and implementing partners on climate change, disaster risk reduction, and gender and social inclusion. It also partners with scientific agencies and organisations to develop and broker climate and disaster information.

Contact

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