Capacity Building
to enable the
Development of Adaptation Measures in Pacific Island Countries
(CBDAMPIC)

ECONOMIC ASSESSMENT OF PILOTS

- FINAL REPORT -
to
SPREP

Peter Kouwenhoven
Chris Cheatham
International Global Change Institute (IGCI)
University of Waikato
Hamilton, New Zealand

March 2006

.I.G.C.I.
The International
Global Change Institute

THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

Table of contents

Acknowledgements

This study[1] had to be executed between 21 October 2005 and 20 December 2005. The final contract was only signed beginning of October 2005, leaving a very short time for making travelling arrangements to meet with the pilots coordinators, people involved in the pilots execution, seeing some of the pilots, and meeting with the local communities. Because of this tight schedule, people were informed at a very late stage. Nevertheless, everybody involved gave their full cooperation and did their ultimate to facilitate meetings and pilot sightings. Knowing that there are formal procedures to follow, which makes things even more complicated, I would like to express my thanks to everybody involved. Without their cooperation, this study could not have been executed.

[1] In this report "study" refers to the economical assessment as reported on. "Project" is the CBDAMPIC project, of which this study is a finalizing part. "Pilot" is one of the nine implementations that were executed on four Pacific Islands within the CBDAMPIC project.

Executive summary

The CIDA (Canadian International Development Agency) financed CPDAMPIC project (Capacity Building to enable the Development of Adaptation Measures in Pacific Island Countries) has executed nine pilots on four islands in the Pacific: Cook Islands, Samoa, Fiji and Vanuatu. Through intensive community consultations, problems related to climate change were identified and prioritized, and adaptation measures were formulated and implemented. Core to all pilots was the participation, capacity building and establishment of institutional networks to enable and empower local communities to deal with issues arising from climate change, climate variability and the associated risks.

This report investigates and assesses the economical costs and benefits from the pilots: how was the money spent, what were the in-kind contributions, what are the results, what went according to expectations, what can improved. Using the documents and reports that were generated by the project, interviewing project team leaders and participating institutions, as well as getting first-hand experiences in the communities where the pilots were implemented, a picture was drawn of the actual implementations and the failures and successes.

The conclusion is that without exception the pilots were extremely successful: there was a high degree of community participation and in-kind contributions, both problems and solutions were linked with climate change and all communities felt a big improvement in day-to-day life. The CPDAMPIC project succeeded to improve the conditions for nine communities (almost 4000 people) with relatively low financial inputs for US$600K from CIDA. This was matched by in-kind contributions of more than US$600K.

It is recommended that the same approach is followed more widely, both on the same islands and on other Pacific islands, building on the capacity that was developed in the CBDAMPIC project and on the institutional networks that it helped to create. A stronger economic component (with a proper a priori cost-benefit analysis) and use of climate change models (to assess the potential future effects of climate change) will improve the approach even further. Care must be taken to find the delicate balance between “doing” and “research”, in order to get an equally high in-kind contribution.

1. Introduction

Context

The “Capacity Building to enable the Development of Adaptation Measures in Pacific Island Countries” (CBDAMPIC) project is an adaptation to climate change project focusing on improving the sustainable livelihoods of Pacific Island people by increasing their adaptive capacity to climate-related risks. The project is implemented in four countries: Cook Islands, Samoa, Fiji and Vanuatu and was executed from January 2002 till March 2005.

One of the main outputs of the CBDAMPIC project is the identification of community vulnerabilities to climate related risks, including current coping capacity as well as their resilience to current climate risks. In the four project countries, this information was assessed from the community using the vulnerability and adaptation assessment CV&A (Community Vulnerability and Adaptation Assessment and Action) approach.

As a result, vulnerabilities were identified and assessed, and coping capacities determined. The communities also made suggestions as to how their current vulnerabilities could be improved by means of specific adaptation measures. In discussion with the communities, several adaptation options were identified for the CBDAMPIC project to fund as part of the project’s contribution to increasing adaptive capacity at community level.

Due to the lack of expertise at national level as well as the very tight time-frame at which the CBDAMPIC project was operated, it was not feasible to carry out a detailed economic cost-benefit analysis of adaptation options. Some crude economic cost-benefit analysis was carried out during the assessment stages to determine adaptation recommendations for implementation.

In light of future developments in the climate change debate (both globally and regionally), it is considered beneficial to determine some of the economic issues of adaptation in the Pacific drawing lessons from the CBDAMPIC project, one of the first Stage III projects to be implemented globally (adaptation stages agreed to by the First Conference of the Parties (COP)).

SPREP asked the International Global Change Institute (IGCI) of the University of Waikato in Hamilton, New Zealand, to execute a limited economic assessment of the CPDAMPIC project. As IGCI was involved in the definition of the project and already executed several economic assessments in the region (i.e. for the CLIMAPS project, Hay, 2004) it gladly took on this task, well realizing the potential pitfalls that came with it.

Mandate

The terms of reference for this assessment specify the analysis of, in particular, the net economic benefit of the various adaptation measures implemented by the CBDAMPIC project in the nine pilot sites in the four countries. The result of the analysis should provide an insight into the appropriateness of adaptation recommendations already implemented from an economic perspective. Study results should also provide stakeholders with alternative intervention scenarios (if any) that derive the highest economic net benefit.

The expected outputs from the economic study are:
- An assessment of the economic net benefits of implementing the various adaptation projects employed in the four countries/pilot sites in addressing climate change;
- An analysis of the economic implications of the adaptation options that have been implemented at the pilot sites to address current and future climate change, and in each case comment on whether the pilots have improved community resilience;
- A quantification of the communities' in-kind contribution to the adaptation measures that have been implemented;
- Discussion of lessons learned from the relevance of CBDAMPIC project work that may be relevant to current debates and developments on the economic cost of climate change adaptation;
- Recommendations for climate change policy development at the national level.

The benefit cost analysis should include:
- The economic net benefit of the "proactive risk management" activities based on work already implemented by the CBDAMPIC project;
- Identification and comparison of a "with" and "without" scenario - that is, what would happen in the presence and absence of any interventions. The "with" and "without" scenarios will be used as the basis against which to compare the economic net benefit of implementation of the options employed at the pilot sites;
- Assessment of the net economic benefits of implementing the various options and using an economic benefit cost framework and referring to the "with" and "without" scenarios identified above. Quantitative estimates of the net economic benefits from adopting alternative interventions will be made. In addition, where appropriate, comment on the robustness of these estimates (sensitivity analysis). In cases where quantitative estimates are not possible or appropriate, the consultant will make appropriate qualitative assessments of net economic benefits;
- Full explanation of assumptions and scenarios used in the analysis. For example, relevant climate experts should be consulted regarding the appropriate base climate scenario(s) to be used when planning an adaptation intervention based on future climate projections (possibly 10-50 years in the future);
- Comparison of the likely net economic benefits of the various options and scenarios; and
- Quantifying communities' in-kind assistance to the adaptation option implemented and how it affects overall cost of the adaptation measure employed.

Limitations

The timing of the assessment in relation to the CBDAMPIC project execution (at the end, instead of as part of project) limits its extent.
No detailed economic cost-benefit analysis of adaptation options was carried out when implementing the pilots, due to the lack of expertise at national level and the very tight time-frame the project was operating on. Thus, the CBDAMPIC project

implemented adaptation options that were not primarily aimed at achieving a maximum or even an optimal cost-benefit ratio, but at empowering local communities to solve the huge ongoing problems they are facing, often aggravated by climate change.

This approach influenced a lot of choices that are part of a regional project like this. The first one is about the allocation of project money. No in-country experience was available for executing the pilots. Usually when budgeting pilot projects, a large portion is set aside for research (model development, data collection, etc.), which leaves a smaller portion for actual implementation of identified adaptation options. The CBDAMPIC project deviated from this by allocating most of the money to implementation, forgoing the argument that because of the "pilot"-nature of the projects, research is required to be able to fully learn from the experience, enabling a bigger scale implementation.
As a result of this, most pilots lack clearly identified alternative solutions (targeting the same problem from different angles). Usually there is one major adaptation option, which is amended with potential additions. That is the result of the chosen CV&A approach.

As there were no alternatives to the pilots that were implemented, there is no way to do a least-cost analysis or a relative cost/benefit analysis on comparative approaches. All pilots had to do with "no choice" - e.g. houses had to be moved to escape flood danger; water supplies had to be supplemented to meets villages' needs. IGCI could have postulated alternatives for analysis in this economical assessment, but there was no time to specify and especially cost these.

In this light, the economic benefits that are relevant are largely non-quantifiable and anecdotal (community satisfaction with the end result, and community mobilisation for pilot specification, design and construction, hence "empowerment'").

The fact that the single most important result of CPDAMPIC is the empowerment of local communities to implement solutions for day-to-day problems they are facing (aggravated by climate change), makes this "post" economic assessment look somewhat futile. However, as the Pacific Islands are just embarking on the implementation of climate change adaptations, future adaptation programmes can still learn from a posteriori economic assessment.

2. CPDAMPIC project

Definition

For Pacific Island countries the need for climate change adaptation is a priority even with a swift implementation of global agreements to reduce emissions. The frequency and severity of extreme events, such as heat waves, tropical cyclones and storms, storm surges, and possibly El-Nino-like conditions, are likely to increase in a warmer world. This has had a range of adverse effects to the development efforts of Pacific island countries. It is predicted that climate-related extreme events will increase in the near future thus seriously threatening their overall sustainable development efforts.

The climate change impacts in the Pacific will be felt for many generations due to the islands' low adaptive capacity (in terms of resources and capability), high sensitivity to external shocks, and high vulnerability to natural disasters.

At the international level, the Barbados Programme of Action (BPoA) recognised the special situation of Small Island Developing States (SIDs) and their vulnerability to global climate change, climate variability, and sea-level rise. The BPoA provides for international support to SIDs across a number of sectors to assist them in adapting to climate change. The 22nd Special Session of the United Nations General Assembly (UNGA) reaffirmed the commitment of the international community to the BPoA and sought to accelerate programmes of assistance.

Governments of Pacific Island countries have over the years made statements on the need for action to address the adverse affects of climate change. In a joint statement prepared for the Sixth Conference of the Parties (COP 6) to the UN Framework Convention on Climate Change (UNFCCC), Pacific Island Governments urged the international community to consider the need for funding climate change adaptation (COP Preparatory Workshop, 2001). SIDs have also specifically requested for capacity building to be reflected under the adaptation funding.

SPREP, with funding provided by the Government of Canada and its people, has responded by supporting Pacific island countries to develop adaptation measures that will reduce climate related risks at the national and community level to the effects of climate change and climate variability and sea level rise. The CDN 2.2 million-dollar “Capacity Building for the Development of Adaptation Measures in Pacific Island Countries” (CBDAMPIC) project has been executed by SPREP over three years (January 2002 to March 2005). The project involves four countries: Cook Islands, Samoa, Fiji and Vanuatu (see Chapter 4 for an overview of the pilots).

The purpose of the CBDAMPIC project is to develop and implement a capacity-building programme that will increase the countries' capability to reduce climate-related risks at the institutional and community level. The project aims to help build the capacities, not so much of the regional organizations in the region, but of the government structures and communities themselves to better deal with climatic change risks and vulnerabilities. It has endeavoured to achieve these in the course of the project through two main outcomes and five main outputs.

The two main outcomes are:

- Climate change vulnerabilities and risks are mainstreamed into national planning and sectoral planning and budgeting processes; and
- Communities' adaptive capacity to climate change related risks and vulnerabilities is increased.

The five main outputs are as follows:

- Increased awareness by policy and decision-makers on climate change risks for their people's livelihoods and economic sectors and the adaptation options that could be put in place at national and community level to increase adaptive capacity;
- Senior government policy-makers committed to integrate and mainstream climate change adaptation into national and sectoral policies and a process is in place to incorporate climate change risk management into national planning;
- Increased awareness by communities of the vulnerabilities associated with climate change and the adaptation options available (traditional and contemporary);
- Pilots implemented in communities to reduce their vulnerabilities to climate change related risks; and
- Regional linkages developed and maintained that will ensure mutual advocacy platforms in the international arena and joint activities carried out to reduce vulnerabilities of Caribbean and Pacific regions to climate related risks.

The project adopts a "learning-by-doing" approach, which implies that although planning has been carried out and risks accounted for, it is envisaged that the approach will need to be flexible in order to take into consideration new directions and opportunities that may be learnt in the course of the project. Adaptation to climate change is a new component of climate change activities in the Pacific region therefore would provide challenges that the project will need to consider strategically.

Community resilience

CBDAMPIC is one of the few focused projects attempting to build community resilience to the longer term impacts of climate change. Researching other efforts provides little comparison to this particular project. For example, the GEF funded Pacific Islands Climate Change Assistance Programme (PICCAP, 1997-2000) focused primarily on capacity development at the national level, whereas some other national projects, such as the World Bank funded Samoa Natural Hazards project (2000-2002) emphasised community resilience however, only in terms of short term climate variability.

Consequences

There are several consequences of the approach taken. The pilots where aimed at empowering the local communities: they were solely responsible for identifying the most urgent problem, the best solution for this problem and for the implementation of this solution. Although some thoughts were given as to the costs and benefits of the potential solutions, the formulation and selection itself were not aimed at achieving a certain (i.e. maximal or optimal) cost benefit ratio. This hampers the economic assessment somewhat, as there is little information on alternative solutions (and their costs). Furthermore, most of the benefits (the empowerment, the awareness raising, the capacity built, the health improvements, the relief of stress, the impact on gender issues) are intangible. Some of the respondents interviewed for the economic assessment feel that this essence of the CBDAMPIC project is not reflected by a pure (that is money-based) cost-benefit analysis. Some other concerns were raised as well: establishing a cost-benefit ratio for the individual pilots would allow for a ranking: the best-performing pilots vs. the worst. It would also allow for an overall project evaluation that is no longer reflecting the primary results. This was considered a negative development.

3. Methodology

To assess the economical aspects of the CPDAMPIC project the following resources were investigated:

- The CBDAMPIC project coordinator, Taito Nakalevu, made available some project documentation at the start of the economic assessment (21 October 2005)
- SPREP was visited on Samoa to discuss the purpose and overall approach and methodologies of CBDAMPIC, as well as the purpose and approach of this economic assessment (26 October 2005).
- The country teams of Samoa, Fiji and Vanuatu were visited on their respective islands (26 October – 12 November 2005). Meetings were held with some of the people that are, or were, involved in the execution of the pilots. Information regarding the completion and performance of each of the CBDAMPIC pilots was obtained during these consultations.
- During the country visits, three of the nine pilot sites were inspected (Aitutaki on the Cook Islands, Saoluafata on Samoa and Bavu on Fiji) and representatives of local communities were interviewed.
- As SPREP was having a pre-COP meeting on Fiji while visiting the island, some of the interviews with the coordinators of the pilots were held there.

