COST BENEFIT ANALYSIS WORK PLAN

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INTRODUCTION

This report documents the Cost-Benefit Analysis (CBA) work plans developed as part of the Pacific Adaptation to Climate Change (PACC) project. The objective of these work plans is to guide PIC Government officials to conduct a CBA of their PACC pilot project. PIC Government officials will be supported by regional economists to implement their CBA work plans.

PACC CBA work plans were developed at three sub-regional workshops delivered between November 2011 and February 2012. More information on the PACC CBA Work Program can be found at www.sprep.org/Regional-Workshops/cost-benefit-analysis.

The countries that finalised CBA work plans for their PACC pilot projects and who will progress this work are:

1. Cook Islands (coastal)
2. Niue (water)
3. Palau (food security)
4. Republic of Marshall Islands (water)
5. Samoa (coastal)
6. Solomon Islands (food security)
7. Tuvalu (water)
8. Vanuatu (coastal)

CBA work plans for each of these PACC pilot projects are provided below. Note, the below work plans do not necessarily represent the final approach to be taken for that CBA.

COOK ISLANDS CBA WORKPLAN: COASTAL SECTOR PILOT PROJECT

The below CBA work plan is to be undertaken primarily by the Cook Islands PACC CBA team with technical backstopping support from the SPREP economist. Comments are included in this CBA work plan to guide this work. Note, further development of the below problem statement will be required for the CBA report.

This CBA work plan is organised as follows:

- Problem Statement
- Options
- With and Without Analysis
- Measuring costs and benefits (data needs and sources)
- Aggregating costs and benefits
- Sensitivity Analysis
- Timeline of activities

Problem Statement

The Mangaia wharf is the only wharf on Mangaia and services a population of over 400 people. In 2005, wave-overtopping associated with Cyclone Meena destroyed the Mangaia Harbor. It took 4 years to reconstruct the wharf during which time shipping businesses and fisherman were not able to use it. This resulted in:

- reconstruction costs of NZ$814,000
- losses of shipping service revenues (and associated upstream and downstream impacts including more expensive transportation of medical and education supplies)[1]
- losses of fish catch revenue (fisherman use the wharf on rough sea days when it is not safe to use reef passes)

The re-constructed Mangaia wharf is similar in design to the previous wharf - which is to withstand wave-overtopping stresses associated with a 1 in x year cyclone event. As such, the Mangaia wharf (and its community) is still exposed to the same (high?) level of disaster risk. Moreover, this risk may be increasing as climate change potentially increases the frequency and intensity of cyclone hazard events.

In addition, like the previous design, the re-constructed Mangaia wharf is unsafe for larger vessels to use during moderately rough sea weather. The average number of days per year that moderately

[1] some businesses and community members use air transport services during these times, which is provided at twice the rate. Exporting prices of local taro and pineapple has risen from a cost of $200.00 using sea freight to 400.00 by air.

Comment [a1]: Hi Vaipo, do we have information on the throughput of the wharf (i.e. type, quantity, and economic value of cargo. whether it is imports or exports)? Even old/draft reports would be good.

this information would be useful to demonstrate the importance of the wharfage services. it would also be useful to help identify which community groups are vulnerable and thus stand to win/lose from the project.

Comment [a2]: It is my understanding that shipping services to Mangaia stopped during wharf re-construction.

Another possibility is that during this time, shipping businesses used reef passes and other access points to load and unload cargo (which would take more time and increase costs).

Vaipo, can you please confirm what happened - stopped or used other access points? This has implications for how we measure losses under the without project/baseline scenario.

Comment [a3]: Vaipo, i understand we do not have historical information on the usage of the wharf by fisherman (i.e. number of fisherman/fishing boats that use the wharf and the number of days per year they use it) and the catch/revenue generated by each fisherman/fishing boat per day.

this information is required for the CBA. if we can't get it from secondary sources, we will get it through interview/survey.

Comment [a4]: Vaipo, what level of cyclone hazard is the current wharf designed to withstand?

this information should be outlined in engineering and NIWA/SOPAC reports.

rough seas occur is x and this may be increasing with climate change. On these days, shipping revenues are foregone. Some cargo is transported by air (at twice the cost) whilst other cargo is postponed or thrown out (i.e. pineapples). Fishermen are still able to use the wharf on these days.

Unreliability of wharfage access (due to unsafe conditions during rough sea weather) may also be restricting/limiting economic activities such as tourism (cruise ship and yacht visitations).

Cause(s) of problem

Climate-related causes

- Frequency and intensity of cyclone events potentially increasing
- Frequency of rough seas potentially increasing
- Inadequate climate change information on the above

Other causes

- No user-fees for wharf and small budget allocation from Government. These financial resources are not enough to provide for proper design and maintenance.

Objective

The overarching objective of the Cook Islands PACC pilot/demonstration project is to increase resilience of the Mangaia harbor to climate change-related hazards (cyclones, and rough seas).

More specifically, the objectives of the pilot demonstration project are to:

- increase the resilience of wharf infrastructure so it can withstand a 1 in x year cyclone event; and
- increase the usability of the wharf so that it is safe to use by large vessels during a 1 in x day rough sea event (alternatively, this objective can be described in terms of reducing wharf interruptions to less than x days per year).

Option(s)

The option identified to achieve the stated objective is to retro-fit the existing Mangaia wharf. A team of engineers have already designed and costed this retro-fit design. It comprises:

With and Without Analysis

Without the project, the Mangaia wharf is vulnerable / exposed to a 1 in x year cyclone event and cannot be used by large vessels during moderately rough sea days. Expected damages and losses for these hazard events are:

- damage to infrastructure
- Loss of shipping revenues (during re-construction and rough seas). Note these losses of shipping revenues captures losses to upstream and downstream markets that use the port

Comment [a5]: Vaipo, i understand we do not have historical information on the number of days that the wharf cannot be used by large vessels due to rough weather.

this information is required for the CBA. if we can't get it from secondary sources, we will get it through interview/survey and validated by info from the MET.

Comment [a6]: Vaipo, do we have any evidence of this?

As discussed, due to uncertainties about this matter, we may just discuss in qualitative terms or include as a sensitivity.

Comment [a7]: We need historical information on the frequency and intensity of cyclone events and rough seas. this information can be collected from the Cook Islands MET and possibly the geospatial framework for climate change adaptation in the coastal zone of Mangaia Island. The Cook Islands MET also has access to the Australian Government Pacific Climate Change Science Program products, which would include this information.

Comment [a8]: Vaipo, can you please confirm that only one retro-fit design has been done. what level of cyclone hazard was this designed to withstand and how was this level determined?

Comment [a9]: Vaipo, can you please list the various design elements of the retro-fit design. Beside each measure can you please indicate whether it is designed to increase resilience to cyclone events (c), increase useability during rough sea days (rs), or a combination of both (c+rs). Cheers.

transport services (e.g. taro and pineapple producers). To include both would be double-counting.

- loss of fishing revenues (during re-construction only)
- Low or no visitation by cruise ships and yachts.

The below table lists these expected outcomes for the without project scenario. Taking the without-project as the reference, the table also lists the costs and benefits related to each identified project option.

Without project/baseline (Keep existing design of Mangaia wharf)	Project option 1 Retro-fit Mangaia wharf
	Costs
▪ **Expect damages to the wharf from possible cyclone events are high.** ▪ **expected losses of shipping revenues during possible wharf reconstruction are high** ▪ **expected losses of shipping revenue during possible rough sea days are high**	▪ consultation (Civil Engineer & Construction Company) ▪ design (Engineering, and Science) ▪ construction (Materials and Labour) ▪ maintenance (Island Administration cost of materials and labour of harbor upkeep
	Benefits
▪ **expected losses of fishing catch/revenue during possible wharf reconstruction (on rough sea days) are high** ▪ **low visitation to Mangaia from cruise ships and yachts**	▪ avoided damages to wharf ▪ avoided losses of shipping revenue during reconstruction ▪ avoided losses of shipping revenue during rough sea days ▪ avoided losses of fish catch/revenue ▪ possible increased visitation to Mangaia from cruise ships and yachts

Measuring costs and benefits

This section details the data required and the source of data for each of the costs and benefits identified in the 'with and without' analysis above.

This is done as a table for each project option, starting with the without project scenario.

Without project/baseline: (keep existing design of Mangaia wharf)

	Data required	Source of data
expect damages to the wharf from possible cyclone events	1. Cyclone hazard map for Mangaia wharf 2. Damage function (stage-damage curve) for Mangaia wharf 3. Cost of re-constructing wharf (NZD$814,000) 4. Value of assets damaged	1. Geospatial Report- SPC-SOPAC, NIWA. 2. Engineering report (NIWA) 3. Cook Islands Investment Corp (CIIC) and/or Ministry of Infrastructure & Planning (MOIP)- Rapid Assessment report of Gov Assets 4. Cook Islands Investment Corp (CIIC) and/or Ministry of Infrastructure & Planning (MOIP)- Rapid Assessment report of Gov Assets
expected losses of shipping revenues during possible wharf reconstruction	1. Time taken to reconstruct (number of days, currently estimated at 3 months) 2. Number of shipping boats operating	1. 2011 CIPACC work plan, Ministry of Finance Economic Management (MFEM)

Comment [a10]: i need to double-check this is correct.

Comment [a11]: Vaipo, what are the assets you are referring to? Are they separate/different to the wharf infrastructure?

Comment [a12]: Note that if, as per comment a2, shipping businesses use other access points instead of stopping operations, then this item will measure the additional cost of loading and unloading at these alternate access points. This cost will comprise mostly of additional time (labour) and fuel. This information would be collected through survey.

	(historical and predicted number in future) 3. (Average) shipping revenue per day for each boat	2. Mangaia Island Administration, Port Authority 3. Annual reports of shipping businesses. Survey of shipping businesses.
expected losses of shipping revenue during possible rough sea days	1. Number of days where shipping businesses can't operate due to rough sea days (this is estimated at approx 2-3 day per month) 2. Number of shipping boats operating (historical and predicted number in future) 3. (Average) shipping revenue per day for each boat	1. Mangaia Island Administration, Port Authority, Cook Islands MET 2. Mangaia Island Administration, Port Authority 3. Annual reports of shipping businesses. Survey of shipping businesses.
expected losses of fishing catch/revenue during possible wharf reconstruction (on rough sea days)	1. Time taken to reconstruct (number of days, currently estimated at 3 months) 2. Number of days within this reconstruction period which is expected to be rough sea days (this is estimated at approx 2-3 day per month) 3. Number of fishing boats that use wharf (historical and predicted number in future) 4. (Average) fish catch per day per (average) boat 5. Market price of fish @ Mangaia	1. 2011 CIPACC work plan, Ministry of Finance Economic Management (MFEM) 2. Mangaia Island Administration, Port Authority, Cook Islands MET 3. Ministry of Marine Resources, and Fishing Club, and Fisherman (survey) 4. Ministry of Marine Resources, and Fishing Club, and Fisherman 5. Mangaia market

Option 1: Retrofit Mangaia wharf

	Data required	Source of data
Costs		
▪ **Consultation (Civil Engineer & Construction Company)**	1. Project Engineer fee (25,000) 2. Construction (500,000)	1. CIPACC Annual Work Plan 2. CIPACC Annual Work Plan
▪ **Design (Engineering, and Science)**	1. Design Plan (7,500) 2. EIA Baseline study (1,500) 3. Project Implementation Document (PID)(5,000) 4. Infrastructure Committee and Govt approval 5. Hazard Map, and Damage function (Geospatial Report NZD188,000) 6. Cost of constructing wharf (NZD$814,000) 7. Cost of assets damaged (zero cost)	1. MOIP- Paul Maoate 2. MOIP (consultation yet to be completed) 3. MOIP (PID to be completed) 4. IC & Cabinet Minutes (stating approval) 5. Geospatial Report- SPC-SOPAC, NIWA. 6. Engineering report 7. Cook Islands Investment Corp/MOIP Rapid Assessment report on Govt Assets
▪ **Construction (Materials and Labour)**	1. Successful Tender quote Contracted out construction work	1. MOIP (materials and labour cost within tender document)
▪ **Maintenance (Island Administration cost of materials and labour of harbour upkeep)**	1. Annual operation maintenance - estimate as a % of capital cost	1. Director of Outer Island Affairs
Benefits		
▪ **avoided damages**	1. Damage Function (stage-damage curve)	1. MOIP, NIWA

Comment [a13]: has this tender already been run?

i would expect that we do the CBA before the tender in which case we would need to get information from another source.

engineers can provide reasonable estimations of these costs.

	to wharf	for upgrade/retrofit design	
▪	**avoided losses of shipping revenue during reconstruction**	1. number of reconstruction days avoided (derived from damage function/stage-damage curve)	1. MOIP, NIWA 2. MFEM
▪	**avoided losses of shipping revenue during rough sea days**	1. number of days with no access to wharf during rough sea days avoided (derived from damage function/stage-damage curve)	1. MOIP, NIWA, MET
▪	**avoided losses of fish catch/revenue**	1. number of days with no access to wharf during rough sea days during reconstruction avoided (derived from damage function/stage-damage curve)	1. MOIP, NIWA, MET
▪	**possible increased visitation to Mangaia from cruise ships and yachts**	The economic value of cruise ship and yacht visitations to Mangaia will be difficult to determine. It will also be highly uncertain. For these reasons, i suggest we just qualitatively describe, at least in the first instance. Base this description on experience in other parts of the Cook Islands.	1. Islands Admin or Mangaia Port Authority 2. Tourism

Aggregating costs and benefits

Since Cook Islands Government does not prescribe a discount rate in its assessment of Government projects, use 4% discount rate.

Calculate NPV. Also calculate B/C ratios.

