

## Reducing vulnerability of island coasts



Photo: Luke McPake.

- Sea level rise, storms, high waves and high tides are already damaging fragile and often densely populated coastal zones. With the added threat of climate change, measures are urgently needed to protect and manage the coasts. These must take into account the natural systems, environmental change and people's needs.
- Reducing the vulnerability of coasts through appropriate adaptation measures is one of the focus areas of the Pacific Adaptation to Climate Change (PACC) programme. PACC has four coastal zone demonstration projects, in the Cook Islands, the Federated States of Micronesia, Samoa and Vanuatu. Three of the projects demonstrate 'climate-proofing' of coastal infrastructure, and the fourth focuses on community-based integrated coastal management.
- Climate analysis is a key step in the early planning stages of climate-sensitive projects, alongside other essential assessments such as socio-economic assessment and cost-benefit analysis. The PACC projects demonstrate how to do this for coastal zone management projects, within a vulnerability and adaptation assessment framework.
- Good strategic planning and governance is also essential to protect coasts, and the PACC projects are also demonstrating ways to do this. For example, the project teams are working with government departments to mainstream climate change into national-level coastal policy and planning, and with communities to develop practical integrated coastal zone management plans and actions.

### Coastal zone vulnerability

Low-lying coastal areas are often the most populated parts of islands, with villages, towns, agriculture, infrastructure and tourist development competing for space. Unfortunately, coasts are also particularly vulnerable to weather impacts

and to climate change, in particular sea level rise and extreme weather events such as cyclones. The resulting impacts – coastal erosion, infrastructure damage, flooding and salt water intrusion – present a critical challenge to many Pacific island coastlines.

Coastal zones are fragile even without climate change. Where land meets sea, there is a delicate balance between terrestrial and marine systems. Waves and wind are a continuous physical factor, and natural coastlines are in constant flux. Economic development over recent decades has often overlooked this fragility. Indeed, some human actions, such as removing coastal vegetation, beach mining and building too close to the shoreline, are adding to coastal erosion and flooding problems.

In coastal zones, adaptation to climate change means finding new ways to protect and manage coasts and coastal systems, that take into account the natural systems, environmental change and human development needs. This is especially important on small low-lying islands, where the entire island is essentially a coastal zone.



Land meets sea. Photo: Haden Talagi, Niue PACC project.

## The added risk of climate change

Sea level rise is an obvious threat to coastal zones. Since the mid-1990s, the global average rise in sea level has been between 2.8 and 3.6 mm/year. However, in some parts of the Pacific the measured increase has been four times higher than the global average, that is, up to 12 mm/year.

The threat of sea level rise is compounded by more transient events – high waves and winds due to storms and cyclones, king tides, and other natural phenomena. These are already contributing to damage to coastlines and coastal systems. Climate change projections for the region indicate that the frequency and intensity of these events may change, but they will continue to occur and to pose a risk to coasts.

The impacts of these climate factors are already being felt along the coastlines of the Pacific islands.

There are numerous examples of coastal erosion across the Pacific region – probably every island has examples. Beaches are particularly vulnerable, but some islands have seen coastal buildings, roads and other infrastructure destroyed, either gradually over time or in a single extreme event such as a cyclone. In the Cook Islands, for example, Mangaia Island's only harbour was damaged beyond use following a succession of cyclones in 2005.

Inundation with seawater is also affecting coastal communities. In some areas, buildings and infrastructure are becoming unusable, and crops are being destroyed. Without adaptation measures, many low-lying coastal areas will soon be submerged.

These photos from FSM tell the story better than words.



## Adaptation in action – climate-proofing the coastal zone

Coastal zone management is one of the three focus areas for the PACC programme. Four of the 14 participating countries – the Cook Islands, the Federated States of Micronesia (FSM), Samoa and Vanuatu – selected coastal zone management as their priority, and subsequently developed projects piloting adaptation along their coastlines.

Three of the projects demonstrate the ‘climate-proofing’ of existing coastal infrastructure. In Kosrae, FSM, a section of coastal road has been redesigned and rebuilt to withstand heavier rainfall and higher sea levels; and a similar road design project is underway on Epi island in Vanuatu. Mangaia Island in the Cook Islands has a new climate-proof harbour as a result of the PACC project. The fourth project, in Samoa, has focused on community-based integrated coastal management, with activities including re-vegetation of coastal areas, building protection structures, and raising awareness.

A key step in the early planning stages of the projects was climate analysis, within a vulnerability and adaptation assessment. This involved examining current climate and projected future climate in the project area, analysing vulnerabilities, and assessing adaptive capacity and adaptation options. With this information, appropriate project interventions could then be developed. Including climate analysis alongside other essential assessments, such as socio-economic assessment and cost-benefit analysis, is a vital part of climate-sensitive projects that contribute to climate-resilient development.

The PACC project teams are also working to strengthen coastal governance and management at all levels. The teams are working with government departments to mainstream climate change into national-level coastal policy and planning, and with communities to develop practical integrated coastal zone management plans and actions.

The four coastal zone projects are described in the boxes.



**Flooding and coastal erosion are affecting people's lives.**

Photos: FSM PACC project.