Using the information gathered, the pilots were assessed for the following information:

- Where was the pilot executed (location, population, households)?
- Problem-identification: what is the problem, why is it a problem, for whom is it a problem?
- What is the preferred solution, what are alternative solutions?
- What were the costs of the preferred solution (direct costs, in-kind contributions)?
- What are the benefits of the preferred solution?
- What are the climate change aspects in the problem and in the solution?

The costs could be assessed quantitatively, based on an analysis of the pilot descriptions, from which labour and materials could be estimated. The benefits were estimated qualitatively by identifying benefits for different categories, like health and safety, and scoring these to reflect their relative importance. Although initially it was planned to do the same for alternative solutions, none of the pilots clearly identified these solutions.

The influence of climate change is assessed as follows:

- Is the problem (potentially) caused or aggravated by climate change effects (i.e. changes in sea level, changes in temperature, changes in rainfall)?
- To what degree is the solution taking climate change into account?

Water-harvesting is part of all but one pilot (the seawall pilot). The effect of climate change can be analysed for the water-harvesting solutions with the water tank module of the SIMCLIM model (IGCI, 2005). With a specification of the water tank size, the area of the catchment, and the daily usage, the model then either takes a historic rainfall series (daily data) or a series generated for a certain climate scenario and computes the longest drought period (with drought defined as less water in the tank than needed for the daily usage), as well as the number of droughts longer than a certain period (i.e., four weeks). This can be used to assess if the chosen solution (size of water tank and catchment area for a given daily usage) is optimal and robust for climate change.

4. Assessment of pilots

The following pilots are executed within the CPDAMPIC project:

location	*finished*	*type*	*climate change threat*
COOK ISLANDS			
Aitutaki	yes	water harvesting: installing water tanks	rainfall, sea level rise (salt intrusion)
SAMOA			
Soaluafata	yes	sea wall	floods (sea level rise, extreme events)
Lano	yes	water harvesting: spring protection, community water tank	rainfall, sea level rise (salt intrusion)
FIJI			
Bavu	yes	water harvesting: additional community water tank	rainfall
Volivoli	NO[1]	water harvesting: drilling of borehole	rainfall
Tilivalevu	yes	water harvesting: drilling of borehole	rainfall
VANUATU			
Lateu,Tegua	yes	relocation of village	floods (sea level rise, extreme events)
Luli, Paama	yes	water harvesting: water supply, catchment system	rainfall, sea level rise (salt intrusion)
Panita, Tongoa	NO[2]	relocation of village	floods (sea level rise, extreme events)

[1] Drilling the borehole in Volivoli proved to be quite challenging. Normally water is hit at a depth of 40 meters (in fact some commercial drilling companies only offer drilling up to 42 meters). In Volivoli, at 62 meters (when the equipment broke down for a second time), no water was found. Only at 70 meters, water was found (end of October 2005).

[2] The relocation of the Panita community will commence shortly; all materials are in place, and technical staff will arrive in November 2005 to set up the water tank and catchment sheds.

The analysis of the pilots that were not finished at the time of this study (Volivoli, Fiji and Panita, Vanuatu) was executed assuming that their implementation was successful.

COOK ISLANDS

Aitutaki: Water harvesting pilot (household water tanks) Ca. 900 people, 246 households, 3.7 persons/household

What is the problem?[2]

Availability of drinking water is of great concern, due to the increasing saltiness of the mains water and length of dry periods affecting roof catchment supply. Most households are connected to the public water mains, which draw on water pumped from intake galleries and reservoirs. These become brackish with overuse and salt water intrusion from sea, so they are used mainly for non-drinking purposes. There are 43 communal rainwater tanks, but many are in disrepair or landowner issues limit access and maintenance.

The Island Council has noted that a recent AUSAID upgrading of all the reticulated mains system piping as well as improving a number of the community header tanks for the island, although useful, falls short of consumption requirements. The AUSAID project aimed to provide 175 litres per person per day, recognising that might not fulfil demand, and to overcome supply losses through old rusty pipes (estimated at 60-70%). All households have septic tanks.

[2] The descriptive text for the various pilots was taken from their respective reports. Evident errors in the texts were corrected, but otherwise only reformatting and restructuring was applied.

What is the solution

Aitutaki is one of the few places where hydrological surveys to understand the ground water potential have been carried out. Up-welling and saltwater-intrusion are the biggest issues for the galleries that feed the water mains system. Village demand is projected to increase from population concentration (although the total population of Aitutaki is roughly stable) and the introduction of more water-demanding modern conveniences such as washing machines.

Now that AUSAID has completed an upgrade of the reticulated water system, improved rainwater catchment systems are the most obvious adaptation. Water available through seasonal rainfall can supply the needs of the population. Most climate change scenarios show an increase of precipitation in the Southern Group, although given the size of the island compared to the resolution of the models, their reliability is limited. Rainwater is the most cost-effective and cleanest source of water for the people in these villages, and there remains great potential for its capture, storage and use, as only 10-30% of the rainwater potential is being captured from the iron roofs. Lack of funding, cyclones and lack of storage capacity have set back government and village initiatives in installing and maintaining this infrastructure. There needs to be incentives for maintaining guttering and pipes to tanks.

Regular drinking water testing is recommended to determine quality issues. Water treatment ranges from boiling to chemicals. Because the gallery-fed water is often quite brackish and hard, many people in Aitutaki consistently boil their water, especially for babies. This is a low-cost adaptation that needs to be encouraged, relative to the high cost of chemical treatment at the source. In house filtration systems that remove giardia and other health harming micro-organisms are available in the Cook Islands, but at between NZ$300-$600 each they are unlikely to become widely used.

Already there is a need for control of public water resources in the form of meters and rationing when needed because of the cost of running the pump and the potential exhaustion of the header tank. At an agricultural meeting the mamas complained because on the one hand they were being asked not to water their gardens during water shortages, while at the same time the FAO was trying to promote backyard agriculture. User pays or penalties for excessive use could be necessary if more commercial enterprises were established in the future using a disparate amount of water compared to the general public. The Island Government encourages people to store and conserve their own water, and perhaps should enforce a by-law requiring the tourist accommodations and other small businesses to install rainwater tanks.

Given that the bank based in Aitutaki is unable to give out loans for personal or household use, under the CBDAMPIC project a revolving fund was developed. Money loaned to households to purchase rainwater tanks and spouting (currently prohibitively expensive at roughly $1 per litre storage) once (partly) repaid would then be loaned to other households for similar equipment purchase. Community tanks face the problem of no-one being willing to maintain them, however people tend to be more vigilant about personal resources.

At the same time, villagers could ensure that when new pipes are laid they suit the environment (rust-proof) and are standardised for ease of maintenance and efficiency. Underground piping shields the connections from the worst wind forces, although breaks are harder to monitor, and the introduction of the new reticulated mains system with increased pressure has blown many of the aging household connections actually increasing water leakage, so a household-level initiative is required to reduce water loss.

Further adaptation options to explore include, using brackish or seawater for appropriate systems and cleaner toilet systems, for example the compost toilet, which might reduce contamination as well as having positive spin-offs for agriculture.

What are the costs?

	Pilot Component	Pilot	Community	Totals	Notes
I	**Rainwater Harvesting**				
	CV&A Assessments	$5,000	$6,000	$11,000	1
	246 x 2,000-litre rainwater tanks , without fittings	$37,000	$37,000	$74,000	2
	Installation labour (20 hrs of labour per household)		$14,760	$14,760	3
	House guttering (12 m of guttering works installed per household)		$25,395	$25,395	4
	Repair of Community tanks	$3,400		$3,400	
	O&M program	$4,600		$4,600	5
	Total Rainwater Harvesting sub-pilot costs	$50,000	$83,155	$133,155	
		38%	62%		
II	**Management of water supply infrastructure**	$45,000		$45,000	
III	**Improvement in water quality**	$15,000		$15,000	
IV	**Demand Management Programs**	$40,000		$40,000	
	Total Pilot Input Costs	$150,000	$83,155	$233,155	
		64%	36%		

Notes on assumptions:

1 CV&A estimated assessment costs covered by pilot include on-site survey costs plus travel and accommodation. Personnel salaries not included. In-kind contribution to CV&A from households includes time input valued at $20 per household, for approximately 300 households surveyed.

2 The total tank procurement cost of $74,000 (shared 50/50 by the pilot and households) is equivalent to about US$300/tank. Includes shipping

3 Installation includes site prep, hook-up, etc., assumed 20 person-hrs/household valued at $60.

4 50 percent of the recipient households (123) must install NZ$300 (about US$200) worth of fittings (gutters, etc) to their tanks at their cost. Other households are assumed to have fittings already in place.

5 As per pilot budget.

Summary:

Total pilot costs, $233,155; per benefiting person. $259

In kind contribution, $83,155; 36% of total costs; per benefiting person, $93

What are the benefits?

Issue	Improvement	Relative importance[3]
health	less water quality related health issues	low
gender issues	as women are more involved in the day-to-day water usage of the family, they are more benefiting from resolving the water supply issue	low
stress	less stress over the availability of daily water	high
climate change issues	the whole process, starting with problem identification (through community consultation), going through formulating potential solutions, selecting a solution, implementing the solution and after-care, built the capacity of the community to deal with the effects of climate change	low
empowerment	community became owner of problem and solution; contributed to solution (because of the subsidizing scheme)	high
awareness	community more aware of the use of water: water-saving, water-tanks with mortgage	high
network	the wide contribution and participation in the pilot built a knowledge and capacity network, in the village communities, between the communities, nationally and regionally	high

What were potential other solutions?

- desalinisation installation (very expensive solution)
- upgrade of mains system (already tried: AUSAID project)

How is climate change dealt with?

in the problem

Being a small island, rainwater is the only source of water. Climate change projections for the Cook Islands predict a 5.7 mm per year decrease of rainfall, which is very substantial (NIWA: Climate trends & variability in Oceania, 5-9 November 2001 Workshop). A decline in rainfall for the whole island impacts the freshwater lens, which in turn aggravates the salt water intrusion problem, which impacts the mains water availability and quality. Thus, the impact of climate change on the (future) availability of drinking water is recognized.

in the solution

The size of the tank is based on a straightforward analysis: annual rainfall, water usage per person, available money and households (expected) to be served. This resulted in the selection of 2000 litre tanks. Historic rainfall data allows for evaluating the performance of the system chosen. A very long time series from 1 January 1914 till 31 December 1996 (spanning 83 years), gives the following results for a household that consumes 73 l/d (3.65 persons using 20 l/d) and has a catchment area of 15 m^2:

[3] The relative importance has been subjectively assessed by IGCI, taking into account all information sources (like interviews and reports).

- the longest period that there is insufficient water in the tank (<73 l) is 56 days
- the number of periods longer than 14 days (2 weeks) that there is insufficient water in the tank is 48 (or 0.58 per year, or once in every 1.73 years)

The long term (83 year) rainfall normal is 1936 mm/year. The 5.7 mm per year decrease is consistent with 0.294% per year, or 8.83% in 30 years, lowering the normal to 1765 mm/year. This almost 10% decrease means that instead of 20 l/d/p, 18 l/d/p is available in 30 years.

Conclusion

The 2000 litre tanks were chosen to help as many households as possible given the amount of money available. The financing scheme proved to be successful as 246 tanks were installed, which potentially accumulate almost 500000 litres of water! Four tanks were damaged during transport and negotiations with the transporter are underway to deal with this issue (NB. originally the scheme provided for 200 tanks, but because the pilot is an aid-project, it was tax-exempt, allowing for an additional 50 tanks to be installed).

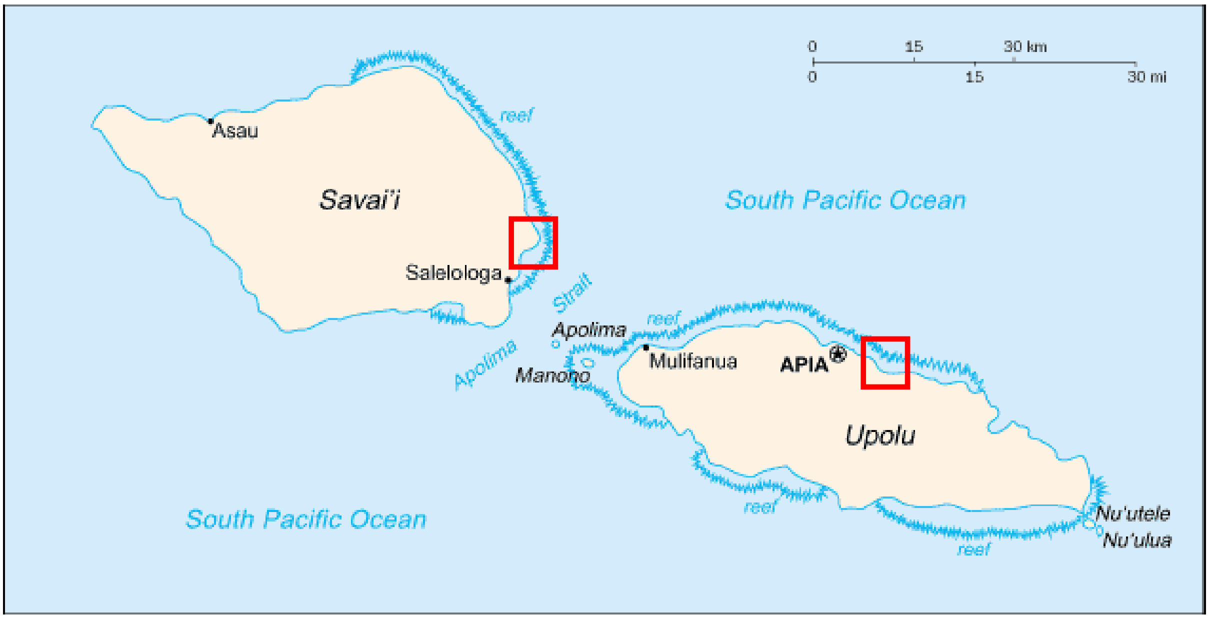
Without the financial limitations, bigger tanks would be preferable: they perform better on the historic rainfall time-series, and are more robust to climate change effects.

Choosing plastic tanks allows for protection in case of hurricanes (they can be emptied and put inside). How well this works still needs to be proved in practice.

The local community was fully engaged in the whole process and was prepared to come up with a substantial financial contribution.