Sensitivity Analysis

Parameters to be tested using sensitivity analysis will be identified during stages of collecting/generating data. Likely parameters to be tested include:

- Frequency of cyclone hazard under climate change
- Frequency of rough sea weather under climate change
- Shipping revenue losses

Timeline

Action	Date	Responsibility
Data collection on expected damages and damages avoided	March - mid May	Vaipo Mataora (PACC Co-coordinator), Solomona Solomona (Administrator, Ministry of Infrastructure and Planning), Paul Joseph (Civil Engineer, Ministry of Infrastructure and Planning)
Data collection on expected losses.	March - mid May	**Ewan Cameron**, supported by Vaipo Mataora, Vaine Wichman, and Aaron Buncle
Data collection on project costs	March - mid May	Vaipo Mataora (PACC Co-coordinator)
Data analysis	Early June	Vaine Wichman (Cook Island economist), Aaron Buncle will visit to support this activity
Draft CBA report	End June	Cook Islands CBA team supported by Aaron Buncle

Support Review	Early July	Review by Aaron Buncle
Peer Review	Mid July	Review by UNDP and other interested CROP economists
Final CBA report	End July	CBA team and Aaron Buncle

NIUE CBA WORKPLAN: WATER SECTOR PILOT PROJECT

There has been little background analysis undertaken of water supply and demand in the Upper Terrace project area as part of Niue PACC project. Therefore, much of the below problem and objectives analysis is based on IWRM assessments of the nearby Alofi area. More specifically, these assessments are the Niue IWRM Diagnostic Report as well as the Niue IWRM Demonstration Project Paper. Some further work is required to confirm that these same problems apply to the Upper Terrace project area (this appears likely).

The below CBA work plan is to be undertaken primarily by the SPREP economist as there is no suitable and available officials within Niue to do this work or build capacity to do this work (population is < 1400 people).

This CBA work plan is organised as follows:

- Problem Statement
- Options
- With and Without Analysis
- Measuring costs and benefits (data needs and sources)
- Aggregating costs and benefits
- Sensitivity Analysis
- Timeline of activities

Problem

Upper terrace villages of Niue are heavily reliant on groundwater for supply of potable and non-potable water. This is a problem because there are several risks to the quality of this water. These risks are:

- saline up-coning; and
- pollution/contamination

There is also some other, less significant, problems associated with the reliability of water supply from the groundwater system. These are:

- risk of multi-day interruption associated with cyclone and associated infrastructure damage and loss; and
- Regular, small interruptions to water supply (approx 2 hours per day, 2 days per week) associated with electricity failures.
- ~~Possible external impacts on habitats and species.~~

It is worth noting that annual quantity of supply to all areas of Niue is relatively high. In 2009, this was estimated at around 350 liters per day per person and is increasing. Population in Niue is decreasing.

Comment [a14]: is this water supply all from groundwater sources?

how many households already have rainwater tanks and how much water is yielded from these tanks?

Causes of problem(s)

Each of the problems identified above are addressed separately below.

Risk of saline up-coning

Saline up-coning is a function of, among other things, abstraction and re-charge.

- (Too) high abstraction relates to inadequate management and control. Part of this is a lack of pricing/charging for water services. Appropriate pricing is needed to help fund monitoring and improvement of supply system (e.g. to reduce leakage) as well as provide appropriate incentives for efficient consumption.
- Low re-charge relates to the highly variable rainfall experienced on Niue, including drought periods. Climate change may exacerbate this observed rainfall variability and drought periods.

Risk of pollution/contamination

There are a number of factors contributing to this problem. These include:

- threats from domestic pollution (sewage and wastewater)
- threats from agricultural pollution (agro-chemicals and piggeries)
- Threats from other industry activities? e.g. aggregate quarry
- inappropriate/inadequate land use planning, which threatens the integrity of the catchment areas and water supply
- inadequate overall protection of the watershed area and its ecosystem functions (particularly as a water source)

Comment [a15]: Haden, do these factors apply to Upper Terrace area?

If so, what is the significance of these risks?

Also, what is being done to address these factors (if anything)?

Underpinning many of these factors is poorly defined property rights for water.

Risk of multi-day interruption

As mentioned above, this risk primarily relates to cyclone hazards. Cyclone is a frequent hazard experienced by Niue (e.g. category 5 cyclone Heta, Jan 2004) and can cause severe damage to the water supply infrastructure (e.g. pumps) and related losses (e.g. additional cost of providing emergency water). Climate change may increase the frequency and/or intensity of cyclone hazards experienced by Niue.

Regular interruption

As mentioned above, these interruptions relate to electricity-supply failures, which power the groundwater pumps. There are multiple market failures in the Niue electricity sector and are outside the scope of this project.

Objective

Increase resilience of the Niue community to climate change related effects on the water sector. The focus of the project is to reduce the risk of saline up-coning.

Options

The options identified to achieve the stated objective are supply-side measures. These are:

1. Install household rainwater tanks.
2. Install community rainwater tanks
3. Leakage reduction program?

Demand-side measures are being considered as part of the IWRM demonstration project, though this is not expected to apply to the upper-terrace area in the project period. This includes the possible introduction of staged tariffs. The IWRM Diagnostic Assessment consultations found there was public support for introducing a water usage based charging system for excessive water usage.

With and Without Analysis

Without the project, water to upper terrace areas of Niue is expected to continue to be supplied almost entirely from groundwater sources. No new rainwater tanks are expected in the project area under the without-project scenario, reflecting the assumption that the current (no) charging regime will continue in the upper terrace area (which in turn acts as a disincentive for private water supply/adaptation measures). Quantity of abstraction is assumed to continue at current rates as is quantity of water supplied to Upper Terrace area households. Implicit in this is the assumption that leakage from pipes will continue at current levels.

Comment [a16]: need to check this is a valid assumption. check historical records of abstraction/water consumption.

As such, without the project, risks to groundwater quality associated with saline up-coning are expected to persist at current levels and possibly increase.

Activities contributing to groundwater pollution are expected to continue. The IWRM demonstration project is assumed not to reduce these risks in the Upper Terrace area during the project period.

Comment [a17]: Haden, can you please advise whether this is a valid assumption.

Similarly, risks of interruption caused by cyclone (and associated infrastructure damage) as well as electricity failures are expected to persist at current levels and possibly increase.

Without the project there may also be some environmental impacts to habitats and species.

Comment [a18]: Haden, what are these environmental impacts if any?

The below table lists these expected outcomes for the without project scenario.

Taking the without-project as the reference/baseline, the table also lists the costs and benefits related to each of the project options identified above.

Baseline – fossil fuel groundwater pumping	Household rainwater tanks	Community Rainwater tanks	Leakage reduction program
Cost of supply **- Capital costs (pumps, installation, distribution network)** **- Operational costs (fuel, repairs and maintenance, monitoring)** **- Cost of Carbon (associated with use of fossil fuels for electricity generation)**	Capital costs (tank, guttering, installation) Operational costs (repairs and maintenance, monitoring)	Capital costs (tank, guttering, installation) Operational costs (repairs and maintenance, monitoring)	Assessment costs Capital costs (pipes, installation) Operational costs (repairs and maintenance, monitoring)
Quantity of supply **- quantity of water delivered** **- quantity of abstraction** **[- leakage rate]** **Quality of supply** **- Expected degradation of groundwater quality from saline up-coning** **- Expected degradation of groundwater from pollution** **Reliability of supply (number and duration of interruptions)** **Expected cost/loss of water supply interruptions from electricity failures** **- Expected interruptions from cyclone hazards and damage to groundwater supply infrastructure** **Expected environmental impacts on habitats and species from groundwater abstraction**	Avoided cost of providing groundwater (capital, operational, carbon) [Quantity of water delivered to households is same (i.e. replace groundwater abstraction)] Improved water quality from avoided saline up-coning (pertaining to lower quantity of abstraction) Avoided damage to infrastructure and associated losses from cyclone hazards Improved water supply reliability from less electricity failure interruptions Improved habitats and species	Avoided cost of providing groundwater (capital, operational, carbon) [Quantity of water delivered to households is same (i.e. replace groundwater abstraction)] Improved water quality from avoided saline up-coning (pertaining to lower quantity of abstraction) Avoided damage to infrastructure and associated losses from cyclone hazards Improved water supply reliability from less electricity failure interruptions Improved habitats and species	Avoided cost of providing groundwater (capital, operational, carbon) [Quantity of water delivered to households is same (i.e. replace groundwater abstraction)] Improved water quality from avoided saline up-coning (pertaining to lower quantity of abstraction) Avoided damage to infrastructure from cyclone hazards Improved habitats and species

Comment [a19]: need to check what scheduled costs are included for replacement of pipes.

Measuring costs and benefits

This section details the data required to measure each of the costs and benefits identified in the 'with and without' analysis above as well as the source of this data.

This is done as a table for each project option, starting with the without-project scenario.

Baseline/Without-project scenario

Baseline/Without-project scenario – Fossil-fuel groundwater pumping		
Groundwater supply costs (capital,	Per unit cost of supplying groundwater	PWD (Annual Reports, SCI Reports,

operational, carbon)	Electricity used per unit of water pumped Emissions released per Kwh of electricity Price of carbon/social cost of carbon	other internal documents) SOPAC report 447 IPCC reports, regional organisations IWRM documents
Quantity of supply (quantity of water delivered)	Historical records of quantity of supply to upper-terrace area Population growth rate	PWD Census Other water supply studies [refer IWRM Diagnostic Report references] IWRM documents
Quantity of supply (quantity of water abstracted, [leakage])	Historical records of quantity of water abstracted Leakage rate	PWD Other water supply studies [refer IWRM Diagnostic Report references] IWRM documents
Quality of supply - Expected degradation of groundwater quality from saline up-coning	Storage capacity of groundwater lens Abstraction rates Re-charge rates (rainfall data, proportion of rainfall that goes to groundwater lens) Damage (quality deterioration) function of over-abstraction relative to re-charge Value of good-quality water Value of degraded water	The beside information is not likely to be readily available and would be difficult and expensive to obtain. The value of this information and hence the decision to obtain it will be evaluated during the analysis. IWRM documents
Quality of supply - Expected degradation of groundwater from pollution	Storage capacity of groundwater lens Quantity and type of pollution Damage (quality deterioration) function of pollution Value of good-quality water Value of degraded water	The beside information is not likely to be readily available and would be difficult and expensive to obtain. The value of this information and hence the decision to obtain it will be evaluated during the analysis. IWRM documents
Expected damage to groundwater supply infrastructure from cyclone hazards	Damage to infrastructure from cyclone Heta Frequency and intensity of cyclone hazards Duration of interruptions	Information from NZ Aid on cyclone Heta experience PASSAP climate futures tool
Expected losses associated with cyclone damage to groundwater supply infrastructure	Cost of providing 'emergency' water Frequency and intensity of cyclone Duration of interruptions	Information from NZ Aid on cyclone Heta experience PASSAP climate futures tool
Reliability of supply - interruptions from electricity failures	Number and duration of interruptions	PWD
Expected environmental impacts on habitats and species	Biophysical impacts from groundwater abstraction Value of habitats and species	The beside information is not likely to be readily available and would be difficult and expensive to obtain. The value of this information and hence the decision to obtain it will be evaluated during the analysis. IWRM documents

Comment [a20]: note, this is a relatively crude method of estimation. this is because the value of this information is not considered to be high (and hence not worth the effort of developing a detailed hazard map, damage function etc).

Comment [a21]: note, this is a relatively crude method of estimation. this is because the value of this information is not considered to be high (and hence not worth the effort of developing a detailed hazard map, damage function etc).

Option 1: Household Rainwater Tanks

Household rainwater tanks		
Costs		
Capital Cost of rainwater tank: (Purchase price tank + frame + FOB (ex) freight costs, bulk procurement (cheaper), installation, consultation, land)	Water yield per tank (function of tank size, catchment area, and rainfall) Quantity of tanks Market price of tank Useful life Labour days Wage rate Regulated land lease rate	PWD pilot assessment (refer SOPAC Technical Report 447) for yield SOPAC Technical Report447, p.29 • Need to verify useful life • Suppliers (local); regional (SOPAC, UNDP, etc)
Operational Costs Repairs/maintenance (ex) transportation (incl. fuel), monitoring, machinery etc	Quantity of materials Market price of materials Labor days wage rate ➔ May be able to approximate this by assuming a certain percentage of capital costs(e.g. 5%) – ask SOPAC or PWD	Secondary sources (SOPAC) - Suppliers (local); regional (SOPAC, UNDP, etc)
Benefits		
Avoided cost of providing groundwater (capital, operational, carbon)	As per baseline - quantity * unit cost	As per baseline
Improved water quality from avoided saline up-coning (pertaining to lower quantity of abstraction)	Quantity of abstraction reduced Salinity up-coning damage function Value/WTP of improved quality	The information is not likely to be readily available and would be difficult and expensive to obtain. A stated-preferences survey would be required to (reasonably) accurately assess value/WTP of improved quality. The value of this information and hence the decision to obtain it will be evaluated during the analysis.
Avoided damage to infrastructure and associated losses from cyclone hazards	As per baseline. It is assumed that household rainwater tanks will not be damaged by a cyclone event.	As per baseline.
Improved water supply reliability from less electricity failure interruptions	As per baseline. It is assumed that there will be no (regular) interruptions experienced from household rainwater tank supply. WTP for improved reliability.	Stated-preferences survey would be required to assess WTP. The value of this information and hence the decision to obtain it will be evaluated during the analysis.
Expected environmental impacts on habitats and species	Reduced biophysical impacts from groundwater abstraction Value of habitats and species	The beside information is not likely to be readily available and would be difficult and expensive to obtain. The value of this information and hence the decision to obtain it will be evaluated during the analysis.

Comment [a22]: Haden, is this a valid assumption? What was the experience with Cyclone Heta - did household rainwater tanks get damaged.

Option 2: Community Rainwater Tank(s)

Community rainwater tanks

Costs		
Capital Cost of rainwater tank: (Purchase price tank + frame + FOB (ex) freight costs, bulk procurement (cheaper), installation, consultation, land)	Water yield per tank (function of tank size, catchment area, and rainfall) Quantity of tanks Market price of tank Useful life Labour days Wage rate Regulated land lease rate	SOPAC or other technical expertise for yield SOPAC Technical Report447, p.29 • Need to verify useful life • Suppliers (local); regional (SOPAC, UNDP, etc) IWRM documents
Operational Costs Repairs/maintenance (ex) transportation (incl. fuel), monitoring, machinery etc	Quantity of materials Market price of materials Labor days wage rate ➔ May be able to approximate this by assuming a certain percentage of capital costs(e.g. 5%) – ask SOPAC or PWD	Secondary sources (SOPAC) - Suppliers (local); regional (SOPAC, UNDP, etc) IWRM documents
Benefits		
Avoided cost of providing groundwater (capital, operational, carbon)	As per baseline - quantity * unit cost	As per baseline
Improved water quality from avoided saline up-coning (pertaining to lower quantity of abstraction)	Quantity of abstraction reduced Salinity up-coning damage function Value/WTP of improved quality	The information is not likely to be readily available and would be difficult and expensive to obtain. A stated-preferences survey would be required to (reasonably) accurately assess value/WTP of improved quality. The value of this information and hence the decision to obtain it will be evaluated during the analysis.
Avoided damage to infrastructure and associated losses from cyclone hazards	As per baseline. It is assumed that community rainwater tank(s) will not be damaged by a cyclone event.	As per baseline.
Improved water supply reliability from less electricity failure interruptions	As per baseline. It is assumed that there will be no (regular) interruptions experienced from community rainwater tank supply. WTP for improved reliability.	Stated-preferences survey would be required to assess WTP. The value of this information and hence the decision to obtain it will be evaluated during the analysis.
Expected environmental impacts on habitats and species	Reduced biophysical impacts from groundwater abstraction Value of habitats and species	The beside information is not likely to be readily available and would be difficult and expensive to obtain. The value of this information and hence the decision to obtain it will be evaluated during the analysis.