## PACC CASE STUDY

## Climate proofing Mangaia Harbour, and protecting the island's coastline

Mangaia is the southernmost and second largest of the Cook Islands, and has a population of about 600 people. Mangaia's harbour – the transportation hub and entry point for all supplies to the island – was badly damaged by a succession of tropical cyclones in early 2005. The aim of the PACC project was to develop a stronger and safer harbour that can withstand current and future climate-related threats. In parallel, the project has been helping to develop an integrated coastal management policy framework and implementation plan for the whole of Mangaia's coastline.

The PACC project brought together engineers, climate scientists and the community to discuss the redesign and construction of the harbour. Combining climate analysis with complex engineering approaches, the project developed new tools to help design the harbour:

- A 'geospatial assessment framework', to better understand the shape and height of the foreshore, offshore and nearshore topography and bathymetry of Mangaia, which will help understand the climate change impacts on Mangaia and its infrastructure over the next 10 years;
- The Cook Islands Coastal Calculator, which provides information on waves and water levels and circulation, including undercurrent, using current variability, frequency and future scenarios. Understanding extreme water levels and wave conditions, how likely they are to behave and react during cyclone and large swell events, and how these two parameters influence wave set-up, wave run-up, overtopping and over-washing at the shoreline, is fundamental in understanding and assessing inundation of land areas, and impacts on other coastal assets.

The findings from these tools were presented to the community, who helped to ground-truth them. With this information, the project team and the community were able to make informed decisions about the harbour improvements. The new climate-resilient harbour was opened in April 2014.

A cost-benefit analysis (CBA) was carried out late in the project cycle, and too late to inform the decision on the interventions chosen. The CBA drew attention to the fact that strengthening harbour structures to cyclone forces is more efficiently done at the design and construction of the original structure, rather than as retrofitting to a built harbour.

A first draft of the Mangaia Integrated Coastal Management Policy Framework was released in June 2014 and is under review. The draft envisages a comprehensive management approach that includes a baseline assessment of the coastline, coastal management legislation, institutional arrangements for coastal management, and a coastal management plan.



*For more information on the Cook Islands PACC project, please visit the project webpage: <https://www.sprep.org/pacc/cookislands>*

Starting work on the new harbour at Mangaia.  
Photo: Andrea Egan.

## PACC CASE STUDY

## Climate proofing Kosrae's coastal road

Kosrae, one of the four States comprising the Federated States of Micronesia (FSM), was selected to host the country's PACC project. Kosrae has a population of 6,616 (2010 census), and more than 75% of the island's people and infrastructure are located in the coastal zone. The demonstration project focused on improving a section of Kosrae's coastal road, which is the main transport route on the island.

The project identified a 7 km section of the road in the Tafunsak municipality which was being progressively damaged by flooding from heavy rains and high tides. The original road had been designed to withstand a maximum hourly rainfall of 178 mm. Analysis of climate and sea level data, and projections to 2050, concluded that the road should be redesigned to withstand maximum hourly rainfall of 254 mm.

Following a socio-economic assessment, community consultations, and input from expert coastal engineers, the road was redesigned and rebuilt to withstand the anticipated heavier rainfall and higher sea levels. Adaptations included raising parts of the road by up to one and a half metres, fitting larger culverts, and improving drainage. The improved road was officially opened in May 2014. The PACC team is now developing guidelines to share their experiences with climate proofing the road, which will help others to replicate this success.

Also under the PACC project, a tide gauge and rainfall gauges were installed on Kosrae in 2011 to improve availability and quality of local climate and sea level data. These will also feed into climate-sensitive decision making and development for the state.

The project team has also been promoting the mainstreaming of climate risk into all development in the state and the country. The team supported development of the Kosrae State Climate Change Act, which was endorsed in 2011; and amendments to Kosrae's Regulations for Development, which now require all development projects to consider the potential impacts of climate change. The team also contributed to the recently revised Kosrae Shoreline Management Plan, which provides a comprehensive strategy for building resilience of Kosrae's coastal communities and infrastructure into the future.

*For more information on the FSM PACC project, please visit the project webpage: <https://www.sprep.org/pacc/fsm>*



A new culvert to help improve drainage.  
Photo: FSM PACC project.

## PACC CASE STUDY

## Lessons from the Samoa PACC project

The Samoa PACC project aims to develop a community-based integrated coastal protection model, to increase the resilience of the country's coastal communities and infrastructure to the impacts of climate change.

The early stages of the project were disrupted by a deadly tsunami which struck the south of Upolu in late September 2009. As a result, attention became focused on the village of Tafitoala, which is located on the south coast, as a pilot site for the PACC project. Probably as a reaction to the tsunami, the community identified a seawall as a priority for the project, and this was built in 2010. The seawall was also supported by 'soft' adaptation measures such as planting of salt-tolerant coastal plants to create natural barriers along the coastline, and planting along the streamside from ridge to coast.

In December 2012, Samoa was hit by Tropical Cyclone Evan, and this exposed technical problems with the seawall. For example, flooding was exacerbated because the seawall did not have appropriate culverts to allow sufficient flow from the rain-swollen river into the ocean. A later review identified more non-sustainable features of the seawall, and concluded that the design had not been based on a full understanding of coastal science, coastal hazards, and climate risks.

In addition, the review showed that the project did not follow rigorous decision-making processes to fully assess coastal vulnerabilities and the implications of interventions. The planning process did not consider and evaluate all possible options.

A key lesson from the Samoa project is the importance of careful and thorough planning in the early stages of adaptation projects, and the use of tools such as vulnerability and adaptation assessment, socio-economic assessment and cost-benefit analysis to identify and evaluate all options in order to select the most appropriate one.

Another lesson is that 'hard' adaptation measures need to be designed based on a detailed understanding of the surrounding coastal and watershed environment and flood conveyance routes. This should include coastal and flood risk modelling, and climate and sea level projections.

A third lesson is the need for awareness raising among decision makers, including communities, of climate change and its impacts, and especially the range of measures available to reduce vulnerability. When decision makers understand the climate risk, and the options to reduce the risk, they will make informed and better decisions.

The PACC team is now developing a 'Living with Rivers and Seas' manual, to provide clear guidance on how to design, construct and monitor river and sea defence schemes in the future. The same concept is being promoted at the policy level, to provide a strategic framework for an integrated approach to addressing the vulnerability of Samoa's coastline.

For more information on the Samoa PACC project, please visit the project webpage: <https://www.sprep.org/pacc/samoa>



The seawall following Cyclone Evan.  
Photo: Samoa PACC project.

## PACC CASE STUDY

## Climate-proofing coastal infrastructure in Vanuatu

The target for the demonstration project in Vanuatu is national roads on the island of Epi. Flooding and coastal erosion on the island have been causing increasing damage to the roads, and the project is working with local communities to develop appropriate solutions that work now and into the future.

The Vanuatu team has worked hard to build community ownership of the project. One particularly successful approach to engaging communities has been three-dimensional participatory mapping, which helps understanding as well as participation in decision making. Another initiative is the Epi Island Climate Change Committee, established in March 2013, which includes representatives from community and government.

A 39 km stretch of road has been selected for improvements and work is underway. The road improvement strategies are based on the results of the community mapping exercise, a vulnerability and adaptation assessment and an environmental impact assessment. The design work has been completed, and the communities themselves are being trained to carry out the roadworks, using locally available materials and with guidance and training from the PACC project team.

A guideline has been produced for communities, which explains soft engineering options for coastal protection. This capacity building is seen as key to building resilience at the community level. The project is also developing a guideline to be used by at the national level as part of the environmental impact assessment process for future coastal infrastructure development.

For more information on the Vanuatu PACC project, please visit the project webpage: <https://www.sprep.org/pacc/vanuatu>



Three-dimensional participatory mapping to support decision making in pi. Photo: Vanuatu PACC project.



The Pacific islands must protect their coasts for future generations. Photo: FSM PACC project.

## Conclusion

Pacific islands must develop new ways to protect and manage their coasts in the face of climate change. The PACC projects are demonstrating ways to do this, for example, climate-proofing of existing coastal infrastructure. These redesigned and rebuilt structures will contribute to more resilient coasts and coastal communities in the coming years.

The projects offer some valuable lessons, both positive (what worked) and negative (what didn't). These will be shared widely to support future efforts across the region to build more resilient and sustainable coasts.

## The PACC programme

The PACC programme is the largest climate change adaptation initiative in the Pacific region, with activities in 14 countries and territories. PACC is building a coordinated and integrated approach to the climate change challenge through three main areas of activity: practical demonstrations of adaptation measures, driving the mainstreaming of climate risks into national development planning and activities, and building and sharing knowledge in order to build adaptive capacity. The goal of the programme is to reduce vulnerability and to increase adaptive capacity to the adverse effects of climate change in three key climate-sensitive development sectors: coastal zone management, food security and food production, and water resources management. PACC began in 2009 and is scheduled to end in December 2014.

The PACC programme is funded by the Global Environment Facility and the Australian Government with support from the United Nations Institute for Training and Research (UNITAR) Climate Change Capacity Development (C3D+). The Secretariat of the Pacific Regional Environment Programme (SPREP) is the implementing agency, with technical and implementing support from the United Nations Development Programme (UNDP).

## Building and sharing knowledge under the PACC programme

The PACC Experiences series covers topics where PACC is building experience and knowledge. Aimed at national and regional decision makers, climate change practitioners, and concerned communities and individuals, each one explains a key issue relevant to climate change adaptation in the Pacific, and draws on experiences within the PACC projects to describe the practical realities, lessons learned, and implications for both policy and practice. PACC Experiences includes webspace at [www.sprep.org/pacc/experiences](http://www.sprep.org/pacc/experiences) where additional experiences, case studies and lessons learned are available on the different topics.

The PACC Experiences series is complemented by the PACC Technical Report series. This series is a collection of the technical knowledge generated by the various PACC activities at both national and regional level, and is aimed at climate change adaptation practitioners in the Pacific region and beyond.

[www.sprep.org/pacc](http://www.sprep.org/pacc)