SAMOA

On Samoa, 2 pilots were implemented, in Saoluafata and Lano, with a seawall and a water-harvesting pilot respectively.



Saoluafata: Sea wall pilot complemented with cleanup and protection of spring 674 people, 88 households, 7.7 persons/household	

<u>What is the problem?</u>

Problem	Description
Land loss and inundation	Saoluafata is particularly vulnerable to coastal erosion and inundation, causing loss of land and homes, and threatening school buildings and the village malae. Storm surges destroy homes and properties along the coast with the highest waves reaching the main road located approximately 100m inland. Sea-level rise and frequent storm surges plus the refraction effect of the government built seawall adjacent to the village is accelerating the coastal/beach erosion.
Deteriorating Marine Environment	Coral bleaching or the visible whitening of coral in the village marine reserve is reported. Due to bleaching some corals do not recover thus affecting the total fish catch in the area. The corals are impacted adversely from warming waters and sedimentation during flood events.
Salinisation and contamination of freshwater springs	The freshwater bodies used to drink from in times of water shortages and also for cooking are suffering from salt-water intrusion and flooding due to storm surges making it unsafe for consumption. The possible cause of the salinisation problem is that the river flow is too weak while the sea flow is too strong.
Salinisation and contamination wetland	This wetland ecosystem is used for fishing. Recently, the village established a nursery where they introduced "tilapia" mainly for the village consumption, but the wetland became too salty for the tilapia species' survival. The wetland has also become shallow due to deposition of sand during cyclones and high waves. It also

	suffers from deposition of debris from upland during flooding events adversely affecting the wetland's biodiversity.
Destruction of Crops	Droughts result not only in the drying up of plants, but also in a shortage of water needed for plantations to grow and bear fruit, resulting in decreased quantity and quality of root crop production, particularly that of taro and yams. The soil had lost fertility due to the lack of moisture. Plantations are often flooded, leading to a decline in crop production. Flooding can lead to landslides washing away the topsoil. Households have had to move their plantations further upland, accelerating the problem of soil erosion due to land clearing.
Health risks from water and vector borne diseases	Poor water quality during flooding leads to Diarrhoea, Typhoid and skin diseases. Dust during dry periods leads to more frequent outbreak of Red eyes. Intense rainfall and heat stress lead to Flu-like symptoms and coughing, diarrhoea, skin diseases and dengue fever.

Prioritized Vulnerability	**Current Coping Strategy**
Coastal erosion & inundation	- Reclamation (2 families), - Temporary seawall (2 families), - Village-made drainage system - Banned sandmining
Salinisation & Sedimentation of water resources	None
Destruction of crops	- Plant new species, pesticides control - Plantation competition - Community replanting program
Coral bleaching	- Replant corals in marine reserve and support from fisheries division - Clean up by village
Health	Counter approach: treat when affected

Vulnerabilities identified	**Who is vulnerable**	**Causes of Vulnerability**
Loss of land to due to erosion from the sea	- 60% of the village - 12 family homes - School - Village malae - Village infrastructure	- Sea-level rise - Storm surges/ cyclones - Households live on the coast near the sea
Flooding, inundation of land & sedimentation	- 85% of the village - Village school - Marine & freshwater ecosystems - Village infrastructure	- Intense rainfall - Cyclones - Location - Graphic features (households live on flat land opposite high land - No proper drainage system - Deforestation of upland areas
Lack of quality water supply	100% of the village is affected.	- Sea-level rise - Storm surges - Sporadic intense rainfall - Location of coastal springs near the sea and roads - Deforestation of upland areas

Destruction of crops	100% of the village is affected as all families have plantations for income earning and consumption.	- Droughts - Intense rainfall - Cyclones - Climate variability - New airborne pests & diseases
Coral bleaching less fish stock	100% of the village is affected, as all depend on the sea for consumption and income.	- El Nino - Droughts - Increase temperature - Sedimentation intense rainfall

What is the solution?

The village proposed that a seawall be constructed to protect coastal settlements and properties and the main road from coastal erosion and storm surges associated with tropical cyclones. The safety and security of those living along the coast are the primary concerns of the village. The people feel very strongly about protecting the malae and the burial grounds of their ancestors, both located near the coast. Their land is their heritage and their home; the people of Saoluafata see retaining their land as a priority to them.

Adaptation Option	**Cost**	**Benefit**	**Comment**
Build seawall to protect malae, school, and houses.	+++	+++	This has been prioritised as the urgent need to protect the school, malae and houses. The community offering the labour and resources (rocks, sand) needed for the seawall and food for the workers.
Rehabilitation of coastal areas by revegetation along coastlines and mangroves in the wetland.	+	++	Current vegetation cannot stop erosion.
Restore freshwater springs	+	+++	A solution to this is to protect the coast from high wave energy and sedimentation.
Maintenance of existing village water tank	+	++	This could assist the community with water need.
Proper drainage system	++	+++	Reduces the impact of flooding.
Reforestation/watershed management program	+	+++	Important for the village to sustain water supply and biodiversity of the wetland.
Awareness program	+	+++	Increased knowledge of the community will complement efforts to adapt to climate change.

Implementation plan

Climate	Vulnerabilities	Solutions & Reasons	Expected Outcome
Cyclones	- Damage to buildings - and properties - Endangered lives - Plantations destroyed - Water contamination - Sedimentation in wetlands - Alteration of coastline - Loss of land	- Construct a seawall on the seaward side of the village to protect the school, land and heritage (Malae) of the village. - Strengthen existing sea walls built by families. - Manage domestic sand mining to protect coastline and ensure sustainable use of the resource. - Plant trees and other vegetation in coastal areas and enable vegetation to grow. - Install water tanks for families to ensure availability of safe drinking water and prevent health hazards. - Provide adequate drainage along and under the new village road to prevent flooding and sedimentation on lowlands. - Existing drainage built by families is only a temporary means to protect, but also diverts the problem to other neighbouring families. - Restoration of coastal springs in the village to ensure availability of safe drinking water. - Implement an appropriate programme to control invasive species and crop diseases. - Reforestation and banned clearing of trees on the hillside to prevent flooding, soil erosion, water contamination during heavy rains. - Implement measures to protect the wetland from storm surges and	- Improved ability of the village to protect itself from climate-related risks. - Enhance resilience and prevent disastrous consequences of global warming and sea level rise. - Reduced impact on the natural environment and the livelihoods of the people. - Assist poor families to build their capacity to adapt to climate change related risks in the long term. - Ensure the protection of the village heritage and preservation of cultural significance of communal assets. - Ensure long-term sustainability of sources of food and income security. - Improved health and well being of village people. - Continuous availability and supply of safe drinking water for the village. - Increased land productivity and environment protection. - Increased capacity and understanding of adaptation measures to climate risks.
Flooding	- Endangered lives - Diseases - Damages to houses and properties - Contamination of water supply and sources and coastal water springs - Soil and land fertility decrease - Land inundation - Corals affected		
Storm surge	- Coastal erosion - Loss of land - Schools and homes are threatened by visible erosion - Salinisation of coastal springs (source of water supply for the village) - Wetland affected due to the sedimentation of sand		
Droughts (1997/1998)	- Plantations and almost all crops - died. - Food supply decreased - Income reduced - Coral Bleaching		

Climate Variability - Intense rainfall - Hot suns - Seasonal changes	- Increase health problems such as pink eyes, flu-like symptoms, diarrhoea and typhoid - Land prone to flooding with intense rainfall - Prone to landslides - Vegetable gardens and plantations infested with pests - Contamination of drinking water - Mango and breadfruit seasons varies - Size and quality of fruits changes	sedimentation during flooding periods. - Continuous awareness programmes on climate change and other environmental issues such as water management and conservation. - Health education programmes and improves health facilities	

What are the costs?

Pilot Component		Pilot	Community	Totals	Notes
I	**Construction of Seawall**				
	CV&A Assessments		$1,800	$1,800	1
	Seawall: materials, labour, and construction expertise	$50,000	$106,196	$156,196	2
II	**Restoration of Springs and Community Water Storage**				
	Cleanup and protection of coastal springs	$4,500	$2,500	$7,000	3
	Restore community water tank	$10,000	$1,500	$11,500	3
	Total Water Supply Restoration work	$64,500	$111,996	$176,496	
		37%	63%		
III	**Other Pilot Components** Community Awareness Reforestation and watershed management	$10,500	$10,500	$21,000	3
	Total Pilot Input Costs	$75,000	$122,496	$197,496	
		38%	62%		

Notes on assumptions:

[1] It is understood that CV&A assessment was carried out prior to the CBDAMPIC project, therefore only community inputs to this are recorded. In-kind contribution to CV&A from households includes time input valued at $20 per household, for approximately 90 households surveyed.

[2] The Pilot allocation to the seawall was WST 144,050 (US$50,000); the total costs including local labour and materials is estimated (SPREP) at WST 450,000 (US$156,196).

[3] Pilot input: as per pilot budget. Local input: assume 140 people over 3 days (420 person-days) at US$25/day + local materials (if applicable)

Summary:
Total pilot costs, $197,496; per benefiting person, $293
In kind contribution, $122,498; 62% of total costs; per benefiting person, $182

What are the benefits?

issue	improvement	relative importance
health	less water quality related health issues as the springs are restored	low
gender issues	as women are more involved in the day-to-day water usage of the family, they are more benefiting from resolving the water supply issue	medium
safety	community protected from coastal erosion and (1 in 100 year) flood events	high
stress	less stress over the availability of daily water	medium
climate change issues	the whole process, starting with problem identification (through community consultation), going through formulating potential solutions, selecting a solution, implementing the solution and after-care, built the capacity of the community to deal with the effects of climate change	high
empowerment	community became owner of problem and solution; contributed to solution (labour, materials)	high
awareness	community more aware of coastal erosion issues in relation to climate change (i.e. importance of healthy reef and vegetation)	high
network	the wide contribution and participation in the pilot built a knowledge and capacity network, in the village communities, between the communities, nationally and regionally	high

NB. There is no longer a beach at Saoluafata. This used to attract tourists (in fact the road sign pointing to the beach is still there) generating income. As the beach was already severely eroded, this income was diminishing anyway.

What were potential other solutions?

Vulnerability	Priority Adaptation Measure
Coastal erosion & inundation	- Rehabilitation/revegetation of coastline (this is now done by the community)
Salinisation & sedimentation of freshwater systems	- Maintenance of existing village water tank - Construct proper drainage system - Replanting mangroves
Destruction of crops	- Reforestation upland - Watershed management program - Awareness program on invasive species & resistant crops (executed)
Coral bleaching	- Replanting corals (a workshop is prepared)

How is climate change dealt with?

in the problem:

Coastal erosion: aggravated by sea-level rise issues and increase of extreme events, plus deteriorating condition of coral reef. Interesting is the urgency of the problem: 30 meters of coastal erosion in the last 5 years. The initial suggestion that it is caused by the sea-wall built 5 years ago in Apia seems unlikely (quite a big distance, no clear reflective wave patterns). The sand removed apparently "disappears" from the system: possibly deposited over the reef-edge. A more daunting explanation is that local sea-level rise is aggravated by negative land movement, exceeding some threshold, enabling the wave-energy to reach the coast, suddenly increasing the coastal erosion.

in the solution:

The design of the sea-wall is based on a 1:100 year event under "future" conditions. This means that it should be able to cope (for the coming 30 years) with extreme events that occur with a frequency of one or more every 100 years.

Conclusion

The pilot provided the means (design and equipment) to the community to deal with the coastal erosion problem in a very straightforward way: building a sea-wall. The design of the sea-wall is a low cost approach: an open structure that captures sand that will reinforce it. The community contributed materials (soil and rocks), labour, hosting and food (for the technical staff). The community is also taking care of maintenance. The capacity built through the program is showing in the revegetation efforts (along the sea-wall) and the coral-gardening workshop that is organized. The freshwater springs in the wetland area (restored by the pilot) are also maintained by the community.

Lano: Water harvesting (through cleanup and protection of springs)

720 people, 98 households, 7.3 persons/household

What is the problem?

Problem	Description
Salinisation and shortage of safe drinking water	Flood events and droughts have crippled the village drinking water supply especially from coastal springs, which play a major role not only in supplying water for consumption, but also more significantly as a symbol of their cultural identity and heritage. When intense rainfalls flood the village, piped water supply is occasionally shut off. Piped water supply is insufficient: droughts lead to water shortages throughout the village for months. Freshwater pools are salinated and not safe for consumption while being the main source of water for consumption and cooking. Most of the springs are already salinated due to salt-water intrusion whilst some have disappeared due to coastal erosion and high seas. The ones that still exist are further down inland in the mangrove areas. These springs are usually contaminated during flooding events from upstream sediments which may also include fertilizer or pesticides from farmers' plantations.
Land loss and inundation	Rising seas and high storm surges as well as sandmining activities have eaten away land at a rate of 5 m/yr. Deforestation along the

	coast has further worsened the situation. The residents are very concerned for their security in the event of increased sea level rise and tropical cyclones. The road protects most family lands near the coast, but a great deal of land has been lost already.
Waterborne and vector-borne diseases	After floods people are suffering from skin diseases, stomach-aches and flu, likely due to the fact that floods last for days or even a week or two, as the ford (with poor drainage) blocks the flow of river. This results in contaminated water supply and a breeding environment for mosquitoes. Low river flow through the ford allows sand to deposit at the mouth of the river, making the water stagnant threatening the village with vector-borne diseases. A warmer and more variable climate may be the cause for the increase in cases of flu, severe headaches, diarrhoea, skin diseases and an overall lower level of health for the children. Areas of the village that were not prone to flooding are now extremely vulnerable due to the ford. Intense rainfall occurs approximately once a month and stagnant water bodies have developed near houses.
Wetland ecosystem	Lano village is flanked by mangrove ecosystems that support fish stocks. The "Puka" river was able to supply the whole village with stock of fish they needed. Sediment from flooding events accumulates in the stream leading to eutrophication, impacting adversely on the mangroves and its associated biodiversity. Deforestation near watershed catchments has contributed to the increased erosion, destruction of the wetland and mangrove ecosystem.
Deteriorating Marine Resources	The village depends on the sea for subsistence livelihood. Most of the reefs and corals are turning white believed to be a consequence of rising seas, warmer waters and high waves. The decreases in fish catch and extinct of fish species such as "faagoa" is believed to be caused by reef destruction, sedimentation of mangroves and unsustainable fishing methods.
Destruction of crops	The warmer climate has lead to drier soils and poorer crop growth with poor yields. Plantations are facing new diseases, such as the lega (taro leaf blight). The ulu (breadfruit) trees now bear fruit year round but the fruit has decreased in quality. Tropical cyclones used to occur only in the first few months of the year but can now occur year round.