Comment [a23]: Haden, is this a valid assumption? What was the experience with Cyclone Heta - did household rainwater tanks get damaged.

Option 3: Leakage reduction program

Leakage reduction program		
Costs		
Assessment costs	Number of days Consultancy rate per day	PWD IWRM documents
Capital Cost of replacing/repairing pipes: (Purchase price tank + frame +	Quantity of pipes required Market price of pipes	PWD SOPAC or other technical expertise for

FOB (ex) freight costs, bulk procurement (cheaper), installation, consultation, land)	Useful life Labour days Wage rate Estimated quantity of leakage reduction	yield SOPAC Technical Report447, p.29 • Need to verify useful life • Suppliers (local); regional (SOPAC, UNDP, etc) IWRM documents
Operational Costs Repairs/maintenance (ex) transportaion (incl fuel), monitoring, machinery etc	Quantity of materials Market price of materials Labor days wage rate ➔ May be able to approximate this by assuming a certain percentage of capital costs(e.g. 5%) – ask SOPAC or PWD	PWD Secondary sources (SOPAC) - Suppliers (local); regional (SOPAC, UNDP, etc) IWRM documents
Benefits		
Avoided cost of providing groundwater (capital, operational, carbon)	As per baseline - quantity * unit cost	As per baseline
Improved water quality from avoided saline up-coning (pertaining to lower quantity of abstraction)	Quantity of abstraction reduced Salinity up-coning damage function Value/WTP of improved quality	The beside information is not likely to be readily available and would be difficult and expensive to obtain. A stated-preferences survey would be required to (reasonably) accurately assess value/WTP of improved quality. The value of this information and hence the decision to obtain it will be evaluated during the analysis.
Avoided damage to infrastructure from cyclone hazards	Damage as per baseline. It is assumed that pipes will not be damaged by a cyclone event. Losses won't be avoided as electricity interruptions will still occur.	As per baseline.
Expected environmental impacts on habitats and species	Reduced biophysical impacts from groundwater abstraction Value of habitats and species	The beside information is not likely to be readily available and would be difficult and expensive to obtain. The value of this information and hence the decision to obtain it will be evaluated during the analysis.

Comment [a24]: Haden, is this a valid assumption? What was the experience with Cyclone Heta - did household rainwater tanks get damaged.

Aggregate costs and benefits

The analysis period will allow for replacement of existing infrastructure.

A 4% real discount rate will be used to compute present values.

Incorporating climate change projections into the CBA will be done differently for rainfall and cyclone events. For rainfall, a best-estimate as well as an upper and lower bound range included through sensitivities will be applied. Because the probability distribution of future rainfall is not known, a probabilistic approach to incorporating climate change effects on rainfall is not appropriate. For cyclone events, probabilistic CBA may be used. Consult with Philip Wiles on determining upper and lower bounds, and probability distributions.

Comment [a25]: Phil to confirm

The analysis will attempt to calculate NPV's and B: C ratios. Given there are some benefits that likely will not be quantified and valued, the analysis will also employ a type of break-even analysis. This will also inform the value of information and hence the need for further data/information collections.

Sensitivity Analysis

Parameters to be assessed as part of sensitivity analysis will be identified as part of preliminary data analysis. Key sensitivities will likely include, but are not limited to:

- Frequency and intensity/impacts caused by cyclone (incorporating potential climate change effects)
- Projected quantity of annual rainfall (incorporating climate change effects) and subsequent impact on:
    - Yield from rainwater tank designs
    - Quantity and quality of yield from groundwater sources (refer to findings of current SOPAC study to assess whether this sensitivity is relevant and if so what the ranges should be)
- Useful life of diesel pumps
- Useful life of rainwater tanks
- Effectiveness of rainwater tanks in providing back-up supply during/following cyclone events (i.e. are tanks damaged during cyclones that would impact yield available during this time)

Timeline

Action	Date	Responsibility
Data collection	21 - 25 May	Niue PACC Co-ordinatorSPREP economist
Data analysis, including value of information/data needs analysis	Mid June	SPREP economist
Draft CBA report	Early July	SPREP economist
Peer Review	Mid July	UNDP, CROP economists, Niue PACC Co-coordinator
Final CBA report	End July	SPREP economist

PALAU CBA WORKPLAN: FOOD SECURITY PILOT PROJECT

This CBA work plan has been developed approximately 1 year into project implementation. As such, the purpose of assessing the project under the CBA framework is to refine project design as well as to ensure required data/information is collected (as part of monitoring) so that the project can be properly evaluated at the end of the project period (using an ex-post CBA).

The following CBA work plan is for an ex-post analysis. This is largely because the main part of the project (new taro varieties + elevated taro plots) is experimental/R&D in nature, which means that taro yields benefits, cannot be easily/accurately estimated ex-ante.

Some project refinements (i.e. introduction of various 'control' plots) are suggested in this work plan to allow for separate evaluation of project components (i.e. separately evaluate new taro varieties and elevated taro plots). This will be important for informing which aspects of the project should be up-scaled.

The CBA work plan also includes a timeline of activities to prepare for the ex-post CBA. This includes, among other things:

- further work to develop the problem analysis;
- collation/completion of baseline information; and
- Construction of an excel worksheet which is to be populated periodically as the project is implemented.

Problem

Food security and related health problems.

One component of this problem is decreasing local production. This mostly pertains to taro production, fruit production, and near-shore fish harvests.

The main focus of the Palau PACC food security pilot project, and this CBA, is on low taro production.

Cause(s) of problem

There are a range of causes and drivers contributing to decreasing taro production.

Saltwater inundation to plots has caused almost all swamp taro plots on the east side of Babeldaop (big island) to be abandoned over the last 20 years (indeed, PACC project staffs are unaware of any remaining taro production in these parts). The incidence of saltwater inundation due to extreme tides has been reported to have increased over this time period despite the same farming techniques (including the use structural dikes to regulate water flows) being used. Sea-level rise may be contributing to this.

Shifting preferences towards the cheaper and more convenient rice and flour substitutes (and thus lower demand for taro) also contribute to the lower observed taro production. Related to this is a lack of awareness of the high nutrient value of taro relative to rice and flour.

Objective

Increase resilience of taro-crop to saltwater inundation.

Comment [a26]: Jerome, we need to elaborate on the nature and extent of this food security problem. Refer to Otto Judy (2000).Nutrition and Food Security in the Republic of Palau, Report prepared for FAO for more information on this.

Also, report findings from V&A and SEA-PACC.

Comment [a27]: Jerome, do you have historical data/information showing how taro production (swamp taro in particular) has decreased over the last 10 to 20 years? Not in terms of record keeping but by interview and witnessing taro patches neglected... basically one of the reason in this case is moving away from the province to the capital due to children's easy access to schools as well as food purchase, etc...

Refer to Otto Judy (2000).Nutrition and Food Security in the Republic of Palau, Report prepared for FAO for more information on this. Also, report relavant information from V&A and SEA-PACC. Although Palau PACC did the food survey last year our partners still has not put out the report.

Comment [a28]: Jerome, are there any reports/evidence to support these statements? Report in writing is lacking in this case but evidence is there to see.

Also, it is important that we detail the frequency as well as the magnitude/extent of these inundation events and how we think this may change in the future with climate change. Need a lot of capacity building as to collect and record for keeping data which our MET office can only do part of this activity with other agencies to be tasked and work in collaboration together.

Your country MET office may be able to help with climate change matters. PACCSAP tool could be used here. Yes... I agree that our MET office can help with the training provided to them last year from Australia and although we have discussed working together on this unfortunately it has not come about however this does not mean we won't try to work together.

Options

The project option currently being implemented comprises of three distinct sub-projects which will be evaluated separately. These sub-projects are:

a. Trial/demonstrate production of newly developed salt-resistant taro varieties, including giant taro (Cyrtosperma merkusii).
b. Construction of elevated taro 'plots' so that less saltwater inundates patches (compared to traditional plots/gardens design used previously that have now been abandoned)[2].
c. Combined new taro varieties and elevated taro plot design.

With and Without Analysis

Without the projects, lowland/swamp taro production on the east side of the big island is expected to remain low (current information is that taro production in these areas is zero). Corresponding imports of rice (main carbohydrate import and substitute for taro) would be expected to continue. Rice is far less nutritious than taro, so this trend is expected to continue/worsen existing nutrition-related health problems.

Given this CBA will be an ex-post, much of the data for the project options will be collected as the project is implemented.

For the 'with and without' analysis, it is assumed that taro yields will 100% offset rice imports (measured in calorific terms). It is further assumed the nutritional and market values of traditional and new varieties are the same.

Baseline – status quo	**1.salt-resistant taro varieties**	**1.b elevated taro plot design**	**1.c combined salt-resistant taro varieties and elevated taro plot design**
▪ **Taro production on the east side of the big island remains at zero.** ▪ **imports of grains, mostly flour and rice remain high (as a result of decreased local production)** ▪ **nutrition-related health problems persist**	Costs		
	▪ land related costs ▪ set up (capital) costs (materials, labour, tools) ▪ operating costs (materials, labour)	▪ land related costs ▪ set up (capital) costs (materials, labour, tools) ▪ operating costs (materials, labour)	▪ land related costs ▪ set up (capital) costs (materials, labour, tools) ▪ operating costs (materials, labour)
	Benefits		
	▪ savings from lower grain imports + added value of taro relative to rice ▪ improved nutrition-related health outcomes ▪ improvement of	▪ savings from lower grain imports + added value of taro relative to rice ▪ improved nutrition-related health outcomes ▪ improvement of	▪ savings from lower grain imports + added value of taro relative to rice ▪ improved nutrition-related health outcomes ▪ improvement of

[2] http://www.guampdn.com/article/20120201/OPINION02/202010338/Palau-focusing-climate-change-impact

Comment [a29]: Jerome, i suggest that in addition to option c (combined new taro varieties and elevated taro plot design) that the project also run sub-projects a (new taro varieties only) and b (elevated taro plot design only) as well as a control plot where traditional taro varieties are combined with non-elevated taro plot design. I agree with you and have consulted with partners on this issue and there are fine with it which we will incorporated into our activities for this year.

This is considered necessary to properly identify/assess what measures (i.e. new varieties, elevated plot design, or both) yields can be attributed to. This will be important for making recommendations about up-scaling (i.e. we don't want to recommend combined approach if the new varieties are wholly responsible for observed increased yields). Partners will look into this as well.

Comment [a30]: Jerome, we need to also state/find out what the yields are for traditional taro varieties with the elevated plot/garden design. Has the Palau Community College research done this? Has other studies been done that may inform this? Actually with Palau's Taro Festival last year a report on the economics of taro in Palau was shared on this issue... will find the report as we have no copies in the office.

If not, project should include a traditional variety plot (using elevated design) as a 'control'.

▪ **cultural values relating to taro production and consumption remain low**	cultural values related to taro production and consumption	cultural values related to taro production and consumption	cultural values related to taro production and consumption

Measuring costs and benefits

Without project scenario/baseline

If this information has not already been collected, it should be done so as a matter of priority as delays in its collection may distort what the baseline actually is (given the project is underway).

Cost/benefit	Data required	Source of data
Taro production on the east side of the big island remains at zero.	Kg of taro produced on the east side of Babeldaop (big island) Kg of taro produced on control plot (i.e. Traditional varieties/non-elevated plot). Information on the incidence of hazard should be recorded for each year as well as other relevant climate variables (e.g. rainfall).	SEA-PACC HIES (2000, 2006) ? Yield data collected each season/year as part of monitoring.
Imports of grains, mostly flour and rice	Just want information (study, report, survey) showing that since taro production has decreased, rice import is substituting for this. Does not need these numbers to input into CBA excel, just to help support our assumption (in analysis of project 1) that taro production will offset rice imports.	SEA-PACC HIES (2000, 2006)
nutrition-related health problems persist	Qualitative description of how higher rice consumption impacts on health. Very unlikely that we will be able to support with data but worth a try.	Otto Judy (2000).Nutrition and Food Security in the Republic of Palau, Report prepared for FAO Health department's reports and discussions with health experts.
cultural values relating to taro production and consumption remain low	Just describe what the cultural values of taro production are. Too difficult to valuate for this CBA. Cultural values of this project are considered to be significant. Particular impact on gender given that it is the women's role to farm taro plots.	Seniloli, M et al (2002). 'Gender issues in environmental sustainability and poverty reduction in the community: social and community issues', Development Bulletin, no. 58, pp. 96-98

Comment [a31]: Jerome, you have advised that there is no farming of taro (traditional or new varieties) in swamp areas of the east side the big island (the project site/region) at all. Can you please support this advice with evidence from study/survey/research. Perhaps this is documented in the V&A? Actually there are more taro patches on the east coast than the west, especially to the north of the big island of Babeldaob. The west coast of the island is mostly mangroves with taro patches behind the mangroves inland. I am sending you a presentation from September 2007 that hopefully will help in this regard.

If this is not in fact the case, we can use the control run (i.e. traditional swamp varieties, non-elevated plot design) as baseline.

Option 1a – salt resistant taro varieties

This information is to be collected as the project is implemented.

