

Building resilient freshwater systems



Photo: Tonga PACC project.

KEY MESSAGES

- Freshwater systems on small Pacific islands are fragile, and highly vulnerable to climate change. The islands need resilient freshwater systems to ensure water security for their people into the future.
- Building resilient freshwater systems is one of the focus areas of the Pacific Adaptation to Climate Change (PACC) programme. Six participating countries have developed climate-resilient water systems under the PACC programme. Adaptation measures demonstrated by the projects include upgrading water infrastructure to improve water capture and storage, increasing the options for sourcing water, and improving water quality.
- 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 within a vulnerability and adaptation (V&A) assessment framework.
- Good governance is also vital for building resilient freshwater systems, and the six PACC projects also demonstrate how to strengthen water governance. For example, they are working with government departments to mainstream climate change into national water policy and planning, as well as improving practical water management at national and community levels.

Freshwater resources on Pacific islands

Small islands generally have very limited freshwater, and rely heavily on rainfall for their supplies. Their freshwater systems are therefore highly vulnerable to unpredictable rainfall, and especially to drought. With climate change, rainfall patterns are becoming less predictable, and for many islands

droughts are likely to continue to occur and may worsen. Freshwater systems are also vulnerable to heavy rainfall and flooding, which can cause water contamination as well as damage to infrastructure. Rising sea levels and extreme tides are also leading to saltwater contamination of freshwater systems.

As well as the climate change threat, some Pacific islands are facing the challenge of increasing populations and economic development, leading to rising demand on these fragile and limited resources. In addition, highly permeable soils make groundwater resources extremely vulnerable to contamination from human activities taking place at the surface. It is clear that the Pacific islands must build more resilient freshwater systems to ensure water security for their people into the future.

Sources of freshwater

Many small islands have no surface water, such as streams or lakes. They have two main sources of freshwater: groundwater (from an underground lens or aquifer) and rainwater. Groundwater may be drawn from wells at the household or village level, or managed more centrally and piped to houses through a reticulation system. Similarly, rainwater can be collected by individual households into small water tanks, or over larger catchments and stored in large tanks or reservoirs.

Many islands use both sources, with higher dependence on groundwater when rainfall is low and water tanks empty. On some islands excessive drawing on the groundwater, due to increasing demand or during drought, is resulting in the groundwater lens becoming depleted, polluted, and contaminated with saltwater.

Water uses

Freshwater is one of the basic needs of life. As in other parts of the world, Pacific islanders need water for drinking, washing and other daily household needs. Freshwater also plays a vital role in agriculture, for irrigating crops. Many Pacific island countries and territories are working to improve their food security by boosting local food production and reducing dependency on imported foods, so that water availability for farming is becoming increasingly important.



Pacific islands have very limited supplies of freshwater.
Photo: Joe Hitchcock, Tuvalu.

Water in crisis

Recent droughts have demonstrated the shortcomings of freshwater systems on several Pacific island countries. In 2011 for example, a La Niña event was responsible for greatly reduced rainfall across an extensive area of the region, affecting countries including Tuvalu, Tokelau and Tonga. On Tuvalu's main atoll of Funafuti, households were limited to two buckets of freshwater a day, and a state of emergency was declared. The emergency response included bringing in bottled drinking water by air and sea. Similarly in the Marshall Islands in April 2013, a state of emergency was declared for the northern islands following a prolonged dry season and resulting severe drought. Again, international aid was needed to support communities through the crisis.

Adaptation in action – building resilient freshwater systems

Pacific island governments understand the urgent need for strengthening their freshwater systems. Thus, this became one of the three focus areas for the PACC programme. Six of the 14 participating countries – the Marshall Islands, Nauru, Niue, Tokelau, Tonga and Tuvalu – identified water resources as their priority concern at the start of the programme, and developed projects that demonstrate ways to build more resilient freshwater systems.

Each project is tailored for the individual country and pilot site situation, and the unique vulnerabilities and adaptive capacities within the pilot communities. A key step in the planning stage of each project was climate analysis, usually 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 adaptation measures demonstrated by the projects include upgrading water infrastructure to improve water capture and storage (in the Marshall Islands, Tonga, Tuvalu and Tokelau, for example), increasing the options for sourcing water (in Niue, for example), improving water quality (in Tokelau, for example), and introducing new technologies (solar water purifiers in Nauru, for example). All of the projects include a public awareness component to develop public responsibility for water protection and conservation.

Though tailored for the pilot sites, many of the project components have the potential to be replicated or adapted and extended to other areas or other islands. This is already starting to happen, for example solar water purifiers demonstrated in one community on Nauru have now been introduced more widely around the island, and the technology has also been extended to some of the remote outer islands of the Marshall Islands.

The PACC project teams are also working to strengthen water governance at all levels. They are working with government departments to mainstream climate change into water policy and planning, as well as improving practical water management at national and community levels.

The six PACC projects that are helping to build resilient freshwater systems are described in the boxes.

PACC CASE STUDY

Upgrading water infrastructure in the Marshall Islands

The Marshall Islands is an atoll nation with average elevation just 2 metres above sea level. About half of the population of around 53,000 live on the main island of Majuro, and this densely populated island was chosen as the site for the PACC demonstration project.

Majuro has a public water supply system that uses both rainwater and groundwater to supply the main populated areas of Rairok, and Darrit, Uliga and Delap (collectively known as DUD). Rainwater is collected on the airport runway, which is the largest paved area on the island. It is pumped to a series of reservoir tanks where it is treated before being piped to the communities. During times of drought, it is necessary to pump water from the underground water lens in the Laura area (more than 45 km from DUD) to supply the reservoirs. However, this is putting strain on the underground lens.

The water network was designed in the 1970s, when the airport was built. Although there had been some upgrades through the years, maintenance of the system was not keeping up with the demand from an increasing population, and this was compounded by increasing uncertainty of rainfall.

The aim of the PACC project in the Marshall Islands is to build resilience to drought, and reduce reliance on the underground water lens. A 2011 assessment of the water sector in Majuro identified improvement of the airport catchment as a key way to do this, and the PACC project built on these findings. A vulnerability and adaptation (V&A) assessment was carried out, and this was supported by cost-benefit analysis, to identify the best options for PACC investment. Following the recommendations from these analyses, PACC activities focused on repairing the reservoir, relining the tanks and installing a cover to reduce evaporation.

The renovated reservoir was officially opened in April 2014. The reservoir is now able to hold up to 36.5 million gallons, compared with 31.5 million gallons prior to the improvements. The higher capacity means greater water security for the 28,000 people living in Majuro.

The PACC project team built a gender perspective into its activities through a close collaboration with the NGO Women United Together Marshall Islands (WUTMI). At the start of the project WUTMI was invited to join the core PACC advisory group, and has been an active member with a representative attending most meetings. This has contributed to the inclusion of a gender perspective across project activities.

The PACC team has also contributed to mainstreaming of climate change into some key strategic documents, including the National Water and Sanitation Policy (endorsed in March 2014).

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

The new reservoir cover.
Photo: Marshall islands PACC project.



PACC CASE STUDY

A conjunctive water supply system for Nauru

Nauru is a single island of about 22 km², with most of the population of about 10,000 living in the 150–300 m wide coastal strip. The island has very limited freshwater resources and relies heavily on rainwater and desalination of seawater. Drought is a major threat to water supply, and is also exacerbating groundwater contamination by saltwater. The aim of the Nauru PACC project is to improve resilience to drought by improving management of the island's water supply.

The PACC project has been contributing to development of a conjunctive water supply system for Nauru. This means using water from the various sources for different uses at different times. Because desalination is expensive, using rainwater, seawater and groundwater appropriately and depending on availability is a sensible way to sustainably improve Nauru's water supply. An example of how this might work is shown below.

Water source	Above average rainfall	Low rainfall	Extended drought
Rainwater	All uses	Drinking and cooking	Not used (storage empty)
Desalinated seawater	Not used (no need)	Drinking and cooking	Drinking and cooking
Groundwater	Outdoor Laundry	Outdoor Laundry Personal bathing	Outdoor Laundry Personal bathing

The project team identified Aiwo district as the site for the demonstration project, and carried out a vulnerability and adaptation (V&A) assessment to fully assess the vulnerabilities of the community, and to identify potential adaptation measures. These measures were then subjected to multi-criteria analysis to select the most feasible, relevant and sustainable option.

By this process, the option selected for the Nauru demonstration project in Aiwo district was the introduction of solar water purifiers. These units, which have solar panels linked to a water distillation circuit, produce clean drinking water from non-potable sources such as seawater or contaminated groundwater.

Nineteen households had solar purifier units fitted, providing 80 L of additional potable water per day per household. During a drought, this can be used for drinking, cooking and if in sufficient quantity, personal bathing. Even when not under drought conditions this is a useful and safe potable water supply. The system is operated by the household and does not require any major maintenance. The lifespan of the solar purifier is 15 years and no replacement of material is expected during this time.

Alongside the practical demonstration, the project is supporting effective planning for water management to promote best use of potable and non-potable water from different sources.



Solar water purifiers.
Photo: Marshall islands PACC project.

The project has also had some major mainstreaming achievements through its contributions to the endorsement of three key documents – the National Water, Sanitation and Hygiene Policy, which incorporates climate change; the Water Sector Climate Change Action Plan; and the Drought Management Strategy. The project team has also helped to set up a Water Unit, a Water Technical Committee, and other coordination mechanisms that are contributing to mainstreaming climate change into the water sector.

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

PACC CASE STUDY

An alternative water source for Niue

Niue is a single island of raised limestone, of area approximately 260 km², and has no surface water. The population of about 1,600 has been mainly relying on the underground lens for its freshwater. However, depending on this single source contributes to vulnerability to climate change. The underwater lens is vulnerable to drought, and could become rapidly depleted. It is also at risk of contamination after heavy rain or a cyclone. An additional factor is that pumping groundwater depends on imported fuel, which makes it expensive and at risk if the power supply is cut for any reason.

The PACC project therefore sought an alternative water source, and identified rainwater harvesting as the most promising. Indeed, in the past the people of Niue harvested rainwater, but the systems had deteriorated and were no longer functional.

A process of research, consultation and analysis led to the decision to build a tank moulding facility and begin manufacturing water tanks in Niue. Tanks could be made at half the price of importing them, and this would further increase resilience by reducing dependence on imports. The PACC team joined forces with the Global Climate Change Alliance: Pacific Small Island States project, which is funded by the European Union and implemented by the Secretariat of the Pacific Community (GCCA PSIS – SPC), to implement the project.

The new moulding facility was opened in December 2013. The facility is capable of producing up to eight 5,000 litre tanks each day. The tanks are made of a robust plastic called high-density polyethylene (HDPE), which is imported in powder form before it is processed and moulded into tanks. The tanks are lightweight, there are no joints that can split, and the plastic material complies with New Zealand and Australian safety standards. Properly maintained, the tanks will last for many decades.

The project is providing a tank to each household on the island. Householders are responsible for maintenance of their tanks, and are required to cover the costs of guttering and fascia boards needed to complete the system. The project team has been working within communities to raise awareness of the value of the tanks, and carrying out training on system maintenance to ensure the tanks are kept in good order.

In parallel, the project has been raising awareness on water conservation and protection, related to climate change.

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



Testing water quality.
Photo: Tuvalu PACC project.

PACC CASE STUDY

Improving water quantity and quality for the atolls of Tokelau

Tokelau's three atolls total about 12 km² of land, rise to no more than 5 m above sea level, and are home to about 1,400 people. With drought a major threat, the PACC project has worked to improve water security in terms of both quantity and quality, and at both the household and community levels. Activities on all three atolls have included renovating or replacing water infrastructure such as pipes, guttering, and water tanks; and installing 'first flush diverters' which ensure that contaminants from the roofs do not enter the drinking water tanks.

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



Improving quantity and quality of water in Tokelau. Photo: Tokelau PACC project.

PACC CASE STUDY

Improving water supply in Hihifo district, Tonga

In Tonga, stakeholders selected Hihifo district in the northwest of the island of Tongatapu as the pilot site for the PACC project. The six communities had long struggled with an unreliable water supply, and changing rainfall patterns and recurrent drought threatened to make things even worse.

The PACC team carried out a socio-economic assessment of the district to understand the current situation and to collect essential baseline data. From a survey of all 354 households and a focus group discussion with key members of the communities, the SEA found that the problems were due to a combination of natural, governance and technical factors: the fragile and thin water lens which is increasingly vulnerable; a lack of community participation in the management of the precious water resources; and technical issues, such as breakdown of pumps and leakages. Solutions proposed included:

- Putting a water meter in every household;
- Installing solar water pumps in villages;
- More water tanks;
- Strengthening governance capacities of water committees; and
- Better transparency and communication between water consumers and water committees.

The project was designed with the objectives to improve the water supply system to provide Hihifo residents with better access to water in terms of reliability and pressure, and better water quality; and to enhance the capacity of the residents to sustainably manage their water resources and to effectively operate and maintain the improved water supply system.



A new water tank installed by the PACC project in Tonga. Photo: Martin Pritchard.

In 2013, the project installed three 45,000 litre water tanks, an overhead tank holding 22,500 litres, and 30 smaller tanks that hold 10,000 litres each, in the six villages. To complete the system, monitoring and production boreholes have been drilled, new pipelines and pipes laid, water meters have been installed for each household, and there are new solar and diesel powered pumps. Hihifo's new water supply system was officially opened in April 2014, and all Hihifo households are now benefiting.

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

PACC CASE STUDY

Communal water reserves in Funafuti, Tuvalu

Tuvalu has nine low-lying islands scattered over 500,000 km² of ocean with a total land area of 27 km². Tuvalu's population was estimated at 11,206 in 2011, with approximately half living on the island of Funafuti.

Lofeagai, which has a population of 637 in 97 households, was selected as the pilot site for the PACC demonstration project through a vulnerability and adaptation (V&A) assessment and a stakeholder consultation process. This process identified Lofeagai as the most vulnerable community on Funafuti, followed by Tekavatoetoe. The only source of freshwater in Lofeagai is rainwater and desalinated water purchased from the government. Before the PACC project, there was no communal cistern and rainwater was stored privately only, and supplies quickly ran out during dry periods.



Photo: Tuvalu PACC project.

The project design stage included a socio-economic assessment in the Lofeagai community, community consultations, and a cost-benefit analysis. These helped to clarify the decision to build a cistern with capacity of 700,000 L. It was also decided this would be linked to and managed by the EKT church (Ekalesia Kelisiano Tuvalu, or Congregational Christian Church of Tuvalu), of which 75% of the community are members. Construction began in early 2012 and the cistern was completed in late 2012. As a result, at least 90% of the Lofeagai population now have access to the minimum water supply of 40 L per household per day during dry periods and droughts.

As a community-based adaptation project, the involvement of the Lofeagai community in all stages of the project was crucial. Because the cistern was built within the EKT church area, one important objective was to ensure that the 25% of the community who do not belong to the EKT church did not feel excluded from the project.

Tuvalu's demonstration project is a good example of how comprehensive planning and proactive management can successfully deliver outcomes. The project successfully identified one of the most vulnerable communities, selected a sustainable and efficient solution within the PACC budget, and used informal community leadership to implement and manage the adaptation measure. The project has also incorporated a gender perspective by actively involving the Tuvalu National Council of Women.

Following successful implementation of the project in Lofeagai, Tuvalu was given additional funding in the next phase of PACC (called PACC+) to replicate the project in Tekavatoetoe. The new cistern is smaller than the one built in Lofeagai (288,000 L) but will follow the same arrangement with the EKT church in Tekavatoetoe. Handover to the Tekavatoetoe community is expected in November 2014.

As well as carrying out the demonstration project, the Tuvalu PACC team has been central to the development of *Te Kaniva*, the Climate Change Policy Framework, and the National Strategic Action Plan (NSAP) for climate change and disaster management. PACC and the Integrated Water Resources Management (IWRM) projects have also coordinated the development of a national Water and Sanitation Policy.

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

Conclusions

Water supply systems that are resilient to climate variability and climate change are vital for the future of the Pacific islands. The six PACC water projects have demonstrated different ways to build resilience into island water systems. They have also shown how climate risk can be incorporated into water development projects. They offer knowledge and lessons that other projects can build on, to ensure a water-secure future for the people of the Pacific.

As well as learning from their own experiences, the projects are sharing experiences and learning from each other. Indeed there is already a sharing of ideas between Nauru and the Marshall Islands, with the transfer of solar water purifiers, first demonstrated in Nauru, to the outer atolls of the Marshall Islands.

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 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