Prioritised Vulnerability	**Current Coping Strategy**
Land inundation from flooding	None
Salinisation and sedimentation of fresh water springs	Protect some springs by building cement walls on the edge of springs.
Coastal erosion	Government build sea-wall, but does not cover the whole village
Destruction of crops from cyclones, droughts, pests and diseases	Introduce new species
Coral deterioration	Control use of destructive methods of fishing
Health	Counter approach: treat when affected
Destruction of houses during cyclones	Find shelter at the church and school building
Loss of income	Depend on assistance from families overseas

Vulnerabilities identified	Who is vulnerable	Causes of Vulnerability
Flooding, inundation and sedimentation	- 85% of the village - Human lives - Water supply - Mangrove ecosystems - Households and infrastructure	- Ford - Sporadic Intense rainfall - Cyclones - No proper drainage system - Deforestation
Salinisation and sedimentation of fresh water springs	- 100% of the village - Health affected - Lack of safe drinking water supply	High seas
Deterioration of mangrove ecosystem	- 90% of the village - Village fish supply decreased - Affect coastal protection	- Ford affect natural flow of water - Sedimentation from flooding events - Increase flooding events - Deforestation upland areas
Destruction of crops	- 100% of the village - Farmers mostly depended on plantations for living	- Natural hazards - Crop diseases - Proximity to river banks - Location of plantations mostly upland - High soil erosion rate
Loss of land and houses inundated	- 30% of the village - Houses and land	- High storm surges - Strong winds and waves during tropical cyclones - Flooding

<u>What is the solution?</u>

The ford blocks the water from flowing freely, thereby flooding the whole village. Uplifting the existing ford will allow flow of water achieving the same goal as building a new bridge (which requires more resources).

A seawall would protect coastal settlements and properties from coastal erosion and sea level rise. It is crucial that a ban be placed on sand mining, which only exacerbates coastal erosion.

The village requires a drainage system to redirect rainwater during flooding events.
The village also requires water tanks. Their piped water supply is not a reliable source of clean drinking water, particularly during a flooding event when debris and runoff collect in the source. Freshwater pools are no longer a source of drinking water since they suffer from saltwater intrusion. Water tanks would also safeguard the village against drought, when their water source is apt to dry up. It was also suggested that new water wells be dug. The existing wells have been contaminated

by salt water. Food and water supply should be on hand in case plantations are destroyed or the water supply system shuts down.

Adaptation Options	Cost	Benefit	Comment
Replace ford with proper bridge	+++	+++	It is a priority for the village to reduce the risk from future flooding events. Different options have been identified: 1) replace the ford with a new bridge and 2) build the ford higher up and add more pipes to allow the flow of water
Reforestation & Watershed management	+	+++	The village is willing to work together with the pilot to achieve this. The costs involve initial set-up such as the nursery and workshops.
Proper drainage system	++	+++	This will assist in reducing the impact of flooding in the village
Install water tanks	+++	+++	Installation of water tanks will assist the community with water problems.
Restoration of Coastal Springs	++	+++	The solution is the protection of the coast from high wave energy and sedimentation during flooding.
Conserve mangroves	+	+++	To strengthen protection from high storm surges and enrich biodiversity and fish stock.
Establish Marine Reserve	+	+++	A marine reserve is needed to replenish the marine ecosystems. The pilot will cover the cost of initial set-up of the marine reserve.
Manage sandmining	+	+++	The community has proposed to ban sandmining.
Awareness program		+++	E.g., promote agro forestry, teach methods of risk assessments and other issues that will complement efforts to adapt to climate change.

Implementation plan

Climate Risks	Vulnerabilities	Solutions & Reasons	Expected Outcome
Cyclones	- Endangered lives - Plantations and forest destroyed - Water contamination - Sedimentation in wetlands (Mangroves) - Alteration of coastline - Loss of Land - Coral destruction	- Replace ford with a proper bridge to allow free flow of water and minimize risks of flooding. - Construct a seawall on the seaward side of the village to protect families residing along the coast. - Management of domestic sand mining to protect coastline and ensure sustainable use of the resource. - Conserve mangrove ecosystems in Lano. - Establish marine reserves in the village.	- Improved ability of the village to protect itself from climate related risks. - Enhance resilience and prevent disastrous consequences of global warming and sea level rise. - Reduced impact on the natural environment and the livelihoods of the people. - Assist less fortunate families with

<table>
<tr>
<td>Flooding</td>
<td>- Endangered lives (especially children)
- Diseases
- Damages to houses and properties
- Contamination of water supply and sources
- Plantations and livestock destroyed
- Soil and land fertility decreased
- Land inundation for weeks
- Corals and fish stock affected due to sedimentation
- Eutrophication of the mangrove ecosystem and river
- Coastal erosion</td>
<td rowspan="4">- Planting trees and rehabilitates vegetation on coastal areas.
- Install water tanks for families to ensure availability of safe drinking water and prevent health hazards.
- Provide adequate drainage along and under the new village road to prevent flooding and sedimentation on lowlands.
- Restoration of coastal springs in the village to ensure availability of safe drinking water.
- Implement an appropriate programme to control invasive species and crop diseases.
- Reforestation and banned clearing of trees on the hillside to prevent flooding, soil erosion, water contamination during heavy rains.
- Implement measures to protect the wetland from storm surges and sedimentation during flooding periods.
- Continuous awareness programmes on climate change and other environmental issues such as water management and conservation.
- Health education programmes and improves health facilities</td>
<td rowspan="4">economic limitations to build their capacity to adapt to climate change related risks in the long term.
- Ensure the protection of the village heritage and preservation of cultural significance of communal
- Ensure long-term sustainability of sources of food and income security.
- Improved health and well being of village people.
- Continuous availability and supply of safe drinking water for the village.
- Increased land productivity and environment protection.
- Increased capacity and understanding of adaptation measures to climate risks</td>
</tr>
<tr>
<td>Storm Surge</td>
<td>- Loss of land
- Coastal settlement threatened by evident erosion
- Salinisation of coastal springs (source of water supply for the village)
- Deposition of sand in the mangrove areas make it shallow and upset ecosystems
- Plantations and crops died</td>
</tr>
<tr>
<td>Droughts (1997/1998)</td>
<td>- Shortage of water supply
- Food supply decreased/decrease crop production
- Income reduced
- Coral bleaching
- Reduce fish stock Increase health problems such as flu like symptoms, diarrhoea, typhoid</td>
</tr>
<tr>
<td>Climate Variability
- Intense rainfall
- Hot Suns
- Seasonal changes</td>
<td>- Land prone to flooding with intense rainfall
- Plantations infected with pests
- Contamination of drinking water
- Breadfruit seasons varies
- Size and quality of fruits changes</td>
</tr>
</table>

What are the costs?

	Pilot Component	Pilot	Community	Totals	Notes
	CV&A Assessments		$2,000	$2,000	1
I	**Flood Mitigation**				
	Improvements to Drainage	$4,000	$3,000	$7,000	2
	Raising of the Ford (or construction of bridge?)	$10,000	$3,000	$13,000	2
II	**Restoration of Springs and Community Water Storage**				
	Cleanup and protection of coastal springs	$8,000	$2,500	$10,500	3
	Restore community water tank	$10,000	$1,500	$11,500	3
	Total Flood Mitigation and Water Supply Restoration work	$32,000	$12,000	$44,000	
		73%	27%		
III	**Other Pilot Components**				
	Mangrove conservation	$8,000	$11,250	$19,250	
	Community Awareness	$24,000	$11,250	$35,250	4
	Reforestation and watershed management	$11,000	$3,000	$14,000	
	Total Pilot Input Costs	$75,000	$37,500	$112,500	
		67%	33%		

Notes on assumptions:

[1] It is understood that CV&A assessment was carried out prior to the CBDAMPIC project, therefore only community inputs to this are recorded. In-kind contribution to CV&A from households includes time input valued at $20 per household, for approximately 100 households surveyed.

[2] For community input, 120 person-days of labour assumed, at US$25/person-day.

[3] Pilot input: as per pilot budget. Local input: assume 60 person-days at US$25/day + local materials (if applicable)

[4] Community input costs are in the form of time contributed to community consultations for mangrove conservation involving 150 people from 98 households over 3 days (450 person-days) and community awareness (450 person-days), plus labour to build a nursery (60 person-days) and conduct replanting (60 person-days); each person-day valued at US$25

Summary:
Total pilot costs, $112,500; per benefiting person, $156
In kind contribution, $37,500; 33% of total costs; per benefiting person, $51

What are the benefits?

Issue	Improvement	Relative importance
health	less water quality related health issues as the springs and tank are restored	high
gender issues	as women are more involved in the day-to-day water usage of the family, they are more benefiting from resolving the water supply issue	medium
safety	community better protected because of the improved ford	high
stress	less stress over the availability of daily water and safety	high

climate change issues	the whole process, starting with problem identification (through community consultation), going through formulating potential solutions, selecting a solution, implementing the solution and after-care, built the capacity of the community to deal with the effects of climate change	medium
empowerment	community became owner of problem and solution; contributed to solution	high
awareness	community more aware of climate change impacts	high
network	the wide contribution and participation in the pilot built a knowledge and capacity network, in the village communities, between the communities, nationally and regionally	medium

<u>What were potential other/complementary solutions?</u>

Vulnerability	**Priority Adaptation Measure**
Destruction of crops, houses, and endangerment of lives during flooding periods	- Replace ford with proper bridge to allow free flow of water - Reforestation program and ban clearing of trees on the hillside - Drainage system to control flooding - Awareness programs - Appropriate program to control crop diseases and promote agro forestry
Salinisation and sedimentation of wetlands and drinking water	- Restoration of coastal springs in the village to ensure availability of safe drinking water - Install water tanks for families
Coastal erosion and inundation from flooding and storm surges	- Conserve mangrove ecosystem - Establish a marine reserve - Planting trees and rehabilitate vegetation on coastal areas - Manage sandmining in the village

<u>How is climate change dealt with?</u>

in the problem:

Sea-level rise will increase the extent of salt intrusion as well as coastal erosion. Both are leading to deterioration of the water springs.

in the solution

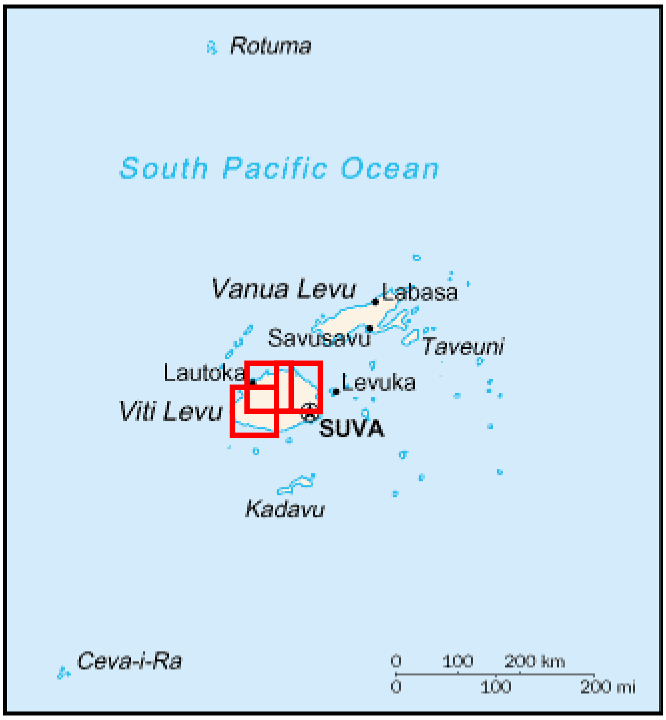
Links with the climate change issue are not strong: the spring cleanup and tank restoration are not adaptation options. The design of the new ford still needs to prove itself. It is unclear how well it will deal with climate change effects.

<u>Conclusion</u>

Living conditions for the community have improved significantly. The situation with respect to the ford is very complex. A definitive solution probably goes beyond the pilot.

FIJI

On Fiji, three pilots were executed: in Bavu, Tilivalevu and Volivoli. These were all water harvesting pilots.



Climate change context in Fiji

Key elements of anticipated climate change as reported in the Climate Change Vulnerability and Adaptation Assessment for Fiji (Feresi et al., 1999) are described below. The following were some key conclusions from this assessment for climate change over the 100-year period from 2001 to 2100:

- Temperature changes using mid-range emissions scenarios are estimated to increase by 0.5°C by 2025, and increasing to 1.6°C by 2100. Applying a higher emissions scenario, these projected temperature increases grow to 0.6°C in 2025 and 3.3°C by 2100.
- Sea level is projected to increase, with mid-range scenarios yielding predictions of 10.5 cm by 2025 and 49.9 cm by 2100, although scenarios based on higher greenhouse gas emission projections indicated a rise twice as high, that is, over 20cm by 2025 and 1m by 2100 (Feresi et.al., 1999).
- Precipitation changes of appreciable magnitude are anticipated, but the direction of the change is highly uncertain. This is because Fiji's climate is strongly influenced by the position of the South Pacific Convergence Zone (SPCZ). Depending on how climate change will influence the position of the SPCZ, Fiji may experience a significant increase or a significant decrease in rainfall in the future (Feresi et.al., 1999, Frisbey et al. 2002).

Bavu: Water harvesting (additional community water tank) 450 people, 55 households, 8.2 persons/household

What is the problem?

Bavu village is one of the six villages in the district of Wai that is vulnerable not only to climate extreme events but also the variability or changes in weather patterns on a particular season. Through a CV&A process conducted by the World Wide Fund for Nature (WWF) lead team, shortage of water was highlighted and prioritised by the village of Bavu as the major climate related vulnerability affecting the daily livelihood of the people. The problem stems from multiple climate and non-climatic conditions. Severe water shortage during the dry seasons has caused the community to ration water use. At times, water from the borehole is unavailable and villagers instead have to look for water in nearby creeks as alternatives.
The periodic dry spells have taken its toll on the water pump that draws water from the borehole thus affecting the livelihood of the people of Bavu. The adaptation recommendation requested was for their current storage tank to be enlarged. The existing tank has a capacity of 27,300 litres that was installed to serve a total of 20-25 households. The village is currently having 50-55 households so the current tank is no longer able to meet the demand of the growing population, let alone provide any security during droughts. This is why the community are requesting that storage capacity be increased to 45,500 litres to help curb the current water problem and be able to assist the community in terms of long periods of dry spells.

Water shortage has also brought about severe heath problems like diarrhoea, and skin infections mainly in young children. Climate variability and change in short to long term is likely to aggravate the problems faced by the village of Bavu and further complicate their socio-economic livelihood and well-being. Adaptation is a matter of priority thus every effort to harness support for adaptation is welcomed by the villagers.