Cost / Benefit	Data required	Source of data
Expected useful life of project land related costs	Number of years Land for wetland taro production is swamp. There is no/very low opportunity cost for this land. No data	Palau Community College

	collection required.	
set up (capital) costs (materials, labour, tools, purchase of cuttings for new varieties)	Quantity of materials Market price of materials Labour days Wage rate (min) Quantity of cutting purchased Price per cutting	Receipts collected by project coordinator
Operating costs - equipment costs (equipment, labour costs of planting and harvesting)	Quantity of equipment Market price of equipment Number of days Wage rate (min)	Receipts collected by project coordinator
savings from lower rice imports + value added of taro relative to rice	Quantity production/yield of new taro (kg/year/standard plot) using old/traditional plot design Equivalent quantity of rice of taro production (in calorific terms) Market price of rice per kg Market price of new variety taro per kg Information on the incidence of hazard should be recorded for each year as well as other relevant climate variables (e.g. rainfall).	Yield data collected each season/year as part of monitoring. SPC Food Composition Tables (1994) for calorific value of various crop types. Store (for price of rice) Local markets/store for price of taro) (this should be done for every year/season)
improved nutrition-related health outcomes	Qualitatively describe as per without. Very unlikely we will be able to attribute any observed health improvements to pilot project, especially given small scale of project. Possibly also conduct post-project survey to obtain this information.	Otto Judy (2000).Nutrition and Food Security in the Republic of Palau, Report prepared for FAO Health department's reports and discussions with health experts.
improvement of cultural values related to taro production and consumption	Qualitatively describe as per without. Possibly also conduct post-project survey to obtain this information.	Seniloli, M et al (2002). 'Gender issues in environmental sustainability and poverty reduction in the community: social and community issues', Development Bulletin, no. 58, pp. 96-98

Comment [a32]: if not known, we will assume it is the same as traditional swamp taro varieties.

Comment [a33]: assume nutrition value of new and old taro varieties are the same, or atleast have the same health benefits.

Option 1b – elevated taro plot design

Cost / Benefit	Data required	Source of data
Expected useful life of project	Number of years	Palau Community College
land related costs	As per option 1a.	
set up (capital) costs (materials, labour, tools, purchase of cuttings for traditional varieties)	Quantity of materials Market price of materials Labour days Wage rate (min) Quantity of traditional cutting purchased Price per cutting	Receipts collected by project coordinator

Operating costs - equipment costs (equipment, labour costs of planting and harvesting)	Quantity of equipment Market price of equipment Number of days Wage rate (min)	Receipts collected by project coordinator
savings from lower rice imports + value added of taro relative to rice	Quantity production/yield of traditional taro (kg/year/standard plot) using new elevated plot design Equivalent quantity of rice of taro production (in calorific terms) Market price of rice per kg Market price of traditional swamp taro per kg Information on the incidence of hazard should be recorded for each year as well as other relevant climate variables (e.g. rainfall).	Yield data collected each season/year as part of monitoring. SPC Food Composition Tables (1994) for calorific value of various crop types. Store (for price of rice) Local markets/store for price of taro) (this should be done for every year/season)
improved nutrition-related health outcomes	As per option 1a.	
improvement of cultural values related to taro production and consumption	As per option 1a.	

Comment [a34]: assume nutrition value of new and old taro varieties are the same, or atleast have the same health benefits.

Option 1c – combined salt resistant taro varieties & elevated plot design

Cost / Benefit	Data required	Source of data
Expected useful life of project	Number of years	Palau Community College
land related costs	As per option 1a.	
set up (capital) costs (materials, labour, tools, purchase of cuttings for new varieties)	As per 1a and 1b.	
Operating costs - equipment costs (equipment, labour costs of planting and harvesting)	As per 1a and 1b.	
savings from lower rice imports + value added of taro relative to rice	Quantity production/yield of new taro (kg/year/standard plot) using new elevated plot design Equivalent quantity of rice of taro production (in calorific terms) Market price of rice per kg Market price of new variety taro per kg Information on the incidence of hazard should be recorded for each year as well as other relevant climate variables (e.g. rainfall).	Yield data collected each season/year as part of monitoring. SPC Food Composition Tables (1994) for calorific value of various crop types. Store (for price of rice) Local markets/store for price of taro) (this should be done for every year/season)
improved nutrition-related health outcomes	As per option 1a.	
improvement of cultural values related to taro production and consumption	As per option 1a.	

Comment [a35]: if not known, assume it is the same as traditional swamp taro varieties.

Aggregating costs and benefits

Since Palau Government does not prescribe a discount rate in its assessment of Government projects, use 4% discount rate.

Analysis should account for different expected useful life of each project option. Preferred way to do this is to extend the timeframe of the analysis out many years.

Calculate NPV. Also calculate B/C ratios.

In addition to an economic CBA, also perform a financial CBA (i.e. financial pre-feasibility study) for each of the project options. That is, perform analysis from point of view of the farmer so that benefits are measured as revenue generated from sale of taro only (i.e. do not account for lower rice imports or any of the other benefits). This is necessary to test whether the projects are financially viable and so assess their commercial 'sustainability'.

Sensitivity Analysis

Parameters to be tested using sensitivity analysis will be identified during stages of collecting/generating data. Likely parameters to be tested include:

- Taro production yield from new variety (new and old plot design)
- Taro production yield from old variety (new and old plot design)
- Market price of each good

Timeline

Action	Date	Responsibility
Further develop problem analysis as per comments in this work plan. **--> This is key information for a project document as well as the CBA report to be prepared at end of PACC project.**	Early August	Jerome Temengil (Palau PACC coordinator) supported by Taito Nakalevu and CBA consultant
Revise/finalize CBA work plan (if required) **--> the need for this will be informed by problem analysis above and consultant input**	Early August	Jerome Temengil (Palau PACC coordinator) and Muriell Sinsak (Department of Planning and Statistics) supported by CBA consultant
Review of final CBA work plan	Early August	SPREP economist
Baseline data collection	Early-Mid August	Jerome Temengil (Palau PACC coordinator) and Muriell Sinsak (Department of Planning and Statistics) supported by CBA

		consultant
Construction of CBA excel spreadsheet	Early-Mid August	Jerome Temengil (Palau PACC coordinator) and Muriell Sinsak (Department of Planning and Statistics) supported by CBA consultant
Draft CBA (Baseline and Data Collection Strategy) Report **--> the idea with this report is to prepare the parts of a CBA report that can be complete at this stage[3], document baseline data, outline strategy for collecting data needed to fully populate ex-post CBA, and document CBA excel spreadsheet**	Mid August	Jerome Temengil (Palau PACC coordinator) and Muriell Sinsak (Department of Planning and Statistics) supported by CBA consultant
Peer Review	Late August	SPREP Economist, UNDP consultant, interested regional economists
Final CBA (Baseline and Data Collection Strategy) Report	September	Jerome Temengil (Palau PACC coordinator) and Muriell Sinsak (Department of Planning and Statistics) supported by CBA consultant
Populate relevant parts of CBA excel spreadsheet	As information is collected	Jerome Temengil (Palau PACC coordinator) and Muriell Sinsak (Department of Planning and

[3] This includes the following:

1 INTRODUCTION

1.1 Problem statement

1.2 Objective in the study, expected outcomes

2 **BACKGROUND**

2.1 Country context

2.3 Issues, problem symptoms in detail etc.

3 METHODOLOGY

3.1 CBA

3.2 With and without analysis, expected general benefits and costs

3.2 Valuing benefits and costs

3.4 General assumptions, scope (private CBA, global CBA etc., time frame etc.)

4 DATA

		Statistics) supported by Aaron Buncle (SPREP economist)
Data analysis	End project	Jerome Temengil (Palau PACC coordinator) and Muriell Sinsak (Department of Planning and Statistics) supported by Aaron Buncle (SPREP economist)
Draft CBA report	1 month after end project	Jerome Temengil (Palau PACC coordinator) and Muriell Sinsak (Department of Planning and Statistics) supported by Aaron Buncle (SPREP economist)
Peer Review	2 months after end project	SPREP economist, UNDP consultant (?), CROP economists (?)
Final CBA report	3 months after end project	Jerome Temengil (Palau PACC coordinator) and Muriell Sinsak (Department of Planning and Statistics) supported by Aaron Buncle (SPREP economist)
Endorsement by SC	4 months after end project	PACC
Submit CBA report (along with project brief) to Cabinet?	4 months after end project	Jerome Temengil (Palau PACC coordinator) and Muriell Sinsak (Department of Planning and Statistics)

REPUBLIC OF MARSHALL ISLANDS CBA WORKPLAN: WATER SECTOR PILOT PROJECT

The project options to be implemented under the Republic of Marshall Islands PACC water pilot project have already been decided. These options are to replace the leaking airport reservoir membrane and repair leaking pipes between the catchment and the reservoir. As such, the purpose of this CBA work plan is to ensure sufficient data/information is collected before (as part of baseline) and during (as part of monitoring) project implementation so that it can be properly evaluated at the end of the project period (using an ex-post CBA).

In addition to data collection, some work is also required to better understand the water problem in the project area. Synthesis of available information (reports, studies, assessments already performed) will be completed over the coming two months concurrently with baseline data collection. Comments are included in this CBA work plan to guide this work.

This CBA work plan is organised as follows:

- Problem Statement
- Options
- With and Without Analysis
- Measuring costs and benefits (data needs and sources)
- Aggregating costs and benefits
- Sensitivity Analysis
- Timeline of activities

Problem Statement

Describe situation/context of Majuro water supply, including current total quantity of supply from airport reservoir system during normal (i.e. non-drought) and drought years.

Water to the DUD area of Majuro is supplied from one source. The quantity of potable water supplied to the DUD area of Majuro is inadequate for year round consumption by DUD households (40 gallon per day per capita).
During drought periods, these problems are exacerbated and per capita consumption is rationed to 5 gallons per day. Households must supplement their water with purchases of imported bottled water and desalination water at a considerably higher cost. Some households cannot afford this

This inadequate water supply is considered to contribute to poor health outcomes (e.g. typhoid, diarrhoea).

Inadequate water supply is also considered to constrain tourism activity.

Comment [a36]: Jo, can you please confirm both these project options are being implemented as part of the PACC.

If the PACC is only replacing the reservoir liner, then this CBA should just assess this option.

Comment [a37]: This information should include, but is not limited to:

•PACC V&A Assessment

•Socio-economic Assessment, SEA-PACC

•SOPAC water reports prepared for project area

•Shapiro. J, "Report on estimation of water losses from Majuro reservoirs

•ADB Climate-Proofing Infrastructure in Majuro report

•EPD Guidance Document, 2007, Water detection and repair program

•USAID Report Adaptation to Climate change June 2009

...

Comment [a38]: Jo/Mark, can you please confirm this statement is correct.

Comment [a39]: how many households in the DUD area? is this number increasing or decreasing? are these low income or middle-income households or a mix?

this information could be sourced from V&A Assessments, Socio-Economic ...

Comment [a40]: Jo/Mark, is this the quantity of water that individuals actually receive/consume? or is it the amount that is actually pumped and therefore does not factor in losses from leakage. ...

Comment [a41]: How frequently do these droughts occur? How long do they typically last? How is this expected to change in the future with climate change? ...

Comment [a42]: this amount is around 18 litres per day and is low.

if consumption during non-drought periods is actually 40 gallons per day, then i suggest the real problem is inadequate water supply during drought periods.

Comment [a43]: Jo/Mark, do you have any reports/studies which support the numbers quoted here?

Is this quantity of water just from the airport reservoir or does it also include purchased bottled water and desalinatio ...

Comment [a44]: Jo/Mark, do we have any evidence/information on these health impacts.

Cause(s) of problem

Climate change related causes:

- increased evapo-transpiration rates
- impacts on rainfall
    - frequency and length of drought periods
    - variation in yearly rainfall

Other causes and drivers

- lack of water policy or regulations (needed for, among other things, defining water property rights)
- inadequate pricing
- Pollution (of alternative water sources, in particular the groundwater lens).

These 3 causes potentially contribute to a number of inefficiencies in the supply ~~and consumption~~ of water including:

- ~~households may be consuming too much water (i.e. more than is economically efficient) during non-drought periods leaving insufficient supplies/reserves for drought periods~~
    - Leakages (in both the pipes and reservoirs) relating to insufficient repair and maintenance are considered to be significant.
    - losses relating to illegal tapping are potentially significant
- population growth is also a driver of low/decreasing per capita water supply

Objective

The overarching objective of this project is to improve the DUD community resilience to potential climate change impacts on water supply.

A more specific objective of the project is to increase year-round supply of water to the DUD community. The target for this additional supply increase is x.

Options

The options that RMI have decided on for their PACC water pilot/demonstration project are:

1. replace the torn membranes at the airport reservoirs; and
2. repair leakages in the main pipes

With and Without Analysis

Without any measures being implemented to increase supply of potable water to the DUD community, the abovementioned problems are likely to persist, and possibly worsen i.e.

Comment [a45]: we need to understand how this may change for RMI and the expected rate of this change.

Jo/Mark, you should get this information from the RMI Met in the first instance. Also refer to Pacific Climate Change Science Program tools/products. Philip Wiles from SPREP, philipw@sprep.org, can help if needed.

Comment [a46]: we need more information on these causes. the problem may not be addressed if these causes are not properly considered/addressed.

Comment [a47]: Jo/Mark, my understanding is that there is not a problem of over-consumption during non-drought periods.

Can you please confirm and provide evidence of this?

Comment [a48]: Jo, your presentation states that it is "difficult to determine the leakage rate at this time because of the lack of metering or logging of bulk flow and pressure. For example, flow and pressure are recorded at Laura when water is pumped to the storage reservoirs at the airport but the meter to measure inflow at the airport is not currently functioning. (SOPAC Report, 2000)". Can you please provide this SOPAC Report and any other relevant water supply studies/reports.

Comment [a49]: Jo/Mark, what is the current population of the project area and how is this forecasted to change over the next 10 to 30 years?

Comment [a50]: or is it supply during drought periods?

this will become clearer as we further develop the problem/situation analysis.

It is important that we clarify this.

Comment [a51]: It would be good to have a target for this water supply project.

this is important for monitoring and evaluation.

- Per capita water consumption during non-drought periods will likely decrease by x% per year with the effects of climate change and population growth.
- Per capita water consumption during drought periods will likely decrease by x% per year with the effects of climate change and population growth. The frequency and duration of these drought events will most likely increase by x. During these times households must purchase bottled water and desalination water at a considerably higher cost. Some poorer households must go without some good quality drinking water.
- Water-related health problems will continue and possibly worsen.
- Flow through impacts on tourism sector will continue and possibly worsen.

Comment [a52]: we need to determine/make a reasonable guess on this baseline decrease

Comment [a53]: we need to determine/make a reasonable guess on this baseline decrease

The below table lists these expected outcomes for the without project scenario. Taking the without-project as the reference, the table also lists the costs and benefits related to each identified project option.

Baseline – status quo	**Project Option 1** **Redesign and retrofit the airport water reservoir by** **Replacing the membrane inner in the storage water catchments**	**Project Option 2** **Repair leakages in the main water pipes**
	Costs	
▪ **Water supply during non-drought is x liters, and decreasing by x% per year**	▪ Capital costs (reservoir Liner materials, labour costs) ▪ Maintenance cost (material and labour)	▪ Capital costs (pipe materials, labour costs) ▪ Maintenance cost (material and labour)
▪ **Water supply during drought is x liters, and decreasing by x% per year. households must supplement water with x liters from desalination sources and x liters of purchased bottled water**	**Benefits**	
▪ **Water-related health problems will continue and possibly worsen.**	▪ additional water for year-round consumption ▪ additional water during drought periods ▪ Lower incidence of water-related health impacts	▪ additional water for year-round consumption ▪ additional water during drought periods ▪ Lower incidence of water-related health impacts
▪ **Flow through impacts on tourism sector will continue and possibly worsen**	▪ water-related impacts/constraints on tourism reduced (Japanese tourism recommenced)	▪ water-related impacts/constraints

Comment [a54]: are these just fancy words for repair/replace or are we really redesigning?

if we are redesigning, then there will be some engineering consultancy/design costs that will need to be factored in.

		on tourism reduced (Japanese tourism recommenced)

Measuring costs and benefits

This section details the data required and the source of data for each of the costs and benefits identified in the 'with and without' analysis above. This is done as a table for each project option, starting with the without project option.

Without-project/baseline

All of the below information should be collected before the project options begin implementation. This should be done concurrently with V&A Assessment. Mark Stege would be a good person to complete this work.

Note, this information should be forecasted for each year of the expected (useful) life of the projects. Recall from Samoa CBA workshop that future conditions without the project are not necessarily the same as current conditions without the project (i.e. there may be a difference between with/without and before/after).

	Data required	**Source of data**
Water supply during non-drought	Quantity of reservoir water supplied to households in DUD area Price of reservoir water charged &full-cost recovery tariff of providing reservoir water (per liter/ML) Number of households (now and into the future)	Majuro Water and Sewer Company RMI Water Authority V&A Assessment SEA-PACC Other studies/reports --> this information is key/essential
Water supply during drought	Quantity of reservoir water supplied to households in DUD area Price of reservoir water charged & full-cost recovery tariff of providing reservoir water (per liter/ML) Quantity of desalination water supplied to households in DUD area Price of desalination water charged Quantity of bottled water purchased per household Price of bottled water Number of households (now and into the future)	Majuro Water and Sewer Company V&A Assessment SEA-PACC Other studies/reports --> this information is key/essential

Comment [a55]: This should be estimated as a function of rainfall.

this is important for, among other things, factoring in climate change climate change (which effect through changing rainfall)

Comment [a56]: this is the total cost of providing water to the DUD area per year (capital + operating costs) divided by the total quantity of water supplied.

this should be calculated as at 2011/12.

[Leakage from reservoir]	Quantity of water lost from reservoir leakage each year	Technical studies such as Shapiro. J, "Report on estimation of water losses from Majuro reservoirs
[Leakage from pipes]	Quantity of water lost from pipe leakage each year	Technical studies such as Shapiro. J, "Report on estimation of water losses from Majuro reservoirs
▪ **water-related health impacts**	Number of incidents per year Severity of incidents --> Will not be able to attribute impacts to inadequate water supply with confidence. But good to have some numbers to base discussion/description on.	V&A Assessment Socio-economic Assessment Health report Discussions with health experts
▪ **water-related impacts/constraints on tourism**	Do not attempt to measure/ valuate. Just want to qualitatively describe constraints water has on tourism and how the project may be relieving these constraints.	Tourism sector reports Water sector reports Discussion with tourism experts

Comment [a57]: This item is a sub-set of the water supply items. i have included it as a separate line for clarity of reading.

Comment [a58]: To work out this, a lot of additional data/information is required.

Comment [a59]: This item is a sub-set of the water supply items. i have included it as a separate line for clarity of reading.

Comment [a60]: To work out this, a lot of additional data/information is required.

Project option 1: replace reservoir liner

All of the below information should be collected in the year it happens.

Note capital costs will be a once-off cost incurred in 2012 or 2013. Maintenance costs and each of the benefit items, **especially additional water**, will be collected on an annual basis. Further, for each year of the project, the number of days that drought occurs (if at all) should be recorded.

	Data required	Source of data
Costs		
Capital costs (reservoir liner)	Quantity of liner required Price of liner per square meter Number of labour days required to fit liner Wage rate	Receipts collected by project coordinator This should be in line with costs estimated in EPD Guidance Document, 2007, Water detection and repair program
Maintenance costs	Quantity of materials required to repair and maintain Price of materials Number of labour days required Wage rate	Receipts collected by project coordinator

Benefits		
Additional water supply	Quantity of additional water supplied/'saved' Price of reservoir water charged & full-cost recovery tariff of providing reservoir water (per liter/ML) Price of bottled water Full-cost of desalination water (per liter)	Data as collected by Majuro Water and Sewer Company RMI PACC officers to monitor and check this data --> This information should be collected/recorded on an annual basis
Lower incidence of water-related health impacts	Number of incidents per year Severity of incidents --> Will not be able to attribute lower incidence to project with any confidence. But good to have some numbers to base discussion on.	Health report Discussions with Health Department staff/experts
water-related impacts/constraints on tourism reduced	Do not attempt to measure/ valuate. Just want to qualitatively describe constraints water has on tourism and how the project may be relieving these constraints.	Tourism sector reports Water sector reports

Comment [a61]: this is reduced leakage from reservoir.

break this down into supply during drought and non-drought periods if possible

this break down is important because we will assign different values to water during non-drought and drought years. i.e. during drought, water is more scarce and hence valuable.

Part of this should also be the amount of rainfall experienced for each year.

Project option 2: repair/replace leaking pipes

All of the below information should be collected in the year it happens.

Note capital costs will be a once-off cost incurred in 2012 or 2013. Maintenance costs and each of the benefit items, **especially additional water**, will be collected on an annual basis. Further, for each year of the project, the number of days that drought occurs (if at all) should be recorded.

	Data required	Source of data
Costs		
Capital costs (pipes)	Quantity of (pipe) materials required Price of materials per unit Number of labour days required to fit liner Wage rate	Receipts collected by project coordinator This should be in line with costs estimated in EPD Guidance Document, 2007, Water detection and repair program
Maintenance costs	Quantity of materials required to repair and maintain pipes Price of materials Number of labour days required Wage rate	Receipts collected by project coordinator
Benefits		
Additional water supply	Quantity of additional water supplied/'saved' Price of reservoir water charged & full-cost recovery tariff of providing reservoir water (per liter/ML)	Data as collected by water authority PACC officers to monitor and check this data --> This information should be collected/recorded on an annual basis

Comment [a62]: this is reduced leakage from pipes.

break this down into supply during drought and non-drought periods if possible. this is important because we will assign different values to water during non-drought and drought years. i.e. during drought, water is more scarce and hence valuable.

part of this should also be the amount of rainfall experienced for each year.

	Price of bottled water Full-cost of desalination water (per liter)	
Lower incidence of water-related health impacts	Number of incidents per year Severity of incidents --> Will not be able to attribute lower incidence to project with any confidence. But good to have some numbers to base discussion on.	Health report Discussions with Health Department staff/experts
water-related impacts/constraints on tourism reduced	Do not attempt to measure/ valuate. Just want to qualitatively describe constraints water has on tourism and how the project may be relieving these constraints.	Tourism sector reports Water sector reports

Aggregating costs and benefits

Since the RMI Government does not prescribe a discount rate in its assessment of Government projects, use 4% discount rate.

Analysis should account for different expected useful life of each project option. Preferred way to do this is to extend the timeframe of the analysis out many years.

Calculate NPV. Also calculate B/C ratios.

Sensitivity Analysis

Because this CBA will be an ex-post analysis there will be less uncertainty about data inputs, providing that data is collected properly. The parameter that is likely to be most uncertain and so should be tested using sensitivity analysis is the value of water (approximated as the price of providing reservoir water, price of providing desalination water, and price of imported bottled water).

Given that the project will likely have some useful life remaining at the time of the CBA evaluation (at end of PACC involvement), the length of useful life and expected rainfall may also be worth assessing as sensitivity.

Action	Date	Responsibility
Further develop problem analysis as per comments in this work plan. **--> this will be done alongside V&A Assessment** **--> this is key information for a project document as well as the CBA report to be prepared at end of PACC project.**	April - May	Mark Stege (local consultant), Joseph Cain (RMI PACC Coordinator), Martha, Alington Robert (Majuro Water and Sewer Company), supported by Taito Nakalevu (SPREP), Espen Ronneberg (SPREP), and CBA consultant

Comment [a63]: Joseph, can you please provide full name and position for Martha?

Revise/finalise CBA work plan (if required) **--> the need for this will be informed by problem analysis (including V&A Report) above and consultant input**	End May	Mark Stege (local consultant), Joseph Cain (RMI PACC Coordinator), Martha, Alington Robert, supported by CBA consultant
Review of final CBA work plan	Early June	SPREP economist
Baseline data collection	April - May	Mark Stege (local consultant), Joseph Cain (RMI PACC Coordinator), Martha, Alington Robert, supported by CBA consultant
Construction of CBA excel spreadsheet	May - June	Joseph Cain (RMI PACC Coordinator), Martha, Alington Robert, supported by CBA consultant
Draft Baseline and Data Collection Strategy Report **--> the idea with this report is to prepare the parts of a CBA report that can be complete at this stage[4], document baseline data, outline strategy for collecting data needed to**	June	Joseph Cain (RMI PACC Coordinator), Martha, Alington Robert, supported by CBA consultant

[4] This includes the following:

1 INTRODUCTION

1.1 Problem statement

1.2 Objective in the study, expected outcomes

2 **BACKGROUND**

2.1 Country context

2.3 Issues, problem symptoms in detail etc.

3 METHODOLOGY

3.1 CBA

3.2 With and without analysis, expected general benefits and costs

3.2 Valuing benefits and costs

3.4 General assumptions, scope (private CBA, global CBA etc., time frame etc.)

4 DATA

fully populate ex-post CBA, and document CBA excel spreadsheet		
Peer Review	Mid June	SPREP Economist, UNDP consultant, interested regional economists
Populate relevant parts of CBA excel spreadsheet	As information is collected	Joseph Cain (RMI PACC Coordinator), Martha, Alington Robert, supported by Aaron Buncle (SPREP economist)
Data analysis	End project	Mark Stege (local consultant), Joseph Cain (RMI PACC Coordinator), Martha, Alington Robert, supported by Aaron Buncle (SPREP economist)
Draft CBA report	1 month after end project	Mark Stege (local consultant), Joseph Cain (RMI PACC Coordinator), Martha, Alington Robert, supported by Aaron Buncle (SPREP economist)
Peer Review	2 months after end project	SPREP economist, UNDP consultant (?), CROP economists (?)
Final CBA report	3 months after end project	Mark Stege (local consultant), Joseph Cain (RMI PACC Coordinator), Martha, Alington Robert, supported by Aaron Buncle (SPREP economist)
Endorsement by SC	4 months after end project	PACC
Submit CBA report (along with project brief) to Cabinet?	4 months after end project	Joseph Cain (RMI PACC Coordinator), Martha, Alington Robert

Equity and Distributional Implications

Identify which stakeholder groups will incur costs and which stakeholder groups will accrue benefits for each project option.

Timeline

SAMOA CBA WORKPLAN: COASTAL SECTOR PILOT PROJECT

The aim of this CBA is to assess the effectiveness of the seawall of Tafitoala. The CBA will be an ex posts analysis because the seawall project has been already implemented. This exercise can help us to review if the priority chosen by the government of Samoa has been addressed in a cost effective way.

Unfortunately some of the benefits and costs that we assess are difficult to estimate due to the uncertainty on the assumptions and also due to the lack of a clear and complete data baseline. Therefore the majority of the benefits and the costs will be assessed from a qualitative point of view.

Problem

The Safata coastline including Tafitoala is identified as being a high risk area in the National Coastal Infrastructure Management Strategy and Coastal Infrastructure Management Plans (CIM Plans). The Tafitoala village is located in this area and its main problems related to climate change are:

- Common problem of land loss (The beach is reported to be eroding at an average rate of about a meter per year).
- Land inundation due to rising sea level and high storm surges leading to displacement and that can help us to damages to assets & properties. In the actual situation all the infrastructures in the 2 different areas analysed by the CIM plans are considered to be at high risk because of its location and the sandy nature of the coast.
- Flooding of low lying areas and destruction of coastal ecosystems- mangroves
- Salt water intrusion

Note: Background information available in past assessments-

National Communication reports, Climate Risk Profile, World Bank- Economics of Adaptation to CC: Samoa ((noted), Review of Economic and Livelihood Impact Assessments of, and Adaptation to CC in Melanesia,
Pilot specific studies: -Socio-Economic Assessments, V& A assessment, consultation reports.
Preliminary Environmental Assessment Report of Tafitoala-seawall

Cause(s) of problem

- Natural Drivers
    - Climate change phenomena
    - Extreme events i.e. more intense cyclones, storm surges
- Human practices
    - Sand mining practices

- Planning, building practices
- Reclamations

Note – Information available in past assessments (as above)

Objective

The overarching objective of the Samoa PACC pilot/demonstration project is to increase resilience of the Tafitoala village to climate change-related hazards (land erosion, sea surges, inundation of low lands).

Project options

The pilot/demonstration project implemented is a seawall. Although the CIM Plans identified other soft and hard adaptation strategies such as:

- *Relocation of the main road:*

  Provide an upgraded work road to allow for a new development area away from the beach near the main road.

- *Re-vegetation of coastal areas:*

  Planting of trees and other vegetation in coastal areas and mangroves along the estuary shoreline to enable this vegetation to survive
  Planting more coconut trees and other small trees such as niu, talie, fetau, milo and pu'a that have localized root systems along the coast behind the seawall as these will act as a buffer zone, minimize possible soil erosion and hold together the foreshore and protect infrastructure.