What is the solution?

With the current population growth and climate variations facing this village, the people have sensed that there is a need to have a larger water tank to meet the needs of the people. A larger tank will also be in a better position to store water for a much longer period, especially during the dry seasons. Since water is a basic necessity of life, the adaptation option proposed would place the village at a much better position to deal with water problems as well as lessen its vulnerability to climate change.

What are the costs?

	Pilot Component	Pilot	Community	Totals	Notes
I	**Capacity Building**				
	CV&A Assessments	$1,250	$1,100	$2,350	1
	Community consultations and reporting	$2,500	$12,500	$15,000	2
	Total capacity building	$3,750	$13,600	$17,350	
		22%	78%		
II	**Water Harvesting**				
	Install new village water storage tank	$20,150	$6,250	$26,400	3
	Total Water Harvesting	$20,150	$6,250	$26,400	
		76%	24%		
	Total Pilot Input Costs	$23,900	$19,850	$43,750	
		55%	45%		

Notes on assumptions:

1 In-kind contribution to CV&A from households includes time input valued at $20 per household, for approximately 55 households surveyed.

2 Assume 100 people from 55 households attend 5 days of awareness raising consultations, @ US$25 person-day

3 Pilot input: apportioned as per pilot budget. For local input, 250 person-days of labour assumed, at US$25/person-day.

Summary:
Total pilot costs, $43,750; per benefiting person, $97
In kind contribution, $19,850; 45% of total costs; per benefiting person, $44

What are the benefits?

Issue	Improvement	Relative importance
health	less water quality related health issues as water availability is improved	medium
gender issues	as women are more involved in the day-to-day water usage of the family, they are more benefiting from resolving the water supply issue	medium
stress	less stress over the availability of daily water	medium
climate change issues	the whole process, starting with problem identification (through community consultation), going through formulating potential solutions, selecting a solution, implementing the solution and after-care, built the capacity of the community to deal with the effects of climate change	low
empowerment	community became owner of problem and solution; contributed to solution (see remark below)	high
awareness	community more aware of climate change issues wrt. the availability of water	high
network	the wide contribution and participation in the pilot built a knowledge and capacity network, in the village communities, between the communities, nationally and regionally	high

The community came with the suggestion to put guttering on the nearby church to harvest rainwater. With remaining money necessary materials were bought and installed by village carpenters. The effective roof-area of the church is over 200 m^2.

With a yearly rainfall of 1500 mm, this contributes 300 m^3 (300,000 litres) of water per year.

What were potential other solutions?

No other solutions were formulated.

How is climate change dealt with?

in the problem:
The available ground water resource is influenced by climate change. However, finding alternative resources was not tried.

in the solution:
The climate change issue played a very minor role in the solution as this mainly focussed on an increased water supply to support the village expansion. Because the new tank provides additional buffer capacity (because of the increase storage capacity), it is better able to deal with variation in water supply from the source (potentially because of climate change).

Conclusion

The additional water tank improves the availability of the village now and in the future. The empowerment of the community to take care of their own problems is best illustrated by the guttering of their church.
The current situation (after the installation of the tank) raises some questions on the completeness of the solution:
- the distance from the borehole (more than 2 km, with vulnerable piping to the village; creating a borehole closer to the village was considered as an alternative adaptation option but rejected)
- the age of the pump probably requires a replacement fairly quickly
- the expansion of the village (plans to go from 45 to 60 houses, for about 540 people)

With 450 people and a total tank capacity of 45500 litres there is a buffering capacity of only 100 litre per person which is not a lot (5 days with 20 l/d/p).

Tilivalevu: Water harvesting (borehole)

160 people, 32 households, 5.0 persons/household

What is the problem?

Water is the main vulnerability that the Tilivalevu community is facing. Not only the quality and quantity, but also the sustainability of supply is also a major issue. Members of the village have frequently experienced water shortages during the dry season thus a good amount of time is spent daily by women and children to harvest water for bathing, cooking and agricultural use. This has contributed to decline in productivity overall and increased incidence of health related diseases such as diarrhoea and skin rashes.

There were other vulnerabilities mentioned, such as the degree of damage of houses in the village during cyclones, freshwater resources affected in times of drought and the damage caused to agricultural crops and livestock during cyclones and droughts. However, the community have outlined water supply as the main problem since it is a daily necessity and basic need for the household.

Urgency for adaptation support to the people of Tilivalevu cannot be further emphasised. Addressing Tilivalevu's current water vulnerability is an important investment in terms of climate change adaptation.

Problems	**Score***
Poor quality and quantity of water	30
Damage of houses caused by cyclones	30
Cannot harvest river and water fishes, as there are none	27
Financial well being affected	26
Livestock dying	25
Transportation problems	23
Health problems (scabies, diarrhoea, head-aches)	20
Selling bad crops	17
Sporadic and intensive rainfall	12
Crop yield smaller	12
Lack of drinking water for livestock	11
Soil erosion	10
Too much/ too little of fertilizers can affect crop yields	10
Rivers and streams become shallow	9
Too much rain damage yam crops	8
Fruits do not flower at the right time	3
Shortage of food	1

* These figures were achieved during the community consultation process: a score of 30 means that 30 people found this problem important. Thus the higher the score, the more people judged the importancy of the problem.

<u>What is the solution?</u>

The proposed adaptation option is to have all piping systems changed and to at least have two rainwater collecting tanks installed in the village. Meeting the above adaptation options will in the long-term help the people of Tilivalevu adapt well to climate change and climate variability. It will also contribute to sustainable supply of water to the growing population's per capita water consumption.

For the people of Tilivalevu, there are only two water tanks that serve the village. Since water is used for many purposes, such as cooking, bathing, washing, etc., there is a need to look for other alternative sources of storing water to meet the needs of the growing population as well as to combat the extremity of climate events that are currently been experienced in Tilivalevu. Currently, there is a main pipe that runs from the tank to all households. There have been leakages along the pipes that run from the dam to the tanks. The following are some of the suggestions made to meet the water needs of the community:

- There is a need to enlarge the dam that serves the people of Tilivalevu. The dam is so small that water collected from the water source is over-flowing from the dam itself. The volume of the dam is estimated to be 10.40 m3. This serves a village of population size of 160 people.
- According to a Public Works Department (PWD) representative, there is a need to install a water tank in the village to collect rainwater that can then be used during the dry season. The pipes already installed from the dam to the village needs to be replaced to better cater for the needs of the community now and into the future.

What are the costs?

	Pilot Component	Pilot	Community	Totals	Notes
I	**Capacity Building**				
	CV&A Assessments	$1,250	$640	$1,890	1
	Community consultations and reporting	$1,500	$6,250	$7,750	2
	Awareness brochures	$2,000		$2,000	
	Monitoring and travel	$2,500		$2,500	
	Total capacity building	$7,250	$6,890	$14,140	
		51%	49%		
II	**Water Harvesting**				
	Replace existing pipes from dam to village	$10,452	$3,000	$13,452	3
	Install water storage tank and repair existing tank	$22,345	$3,000	$25,345	3
	Upgrade existing dam	$3,244	$7,250	$10,494	4
	Total Water Harvesting	$36,041	$13,250	$49,291	
		73%	27%		
	Total Pilot Input Costs	$43,291	$20,140	$63,431	
		68%	32%		

Notes on assumptions:

[1] In-kind contribution to CV&A from households includes time input valued at $20 per household, for approximately 32 households surveyed.

[2] Assume 50 people from 32 households attend 5 days of awareness raising consultations, @ US$25 person-day

[3] Pilot input: apportioned as per pilot budget. For local input, 120 person-days of labour assumed, at US$25/person-day.

[4] Pilot input: apportioned as per pilot budget. Local input: assume 250 person-days at US$25/day + local materials (if applicable)

Summary:
Total pilot costs, $63,431; per benefiting person, $396
In kind contribution, $20,140; 32% of total costs; per benefiting person, $127

What are the benefits?

Issue	Improvement	Relative importance
health	less water quality related health issues as water supply is improved	high
gender issues	as women are more involved in the day-to-day water usage of the family, they are more benefiting from resolving the water supply issue	medium
stress	less stress over the availability of daily water	high
climate change issues	the whole process, starting with problem identification (through community consultation), going through formulating potential solutions, selecting a solution, implementing the solution and after-care, built the capacity of the community to deal with the effects of climate change	medium
empowerment	community became owner of problem and solution; contributed to solution	medium
awareness	community more aware of the relation between climate (change) and the availability of water	medium
network	the wide contribution and participation in the pilot built a knowledge and capacity network, in the village communities, between the communities, nationally and regionally	high

What were potential other solutions?

Listed below are some additional adaptation strategies that could have been carried out and would have contributed to the overall protection of the watershed areas where the village's water supply is coming from.

- Contour farming;
- Planting trees on hillsides;
- Plant fruit trees within crop plots to provide shade for the plants;
- Plant trees that can return nutrients back to the soil; and
- Improve sanitary condition of the people (flush toilets: however, this will increase water consumption)

How is climate change dealt with?

in the problem:

In the larger Tilivalevu catchment, precipitation average varies each month depending on the season. During the hot/wet season (Nov - Apr), this area receives average rainfall of 1770 mm. The cold/dry season (May - Oct) receives an average rainfall of 930 mm but during the El Nino periods, the area suffers extremely from drought. This supports the prioritisation of the water supply as the main issue for this village

in the solution:

The solution implemented should safeguard water supply (even under some unfavourable conditions resulting from climate change) for the community for some years.

Conclusion

The community benefits from the improved water supply in day-to-day life immediately. Spin-offs are in less stress, improved health, and improved situation for woman, empowerment (self-reliance) and built capacity.

Volivoli: Water harvesting (borehole)

259 people; 56 households (2003); 4.63 persons/household
(was 807 in 139 households in 1986!, 5.85 persons/household)

What is the problem?

In Volivoli, Rakiraki on the North-eastern coast of the main island (July 2004), drought was a major vulnerability that the community of Volivoli have been facing over the years and it has lead to the lack of a sustainable supply of quality water for consumption for the community of Volivoli. Not only that, it has also affected severely on other areas of daily living such as the education of the children, agricultural production and health. This finding is consistent with other CV&A findings reported from other communities in other regions of the country. Members of the four communities (Tavarau, Volivoli I and Volivoli II and Raravatu), which included men, women, and youths, all agreed that water is the main issue that needs immediate attention. Currently, the communities of Volivoli are using wells and boreholes (for those who can afford) to draw water from daily, but usually in the five months that are cold and dry, precipitation is very low and haphazard making water very scarce. In most extreme circumstances, farmers are forced to abandon the place and sell their land and livestock at very cheap prices to entrepreneurs who have money. The problems are compounded when some of the wells that the community depend on are now becoming too salinated due to salt-water intrusion particularly during high tides.

There are no government water supply systems running through the whole Volivoli area and according to experts consulted, plans are in place but lack of volume (capacity) from the current water source will be a major stumbling block to extending the piped water system from Rakiraki town to other areas (including Volivoli). It was therefore recommended that communities should consider their own water supply systems, as government support will not be available to them due to constraints mentioned.

At present, the communities have utilized several coping strategies that include: carting drinking water from nearby creeks and town; borrowing or carting water from neighbours bore holes; keeping well water for washing and showers; carting water for drinking; boiling water for drinking and cooking; using non-boiled water for washing and showers; borrowing water from other areas; carting water from bore holes, or in the most extreme case buying drinking water from the shop. These coping strategies are not enough and help is sought for some level of support to the Volivoli communities to ease the water vulnerability they are facing.

Problems
When rain is available the area is flooded due to too much rain
Lack of quality (clean, safe) water for drinking, cooking, washing and shower
Salinisation of water
Lack of water for the crops (vegetables, sugarcane) during dry season
Shortage of drinking water for the livestock
They cart water from nearby boreholes, borrow, collect from nearby creeks which is about 20 km away
Therefore high cost of transport
The quality and the quantity of water from the well are often dirty, salty and not enough
During the dry season, there is often no rain and this leads to the drying of the well
Six houses in the Volivoli area share one well
In Volivoli area at least 24 houses are lacking water and in the Tavarau area almost 12 houses

What is the solution?

In the discussions on adaptation strategies to implemented for Volivoli, it was unanimously agreed that bore-hole is the best option, with water tanks coming second and desalination plant, third. Desalination plants would be ideal but the high cost of the equipment and maintenance prompted the communities to rank the option lower then bore holes and water tanks. Addressing the above adaptation options will in the long term help the people of Volivoli adapt better to climate variation and change. It will also help solve health problems related to water borne diseases and improve the standards of living of the community. It will also contribute to the sustainable supply of water to the rural population, a major policy objective of the current government.

What are the costs?

	Pilot Component	Pilot	Community	Totals	Notes
I	**Assessments and Capacity Building**				
	CV&A Assessments	$1,250	$1,120	$2,370	1
	Environmental Impact Assessment	$1,500		$1,500	
	Community Awareness activities	$2,000	$12,500	$14,500	2
	Total assessments and capacity building	$4,750	$13,620	$18,370	
		26%	74%		
II	**Water Harvesting**				
	Hydrology Survey	$15,612	$3,125	$18,737	3
	Construction of Reservoirs	$15,612	$3,125	$18,737	3
	Drilling and commissioning of bore hole	$46,835	$9,375	$56,210	4
	Total Water Harvesting	$78,059	$15,625	$93,684	
		83%	17%		
	Total Pilot Input Costs	$82,809	$29,245	$112,054	
		74%	26%		

Notes on assumptions:

1 In-kind contribution to CV&A from households includes time input valued at $20 per household, for approximately 56 households surveyed.

2 Assume 100 people from 56 households attend 5 days of awareness raising consultations, @ US$25 person-day

[3] Pilot input: apportioned as per pilot budget. For local input, 125 person-days of labour assumed, at US$25/person-day.

[4] Pilot input: apportioned as per pilot budget. Local input: assume 375 person-days at US$25/day

Summary:
Total pilot costs, $112,054; per benefiting person, $432
In kind contribution, $29,245; 26% of total costs; per benefiting person, $112

What are the benefits

Issue	Improvement	Relative importance
health	less water quality related health issues	low
gender issues	as women are more involved in the day-to-day water usage of the family, they are more benefiting from resolving the water supply issue	medium
safety	NA	NA
stress	less stress wrt. the availability of daily water	medium
climate change issues	the whole process, starting with problem identification (through community consultation), going through formulating potential solutions, selecting a solution, implementing the solution and after-care, built the capacity of the community to deal with the effects of climate change	high
empowerment	community became owner of problem and solution; contributed to solution	high
awareness	community more aware of ...	high
network	the wide contribution and participation in the pilot built a knowledge and capacity network, in the village communities, between the communities, nationally and regionally	high

NB. The pilot in Volivoli still has to be completed (end 2005): drilling commenced sometime ago, but the local circumstances showed to be exceptionally difficult. Normally, water is found at around 40 meters deep. In the Volivoli case, water was hit (October 2005) only at a depth of more than 70 meters.