Baseline – status quo	**Project option 1** **Seawall**	**Project option 2** **Re-vegetation of coastal areas**	**Project option 3** **Relocation of the main road:**
▪ **Continuous loss of land including cultural values due to coastal erosion.** ▪ **Increase cost for repairs of properties /houses due to damages from salt spray and flooding.** ▪ **Loss of time during clean up and reconstruction**	▪ Capital costs. ▪ Social costs – loss of beach area for leisure activities ▪ Monitoring cost ▪ Maintenance costs. ▪ Loss of coral reef (tbc) ▪ Aesthetic cost.	▪ Capital cost ▪ Labour ▪ Maintenance ▪ Administrative costs	▪ Capital cost ▪ Labour ▪ Maintenance ▪ Administrative costs

▪ **Loss of vegetation and environmental values.** ▪			
▪ **None**	▪ Immediate protection to prevent coastline receding. ▪ Provides a sense of security and encourage people to rebuild and re-utilise lands left idle. ▪ Saves time spent on cleaning up post flooding. ▪ Avoided loss of revenue ▪ Avoided damages to infrastructure ▪ Avoided damages to house ▪ Avoided loss of land	▪ Natural barriers strengthened stabilising the coastline, and eventually preventing damages of buildings and properties from salt spray. ▪ Mangroves ecosystem provide habitats/breeding areas for fisheries. ▪ Saves time spent on cleaning up post flooding. ▪ Avoided loss of revenue ▪ Avoided damages to infrastructure and houses ▪ Avoided loss of land	▪ Avoided loss of revenue ▪ Avoided loss of income ▪ Avoided damages to infrastructure ▪ Incentive to move in land for the households (long term)

Measuring costs and benefits

This section should detail the data/information needed to estimate each of the costs and benefits identified in the 'with and without' analysis. It should also list where this data/information can be sourced.

Option 1 – status quo

Cost/benefit	Data required	Source of data
Cost 1 **Continuous loss of land including cultural values due to coastal erosion.**	Value of land loss Rate of coastal erosion Demographic information of people directly affected.	Manual On P Planning And project programming CIM plans Samoa Bureau of Statistics
Cost 2. **Increase cost for repairs of properties /houses due to damages from salt spray and flooding.**	Replacement costs for damages Repair costs for houses/properties	Survey SOPAC data Pacific Disaster Net
Cost 3 **Loss of time during clean up and reconstruction.**	Hours spent in clean up Minimum wage Information from families affected and village mayor.	Survey HIES SOPAC data

Cost 4 **Loss of vegetation and environmental values.**	Qualitative analysis	
Project option 1- Sea Wall		
Cost 1 **Capital costs.**	Cost of construction (Labour & Materials) Community service cost Opportunity cost of the labour. Cost to repair damages to access road used by trucks to transport materials. Cultural exchange cost	Expenditure details of the project Quarterly progress report
Cost 2 – **Social costs – loss of beach area for leisure activities**	Qualitative analysis	
Cost 3 - Monitoring cost	Supervision cost Transport costs	-MWTI, MNRE, LTA, MWCSD
Maintenance costs.	Types of maintenance required	-Benefit/cost transfer SGP costs
Loss of coral reef (tbc)	Qualitative analysis	
Aesthetic cost (tbc)	Qualitative analysis	
Project Option 2: Re-vegetation of coastal areas including mangrove areas		
Capital costs	Labour cost Materials cost – equipments, etc	Benefit/cost transfer SGP costs
Labour	Workshop costs – catering, transport cost	Benefit/cost transfer SGP costs
Maintenance	Monitoring assessment costs.	Benefit/cost transfer SGP costs
Project Option 3: Relocation of the main road:		
Existing cost benefit Analysis	CIM Plans Data	
Option 1 – Seawall		
Benefit 1 **Immediate protection to prevent coastline receding.** **Provides a sense of security and encourage people to rebuild and re-**	Qualitative analysis	

utilise lands left idle.		
Benefit 2 **Saves time spent on cleaning up post flooding.**	Hours spent in cleaning up after a flood event Minimum wage per hour	-Sopac Data -HIES
Benefit 3 **Loss of income and revenue avoided**	Qualitative analysis	
Benefit 4 **-avoided loss of land**	-Assumption on the avoided loss of land due to the sea wall	-Adaptation expert -CiM plan cost benefit analysis
Benefit 5 **-avoided damages to houses and infrastructures**	-Qualitative analysis	
Option 2 – Re-vegetating the coastal area		
Benefit 1 **Natural barriers strengthened stabilising the coastline, and eventually preventing damages of buildings and properties from salt spray.**	-Qualitative analysis	
Benefit 2 **Mangroves ecosystem provide habitats/breeding areas for fisheries.**	-Qualitative analysis	
Option 3 – Relocation of the main road:		
Benefit 1: **Assessed by the existing cost benefit analysis**		-CIM Plans

Aggregating costs and benefits

We chose to use the 8% discount rate as it is suggested in the *Manual on Project Planning and Programming* drafted by the government of Samoa. We will also make a sensitivity analysis with three different discount rates as it is suggested in the paper (6%, 10% and 14%).

When it will not be possible to measure the costs or the benefits, we will assess them from a qualitative point of view trying to give an objective valuation based on existing literature (quantitative).

Sensitivity Analysis

A sensitivity analysis will be made to assess how the cost benefit ratio changes in relationship with the different discount rate. This is analysis is crucial because different discount rates can changes dramatically the profitability of the project.

The second sensitivity analysis will be made assuming different value of land and different rates of coastal erosion

Timeline

Action	Date	Responsibility
Data collection	Mid May	**Marco Arena UNDP I Moira Faletutulu /national CBA team/SPREP economist (support role)**
Data analysis	End May	**Marco Arena UNDP I Moira Faletutulu /national CBA team/Sprep economist (Support Role)**
Draft CBA report	Mid June	**Marco Arena UNDP I Moira Faletutulu /national CBA team/Sprep economist (Support Role)**
Peer Review	Late June	**SPREP economist, UNDP Consultant**
Final CBA report	Early July	**Marco Arena UNDP I Moira Faletutulu /national CBA team/Sprep economist (Support Role)**
Endorsement by SC		**PACC**
Submit CBA report (along with project brief) to Cabinet?		**PIC PACC Coordinator, PIC economist/technical official**

		Receipts collected by project coordinator
		Data as collected by water authority PACC officers to monitor and check this data --> This information should be collected/recorded on an annual basis
		Health report Discussions with Health Department staff/experts
		Tourism sector reports Water sector reports

Aggregating costs and benefits

Since the RMI Government does not prescribe a discount rate in its assessment of Government projects, use 4% discount rate.

Analysis should account for different expected useful life of each project option. Preferred way to do this is to extend the timeframe of the analysis out many years.

SOLOMON ISLANDS CBA WORKPLAN: FOOD SECURITY PILOT PROJECT

Through the process of developing this work plan, it was found that further background work is still required to properly understand the food insecurity problem(s) in the project area. Much of this information may already be available (see reference list at bottom of this document), however some additional effort is required to compile and organise this information in a situation/problem analysis. This is necessary to ensure the project objective is correctly defined and to confirm identified project options are appropriate. This work is also needed to make sure the CBA is correctly constructed and is thus of value for decision-making.

This draft work plan serves as guidance for further work to be undertaken as part of situation/problem analysis (comments are inserted to assist this). It also serves as the basis for a final draft CBA work plan to be completed after situation/problem analysis has been completed.

This work plan also includes a timeline of work activities to complete the situation/background analysis as well as a CBA.

Please note again, the following CBA work plan is a draft only. It has been developed with a limited understanding of the food-security problem in Solomon Islands. Moreover, tables on data requirements and data sources for costs and benefit items have not been fully populated.

Problem

Food security in the low lying atolls (OJ, SK, and Temotu)
One component of the food security problem is declining crop (Giant swam taro, cassava, sweet potatoes and true taro) yields.

Comment [MSOffice64]: I suggest this is somewhat restrictive limiting this just to the low lying atolls. A broader look at climate change and food security would be more useful as there is more scope for remedial action

Comment [a65]: Casper, do we have historical data showing yields of each crop type for each atoll?

Perhaps the V&A details this information?

Need to also detail the implications of declining crop yield here. For example: imports of rice and other substitutes will increase; and Malnutrition will worsen?

In addition, as a result of decreased crop yields, extraction from near-shore fisheries is expected to increase. Harvests from these fisheries are likely to be already greater than (economically) optimal yields and as such, further extraction will cause medium-long term negative impacts (on fish yields).

Cause(s) of problem

Climate change related causes

- Salt water intrusion (mainly for pits)
- Salt spray (for pits and gardens)
- Longer drought periods
- ...
- (Soil fertility)

Comment [MSOffice66]: . Pest and diseases

Comment [a67]: Casper, do we have information on how this has changed over the last 10 years or so?

Also, please consult with your local MET offices to assess how these hazards may change in the future with climate change.

Other causes

- Lack of information/knowledge on good farming practices. There is little agriculture support and extension. Related to this, available planting materials are poor quality.
- Population growth leading to land degradation?
- Logging
- Cash cropping
- Other causes or drivers?

Objective

Increase crop yield ~~and crop diversity (?)~~

More specifically, this is to be achieved by improving resilience of farming practices to saltwater intrusion, sea-spray, and drought.

Options

1. Composting. using seaweed.
2. Introducing improved and resistant varieties
3. small-scale/simple irrigation
4. Raised beds, backyard gardening, agroforestry
5. Nursery/screen house
6. Introduce new legumes (e.g. Mukuna bean) to improve soil fertility

Further information is required here to explain what each of these options will involve and how they link to the stated objective.

With and Without Analysis

Without the project, the observed problems mentioned above are expected to worsen. That is:

- food yields will decrease;
- imports of rice and other substitutes will increase; and
- Malnutrition will worsen.

In addition, as a result of decreased crop yields, extraction from near-shore fisheries is expected to increase. Harvests from these fisheries are likely to be already greater than (economically) optimal

Comment [MSOffice68]: Probably the most important.

Comment [MSOffice69]: To sustainably increase crop yields

Comment [MSOffice70]: Suggest this be broader than just atolls

Comment [a71]: the objective should address the cause(s) of the problem.

Comment [MSOffice72]: It certainly does by increasing the fertility and yield soils

Comment [a73]: how does this option address the specific objective of improving resilience to saltwater intrusion, sea-spray, and/or drought?

Comment [MSOffice74]: Coconut husks

Comment [a75]: these two items should be treated/assessed as separate options

Comment [a76]: this has been identified as an option but no further work has been done in this workplan to identify and measure costs and benefits.

Casper, is option to be assessed in the CBA?

Comment [MSOffice77]: I would certain keen to look at this based on the experience in Tonga and Taveuni

Comment [MSOffice78]: These option are far from mutually exclusive

yields and as such will cause medium-long term impacts on fish yields. Further, terrestrial resources may continue to degrade.

The below table lists these expected outcomes for the without project scenario. Taking the without-project as the reference, the table also lists the costs and benefits related to each identified project option.

Baseline/without-project	Project option 1	Project option 2	Project option 3	Project option 4
	Composting	irrigation	Backyard, Raised beds, Agro forestry	Nursery/Screen House - Honiara & On site
Crop yield continues to decline **Amount of money that people are spending on imported goods** **Nutritional Costs (Malnutrition)** **Exploitation of Marine Resources** **Loss of Terrestrial Resources (Plants, Soil fertility, ect...)**	Costs			
	Composting Materials Transport Gardening tools Timbers Local compost materials Labor ~~Irrigation~~	Transport Water tanks Buckets Watering cans Timbers Roofing materials Building materials Labour Garden Tools	Transport Labour Planting materials Composting materials Timbers Trees Garden Tools	**Honiara** Labour Screen house (new or upgrading of existing) Transport Planting materials Poly bags Irrigation equipments **Community** Transport Cost Shade cloth (green nets) Poly bags labour
	Benefits			
	Increase of crop yield ~~Availability of local foods in the community~~ Reduce spending on imported foods Health improvements (see health assessment reports: OJ) ~~Increase diversity of crops~~ (better able to manage marine resources) Maintenance of terrestrial resources ~~Reliable access to extension officer for support and information's~~	Increase of crop yield ~~Availability of local foods in the community~~ Reduce spending on imported foods Health improvements (see health assessment reports: OJ) ~~Increase diversity of crops~~ (better able to manage marine resources) Maintenance of terrestrial resources ~~Reliable access to extension officer for support and information's~~	Increase of crop yield ~~Availability of local foods in the community~~ Reduce spending on imported foods Health improvements (see health assessment reports: OJ) ~~Increase diversity of crops~~ (better able to manage marine resources) Maintenance of terrestrial resources ~~Reliable access to extension officer for support and information's~~	Increase available planting material & crop yield ~~Availability of local foods in the community~~ Reduce spending on imported foods Health improvements (see health assessment reports: OJ) ~~Increase diversity of crops~~ (better able to manage marine resources) Maintenance of terrestrial resources ~~Reliable access to extension officer for support and information's~~

Measuring costs and benefits

This section details the data required and the source of data for each of the costs and benefits identified in the 'with and without' analysis above. This is done as a table for each project option, starting with the without project scenario.

Without-project scenario/baseline

Category	Data required	Source of data
Increase of crop yield		
Costs of importing foods	Price of goods (selling price in Ontong Java) (rice, taro, cassava, yams, tinned fish & meats, sweet potatoes) Quantity of the sale (time period)	Local business people of Ontong Java. CS
Nutritional Costs (Malnutrition)	This data will likely be difficult to obtain. If so, just qualitative describe	
Exploitation of Marine Resources		
Loss of Terrestrial Resources (Plants, Soil fertility, ect...)		

Option 1 – Composting

Costs	Data required	Source of data
Composting	**Shipping schedules and rates**	**Local shipping companies**
Transport	**Price, type and quantity of garden tools**	**MAL/Shops in Honiara**
Gardening tools	**Quantity of coconut trunk (0 opportunity cost)**	**ACOMFS Project**
Timbers	**Price and Quantity of timbers and nails**	**Timber suppliers and shops**
Local compost materials	**Quantity of green and dry leaves (0 opportunity cost)**	**Extension Support**
Labor of Community Members	**Days and wage rates for community members and extension support**	**Project Document and Government rates**
Labour of Extension support		
Irrigation		
Benefits		ARD , PACCMU & Jules Damutalau
Increase of crop yield	An estimate of local food produced	
~~**Availability of local foods in the community**~~	An est. of no. of households accessing regular local food supply	
Reduce spending on imported foods	An estimate of a reduce spending on imported food stuff	

Health improvements (see health assessment reports: OJ)	Estimated no. of malnutrition children/ Estimated cost of health services
~~Increase diversity of crops~~ (better able to manage marine resources)	~~Estimated no. of crops varieties available/~~
Maintenance of terrestrial resources	
~~Reliable access to extension officer for support and information's~~	

Option 2 – small-scale/simple irrigation

Costs	**Data required**	**Source of data**
Transport	Shipping schedules and rates	Local shipping companies
Water tanks	Price, type and quantity of Water tanks, buckets and watering cans	MAL/Shops in Honiara
Buckets		ACOMFS Project
Watering cans	Price, quantity and type of timbers and roofing materials	
Timbers		Timber suppliers and shops
Roofing materials		Extension Support
labour		Project Document and Government rates
Benefits		ARD , PACCMU & Jules Damutalau
Increase of crop yield	An estimate of local food produced	
~~Availability of local foods in the community~~	An est. of no. of households accessing regular local food supply	
Reduce spending on imported foods	An estimate of a reduce spending on imported food stuff	
Health improvements (see health assessment reports: OJ)	Estimated no. of malnutrition children/ Estimated cost of health services	
~~Increase diversity of crops~~ (better able to manage marine resources)	~~Estimated no. of crops varieties available/~~	
Maintenance of terrestrial resources		
~~Reliable access to extension officer for support and information's~~		

Option 3 – Backyard, Raised beds, Agro forestry

Cost/benefit	**Data required**	**Source of data**
Transport	Shipping schedules and rates	Local shipping companies
Labour	Price, type and quantity of garden tools	MAL/Shops in Honiara
Planting materials	Quantity of coconut trunk (0	ACOMFS Project

Composting materials Timbers/ Trees Garden Tools	opportunity cost) Price and Quantity of timbers and nails Quantity of green and dry leaves (0 opportunity cost) Days and wage rates for community members and extension support	
Benefits Increase of crop yield ~~Availability of local foods in the community~~ Reduce spending on imported foods Health improvements (see health assessment reports: OJ) ~~Increase diversity of crops~~ (better able to manage marine resources) Maintenance of terrestrial resources ~~Reliable access to extension officer for support and information's~~	 An estimate of local food produced An est. of no. of households accessing regular local food supply An estimate of a reduce spending on imported food stuff Estimated no. of malnutrition children/ Estimated cost of health services ~~Estimated no. of crops varieties available/~~	ARD , PACCMU & Jules Damutalau

Option 4 – Nursery and Screen House

Cost/benefit	**Data required**	**Source of data**
Transport Labour Planting materials Composting materials Timbers/ Trees Garden Tools	Shipping schedules and rates Price of garden tools/equipments/materials Previous projects	Local shipping companies MAL/Shops in Honiara ACOMFS Project
Benefits Increase of crop yield ~~Availability of local foods in the community~~ Reduce spending on imported foods Health improvements (see health assessment reports: OJ) ~~Increase diversity of crops~~ (better able to manage marine resources)	 An estimate of local food produced An est. of no. of households accessing regular local food supply An estimate of a reduce spending on imported food stuff Estimated no. of malnutrition children/ Estimated cost of health services ~~Estimated no. of crops varieties available/~~	ARD , PACCMU & Jules Damutalau

Maintenance of terrestrial resources ~~Reliable access to extension officer for support and information's~~		

Timeline

Action	Date	Responsibility
Situation/problem analysis, including country workshop	End May/early June	PIC PACC Co-coordinator, MAL, MDPAC, PIC economist/technical official, and consultant
Revised CBA work plan	End May/Early June	PIC PACC Co-coordinator, MAL, MDPAC, PIC economist/technical official, and consultant
Data collection	End May/Early June	PIC PACC Co-coordinator, MAL, MDPAC and PIC economist/technical official
Data analysis	End May/Early June	PIC economist/technical official, consultant
Draft CBA report	Mid June	PIC economist/technical official, consultant
Peer Review	Late June	SPREP economist, UNDP consultant
Final CBA report	July	PIC economist/technical official, consultant

Comment [a79]: Casper, can you please include actual names in this section?

Reference List

Solomon Islands PACC Vulnerability and Adaptation (V&A) Assessment Report

Solomon Islands National Food Security, Food Safety, and Nutrition Policy 2010-2015

Solomon Islands Red Cross, The adaptive capacity of Pileni Island community, Viakau Ward, Temotu Province, Solomon Islands

Solomon Islands National Disaster Management Office, Action Plan for Ontong Java

Malaita Provincial Government, Agriculture Sector Assessment Report: Tidal Surge on Ontong Java Atolls

Malaita Provincial Government, Water Sector Assessment Report: Tidal Surge on Ontong Java Atolls

Malaita Provincial Government, Medical Sector Assessment Report: Tidal Surge on Ontong Java Atolls

Malaita Provincial Government, Humanitarian Requirement Report: Lord Howe Atolls Assessment

Solomon Islands Ministry of Environment Conservation and Meteorology (Climate Change Division), Trip Report: Ontong Java Multi-sector team assessing the Beche de Mer ban

Solomon Islands Ministry of Environment Conservation and Meteorology (Climate Change Division), Climate Change Assessment Report on Luaniua and Pelau Islands

Solomon Islands Ministry of Environment Conservation and Meteorology (Climate Change Division), Ontong Java Brief Assessment Report: Climate Change Perspective

TUVALU CBA WORKPLAN: WATER SECTOR PILOT PROJECT

Problem

Quantity of (daily) water supply in Lofeagai is inadequate during end of dry season and drought periods.

Household rainwater tanks are dry for around 120-150 days during a typical year. During these times households must purchase their water from expensive desalination ($13.50/500 liters and $15/1000 liters) and some limited bottled water. Government also rations 2 buckets per day per household to poorer households (78% of community population) during these times. There are long delays and waiting costs for each of these back-up supply options.

Cause(s) of problem

- Population growth and migration from outer islands (driver)
- Economic growth (driver)
- Climate change-related impacts on rainfall
- Climate change-related impacts on sea-level rise/storm surge/salt-water inundation
- Lack of awareness how to manage use of water?

Objective

Increase the Lofeagai community's resilience to drought events.

A more specific objective is to increase supply of potable water during end of dry season and drought periods (estimated at between 4-5 months for a typical year). The long term goal is to provide 50 liters/person/day of back-up supply to all Tuvalu communities. The demonstration projects explore the costs and benefits of increased water supply at a smaller scale. Related goals include:

- Reduce costs of sourcing water
- Reduce time costs of sourcing water (time to travel to pay for desalination)

With and Without Analysis

Baseline – status quo	**Increased desalination supply**	**Community Cistern**	**Household rainwater tanks**	**Solar Filtration**
Costs				
▪ **Imported bottled water purchase** ▪ **Use of expensive**	▪ Capital costs ▪ Consultation costs ▪ Repairs and maintena	▪ Capital costs ▪ Consultation costs ▪ Repairs and maintena	▪ Capital costs ▪ Consultation costs ▪ Repairs and maintenance	▪ Capital Costs ▪ Consultation costs ▪ Fuel (pumping)

desalination plant ▪ **Rations (2 buckets per household per day) provided from Government tanks** ▪ **Costs of water shortages (e.g. time of lining up)**	nce ▪ Fuel costs	nce		
Yield				
▪ **X liters per day**	▪ Increased supply of water	▪ Increased supply of water	▪ Increased supply of water	▪ Increased supply of water

Generating data, valuating costs

Information needed for all options:

- Exchange rate
- Rainfall data (BoM, Tuvalu MET, Pacific Climate Change Science Program (PCCSP))
    - o projected length (number of days) and frequency (return period) of future drought events
    - o Philip Wiles (philipw@sprep.org) is available to help develop these projections.

Options 1& 2

Type	Data	Source
Costs of purchasing bottled water	Quantity of bottles purchased Price per bottle	DCCEE/IUCN water CBA study
Cost of purchasing desalinated water	Want to consider replacement of infrastructure and therefore need to calculate cost of production.	
- **Capital costs of constructing and setting up desalination plant**	Materials (quantity + market price) Equipment Delivery Labour installation Wage rate Useful life of plant/key equipment	PWD (unit at PWD – plumbing division) DCCEE/IUCN water CBA study
- **Repairs and maintenance**	Quantity of materials Price of materials Labour days Wage rate	
- **Fuel costs**	Quantity of fuel used to produce 1 liter of water Price of diesel	

- **Delivery costs** - **Other operating costs**	Market price And any other relevant variable costs.	
Time spent sourcing water during drought	Time spent ordering desalinated water. Wage rate as opportunity cost of time.	Lal et al (2006) Lal, P., Saloa, K. and Uila, L. (2006) 'Economics of liquid waste management in Funafuti, Tuvalu,' Apia, Samoa: SPREP ➔ I would think this is a relatively minor cost. If not available in the above-listed secondary sources, I suggest just describing/listing this cost – don't valuate it.
Travel costs associated with purchasing desalinated water	Fuel costs x Distance Is desalt water delivered by the utility to the household? If so, this cost should be included as a variable cost as listed above (i.e. delivery cost)	Fuel retailers GIS maps (Loia)
During states of emergency costs of accessing rationed water	Time spent Type of transport Costs associated with transport	V&A and SE Assessments HIES Report ➔ If data cannot be sourced from secondary, I suggest just describing/listing this cost – don't valuate it.
To be noted but may not be possible to quantify **Anxiety / stress** **Social unrest** **Physical effort of carrying water**		
Yield	Current usage (option 1) Increased yield to level of option 3 (option 2)	

Comment [d80]: May be able to use same data as that for "During states of emergency costs of accessing water".

Option 3 – community cistern

	Data	Source
Capital costs - **Materials** - **Cement** - **Aggregates** - **Rods** - **Transport costs (to deliver materials to site)** - **Installation costs** - **Consultation costs**	- Market prices adjusted for any significant taxes/subsidies/import tariffs - Lifetime of a concrete cistern 20-25 - Number of labour days - Wage rate - Funds spent on consultation	PWD costing report PACC costs
Maintenance costs - **Materials** - **Labour**	Labour days Wage rage Quantity of materials Market price of materials	PWD costing report Otherwise, get estimate from SOPAC (e.g. 5% of capital costs every year)
Land	Rental value of land since this land cannot be used for something else.	Community (church) signed a lease agreement with landowners
Yield	Rainfall Catchment area	SOPAC Technical assessments already

	Storage	undertaken

Option 4 – additional rainwater tanks for all families (96 families)

	Data	Source
Capital costs - **Water tanks ($1,900)** - **Pipes** - **Fittings** - **Base (concrete)** - **Guttering** - **Taps** - **Roofing (in some cases)** - **Screens** - **Delivery costs** - **Consultation costs** - **Installation costs**	$ per unit of equipment - $1,900 approx per tank Capacity of rainwater tank (10,000 liters) Finances spent on community consultations Labour days Wage rate Height costs (fixed payment for risk of injury)	Supplier quotes PWD Finance PACC costs
Maintenance costs - **Materials** - **Labour**	Quantity of materials Market price of materials Labour days Wage rate	PWD
Land	Rental value of land since this land cannot be used for something else.	Community (church) signed a lease agreement with landowners
Yield	Rainfall Catchment area Storage capacity	SOPAC Technical assessments already undertaken

Comment [a81]: Need to consider large(r) tanks to store water from rainy season for dry season.

Option 5 – Solar Filtration

Get data from Nauru. An assumption must be made that the groundwater supply (quantity and quality) and potential extraction costs are similar to Nauru.

Aggregating costs and benefits

Focus of analysis will be on the provision of water during drought days – when existing household rainwater tanks run dry. In this context, capital and other fixed costs are incurred at start of year 1 but variable costs and yield are only estimated for when existing household rainwater tanks run dry – not every day of the year. The exception is solar filtration. The number of drought days is therefore a critical part of the analysis.

Philip Wiles (philipw@sprep.org) is available to help develop projections on the number of drought days. Incorporating rainfall projections into the CBA will be done using a best-estimate as well as an upper and lower bound range included through sensitivities. Because the probability distribution of future rainfall is not known, a probabilistic approach to incorporating climate change effects on rainfall is not appropriate.

Comment [a82]: Phil to confirm

The analysis period will allow for replacement of existing infrastructure.

A 4% real discount rate will be used.

Computations will include:

- Annual costs (discounted and undiscounted)
- Present value of costs
- If appropriate, a Cost-Effectiveness ratio. The CE ratio is calculated by dividing the PV of cost by the quantity of drinking water (supplied or saved).

Sensitivity Analysis

Key sensitivities include, but are not limited to:

- Length of drought period (number of days)
- Quantity of annual rainfall and subsequent impact on:
  - Yield from community rainwater tank
  - Yield from household rainwater tank
- Useful life of desalination plant
- Useful life of community rainwater tank
- Useful life of household rainwater tank
- Useful life of solar filtration equipment
- Effects of inadequate repairs and maintenance of community and household rainwater tanks on yields
- Parameters of costs of solar desalination from Nauru study

Timeline

Action	Date	Responsibility
Data collection	End January	Tuvalu PACC Co-coordinator, Tuvalu economist
Data analysis	February	Tuvalu economist, GIZ Economic Adviser (support role)
Draft CBA report	Early March	Tuvalu economist, Tuvalu PACC Co-coordinator, GIZ Economic Adviser
Peer Review	Late March	PACC economist, UNDP consultant
Final CBA report	April	Tuvalu economist, Tuvalu PACC Co-coordinator, GIZ Economic Adviser (support role)
Endorsement by SC	April	PACC
Submit CBA report (along with project brief) to Cabinet?	May	Tuvalu PACC Co-coordinator, Tuvalu economist

VANUATU CBA WORKPLAN: COASTAL SECTOR PILOT PROJECT

Through the process of developing this work plan for a CBA, it was found more background work is required to adequately understand the coastal problem(s) on Epi Island. This is necessary to ensure the project objective is correctly defined and to confirm identified project options are appropriate.

As such, this work plan is for a broader Pre-Feasibility Assessment, rather than this detailed this assignment is to assist Vanuatu Government officials to identify key elements of the Vanuatu PACC project on climate proofing of the road in Epi, and develop a project design for implementation. This additional work is warranted given the large infrastructure investment potentially required for this project, which is beyond a pilot/demonstration project. [5]

The work plan follows the same format as the CBA work plans used for other PACC CBA's but includes comments to guide where further work is required. It also includes a timeline of work activities to be completed. Key activities are:

- A Situation Analysis comprising (I) projected climate scenarios and expected effects (ii) stakeholder analysis, (iii) risk analysis (problem analysis), and (iii) adaptation option analysis. This should build on the work that has already been done and use tools already developed (e.g. Vanuatu Clim as relevant)
- a revised CBA work plan for preliminary CBA of adaptation options to help select a preferred adaption measure
- a preliminary CBA of adaptation options to help select a preferred adaption measure
- a draft pre-feasibility assessment report; and
- A final pre-feasibility assessment report.