What were potential other solutions?

Desalinisation plant was another option identified, but due to its high cost, it was not considered. Another option is to look for other sources of water from the nearby villages.

How is climate change dealt with?

in the problem

Average rainfall for the larger Volivoli area is significantly low. Classified as a dry zone, it is characterised as an area that receives less than 25% of annual rainfall in the dry season, which equates to about 100-150 rain days per year. Annual rainfall is about 2,600 mm/year and during the dry season, rainfall is less than 500mm.

Sea-level change is a threat to Volivoli settlement in terms of ground water salinisation. Most of the wells and boreholes near to the shoreline are already being saline. If future IPCC projections are accurate in terms of sea-level rise in the Pacific 10 cm till 2050, this community will have its coastal resources, groundwater supply and sustainable livelihood seriously affected. Increasing droughts based on Global Climate Model's (GCMs).
Uncertainty in precipitation for the Volivoli area is a major issue for the future given the fact that it can add to the current stress both to the natural and human systems.

in the solution:

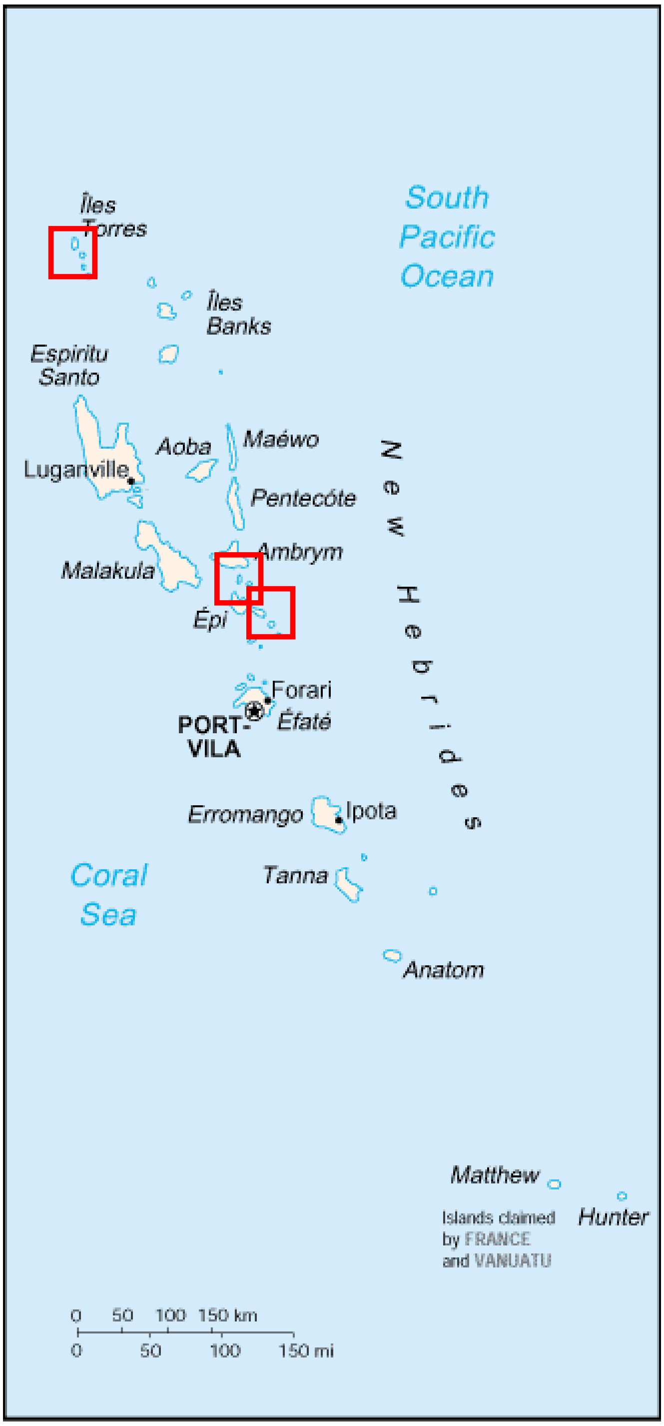
Drilling a borehole creates a water resource that should be less susceptible to climate change influences (i.e., compared to rainwater harvesting). This is an expensive solution but a long-term one.

Conclusion

The community will no longer be under severe stress from lack of reliable and clean water resources. The new borehole will supply them with good quality water for a long period to come and can deal with potential expansion of the village (which is not unlikely as previously about 3 times as many people lived in Volivoli).

VANUATU

Three pilots were implemented in Vanuatu: Lateu (relocation), Luli (water harvesting) and Panita (relocation).



Lateu: Relocation Ca. 60-100 people (large variation because of travelling to/from nearby islands), 16 traditional houses, 1 church house, 1 health aid post, 6.7 persons/household

What is the problem?

Severe coastal erosion of about 50 meters over the last 20 years (2.5 m/yr), sea-level change, and geological processes have raised the underground water lenses, creating permanent flooding and standing pools of water throughout the village. The situation is aggravated during spring tides and higher than usual high tides associated with the south-westerly winds as well as heavy rainfall during cyclones.

The result is a village surrounded by permanent pools of water that bring about a series of health-related issues that affect the daily livelihood of the people of Lateu. The periodic flooding of dwellings deteriorates housing rapidly, prevents cooking on the ground (fireplaces) and results in endless dampness, a health hazard. The flooding also triggers the overflow of pit toilets, which threatens to contaminate the settlement's only underground water well. The flooding condition also creates favourable conditions for water-borne diseases, which have increased significantly, including malaria, diarrhoea and skin infections, especially among children.

Climate variability and change (ie. sea level change) in the short to long term, are likely to aggravate the problems faced by the Lateu community and further complicate their socio-economic well-being.

What is the solution?

the Lateu community prioritised relocation of their settlement (including aid post, church and rainwater catchment and tank) and improved rainwater harvesting technologies (tanks and catchment facilities) as the most appropriate adaptation measure to boost their adaptive capacity to fluctuating precipitation, extreme weather conditions and sea level change.

The principal adaptation option is an all-encompassing measure that will address the main cause (flooding) of the present vulnerability of Lateu community. Most importantly, with the relocation, long-term climate and sea-level change is taken into consideration as the Lateu community coastline continues to recede at a very alarming rate. The movement to the new site will definitely reduce the vulnerabilities of the community from current risks and it is envisaged that it will contribute to the resilience of Lateu community to future climate related risks.

With the increase in understanding of the community to climate and sea-level change and significant commitment towards a safer future, the community has collectively agreed and selected two potential sites for relocation pending relevant impact assessments.

It is envisaged that all sectors of the community will benefit from the relocation of the community (principal adaptation option), which include women and children. Such a measure will be a “first” in Vanuatu and the experiences gained will be invaluable to the rest of the archipelago especially in the area of climate change adaptation involving a small island and small population.

What are the costs?

	Pilot Component	Pilot	Community	Totals	Notes
I	**Assessments and Capacity Building**				
	CV&A Assessments	$1,250	$320	$1,570	1
	Environmental Impact Assessment	$1,356		$1,356	
	Community Awareness activities	$5,445	$3,750	$9,195	2
	Total assessments and capacity building	$8,051	$4,070	$12,121	
		66%	34%		
II	**Relocation of village and water harvesting**				
	Relocation of 16 houses, 1 church, 1 aid post	$29,642	$56,358	$86,000	3
	Construction of water catchment sheds and tanks	$12,307	$6,250	$18,557	4
	Total Relocation of village and water harvesting	$41,949	$62,608	$104,557	
		40%	60%		
	Total Pilot Input Costs	$50,000	$66,678	$116,678	
		43%	57%		

Notes on assumptions:

[1] In-kind contribution to CV&A from households includes time input valued at $50 per household, for 16 households surveyed, based on presumed in-depth consultative process

[2] Assume 30 people from 16 households attend 5 days of awareness raising consultations, @ US$25 person-day

[3] Total buildings relocation costs including church estimated at $61,000 (based on budgeted costs for church and aidpost). Village labour for this estimated at 50 people working for 20 days (=1000 person days) valued at US$25/person-day.

[4] Pilot input: as per pilot budget. Local input: assume 250 person-days at US$25/day

Summary:
Total pilot costs, $116,678; per benefiting person, $1166
In kind contribution, $66,678; 57% of total costs; per benefiting person, $665

What are the benefits?

Issue	Improvement	Relative importance
health	less water quality related health problems	high
gender issues	as women are more involved in the day-to-day water usage of the family, they are more benefiting from resolving the water supply issue	medium
safety	safe from flooding	high
stress	less stress from flooding and well-being threats	medium
climate change issues	the whole process, starting with problem identification (through community consultation), going through formulating potential solutions, selecting a solution, implementing the solution and after-care, built the capacity of the community to deal with the effects of climate change	high
empowerment	community became owner of problem and solution; contributed to solution	high
awareness	community more aware of climate change	high
network	the wide contribution and participation in the pilot built a	medium

	knowledge and capacity network, in the village communities, between the communities, nationally and regionally	

What were potential other solutions

In addition to the principal adaptation option, complementary adaptation measures considered include:

- Awareness needs to be increased;
- Shift pit toilets away from flood prone area;
- Enhance aid post medical supplies/stock consistently;
- Installation of Rannet Radio Information System;
- Improve current ground well;
- Secure rainwater tanks to keep rats away;

How is climate change dealt with?

in the problem:

Climate change is clearly identified as a likely driver of the changes that are forcing the community to reconsider their current location.

in the solution:

A long-term solution is sought by relocating the whole community to safe grounds, providing them with safe water supply at the same time (i.e., dealing with multiple climate change threats: sea level rise, extreme weather, and decline in rainfall). The dimensioning of the catchment system and size of the water tanks is not based on climate change expectations, but on current usage.
The six water tanks of 6000 litre each are fed by five catchment sheds of ca. 35 m^2 each. With an average yearly rainfall of 1500 mm, one shed collects 52500 litre of water per year. Assuming 100% efficiency and storage, a maximum of 144 l/d per shed is available. With five sheds for 100 people, this gives a little over 7 litre per person per day. This is very little. With this low usage, the capacity of the six tanks allows for covering 6000/(16*7)=52 days without rain (more than 7 weeks). That is OK.

Conclusion

Relocating a community is an extreme adaptation measure putting a lot of stress on a community. Successful implementation is usually very difficult. The Lateu community succeeded in completing this daunting task. By creating the incentive of save water availability in a different location, the final move was facilitated. However, the tank/rainwater harvesting set-up is probably not sufficient on the long-term, and modifications are to be expected.

Luli: Water harvesting

Ca. 300 people, 24 households, ca. 12.5 persons/household

What is the problem?

A severe lack of quality and constant supply of drinking water was highlighted and prioritised by the Luli community as the major climate related vulnerability that affects the daily livelihood of the community. With limited access to the main urban centre of Port Vila, or other nearby islands, availability of quality and a continuous supply of water is a critical need that surpasses other socio-economic requirements of the Luli community. Half of the people's effort in a 12-hour period is used on trying to access water wherever it is available particularly in the case of a prolonged drought as was the case during the April-September cold and dry season of 2003. Also, with transportation limited to the use of animal power and canoes with limited carrying capacity, all work that are related to the carting of water for daily consumption is made by human power and largely by women and children.

What is the solution?

The Luli community collectively prioritised the establishment of a network of rainwater catchment and storage per household as the most appropriate adaptation measure to boost their adaptive capacity to climate and sea level change. The prioritised adaptation measure having been put through a cost-benefit analysis is highly recommended for the community.

The principal measure addresses both volcanic fall out and salt spray effects by the use of resistant catchment material. The pilot interventions proposed for the Luli community are practical, easy to implement and should go a long way to contributing to the socio-economic enhancement of this rural community.
Since women are in general responsible for the collection of water, they will benefit greatly from having water close to their homes. The overall health benefits resulting from having a safe and consistent supply of water will benefit all members of the community including women and children. The establishment and construction of water catchment facilities by the Rural Water Supply section of the Vanuatu Government's Ministry of Lands is not new and the experience and lessons gained elsewhere will benefit Luli tremendously in the setting up of their network. The establishment of such systems also involves community training in management and maintenance of the facilities giving them control and ownership of their system. The construction of the facilities uses low-level technology and can be taught to the community. The measure therefore is the best and most appropriate, practical and cost-effective option to address Luli community's water related vulnerability.

24 tanks of 2400 litres each combined with catchment area of ca. 20 m^2 (half the size of a standard size shed) were built.

What are the costs?

	Pilot Component	Pilot	Community	Totals	Notes
I	**Assessments and Capacity Building**				
	CV&A Assessments	$1,250	$480	$1,730	1
	Climate change and water awareness	$3,161	$10,000	$13,161	2
	Agricultural training	$4,016	$15,000	$19,016	3
	Total assessments and capacity building	$8,427	$25,480	$33,907	
		25%	75%		
II	**Water harvesting**				
	Construction of 24 tanks and water catchment sheds, including guttering fixtures, etc	$41,573	$25,000	$66,573	4
	Total water harvesting	$41,573	$25,000	$66,573	
		62%	38%		
	Total Pilot Input Costs	$50,000	$50,480	$100,480	
		50%	50%		

Notes on assumptions:

1. In-kind contribution to CV&A from households includes time input valued at $20 per household, for 24 households surveyed.
2. Assume 200 people from 24 households attend 2 days of climate change awareness raising consultations, @ US$25 person-day
3. Assume 200 people from 24 households attend 3 days of agricultural awareness raising consultations, @ US$25 person-day
4. Pilot input: as per pilot budget. Local input: assume 200 people working for 5 days (=1000 person-days) at US$25/person-day

Summary:
Total pilot costs, $100,480; per benefiting person, $334
In kind contribution, $50,480; 50% of total costs; per benefiting person, $167

What are the benefits?

Issue	Improvement	Relative importance
health	less water quality related health issues	high
gender issues	as women are more involved in the day-to-day water usage of the family, they are more benefiting from resolving the water supply issue	high
stress	less stress over the availability of daily water	medium
climate change issues	the whole process, starting with problem identification (through community consultation), going through formulating potential solutions, selecting a solution, implementing the solution and after-care, built the capacity of the community to deal with the effects of climate change	medium
empowerment	community became owner of problem and solution; contributed to solution	high
awareness	community more aware of climate change impacts on (rain)water availability	high
network	the wide contribution and participation in the pilot built a knowledge and capacity network, in the village communities, between the communities, nationally and regionally	medium

NB. Although the community built most of the water harvesting systems (only one system was build by the technical people, showing the community how to do this; the remaining 23 systems were then build by the community), it still needs to be trained in the maintenance of the rainwater harvesting systems. Some additional funds need to be found for this.

What were potential other solutions?

In addition to the principal adaptation option, other adaptation measures considered in relation to this include;

- Awareness needs to be increased;
- Establishment of an aid post;
- Reinforcement of salt tolerant vegetation buffers;
- Installation of Rannet Radio Information System;

How is climate change dealt with?

in the problem:

The northern most station in the Banks group (Sola) since establishment in 1972 registered a record low of 2212 mm in annual rainfall totals up to October. This is well below the annual average of 4051 mm and surpassing previous low records of 2437mm (1993) and 2811mm (1995). Pekoa station located on the northern island of Santo in August 2003 recorded 6.1mm of rain, the fourth lowest monthly total rainfall recorded since establishment in 1971. Previous low records were only recorded during El Nino episodes in 1977 (4.1mm), 1982 (6.0mm) and 1983 (2.8mm). VNMS White grass station in the southern part of the country also recorded a record monthly low of 4.5mm since establishment in 1999. This shows that any solution with respect to water-availability that harvests rain needs to take climate change and variability into account as a risk.

in the solution:

The 2400 litre tanks per household are very small compared to the usage by on average 12.5 persons. Also the catchment area of 20m^2 is small. With an average rainfall of 2500 mm (taking climate change into account) and 20m^2, when every drop can be collected and used, 50,000 litres per year per household is available. With 12.5 persons per household that is 4,000 litres per person per year, or little over 10 litres per day. With this consumption, the tanks can only span a dry period of less than 20 days. Larger tanks and catchment areas would have been preferred, but the additional costs were prohibitive.

Conclusion

Installation of the 24 2400-litre tanks (with a total capacity of 57600 litres) makes a big difference for the community: water is more readily available, while the system is less vulnerable for the local environmental conditions (i.e. acid rain). Travels to the other side of the island (to collect water) either over land (over a steep hill) or over water (using canoes), both taking about 3-4 hours each day will become much less frequent. Implementation of a better performing set-up (with bigger tanks and larger catchment areas) was limited by 2 factors: 1) finance, 2) size of the tanks (which had to be transported over water and over land under difficult circumstances). Given these limitations, the result of this pilot is quite acceptable.

Panita: Relocation and community water tank

Ca. 200+ people, ca. 40 households, ca. 5 persons/household

What is the problem?

Coastal land loss and recession was highlighted and prioritised by the Panita community as the major climate related vulnerability increasingly threatening village infrastructure and affecting the daily livelihood of the people. In the last 50 years the coastline has receded more than 100 meters at a rate of almost 2 meters per year. The threat to settlement infrastructure is therefore quite significant. Sand mining and removal of coastal vegetation are also contributing to the problem. Coastal erosion is heightened during cyclone events when waves associated with surges wash far beyond the HWM (High Water Mean) and undermine the loose structure of the cliffs that seat Panita. Waves washing into areas of the village are becoming common during cyclone events, continually increasing the vulnerability of the settlement. Additional to this, regular flooding of two creeks that run behind the settlement and out to the sea on either sides of the village is also threatening village infrastructure and the population of 200, especially during the wet November to April season and in the event of cyclones, common during that time of the year with averages of 3 per season. In the event of a flood, water overflows the creeks and flows into the village compound flooding parts of the settlement and flowing into dwellings. Erosion of the creek banks from flowing water is already threatening underground cement rainwater storage well. Heavy and prolonged rainfall heightens the vulnerability of the settlements from flooding by the creeks.

What is the solution?

The Panita community collectively prioritised relocation as the most appropriate adaptation measure to boost their adaptive capacity to climate and sea level change. The prioritised adaptation measure having been put through a cost-benefit analysis is highly recommended for the community.

The adaptation measures identified are the best and most appropriate, practical and cost-effective options to address Panita's problems. The option will go a long way to alleviate the current and future problems that the Panita community is facing on coastal erosion and other climate related hazards such as flooding and landslide. Relocation will also improve the community's access to education, health and communication services as these will be part of the town layout from the beginning.

Being one of the first relocation of its kind in Vanuatu, lessons learnt will be valuable to other similar programmes involving a much larger island with more people.

What are the costs?

	Pilot Component	Pilot	Community	Totals	Notes
I	**Assessments and Capacity Building**				
	CV&A Assessments	$1,250	$2,000	$3,250	1
	Environmental Impact Assessment	$1,356		$1,356	
	Community Awareness activities	$5,445	$10,625	$16,070	2
	Total assessments and capacity building	$8,051	$12,625	$20,676	
		39%	61%		
II	**Relocation of village and water harvesting**				
	Relocation of 40 houses and 1 church,	$22,396	$152,604	$175,000	3
	Construction of water catchment sheds and tanks	$19,553	$7,500	$27,053	4
	Total Relocation of village and water harvesting	$41,949	$160,104	$202,053	
		21%	79%		
	Total Pilot Input Costs	$50,000	$172,729	$222,729	
		22%	78%		

Notes on assumptions:

[1] In-kind contribution to CV&A from households includes time input valued at $50 per household, for assumed 40 households surveyed, based on presumed in-depth consultative process.

[2] Assume 85 people from 40 households attend 5 days of awareness raising consultations, @ US$25 person-day

[3] Total buildings relocation costs including church estimated at $125,000 (based on similar costs for Lateu relocation pilot). Village labour for this estimated at 100 people working for 20 days (=2000 person days) valued at US$25/person-day.

[4] Pilot input: as per pilot budget. Local input: assume 300 person-days at US$25/day

Summary:
Total pilot costs, $222,729; per benefiting person, $1113
In kind contribution, $172,729; 78% of total costs; per benefiting person, $868

What are the benefits?

Issue	Improvement	Relative importance
health	less water quality and availability related health issues	high
gender issues	as women are more involved in the day-to-day water usage of the family, they are more benefiting from resolving the water supply issue; relocation of the village is dominantly implemented by the men	low
safety	relocating the village to higher ground provides a much increased safety against flooding	high
stress	less stress over the availability of daily water and fear for flooding and the future of the village	high
climate change issues	the whole process, starting with problem identification (through community consultation), going through formulating potential solutions, selecting a solution, implementing the solution and	medium

	after-care, built the capacity of the community to deal with the impacts of climate change	
empowerment	the community became owner of problem and solution and contributed substantially to the solution	high
awareness	the community became more aware of climate change and its own ability to deal with some of the resulting issues	high
network	the wide contribution and participation in the pilot built a knowledge and capacity network, in the village communities, between the communities, nationally and regionally	low

NB. This pilot still needs to be finalized (projected end of November 2005): all materials are in place, but the technical people have to come over and build the concrete water tank and catchment systems.

What were potential other solutions?

In addition to the principal adaptation option, other adaptation measures considered in relation to this include;

- Awareness needs to be increased;
- Construction of sea wall along the coast;
- Construction of a bridge over creeks;
- Installation of Rannet Radio Information System;

How is climate change dealt with?

in the problem:

In the face of climate variability and change, current problems could heighten and significantly affect the community's socio-economic well-being. Adaptation is a matter of priority thus every effort to harness support for adaptation is welcomed by the community. Climate change was deemed a factor both for flood-risk as for water availability.

in the solution:

The village is being relocated to a spot (high grounds) that will be safe from coastal erosion and storm-surges under any climate change scenario. The dimensions of the water tank are based on current needs plus an allowance for a growth in demand, which would also deal with (limited) decrease in rainfall (from climate change).

Conclusion

This community put in a very substantial (both relatively and absolutely) contribution to the implementation of the preferred action. The pilot empowered the people (by pointing out the roots of the problems the village was facing and by identifying options through the consultative process), but in the end it was the village itself that had to implement one of the most intense adaptation options there is: relocation. As availability of water is the number one requirement for a village, the building of a community water tank at the new location proved to be the incentive for villagers to move. Although the long-term effects and effectiveness of the relocation still has to be proved, given the problems the community was facing, it can already be concluded that this pilot is very successful.

5. Overall conclusions and discussion

Observations

Although the nine pilots cover three different main adaptations (water-harvesting, relocation and protection), it is interesting to note that in ALL nine pilots the supply of good quality water was a driving factor (and in all but one, THE driving factor). In the relocation pilots, providing a reliable source of good quality water elsewhere proved to be the incentive for the local communities to move to their new location. In the sea-wall protection pilot, two freshwater springs were cleaned and renovated.

The costs of pilots, separated as in-kind costs and contribution by the CBDAMPIC project (note: the CBDAMPIC contribution was fixed at $150000 per country, with countries having 1, 2 or 3 pilots is shown in figure 1.

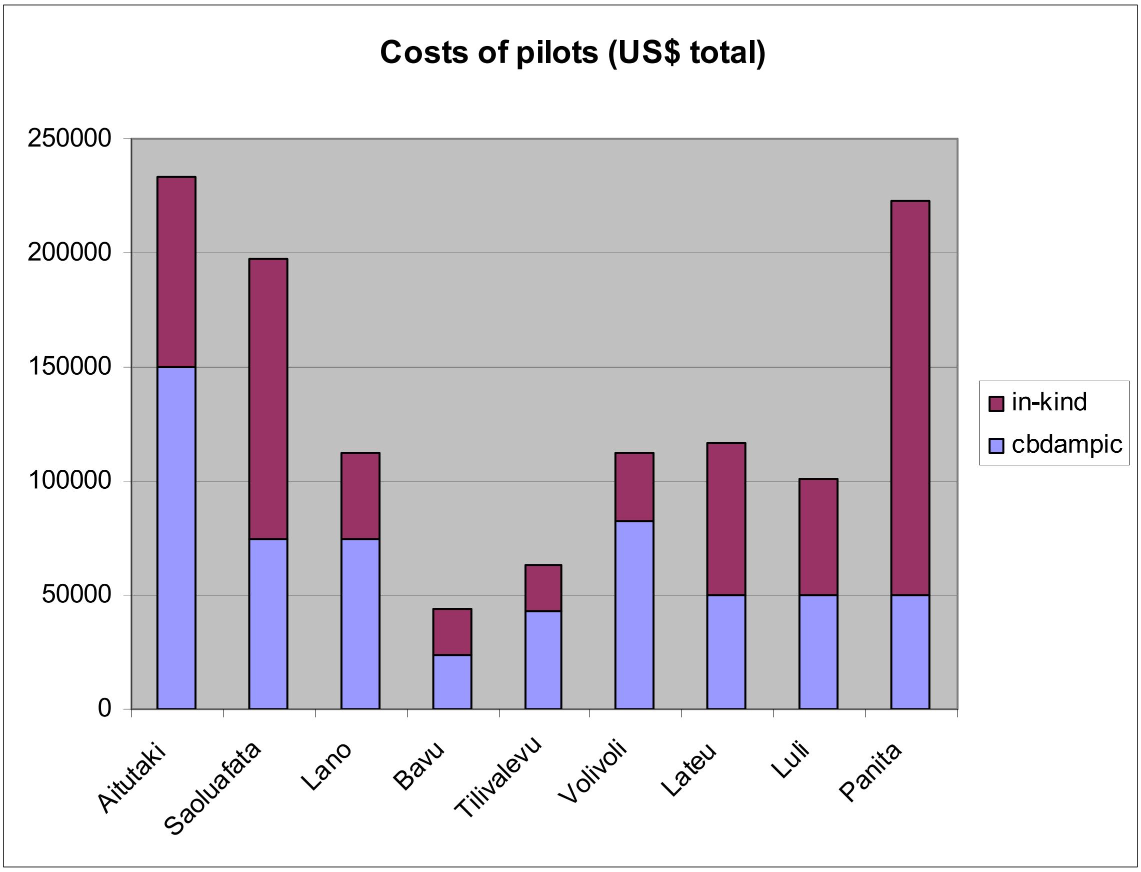


Figure 1 Costs of pilots

The number of people directly benefiting from the pilots differs considerably between the pilots. This impacts both the costs per person as well as the in-kind contributions as can be clearly seen in figure 2 below. The two relocation pilots (Lateu and Panita) have clearly the highest costs per person.

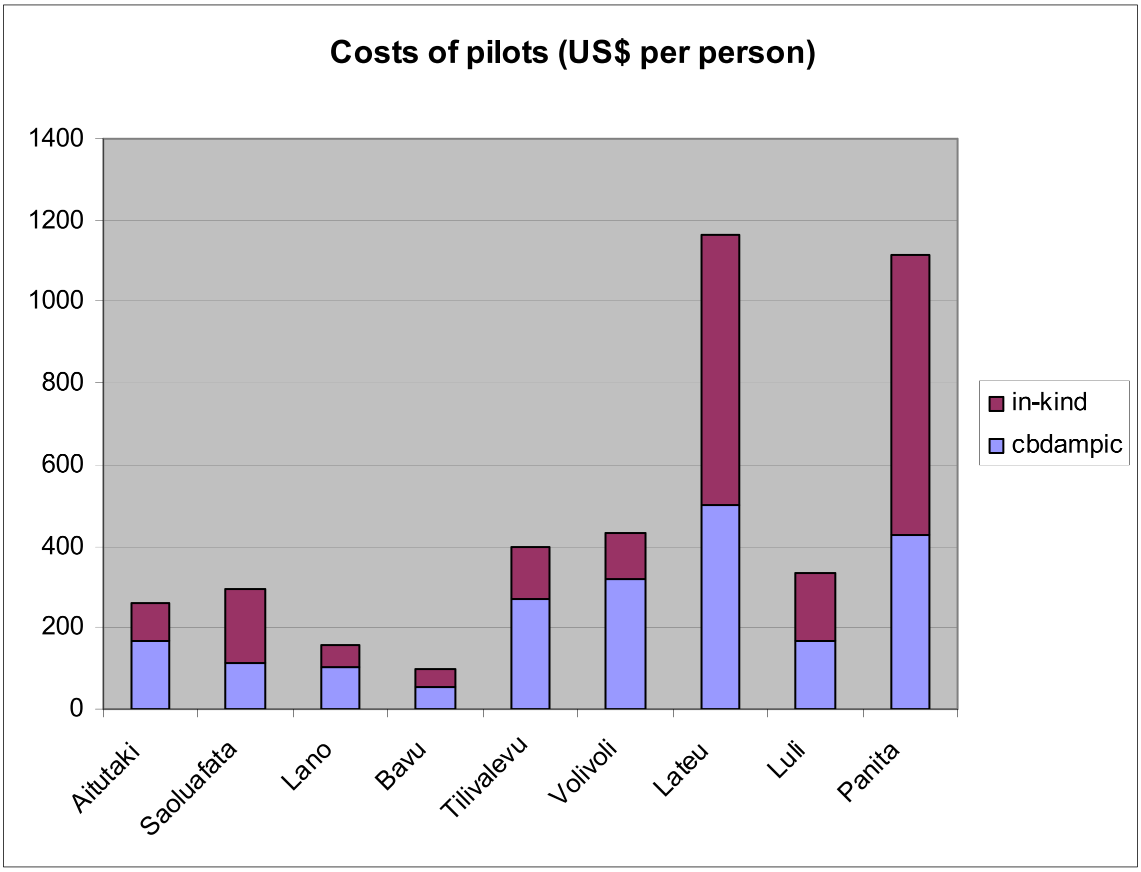


Figure 2 Costs per person of pilots

The institutional context for the pilots differed considerably between the islands, and this was reflected by the various implementation processes.