The Pre-Feasibility Assessment report is not intended to be extensive - 10 to 15 pages, excluding annexes.

Please note, the following work plan has been developed with a limited understanding of the climate hazards on Epi Island and the vulnerability of the community to these hazards. As outlined above, this work plan is to be revised following completion of the Situation Analysis.

Problem

Increasing damage to road infrastructure on Epi Island; this is increasing maintenance and repair costs. It is also interrupting road use and causing related losses. E.g.:

- limited access to markets
- limited access to health, education, and social services.

Comment [a83]: what is the frequency and duration of interruptions and how is this changing over time?

how many people experience each of the mentioned access interruptions and what are the implications/impacts of this lack of access (e.g. poorer health outcomes, lower levels of education for certain villages, decreasing incomes from food sales)? what is the magnitude of these impacts? is this significant?

what is the socio-economic status of individuals/communities in the project area? is there a traditional cultural/social system? if so, how strong is it? are low-income people or select cohorts more severely impacted by road access interruptions than other groups?

what is the cost of repairs and maintenance and to what extent is this increasing over time? why is it increasing - increasing damages or increasing costs of inputs or both?

Comment [a84]: what are the needs and aspirations of community members?

[5] The cost of the proposed climate proofing road infrastructure project is likely to be substantial. However, it appears that there is little point in retro-fitting one section of the road if interruptions will still persist due to damages to other sections. So this assessment will look at the entire Epi road. PACC funds are only available to potentially fund a (small) part of the road project.

Cause(s) of problem

Climate change related causes:

The main climate change related causes pertain to:

- potentially increasing incidence of extreme rainfall events; and
- potentially increasing storm surge events relating to increased cyclone and sea-level rise.
- limited knowledge of potential climate change impacts and adaption measures

Other causes and drivers

Other causes and drivers of the observed road degradation problem include:

- coastal deforestation (environmental externality)
- population growth (driver)
- sand/coral mining (environmental externality)
- limited resources for infrastructure maintenance (partly relating to public good characteristics of roads)
- no proper settlement planning ?
- land disputes?

Comment [a85]: we need to detail the historical frequency and magnitude of these events. we also need to describe how this may change with climate change. refer to VanuatuClim and/or PACCSAP for this information. speak to Vanuatu MET office about this.

further, we need to describe in detail the mechanism for how these climate events cause damage to road infrastructure. the particular geographical/topographical characteristics of Epi Island should be part of this description.

Comment [a86]: each of the listed causes and drivers need to be assessed and properly understood. this should be done as part of the problem analysis component of the Situation Analysis.

Comment [a87]: What are the characteristics of the resource tenure system(s)? does this contribute to observed lack of maintenance?

Objective

Increase the resilience of coastal road infrastructure to extreme rainfall and storm surge events.

More specifically, the objective of the Vanuatu PACC coastal project is to:

- reduced road interruptions to all sections of the coastal road to less than x days per year (alternatively, this can be described in terms of increasing resilience of road infrastructure to withstand a 1 in x year rainfall event and a 1 in x year storm surge event).

Comment [a88]: this will be informed by the Objectives Analysis component of the Situation Analysis.

Options

At this stage, broad project options have been identified only. There may be some options within these options as well as grouping of different options. This will be developed as part of the Pre-Feasibility Assessment.

Nonetheless, for the purposes of guiding future work activities, it is still useful to describe these broad options and identify what information is required to appraise these types of options.

The 4 broad options are:

1. Climate proofing existing roads. These are engineering measures to increase resilience to both extreme rainfall events and storm surge. They do not include protection measures to construct a sea-wall or plant mangroves.
2. Relocation of certain sections of road

3. Protection of existing roads by constructing seawall
4. Protection of existing roads by planting/protecting mangroves

With and Without Analysis

Without the project, the observed problems mentioned above are expected to worsen. That is:

- increasing road repair and maintenance costs
- increasing losses of food sales and other incomes (e.g. tourism)
- lower health outcomes
- lower education levels

Once these problems/impacts reach a certain level, it is expected that communities will relocate to other parts of Vanuatu. This will require substantial resources to do and will also generate a number of social costs.

Comment [a89]: what is this level? how likely is it that this level will be reached? when is this level expected to be reached?

The below table lists these expected outcomes for the without project scenario. Taking the without-project as the reference, the table also lists the costs and benefits related to each identified project option.

Without project - baseline	Climate proofing existing roads	Relocation of road	Seawall building (hard coastal protection)	Coastal vegetation planting
Damage:	Costs			
• **Increasing repair and maintenance cost of existing road infrastructure** **Losses:** • **Income loss due to limited access to markets**	• Capital costs (building material, tools and equipment) • Transport of materials, equipment and tools • Equipment operation (hire, fuel, maintenance) • Labour	• Capital costs (building material, tools and equipment) • Transport of materials, equipment and tools • Equipment operation (hire, fuel, maintenance)	• Capital costs (building material, tools and equipment) • Transport of materials, equipment and tools • Equipment operation (hire, fuel, maintenance)	• Capital costs (planting material, tools, nursery supply) • Labour • Transportation of planting materials and tools • Consultations and data collection (meetings, travel,

(primarily food markets) and economic activities such as tourism • **Increasing health costs and impacts due to lack of access to health services and facilities** • **Social costs associated with limited access to education services and facilities**	• Consultations and data collection (meetings, travel, expert fees) • Technical assessments and design (meetings, travel, expert fees) • Infrastructure maintenance	• Labour • Consultations and data collection (meetings, travel, expert fees) • Technical assessments and design (meetings, travel, expert fees) • Infrastructure maintenance • Associated relocation cost of buildings and some public facilities	• Labour • Consultations and data collection (meetings, travel, expert fees) • Technical assessments and design (meetings, travel, expert fees) • Infrastructure maintenance	expert fees) • Technical assessments and design (meetings, travel, expert fees)
Relocation costs	Benefits			
	• Avoid repair and maintenance cost of existing infrastructure • Avoid loss of income due to limited access to markets and economic activities • Avoid costs associated to lack of access to health services and facilities • Avoid social costs associated to limited access to education services and facilities • Avoided relocation costs	• Avoid repair and maintenance cost of existing infrastructure • Avoid loss of income due to limited access to markets and economic activities • Avoid costs associated to lack of access to health services and facilities • Avoid social costs associated to limited access to education services and facilities • Avoided relocation costs	• Avoid repair and maintenance cost of existing infrastructure • Avoid loss of income due to limited access to markets and economic activities • Avoid costs associated to lack of access to health services and facilities • Avoid social costs associated to limited access to education services and facilities • Avoided relocation costs	• Avoid repair and maintenance cost of existing infrastructure • Avoid loss of income due to limited access to markets and economic activities • Avoid costs associated to lack of access to health services and facilities • Avoid social costs associated to limited access to education services and facilities • Avoided relocation costs

Measuring costs and benefits

This section details the data required and the source of data for each of the costs and benefits identified in the 'with and without' analysis above.

This is done as a table for each project option, starting with the without project scenario.

This section is not complete (and may be inaccurate in parts) and will need to be amended/updated and populated as part of the revised work plan.

Without Project/status quo

	Data required	Source of data
Increasing repair and maintenance cost of existing road infrastructure	-Equip hire (grater, loader, digger, roller, dump truck)	PACC Coordinator, PACC Office, PWD
	-Days and price/day	PWD
	-Materials (gravel, sand, rocks, water, cement, timber)	PWD
	-Price	PWD, Hardware
	-Labor	
	Days and Wage rate	PWD/labor office
	-Transport (Ship)	
	Price/Charter	
Income loss due to limited access to markets and economic activities such as tourism	Forecasted number of days per year with interrupted access	
	Lost revenue (price x quantity) per day for each main good. that is:	
	• Unsold vegetables (Tomatoes, cabbage, carrots)	Community/Shefa market
	Price/ item	
	• Unsold crops(Taro, Yam, Cassava,)	Community/Shefa Market
	Price/item	Community/Shefa Market
	• Nuts (peanuts, coconuts)	Community/Shefa market
	Price/bundle	
	• Fruits (oranges, mangoes, pineapple, breadfruit)	Community/Shefa market
	Price/item	
	• Art and Craft	

Comment [a90]: need to factor in how damage may change over time with increasing incidence of extreme rainfall events and storm surge.

need to also factor in development deficit. that is, roads have historically not been properly maintained such that roads are now sig degraded.

	Price/item	
Increasing health costs and impacts due to lack of access to health services and facilities	-Transport cost Price/person x number of persons	Shefa Province
	-Increase in no. of sick patients (it will be very difficult to quantitatively attribute increase incidence of sick patients to lack of access to health services caused by road. probably the best we can do is qualitatively discuss)	Provincial Health center
Social costs associated with limited access to education services and facilities	Poor literacy rate	-Provincial education office
	Increase crime(theft)	Provincial Police center
	Teenage Pregnancy	Provincial Health Center
Relocation costs		

Comment [a91]: it will be very difficult to quantitatively attribute decreasing literacy rates etc to lack of access to education services caused by road. prob best we can do is qualitatively discuss

Comment [a92]: need to break down this cost into its various components

Climate Proofing Existing Road

Cost/benefit	Data required	Source of data
Capital costs (building material, tools and equipment)	-Equip hire (grater, loader, digger, roller, dump truck) Days and price/day	PACC Coordinator, PACC Office, PWD
	-Materials (gravel, sand, rocks, water, cement, timber) Price	PACC Coordinator, PACC office, PWD
Transport of materials, equipment and tools	Ship charter Price/charter	PWD
Equipment operation (hire, fuel, maintenance)	-Hire Price/charter	PWD
	-Fuel Price/liter	PWD
	-Maintenance Operation ratio	PWD
Labor	-Labor Days &Wage rate	PWD, Labor office

Consultations and data collection (meetings, travel, expert fees)	Travel Per diem, accommodation Expert fees Day & wage rate	PWD PWD
Technical assessments and design (meetings, travel, expert fees)	Travel cost Per diem Expert fees Day & wage rate	PWD PWD
Infrastructure maintenance	-Equip hire (tractor, Backhoe, dump truck) -Days and price/day -Materials (gravel, sand, rocks, water, cement, timber) -Price -Labor Days and Wage rat -Transport (Ship) Price/Charter	PWD PWD PWD PWD
Avoid maintenance cost of existing infrastructure	Equip hire (grater, loader, digger, roller, dump truck) -Days and price/day -Materials (gravel, sand, rocks, water, cement, timber) -Price -Labor Days and Wage rate -Transport (Ship) Price/Charter	PACC Coordinator, PACC Office, PWD PWD PWD PWD, Hardware PWD/labor office PWD
Avoid loss of income due to limited access to markets and economic activities	Unsold vegetables (Tomatoes, cabbage, carrots) Price/ item Unsold crops(Taro, Yam, Cassava,) Price/item Nuts (peanuts, coconuts) Price/bundle Fruits (oranges, mangoes, pineapple, breadfruit)	Community/Shefa market Community/Shefa Market Community/Shefa Market Community/Shefa market

Avoid costs associated to lack of access to health services and facilities	Transport cost Price/person	Shefa Province
	-Increase in no. of sick patients	Provincial Health center
Avoid social costs associated to limited access to education services and facilities	Poor literacy rate	Provincial education office
	Increase crime(theft)	Provincial Police center
	Teenage Pregnancy	Provincial Health Center
Avoided relocation costs		

Aggregating costs and benefits

Since Palau Government does not prescribe a discount rate in its assessment of Government projects, use 4% discount rate.

Analysis should account for different expected useful life of each project option. Preferred way to do this is to extend the timeframe of the analysis out many years.

Calculate NPV. Also calculate B/C ratios.

Sensitivity Analysis

This part of the work plan has not yet been completed.

The revised work plan should list key parameters (e.g. frequency of extreme rainfall event, frequency of storm surge event) for which there is a significant amount of uncertainty.

It should also describe how these uncertainties will be tested through a sensitivity analysis. E.g. detail upper and lower bound values (frequencies) of hazard events based on VanuatuClim.

Equity and Distributional Implications

This part of the work plan has not yet been completed.

The revised work plan should identify which stakeholder groups will incur costs and which stakeholder groups will accrue benefits for each project option. The revised work plan should also comment/assess whether these distributional effects will cause political issues that may threaten the successful implementation of the project.

Timeline

Action	Date	Responsibility
Situation Analysis	April	PACC coordinator (Willie Watson),

		Jerryson Lapi (Infrastructure Policy Analyst, Office of the Prime Minister), x (civil engineer), x (local rural development planner), and x (NDMO/ NACCC/ Planning). guided and supported by consultant
Revised CBA Work plan	Early May	PACC Co-coordinator (Willie Watson), Jerryson Lapi (Infrastructure Policy Analyst, Office of the Prime Minister), x (civil engineer), x (local rural development planner), and x (NDMO/ NACCC/ Planning). guided and supported by consultant
Review of revised CBA Work plan	mid May	SPREP economist
Data collection	May - June	PACC Co-coordinator (Willie Watson), Jerryson Lapi (Infrastructure Policy Analyst, Office of the Prime Minister),
Data analysis	Early July	PACC Co-coordinator (Willie Watson), Jerryson Lapi (Infrastructure Policy Analyst, Office of the Prime Minister), x (civil engineer) guided and supported by consultant
Draft Pre-Feasibility Assessment report	Early August	PACC Co-coordinator (Willie Watson), Jerryson Lapi (Infrastructure Policy Analyst, Office of the Prime Minister), x (civil engineer), x (local rural development planner), and x (NDMO/ NACCC/ Planning). guided and supported by consultant
Review of Draft Pre-Feasibility Assessment report	Mid August	SPREP economist
Final Pre-Feasibility Assessment report	End August	PACC Co-coordinator (Willie Watson), Jerryson Lapi (Infrastructure Policy Analyst, Office of the Prime Minister), x (civil engineer), x (local rural development planner), and x (NDMO/ NACCC/ Planning). guided and supported by consultant
Endorsement by SC	September	NACCC
Submit Pre-Feasibility Assessment report (along with project brief) to Cabinet?	October	PACC Co-coordinator (Willie Watson), Jerryson Lapi (Infrastructure Policy Analyst, Office of the Prime Minister),

Comment [a93]: Willie, we need a couple of other country people to be part of the Vanuatu country team. For the Situation Analysis, we need a NDMO/NACCC/Planning official (mostly to help with situation analysis) as well as a local development planner. We also need a civil engineer.

Can you please provide names and position?