On the **Cook Islands** there is a small and strong team that only dealt with one pilot. Focus was on the participatory aspect of the CBDAMPIC project, which was dealt with through a financing scheme. The link with Climate Change is not very strong, as the size of the water-tanks was not driven by expectations on future rainfall.

Samoa clearly benefited from the presence of the SPREP head-office. The community consultation process was rigorously implemented and executed. This resulted in very strong community participation, establishment of network-relations on all levels, and a clear link to climate change. Focussing on just two pilots helped as well.

The **Fiji** political context makes any project always more complex than in other places. It was in this context that at a late stage one of the proposed pilots was dropped and replaced by another "politically more correct" one. This caused delays in the execution. The institutional support was also not optimal. The decision was made to bring in an external consultant, who did a great job, but at the end of the contract, the network that was built collapsed with the departure of the consultant. These external difficulties are reflected in the quality of the pilots, which (while still achieving good marks) have a less thorough community consultation process and a less clear link with climate change. The fact that three pilots were executed did not help. Nevertheless, the implementations were successful. This is proven by the fact that one of the communities added to the solution (by installing rain harvesting using the nearby church) on its own accord.

Finally, **Vanuatu** benefited from a strong and experienced team leader who succeeded in dealing with all the organizational and logistic challenges the three pilots posed. Each of the pilots was on a different island, away from the main island where all the institutions are located. The two relocation pilots in CBDAMPIC were implemented in Vanuatu. Relocation requires an extraordinary dedication of the communities (which is a compliment for the consultation process) and is clearly linked to Climate processes (aggravated coastal erosion from sea-level rise). The fact that three pilots were executed put strong financial constraints on them. This became apparent in the very high in-kind contributions, but also in the selection of the water tank sizes, too small to deal optimally with Climate Change risks.

Lessons learned

This study identified the following lessons learned:

1) <u>Keep better records of costs</u>
   There was a lot of guesswork involved in the study, even for the materials and labour costs of pilots that specified these.
2) <u>Specify viable alternatives at project design</u>
   This ensures least-cost approaches can be followed.
3) <u>Specify a benefits monitoring framework for projects</u>
   List the measurable benefits expected and say when they are expected, so that when the target dates arrive, it is possible to measure whether the expected benefits are being achieved.
4) <u>Monitor the performance of the projects as they are operated</u>
   Some solutions (i.e. the sea-wall) need to be evaluated over time to determine their success.

Community involvement in the pilots' specification, design, and construction was the outstanding feature of the set of pilots under study.

On a higher level, there are also lessons learned relating to the current debates on the economic cost of climate change adaptation. Identifying the economic cost of adaptation in the Pacific has only recently been undertaken. A World Bank funded study on Climate Change Adaptation (2000) in Fiji and Kiribati set the initial framework for working on the economics of climate change adaptation. Whereas a more detailed Asian Development Bank (ADB) funded project on Climate Adaptation in the Pacific, carried out in FSM and the Cook Islands investigated in detail the socio economic benefits of climate adaptation in those participating countries. Again each of these related studies work in a top down process oriented manner. CBDAMPIC places emphasis in a community based approach. Key lessons learned across these efforts provide for:

1) An island by island, community by community focused project, where any socio economic analysis is based upon the premise that both the community and the government are harmonious in there outlook on least cost options to climate adaptation.

2) Cohesiveness and coordination between projects at local, national, and regional levels provide a good basis for building new projects and which enhance or strengthen local capacities.
3) External agencies need to ensure they recognise national positions on climate change adaptation and the responsibilities for addressing adaptation, both internally and externally. Quite simply, the cost of adaptation should not be borne by local communities and to some extent by national governments of the Pacific.

Recommendations

There has been a dearth of climate policy related information and assistance for development of policy in the Pacific since at least 1990. The implementation of PICCAP focused primarily on policy oriented activities, as well as assisting Pacific Governments formulate negotiating positions on climate issues leading to the annual UNFCCC COP's.
However, much specific national policy on a country by country basis has been lagging behind the regional context of efforts, as capacity to undertake this type of work in the climate change arena is lacking. The pool of expertise to craft policy in this context is small, and often vulnerable to centralised planning, and mainstream economic development issues. CBDAMPIC provided a unique opportunity to enable local community policy on climate adaptation take shape without undue intervention from both national and regional influences

Given the success of the pilots in the CPDMAPIC project, it is recommended to continue the approach on a more widespread scale, building on the expertise that has been gained by the country teams, and using the capacity that was build regionally in other Pacific countries. There is some urgency here, as over time teams get scattered and expertise lost. Extension and expansion of the approach should not exclude the current islands (which might be a logical choice: get to the other islands first), as the community consultation process raised lots of interest of other local communities.

Annex: Contacts

The following people made themselves available for interviews and discussions on the CPDAMPIC project implementation during the visits in the period 26 October till 12 November 2005. Their input is highly appreciated.

COOK ISLANDS

Pasha Carruthers (CBDAMPIC technical adviser)

SAMOA

Taito Nakelevu (SPREP)
Anne Rasmussen (MET-office)
Peni Leavai (Principle Climate Officer)
Ausetalia (Director MET-office)
Dean Solofa (SPREP)
Lavassa Malua (Deputy CEO PUMA)

FIJI

Riteshni Lata (MET-office)
Koshy & Melchior Mataki (PACE, USP)
Manasa Sovaki (Department of Environment)
Ilisapeci Neitoga (AUSAID; former CBDAMPIC coordinator)
officers from Seratoga provincial office
village of Bavu

VANUATU

Brian Philips (MET-office Vanuatu; CPDAMPIC coordinator)
Jotham Napat (director MET-office Vanuatu)
Ernest Bani (Environmental Department)
Rosette (Geological Department, Hydrology)

Annex: Rainfall trends (based on 1950-2000 data) (from: NIWA: Climate trends & variability in Oceania, 5-9 November 2001 Workshop)

Location	***Δrainfall (mm/yr)****	***LAT***	***LON***	***length of series***
COOK ISLANDS				
Rarotonga	**-5.700**	9.00S	158.05W	1929-2000
SAMOA				
Apia	**-0.641**	13.80S	171.77W	1902-1998
FIJI				
Nadi	+1.068	17.45S	177.27E	1942-2000
Suva	**-5.330**	18.15S	178.45E	1942-2000
Rarewai	**-0.503**	17.55S	177.73E	1910-2000
Labasa	+3.221	16.45S	179.35E	1891-2000
Rotuma	**-1.582**	12.50S	177.05E	1912-2000
Ono-Ilau	**-8.863**			
Savusavu	**-2.960**	16.48S	179.21E	1956-2000
VANUATU				
Aneityum	**-5.464**	20.14S	169.47E	1948-2000

* this is the average change in yearly rainfall (decrease or increase) over the observation period

All but 2 stations in Fiji (Nadi, which is located on the far east of Viti Levu and Labasa, which is located North on Vanua Levu) show a (sometimes marked) decrease in rainfall.

Annex: Views on Climate Change and Lateu (Vanuatu) relocation

Climatologist Rejects 'Global Warming' as Cause for Island Evacuation
By Marc Morano
CNSNews.com Senior Staff Writer
December 07, 2005

Montreal (CNSNews.com) - A climatologist has dismissed a Reuters news report claiming that residents of the Pacific Island of Tegua in Vanuatu had to move to escape "global warming."

The article, published Tuesday, cited United Nations officials' claims that the effects of "global warming" caused rising sea levels and more storms, forcing islanders to flee inland. The article's publication coincided with the 11th annual U.N. Climate Change Conference in Montreal.

"That is a shame, quite frankly, that this issue is being played like this at the [U.N.] climate change conference. It demeans the issue when it's so easy to counter a strident assertion with facts," said Patrick J. Michaels, the author of several books on climate change, including a new one that will be released next week entitled "Shattered Consensus: The True State of Global Warming."

Michaels, who believes claims of catastrophic human-caused "global warming" are scientifically unfounded, is an environmental sciences professor at the University of Virginia and a senior fellow at the Cato Institute.

"It would seem that [the Reuters article] about the combination of sea level rise and increased storminess causing people to evacuate (to the island's interior) isn't based upon much real data," Michaels told Cybercast News Service on Tuesday.

The Dec. 6 Reuters article by environmental correspondent Alister Doyle claimed that about 100 residents in the Lateu settlement on Tegua island in Vanuatu were forced to move inland because of cyclone-enhanced "king tides" that caused flooding and made the island uninhabitable.

The Reuters article included a statement from the U.N.'s Environment Program claiming that the residents of Vanuatu had "become one of, if not the first, to be formally moved out of harm's way as a result of climate change." However, the report did not feature any scientists or experts questioning the conclusion that human-caused "global warming" was to blame for the residents' coastal retreat.

Michaels said the scientific data does not back up the claims in the Reuters article about the evacuation of Vanuatu being linked to the U.N.'s projections of melting icecaps and rising sea levels.

"The island in question has experienced no net sea level rise in the last half century, according to the combined satellite and submarine data," Michaels said. "In fact, areas to the west such as [the island of] Tuvalu show substantial declines in sea level over that period," he added.

Michaels added that "the United Nations intergovernmental panel notes a decline in the frequency of tropical storms and hurricanes in the South Pacific in recent decades.

"With sea level not showing a rise and the decline in the frequency of tropical cyclones, it's very hard to make the strident statements that were made in the [Reuters article,]" he added.

The fact that Reuters published the article without quoting experts who question the science behind the "global warming" claim did not surprise Michaels.

"Reuters has generally been very radical on 'global warming.' This is nothing new for them," he said, noting that in much of the media, "the appropriate level of journalistic cynicism does not apply to 'global warming.'"

Cybercast News Service previously reported on a December 2004 article, in which the Reuters reporter Doyle linked the tsunami that devastated parts of Asia to "global warming."

"A creeping rise in sea levels tied to global warming, pollution and damage to coral reefs may make coastlines even more vulnerable to disasters like tsunamis or storms in [the] future," wrote Doyle in last year's article. He attributed the opening paragraph of the story to "experts." However, Doyle's story did not contain any quotes directly mentioning the theory of "global warming."

Michaels challenged the accuracy of computer-generated models that project an alarming rise in sea levels to the melting of icecaps.

"There is a lot of recent research showing that Antarctica has been gaining ice, in other words is contributing negatively to sea level rise. Research published just two months ago in Science Magazine shows that Greenland is still gaining ice at two inches per year, average, over the island," Michaels said.

"I expect that the estimates of sea level rise are going to have to be revised downward. That's a prediction that you just heard from me based upon reality. Computer models eventually have to come in line with reality," he added.

More than 8,000 government leaders, environmentalists and scientists are attending the U.N. conference to discuss what steps to take to further limit greenhouse gases beyond the Kyoto Protocol's provisions. Organizers are calling the conference, which runs until Dec. 9, the largest meeting since the Kyoto Climate Conference in 1997.

References:

Climate Proofing: A risk based approach to adaptation, report by John Hay et. al. for the Asian Development Bank, October 2004

SimClim Climate Change modelling software, International Global Change Institute, 2006

Validation Mission of Capacity Building for the Development of Adaptation Measures in Pacific Island Countries, a project of South Pacific Regional Environment Programme for Asia Brach, Canadian International Development Agency, report by Barry Smit and Diane McFadzien, A. Gupta, J. Parsons, February 2002

Capacity Building for the Development of Adaptation Measures in Pacific Island Countries, Project Implementation Plan, SPREP, March 2003

CV&A: a Guide to Community Vulnerability and Adaptation Assessment and Action, Taito Nakalevu, SPREP

Aitutaki Climate Change Community Vulnerability and Adaptation Assessment Report , Pasha Carruthers & Bobby Bishop, 2003

Aitutaki Pilot Project Implementation Document, prepared by Charles Carlson in association with CBDAMPIC Cook Islands Staff, April 2004

Samoa Community Vulnerability and Adaptation to Climate Change Assessment Report

Lano Adaptation Pilot Project Proposal

Saoluafata Adaptation Pilot Project Proposal

Takina Wai (Bavu) Proposal, Community Vulnerability and Adaptation Assessment, *Fiji*

Community Vulnerability and Adaptation Assessment Report, Takina Wai Pilot Site, Fiji

Tilivalevu CV&A Report, Climate Change Community Vulnerability and Adaptation Assessment Report, prepared by the Fiji Community Vulnerability and Adaptation Assessment and Action Team

Tilivalevu Adaptation Proposal, Fiji

Volivoli Proposal, Community Vulnerability and Adaptation Assessment and Action, Fiji

Volivoli Community Vulnerability and Adaptation Assessment Report, Fiji

Community Vulnerability and Adaptation Assessment and Action Report, CPDAMPIC Vanuatu

A Brief Account of the Opening Ceremony for the New Lateu Settlement, Torba Province, Vanuatu: for the benefit of supporters of climate change adaptation, Taito Nakalevu and Brian Philips

Strengthening Luli Community's Resilience to Climate Related Risks, a Subproject of CBDAMPIC Vanuatu, prepared by NACCC's Core CV&A Team

Strengthening Panita Community's Resilience to Climate Related Risks, a Subproject of CBDAMPIC Vanuatu, prepared by NACCC's Core CV&A Team

Strengthening Lateu Community's Resilience to Climate Related Risks, a Subproject of CBDAMPIC Vanuatu, prepared by NACCC's Core CV&A Team

.I.G.C.I.
The International
Global Change Institute

Published in 2006 by
The International Global Change Institute (IGCI)
The University of Waikato
Private Bag 3106
Hamilton

www.waikato.ac.nz/igci

THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato