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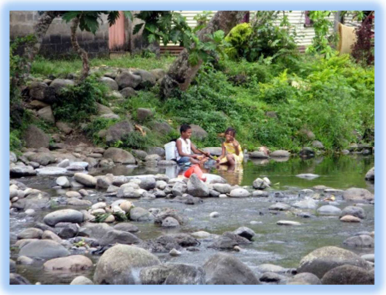

Rapid Vulnerability and Adaptation Assessment of Communities in Taveuni & Yanuca, Cakaudrove Province, Fiji

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Table of Contents

Executive Summary

A rapid vulnerability and adaptation (V&A) assessment was carried by a team of four staff and two Masters Students in Health from the Pacific Centre for Environment and Sustainable Development (PACE-SD), the University of the South Pacific (USP), from the 23rd to the 31st of October 2011. Three priority villages consisting of six sites were identified by the Roko Tui of Cakaudrove Province and visits were made to Naselesele and Qeleni villages in Taveuni, and Yanuca Island located about one an hour boat trip from Taveuni.

The main objectives were to (i) assess the level of vulnerability of the sites identified, (ii) assess the level of community perception on climate change, (iii) assess the coast, water supply, health and sanitation, and (iv) gain traditional knowledge on techniques for food preservation and security.

All of the sites were assessed as moderately vulnerable, with the main issues being coastal erosion (6 sites), flooding (1 site) and water availability and supply (3 sites). Naisogo Point and Vunitarawau sites on Taveuni had the most severe cases of erosion, while Qeleni Village was prone to frequent flooding and had the most problem with clean water availability.

The quality of water was best at Naselesele village (spring and tap water on par with the mineral water control), while the water catchment and spring at Yanuca Island was found to be unfit for consumption with high sediment loads. However poor watershed management practices, including farming and animal husbandry uphill from water catchments were major issues leading to poor water quality.

Qeleni village had the highest population, with 425 persons in 75 households, followed by Naselesele with 370 people in 58 households, while Yanuca Island had only a population of 115 persons distributed in 19 households.

Sanitation practices varied among the three villages with poor management of liquid wastes in all villages, as well as indiscriminate dumping of rubbish in the sea. Management of human waste and personal hygiene was influenced by the availability of sufficient water supply, and fared the worst at Qeleni village. The highest incidences of childhood diseases were trachoma and sores, followed by ringworm infections. Only one incidence of scabies was noted. There was a direct inverse correlation between water availability and the incidence of hygiene-related diseases in children.

Three species of mangroves were seen on Taveuni (*Rhizophora samoensis, Rhizophora stylosa and Bruguiera gymnorhiza*) and none on Yanuca. Very severe erosion at Vunitarawau near Qeleni displaced *Rhizophora* populations and brought *Bruguiera* populations to the forefront on the mudflats. Accretion of sand some distance from eroding sites was seen to affect seagrass beds which were smothered by sediments. Four species of seagrass were found in Taveuni and Yanuca (*Halophila ovalis, Halodule uninervis, Halodule pinifolia* and *Syringodium isoetifolium*). Seagrass beds in Naselesele had a rich biodiversity of invertebrates, with a notable absence of holothurians which were overfished for commercial purposes. A total of 35 species of marine algae were found at the Taveuni sites and 11 in Yanuca Island. Naselesele had the highest number of species, attributed to the still relatively healthy seagrass bed communities. Vunitarawai had the least number of species, associated with a state of severe coastal erosion. Red and Green algae were more abundant than brown algae, with a high incidence of green indicator algae species (*Boodlea composita, Ulva* spp.) at polluted sites.

The three villages visited in this study had a good appreciation and wish to learn about the impacts of climate change, and were willing to take adaptive measures to protect their communities and livelihoods.

1. Introduction

1.1. Background to the EU-GCCA Project

The Pacific Centre for Environment and Sustainable Development (PACE-SD), USP has been awarded funding from the European Union (EU) Global Climate Change Alliance (GCCA) for addressing climate change adaptation (CCA) in the Pacific. This initiative was established in 2007 by the European Commission with the intention to deepen dialogue and cooperation on climate change between the European Union and poorer developing countries which are most vulnerable to climate change, in particular Least Developed Countries (LDCs) and Small Island Developing States (SIDS). These countries are hardest hit by the adverse effects of climate change while they have the least capacity to react and adapt to those climate impacts. The Pacific component of the Intra-African Caribbean Pacific (PACP) project supports 15 Pacific Island Countries which are Fiji, the Solomon Islands, Vanuatu, Papua New Guinea, Tonga, the Cook Islands, Samoa, Niue, Nauru, Kiribati, Tuvalu, the Marshall Islands, Palau, the Federated States of Micronesia and East Timor. The main focal points of this project are: (i) Capacity building, (ii) Community engagement and adaptive actions, and (iii) Applied research (PACE-SD, 2011).

1.2. Description of the action

The initial rapid V&A assessment was carried out by a team of four staff and two Masters Students from PACE-SD from 23rd to 31st October 2011. The Masters students (both Health Officers) conducted research on the effects of climate change on scabies and dengue fever.

The sites visited were three villages in the Cakaudrove Province, with two sites on mainland Taveuni. These sites were Naselesele and Qeleni villages while Yanuca village is located on Yanuca Island about one an hour boat trip from Matei in Taveuni. These sites were identified by the Roko Tui of the Cakaudrove Provincial Office as the three priority vulnerable sites.

The main objectives of this assessment were to (i) assess the level of vulnerability of the sites identified, (ii) assess the level of community perception on climate change, (iii) assess the coast, water supply, health and sanitation, and (iv) gain traditional knowledge on techniques for food preservation and security.

2. Site Descriptions

Taveuni is the third largest volcanic island within the Fiji group and is known as the "Garden Island of Fiji". It is located at 16.82° Lat. S and 179.97° Long. W and has an approximate land area of 435 km^2, being 42 km long and 10.2 km wide (Nature Fiji, 2009). It is a high volcanic island of young geological age, with very fertile soils (Denis & Brookfield, 1983). The main attractions on the island are the International Dateline, numerous waterfalls and springs, forests and marine parks. The main sources of income are taro, yaqona, copra and tourism on a small scale. It has a Government hospital located in Waiyevo with a health center at Bouma, and a Government agriculture research station at Mua. The airstrip is located at Matei, while the jetty for ferries is at Waiyevo.

There are four *Tikinas* (Districts) in Taveuni: Cakaudrove i Wai, Wainikeli, Laucala and Vuna (Figure 1). There are a total of 23 registered villages, 18 primary and three secondary schools within these districts. The total roll for these schools is 4475 students. The main means of accessibility to schools are via public bus, on foot or by carriers (Roko Tui Cakaudrove, *pers. com.*).

The main sources of electricity are village and personal generators, with a limited number of houses powered by solar energy. Drinking water is provided by the Water Authority of Fiji to the Matei Community and Naselesele villages, while other villages depend on rainwater, rivers/creeks and springs for water. The water source and reservoirs for the water reticulation system are located in Mua and stored at Naselesele before being distributed to the villages.

Brief descriptions of sites visited for the rapid V&A are given in Table 1 and hereafter.

Table 1. GPS Position of Sites investigated in the Taveuni & Yanuca CCA Assessment

Locality	Site	Lat. (S)	Long. (W)	Elevation (m)*	Remarks
TAVEUNI	Naisogo Point	16.69987	179.86530	+01	
TAVEUNI	Naselesele Village	16.69728	179.86737	+02	
TAVEUNI	Naselesele Borehole	16.70483	179.87.497	+75	
TAVEUNI	Qeleni River	16.75786	179.85.837	+05	
TAVEUNI	Qeleni Spring	16.75990	179.85921	+15	
TAVEUNI	Qeleni Village	16.75902	179.85910	+19	
TAVEUNI	Qeleni Lower Falls	16.75856	179.86192	+03	
TAVEUNI	Vunitarawau	16.74774	179.86157	+05	Erosion
TAVEUNI	Waiyevo - Dateline	16.79614	179.99960	+30	East of DL
YANUCA	Yanuca Village	16.50234	179.69157	+01	East of DL
YANUCA	Yanuca Borehole	16.50160	179.69244	+26	East of DL
YANUCA	Yanuca Pig Sty	16.50109	179.69266	+30	East of DL
YANUCA	Qilo Primary School	16.49742	179.69647	+02	East of DL
YANUCA	Yanuca Spring	16.50091	179.69281	+24	East of DL

* *GPS elevation data is subject to local variation*

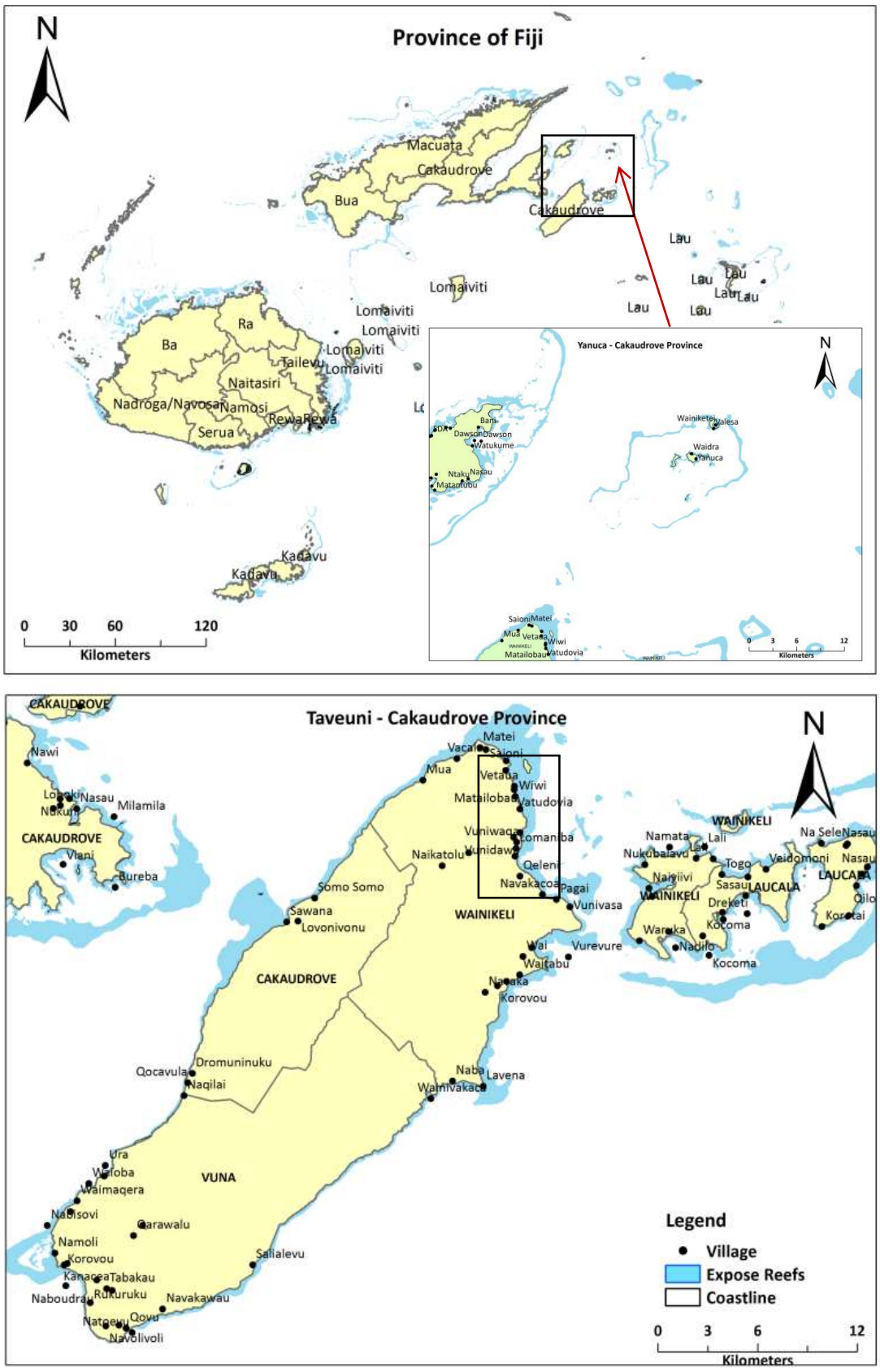


Figure 1. Map of the study area, showing the districts of Taveuni (bottom) and Yanuca (inset, top)

2.1. Naisogo Point

This point, located at 16.69987°S and 179.86530°W is one of the sites most severely affected by coastal erosion, especially since category4 tropical Cyclone Tomas battered northern Fiji with 200-250 km/h winds in mid-March 2010. Destructive storm surges from this event are reported by the local communities to have initiated much of the erosion taking place at Naisogo Point. The coastal road, reclaimed over swampy ground, passes close to this area and is under direct threat from being washed away by king tides and storm events. The Google Earth satellite picture to the left is from 2005, prior to Cyclone Tomas damage, and the coastline does not seem to differ much from an earlier satellite photo taken in 2003. No more recent satellite picture of the area is available at this time.

2.2. Naselesele Village

This village is located at 16.69728°S and 179.86737°W with an elevation of two meters. There are 49 households with 370 people. The main source of income is planting taro and yaqona. Naselesele Primary School has a roll of 122 students, with classes from pre-school to class eight. The water supply is managed by the Water Authority of Fiji (WAF) and is stored in concrete tanks about 20 km from the village. The supply of electricity is through the village generator. This village has numerous springs, however *Naqarakalou* spring is used for bathing, washing and drinking. This spring is located on a creek that leads to the sea and is submerged during high tide. This spring also provides watercress (*ota karesi*) as a source of vegetable to the villagers. The Wiwi settlement is a major part of this village.

2.3. Qeleni Village

Qeleni Village is located at 16.75902°S and 179.85910°W with an elevation of 19 meters in the middle of the village. However, the majority of households are located at an elevation of approximately two meters. The village has 75 households, with a population of 425 people

with eight nearby settlements bringing the total population to 600 people. The two major settlements are Vunitarawau and Vunidawa. The village has a dispensary, a district school and an agriculture export program. The main sources of income are taro, yaqona, prawns and crustaceans. The village generator is the main source of electricity, while the school is powered through an EU-funded solar energy system. Wainikeli District School has a roll of 236 students, with nine teachers from classes one to eight.

2.4. Vunitarawau

Vunitarawau is a settlement north of Qeleni village, and is located at 16.74774°S and 179.86157° W. There is a natural spring near the shore, which several families use for drinking water. This site has been heavily affected by the building of the nearby Laucala Island jetty, used to ferry staff and goods between the resort and Taveuni. The heavily eroded coastline has remnants of *Bruguiera* mangrove stands. It still is an important fishing ground for nearby villages.

2.5. Yanuca Island and Village

Yanuca Island, part of the Ringgold Islands, has only one village, Yanuca Village, located at 16.50234°S and 179.69157°E. The land mass is very limited, with volcanic mountains in the background, and a still relatively pristine natural environment with many white sandy beaches. There are 19 households with 115 people living in this village. The main sources of income are fishing and bêche-de-mer. The sources of electricity are individual generators and solar panels. The main source of water is rainwater, while groundwater and shallow springs supplement for washing and bathing. The borehole system powered by solar energy was damaged during Cyclone Tomas in 2010.

Qilo Primary School is located some distance from the main village, and has three teachers, with a roll of 26 students from classes one to three. This school has combined classes of one and two, three and four, and five and six. The water source for this school is from a spring and rainwater catchments. All supplies and transport of people to and from the island is done by small open boats. Surrounding islets are uninhabited, but are used by Yanuca villagers for goat pastures, logging and fishing. Interestingly, this island is not catalogued on Google Earth and the only form of tourism is a weekly visit by the *Tui Tai Adventure Cruise.*

3. Methodology

The V&A was conducted using the PACE-SD rapid assessment technique (Limalevu, pers. com.). This assessment targeted coastal and inland waters (where applicable), water availability and supply, household and population structure and health and sanitation aspects in three villages. After the customary protocol or *sevusevu*, the PACE-SD team introduced themselves to the communities and explained the purpose of the assessment.

3.1. Community awareness methods

The communities were divided in three focal groups (men, women and youths) to collate information about the communities' perception of climate change, how communities prepare themselves for cyclones (especially for food security; traditional knowledge), observed changes in the environment such as invasive species, loss of certain important plants or animals and changes to shoreline and coast, and the main and alternative sources of income. A head count and photographs of the participants were also taken.

The focal groups presented their findings to the whole community, followed by presentations from the PACE-SD team about climate change issues and awareness, impact on the marine environment, effects of deforestation and impact on watersheds, health and sanitation issues. The findings of the rapid V&A assessment with adaptation recommendations were also presented to the communities. A general discussion with the communities about climate change and general environmental issues followed, and interviews done with village elders on traditional knowledge (TK). The translated results of these exercises are given in Appendices 1 and 2.

3.2. Water quality assessment methods

Water samples were taken from all village springs, rivers and boreholes of the sites investigated. Standard Hydrogen Sulfide (H_2S) ready-made test tubes (obtained from the Institute of Applied Sciences, The University of the South Pacific) were used to do qualitative tests for the water quality, using mineral water (*Fiji® Natural Artesian Water*) as a control. The test samples were left for a maximum period of 72 hours, during which time the change in color of the water indicated the level of contamination (no color change: water is safe to consume; light milky to grayish in color: water shows signs of contamination and is unsafe to consume; black in color: water is contaminated and unfit for consumption).

3.3. Health and sanitation survey methods

The assessment of health and sanitation was conducted by two Health Inspectors from the Ministry of Health, currently Masters students with PACE-SD, USP. Detailed household and

population structures were noted at each community visited. Key informants (village health workers, village headman, clan leaders, and health inspectors) as well as family members and village nurses were interviewed from the three villages. School health records were also consulted where available. Particular attention was made to solid, liquid and human waste disposal, hygiene habits, prevalent diseases, presence of mosquitoes and flies, cooking and washing methods, etc.

3.4. Coastal marine environment assessment methods

The marine environment was inspected by walking transects, and the distribution of the main marine plant and animal species were noted, and where necessary these were collected for identification. Particular attention was made to signs of pollution, sedimentation, invasive species and the general health of the ecosystem was assessed. Voucher specimens of the common marine plants (seagrass and algae) were collected, dried in the field using a standard herbarium press and later fully identified and deposited in the South Pacific Regional Herbarium Marine Collections as reference material. Photographic collections were made of marine invertebrates and mollusks. Mangrove species encountered were noted for abundance and distribution, identified and photographed.

Community awareness exercises at Naselele and Qeleni villages. Assessing the villagers' perception of climate change (top and lower left photos) and presenting them with factual knowledge (lower right)

4. Results

The rapid assessment of V&A for Taveuni included coastal, inland waters, domestic water availability and supply, and health and sanitation. This assessment also looked at the number of households, the population structure as well as health and sanitation.

The level of vulnerabilities assessed is summarized in Table 2 below for Naselesele, Qeleni and Yanuca villages. Specific issues developed from these are discussed more in detail in Section 5.

Table 2. Levels of vulnerability for sites assessed in this study

Village	Site	Sectors Assessed	Level of Vulnerability	Recommended Adaptation(s)
Naselesele	Naisogo Point	Coastal, inland waters, domestic water availability and supply	2 (moderate)	• Mangrove replanting • Replant shore plants • Proper drainage • Reforestation • Relocation of road
	Navasa Point	Coastal	2	• Mangrove replanting • Relocation of road
	Sunrise Beach	Coastal	2	• Replant shore plants
Qeleni	Qeleni Village	Coastal, inland water, domestic water availability and supply	2	• Need proper infrastructure for water supply • Reforestation • Coastal engineers assessment on current movement on the effect of Laucala Jetty
	Vunitarawau	Coastal	2	• Mangrove replanting • Replant shore plants • Coastal engineers' assessment on current pattern and movement
	Vunidawa	Coastal	2	• Mangrove replanting • Replant shore plants • Coastal engineers' assessment on current pattern and movement
Yanuca	Yanuca Village	Coastal, inland waters, domestic water availability and supply	2	• Replant shore plants • Secure water source • Need proper infrastructure for water supply from springs and borehole

5. Issues

5.1. Coastal Erosion

5.1.1. Naselesele Village

The sites assessed for this village included Naselesele village and nearby areas, mainly Naisogo Point, Sunrise Beach and Navasa Point. These sites are in the same *mataqali* (land owning unit) as Naselesele village. The village is not affected by coastal erosion as the road is built on reclaimed land some five meters above sea-level, being supported seaward by rock boulders. However, during heavy rainfall the village grounds flood at rising and high tides through the culvert linking the shore to the ground. This was obvious from the raising of the village power junction box by 30 cm and the observation of sand near the culvert mouth facing the village. Accretion of sand eroded from Naisogo Point was evident on the mudflats facing the village, altering the natural coastal ecosystem and in some places smothering seagrass beds. These issues are discussed further in this report.

Photos of Naselesele Village, showing the seawall (top), culvert across the main coastal road (lower right) and elevated power junction box (lower right)

5.1.2. Naisogo Point

Coastal erosion was observed at Naisogo Point, caused by the intensity of Cyclone Tomas in 2010. It was observed that the shore has eroded some 30 meters, and during high tide seawater now reaches the road. The road was built in colonial time on back shore swampy ground, which is subsiding due to heavy traffic. It was also observed that much of the sand eroded from this point is accreting with ripple marks on the mudflats in front of Naselesele village. South-east trade winds are the prevailing wind pattern for this village and Navasa Point. A similar issue was identified at Navasa Point, where the road is built on back shore area and is also subsiding.

The back shore area for Naisogo and Navasa Points was characterized by plants specific to this ecosystem, such as mangroves and pandanus. According to the *Turaga ni Koro*, the mangrove species *Rhizophora samoensis* (Tiriwai) has regrown naturally at Naisogo Point after 15 years which is indicative of replanting this species for adaptation. However study on current patterns would be helpful in understanding the dynamics of sand movement.

Coastal erosion at Naisogo Point, close to Naselesele Village. Clockwise from top: fallen coconut trees showing former level of sandy coastline; the area at high tide, showing proximity to the coastal road which is now at sea-level; coastal tree (Sinu Dina, Excoecaria agallocha*) with exposed roots attesting to the level of the sandy beach at the site prior to cyclone Tomas in 2010.*

5.1.3. Qeleni Village

Qeleni village and two nearby sites were assessed for vulnerability to coastal erosion. Vunitarawau and Vunidawa are points that border the main shoreline of Qeleni village. The *mataqali* of Qeleni own these areas, except the foreshore of Qeleni Village which is owned by the *mataqali* from Somosomo. The village is not affected by coastal erosion as it is located approximately 500 meters from the shore. However, the lower part of the village is affected by flooding from Qeleni River during heavy rains. As a result the water supply to the village is disrupted as the infrastructure washes away during flooding. This has resulted in poor sanitation and dependence on the river for bathing and washing, and springs for drinking water. The flooding situation in lower Qeleni Village is further aggravated by the fact that the village lies in between two relatively shallow rivers. In 2008, a jetty was built to accommodate the movement of staff and goods transiting to the Laucala Island exclusive resort. Local residents were very vocal about this jetty development as no Environmental Impact Assessment (EIA) was done prior to the development. As a result, most coastal timber has been logged and caused severe damage to the village foreshore.

EU-funded solar panels at Qeleni Village

Qeleni Village and bridge (left) and low-lying areas close to the river (right)

5.1.4. Vunitarawau

According to the *Turaga ni Koro* of Qeleni village, the issue of coastal erosion between Vunitarawau to Vunidawa Points has been aggravated by the development of the Laucala Island Jetty in 2008. This issue worsened with the intensity of Cyclone Tomas in 2010. The shore has eroded some 30 meters and the mangrove species *Bruguiera gymnorhiza* (Dogo) was evident growing on the mudflats with isolated remnants of a peat bog on the beach, along with exposed fossil reef and the stumps of fallen coconut trees some 10 meters out on the mudflats. The prevailing winds at these points are the south-east trade winds. The extreme severity of the erosion at this site could not only be due to the effect of the cyclone, but also to the continuous effect of the recently built jetty further down, which altered the current circulation patterns along the coastline. Past aerial images of this area need to be studied to compare the effects of this development prior to the cyclone.

Extensive coastal erosion at Vunitarawau site (top left & right), presumably caused by the unrestricted construction of the Laucala Island Jetty in 2008 (lower right). Note the presence of Bruguiera gymnorhiza *trees on the beach and mudflats (top left); this species normally occurs in the backshore area and attests to the extensive erosion that took place at this site. Fallen coconut tree stumps can also be seen up to 10 meters out on the mudflats, as well as peat and exposed fossil reefs.*

5.1.5. Yanuca Village

According to local inhabitants, coastal erosion in Yanuca Village has not been evident prior to the intensity of Cyclone Tomas in 2010. As a result this village has proactively built a seawall to protect their shore at a cost of FJD 10,000.00. Relocation within Yanuca itself is not an option, as the only available land for the village location is approximately 100 meters from the shore. Beyond this is the rocky central hill range of the island. While the concrete seawall was not completed at the time of our visit, cracks were already apparent in some sections. Having used stones might have been better in the long run. Some coastal erosion was seen in outlying parts of the village; however the roots of Alexandrian Laurel (*Calophyllum inophyllum, Dilo*) and Ironwood (*Casuarina equisetifolia, Nokonoko*) trees were seen to be quite efficient in retaining soil with their networked roots mitigating the effects of wave action.

Two very severe cyclones, Amy in 2003 and Tomas in 2010, washed away several structures in the village (including the church) causing extensive flooding. The narrow fringing reef and coastal plain of the island offer little protection in times of storm surges or tsunami, with the only option being for the population to move to the hills during these events. While the environment is still relatively pristine (due to the small population of the island), logging for building by local villagers on other islets was evident. This can further aggravate deforestation and soil erosion, due to goat grazing, threatening the marine ecosystem.

Top: Yanuca Village showing hills (left) solar panels (middle) and tidal flooding (right)
Middle: The seawall of Yanuca village, at high tide (middle) and a fissure in the concrete (right)
Bottom: Coastal erosion at the village (left & middle), and local timber from logged trees (right)

5.2. Water Supply and Availability

5.2.1. Naselesele Village

The WAF supplies water from the Mua catchment which is located approximately 20 kilometers from Naselesele village (Figure1). The water source is spring water which is directed into a holding cement pound of 5m (L) x 3.5m (W) x 0.5 m (D) in size. This water is pumped 8.4 kilometers into a 50,000 gallon cement water tank for treatment through chlorination drip method. This treated water is pumped 5 kilometers into two 26,000 gallon cement water tanks at Naselesele reservoir. This water is then supplied to Matei community and Naselesele village. However this catchment is not well protected with farming being evident on the slopes and surrounding areas near the catchment. On the other hand, the Naselesele reservoir and borehole is protected by fencing and a resident pump attendant. This location also has three boreholes.

In 1971 and 1975, two boreholes were constructed however due to poor maintenance and durability of the pumps, these are not currently operational. In 1991, a borehole was developed at Naselesele reservoir to supply water to other villages and nearby settlements. However due to deforestation for farming the water quality and quantity has declined (*WAF pers. com.*). The borehole and Naselesele water reservoir are located at 16.70483°S and 179.87497°W at an elevation of 75 meters. The depth of this borehole powered by a diesel generator is approximately 50 meters and it is used during water disruption from Mua reservoir.

Naselesele village also has a spring source for water that has been used by past generations. This spring is well maintained with a cement wall water collection and protection. During high tide this spring is flushed with minimal seawater and is used for bathing, washing and drinking. The water resources for Naselesele are summarized in Figure 2.

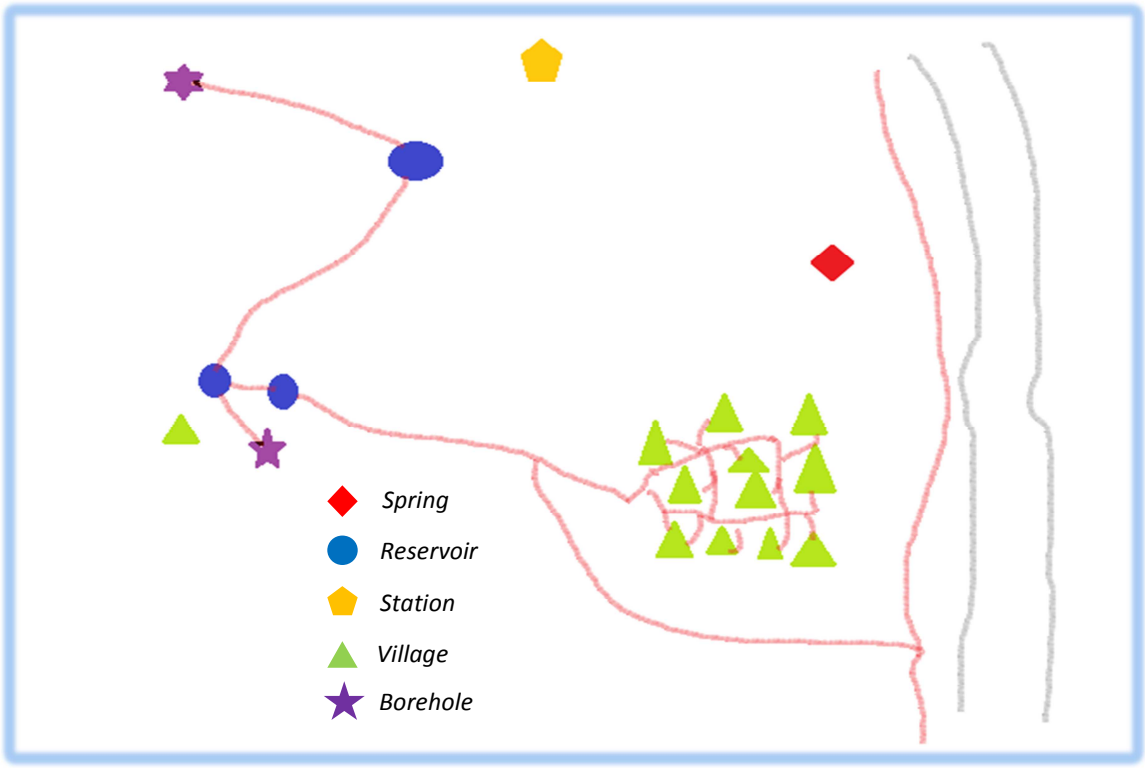


Figure 2. Schematic of Mua reservoir and water resources for Naselesele village

5.2.2. Qeleni Village

The current source of water supply to Qeleni village is from the upper Qeleni River, two kilometers from the village, the lower stream being used for bathing and washing. PVC pipes and gravity flow are used to deliver water to a 20,000 gallon cement water tank located within the Wainikeli District School (left). This tank supplies untreated water to Qeleni village, the school and teachers quarters. However during heavy rainfall this water supply is disrupted. Rainwater collected in water tanks is used to supplement the school during this water disruption. The school has been closed nine times in 2011 due to water disruptions *(Wainikeli District School head-teacher, pers. com., 2011).* The tanks have been provided by the Rotary Club and District Office. The village also has a spring which is used for drinking, with the lower stream being used for washing and bathing. Figure 3 summarizes the water supply for Qeleni village.

In addition, the old water source is located 20 kilometers uphill from the village and has been relocated due to cultivation for farming in the surrounding areas. The forests have been cleared for farming and were damaged during Cyclone Tomas in 2010.

There are two nearby settlements, Vunitarawau and Vunidawa, which have their own spring water source which is used by Qeleni villagers, occasionally, for cooking and drinking..

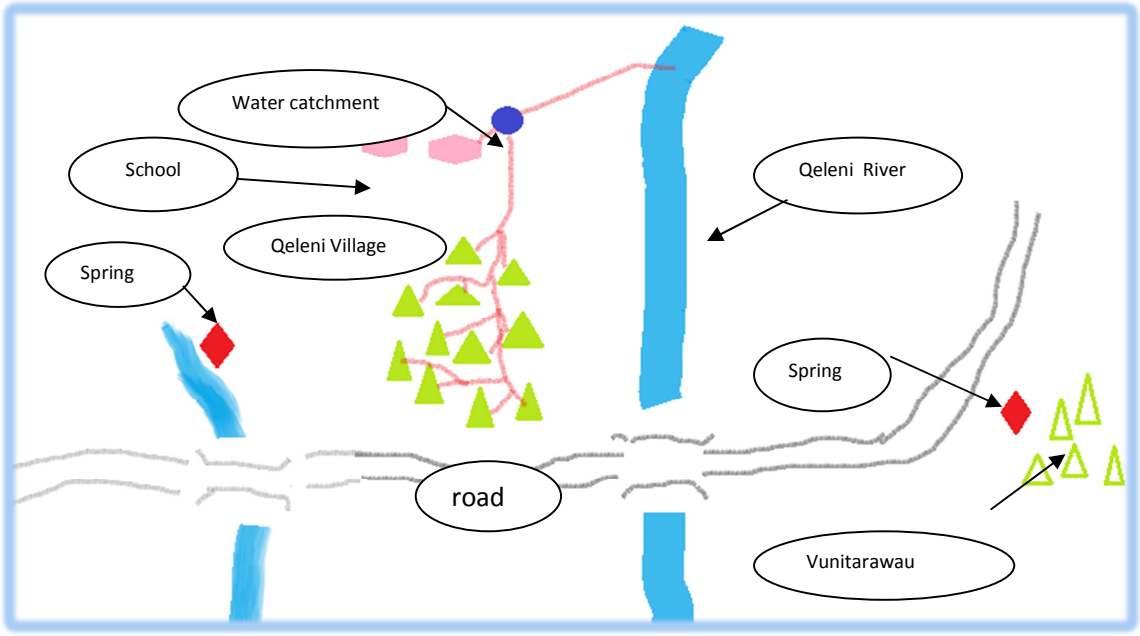


Figure 3. Schematic of water resources for Qeleni village and adjacent areas

Qeleni Village area water sources. Top left: upper Qeleni River catchment. Top right: Vunitarawau spring. Bottom left: Qeleni spring. Bottom right: water bottles at school.

5.2.3. Yanuca Village

The village of Yanuca is heavily dependent on rainwater, spring and ground water as the main source of water supply. The groundwater, used for generations, is used by only one household for washing and bathing, however a pig sty is located above this source. Each household is equipped with plastic water tanks for rain harvesting that is used for cooking and drinking. These water tanks were assisted by the Provincial Office and individual households. Several leaks were noticed in the PVC piping, with many sections improperly attached together causing frequent water disruptions.

A spring (1) is located further uphill which is directed to a 5000 liter plastic tank and supplies water to the remaining village. Close to this tank is a village-funded borehole, 25 meters deep, which was powered by solar energy that was damaged during Cyclone Tomas. The borehole is located at 16.50160°S and 179.69244°E and is now handled manually. Another spring (2) is located further uphill from spring (1) that is used by two households west of the main village. This spring (2) is contaminated from uphill farming.

The Qilo Primary School uses spring (3) as its water source that is stored in a 5000 liter cement tank. Figure 4 gives a summary of the water source location on Yanuca Island.

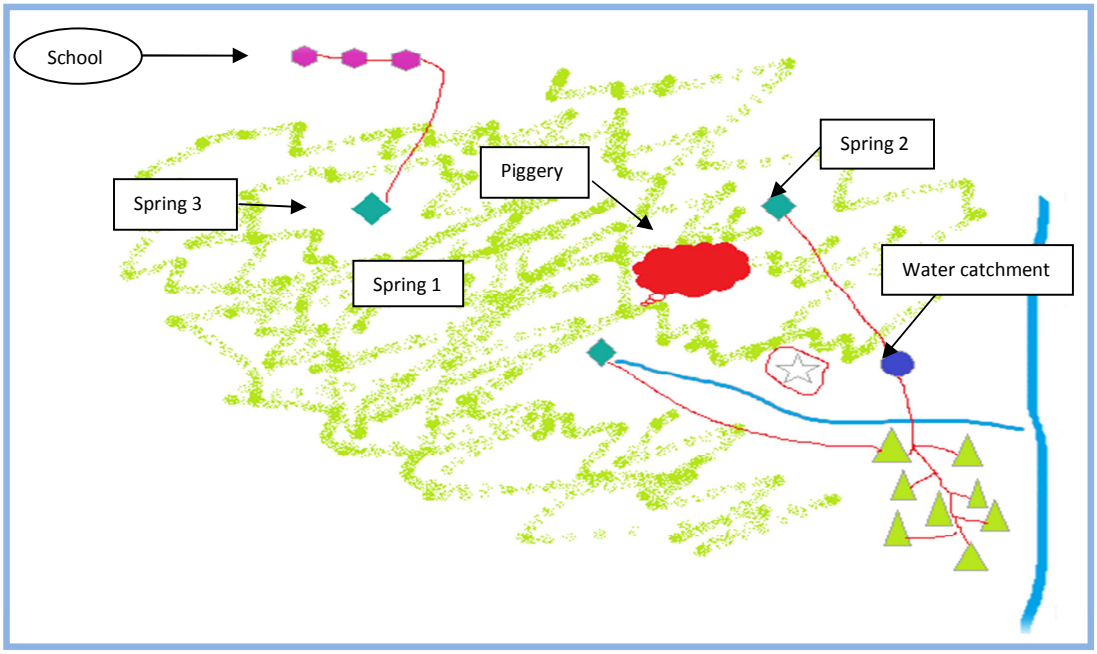


Figure 4. Schematic of water resources for Yanuca Island

Yanuca Village water sources (L-R): rain catchment; groundwater catchment; borehole; pig sty above catchment

5.3. Water Quality Test Results (H_2S)

Table 3. Results of Hydrogen Sulfide (H_2S) water quality tests

Naselesele & Mua

Sample #	Source	Location	Treatment	Time	Date	Results*		
						24hrs	48hrs	72hrs
NWS 01/11	Kitchen Tap	Wiwi settlement	Treated	0815hrs	24/10	A	A	A
NWS 02/11	Spring	Mua Water Catchment (WAF)	Untreated	1005 hrs.	24/10	C		
NWS 03/11	Sink Tap	Mua Research Station	Untreated	1030 hrs.	24/10	C		
NWS 04/11	Bore-Hole	Naselesele Reservoir	Untreated	1640 hrs.	24/10	A	A	A
NWS 05/11	Spring	Naqarakalou	Untreated	0900 hrs.	25/10	A	A	A
Fiji Water 06/11	Control	Control	Control	Control	24/10	A	A	A

Qeleni

Sample #	Source	Location	Treatment	Time	Results*		
					24hrs	48hrs	71hrs
QWS 01/11	River	Qeleni River After water catchment	Untreated	0915 Hrs.	C		
QWS 02/11	Spring	At Source	Untreated	1020 Hrs.	B	C	
QWS 03/11	Spring	Vunitarawau Settlement	Untreated	1205 Hrs.	A	A	A

Yanuca

Sample #	Source	Location	Treatment	Time	Results*		
					Day 1	Day 2	Day 3
YWS 01/11	Spring (1)	24m from borehole [uphill]	untreated	0900 Hrs.	C		
YWS 02/11	Bore-hole	12m from village	untreated	0910 Hrs.	C		
YWS 03/11	Catchment Tank	12 m from borehole [downhill]	untreated	0915 Hrs.	C		
YWS 04/11	Spring (2)	40m from catchment tank [uphill]	untreated	0930 Hrs.	C		
YWS 05/11	Spring (3)	Qilo Primary School	untreated	1005 Hrs.	C		
YWS 06/11	Rain water tank	Jack Matanitikina household	untreated	1600 Hrs.	B	C	

***Results:** **A**-Water is safe to consume [No color change]. **B** - Water shows signs of contamination, unsafe to consume [light milky to grayish in color]. **C** - Water is contaminated do not consume [Black in Color]*

H_2S test vials for Qeleni Village

The above results highlight the variable quality of water resources at the three sites investigated. The village with the best water quality was Naselesele, which was on par with the control for both treated (WAF) and untreated (spring) water. The fact that the spring water percolates through fairly deep sediments and plant roots (photo below) would account for its high quality. However, use of this spring is restricted to low tides as it otherwise gets flooded with seawater due to its low elevation. The elevated Naselesele borehole had good quality untreated water, which was fit for consumption.

Clean percolating spring at Naselesele Village

By comparison, both untreated water sources at Mua were not fit for consumption, possibly due to contamination from farming uphill. It is to be noted that this untreated water currently supplies the Mua Agriculture Research Station.

In the vicinity of Qeleni, the Vunitarawau spring showed high water quality that is due to water percolating through rocky substrate. However, the Qeleni river was found to be contaminated, and heavily charged with sediments even after a short rainfall. The village spring which most households in Qeleni village consume was found to be very contaminated. This spring is habitat for several species of freshwater algae, fishes and prawns that may contribute to sources of contamination through their feces.

Sediment load in upper Qeleni River after a short rainfall

The worst water quality situation was in Yanuca Island, with all water being contaminated and the springs being charged with sediments as well. This is particularly alarming, since most households use this contaminated water for washing, bathing and drinking. The sedimentation and poor water quality is attributed to low range of hills on the island, coupled with deforestation due to farming practices, logging, goat grazing and piggeries above water catchments. As a precaution, the PACE-SD team wisely relied on mineral water during their entire stay on Yanuca.

Chronic sediment load in Yanuca Island water catchment

5.4. Health and Sanitation

5.4.1. Household and Population Structure

The number of households, population structure, and health and sanitation for the three villages surveyed is summarized in Figure 5 below.

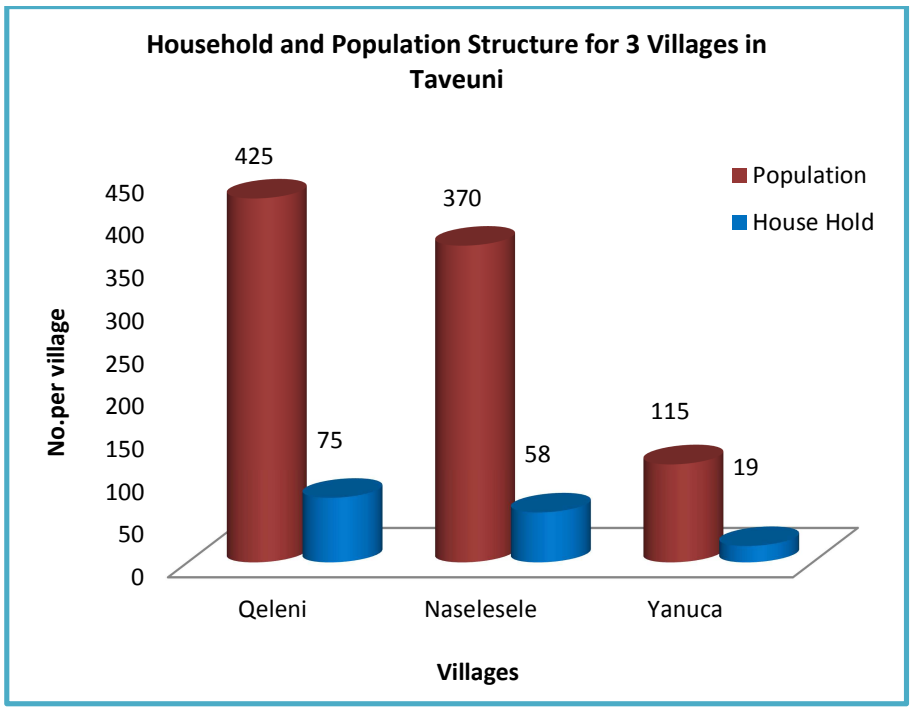


Figure 5. Population and household structures of Naselesele, Qeleni and Yanuca villages

5.4.2. Health

Health in this context refers to the 'presence or 'absence of diseases' within the communities surveyed. World Health Organization (WHO) defines health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." (https://apps.who.int/aboutwho/en/definition.html).

The health status for the villagers was not available from the Health Inspector at the Waiyevo Hospital. The table below, however, shows the data for children (pre-school and primary students) affected by some diseases. Water holes were tested for the presence of dengue-carrying mosquito larvae (left).

The key informants (village health workers, village headman, clan leaders, health inspector) interviewed from the three villages revealed that there have not been any reported cases of dengue fever in the past five years. However, in past 12 months, incidence of diarrhea has been frequent in the villages. The perception for diarrhea was attributed to the poor water quality and food hygiene.

Qeleni village showed high rates of scabies in children below the age of five years. This was perceived to poor water quality. There was an incidence of diarrhea complication with the victim admitted at Waiyevo Hospital in September 2011.

5.4.3. Sanitation

"Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and feces". This has been identified as a major cause of disease world-wide and improvement in sanitation is known to have a significant benefit on health. The maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal also refers to 'sanitation'. (http://www.who.int/topics/sanitation/en/).

5.4.3.1 Solid waste

In all three villages, indiscriminate refuse dumping was evident. In Qeleni and Naselesele villages, communal garbage pits were provided, however improper use was evident with garbage disposed outside the pits. In Qeleni, villagers residing by the river disposed garbage in this river with observations in the coastal area (verified by village health worker). It was observed in Yanuca that the villagers have a tendency to throw rubbish in the bush and the sea.

All three villages had flies (insect) infestation problems, especially Naselesele and Qeleni villages. It was observed that food was not always protected from flies and the villagers were accustomed to having flies around. They associate flies with the weather condition and abundance of fresh fruits and vegetables in the season.

This method of solid waste disposal contributes to mosquito infestation that was experienced by the PACE-SD team during our stay in the villages. This relationship between improper solid waste management and increase in mosquito population as well as vulnerability to dengue fever and other mosquito borne diseases was not well understood by the villagers unless awareness exercises were conducted.

5.4.3.2. Liquid waste

Waste water management is not practiced in all three villages. There was no observed proper drainage system for household and storm water. This was attributed as a problem of flooding in Naselesele village during heavy rainfall.

5.4.3.3. Human Waste

Sanitary accommodation as shown in the graph below is influenced by the availability of sufficient water supply for management of human waste. In Naselesele village, flush toilets (right) are dominant due to reliable water supply from WAF *(the leaves are to remove odor).* However, drums are used as septic tanks which are affordable and maximize use of available land. Many households in Qeleni village shared toilet facilities. In several places, the bush was also seen to have been used as a latrine. In Yanuca, water seal and pit toilets are used (left) which are flushed buckets of water. A summary of the sanitation status for three villages is given in Figure 6 below.

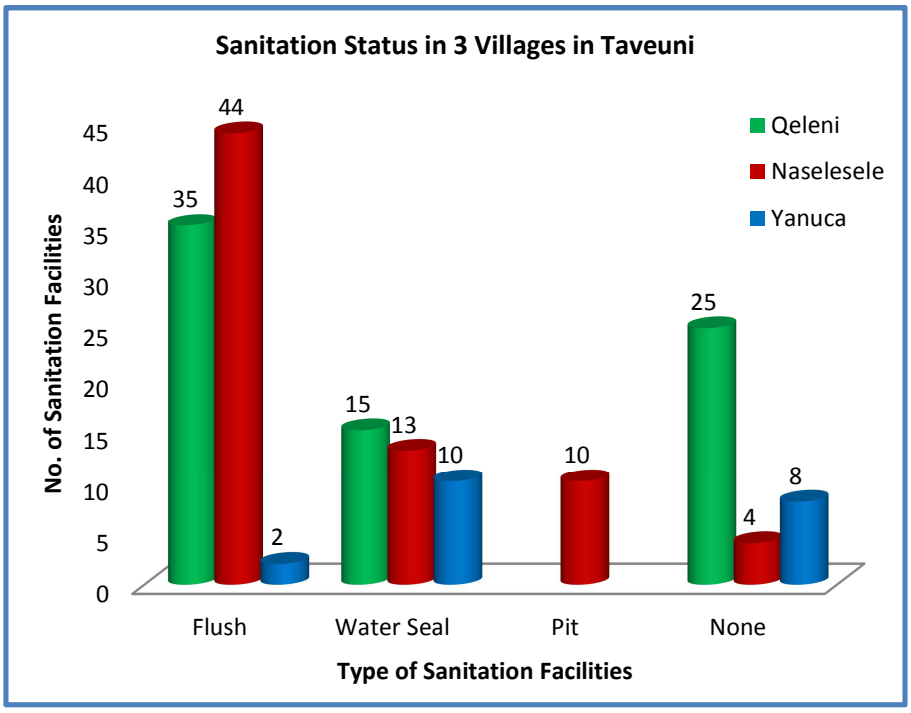


Figure 6. Sanitation status in Naselesele, Qeleni and Yanuca villages (* Households with 'none' usually share facilities with other households)

5.4.4. Child Health Statistics

The health of children below the ages of five years old was also provided by the Health Inspector for the Waiyevo Hospital. Table 4 below summarizes the diseases observed in children from Naselesele, Qeleni and Yanuca villages.

The most prevalent diseases are trachoma and sores, followed by ringworm. These could be avoided by better hygiene practices and cleanliness. Surprisingly, the small community of Yanuca had the least incidence of childhood diseases, despite its isolation from the nearest health center. The only incidence of scabies was in Qeleni.

Table 4. Statistics of children's diseases at three villages visited

Diseases	Naselesele	Qeleni	Yanuca	Total
Trachoma	22	36	3	61
Ringworm	9	9	1	19
Dhani	4	1	1	6
Sores	14	20	0	34
Tuberculosis	1 (infant)	0	0	1
Scabies	0	1	0	1

5.4.5. Overall Health Observations and Recommendations

Naselesele village has an advantage with its health and sanitation status due to the availability of sufficient water supply to individual houses. On the other hand, the Qeleni area has sufficient water sources but they are not readily available in homes, making water collection a cumbersome activity which compromises hygiene practices.

In Yanuca village, about 80% of the houses have their own rainwater catchment tanks that are connected to pipes beside their homes. The villagers of Yanuca have a positive attitude towards development and improving their quality of life and have plans to improve health and sanitation.

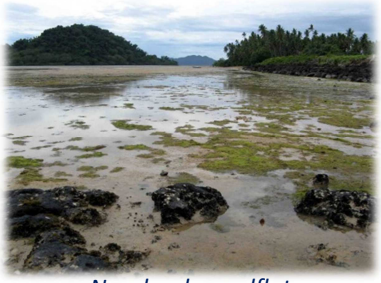
Of the three villages visited, Qeleni is the most vulnerable to health and sanitation impacts in periods of disaster because of the present sanitation state of the village.

5.5. State of The Marine Coastal Environment (By Dr. Antoine De Ramon N'Yeurt)

5.5.1. General observations

The marine coastal habitats encountered at the Taveuni and Yanuca sites were representative of those expected to occur in high volcanic islands. Notably, extensive mudflats with several species of seagrass were seen at all sites, usually fringed on the littoral side by mangroves (*Bruguiera* sp., *Rhizophora* sp.). On Taveuni the barrier reef was not visible from the shore and no fringing reefs were seen although isolated patches of fossil coral and beach rock were exposed at some of the more eroded sites. Yanuca reefs were mostly fringing with numerous *Acropora* heads.

Yanuca Island



Naselesele mudflats

The health of the sites visited ranged from good (Yanuca) to fairly good (Naselesele) and poor / heavily sedimentation (Vunitarawau). There was a notable absence of holothurians at most sites, an alarming situation possibly linked to the overfishing of this resource (mostly "caterpillar", or warty sea-cucumber, *Stichopus horrens*) by local communities for commercial purposes. Holothurians, through their feeding habits, are an essential part of soft-bottom marine ecosystems as they oxygenate and recycle surface sediments, mineralize organic material and enhance the fertility of sediments. Their disappearance would have still unknown negative impacts on the marine ecosystems and fisheries, affecting the livelihood of the communities.

Desolated eroded coastline at Vunitarawai near Qeleni

5.5.2. Mangroves

Rhizophora samoensis

Three species of mangroves out of the seven occurring in Fiji (Fiu *et al*., 2010) were seen on Taveuni (*Rhizophora samoensis*, *R. stylosa* and *Bruguiera gymnorhiza*), and none on Yanuca. *Rhizophora* spp. with their characteristic prop roots typically occur more inwards than *Bruguiera* spp., which tend to be outliers on the shoreline. Mangrove roots trap sediments from land water runoffs, make the water clearer and allow for the establishment of seagrass beds and coral reefs further out. The prop roots of the genus *Rhizophora* provide

Bruguiera gymnorhiza

support and protection for numerous invertebrates, a breeding / nursery ground for fish and crustaceans and protection from oceanic predators. The loss of mangrove habitats, which act as a protective nursery for juveniles of many marine species of fish, mollusks and crustaceans, will have definite negative impacts on fisheries, in addition to an increase in coastal erosion. At most sites investigated, there was a clear link between the absence of mangroves and the high incidence of coastal erosion. A field guide to identify the species of mangroves on Taveuni is given in Appendix 3.

5.5.3. Seagrasses

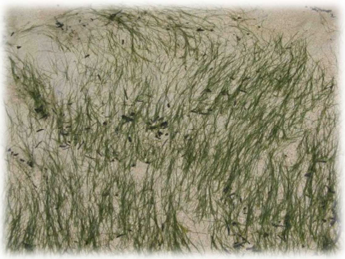
Syringodium isoetifolium

Four species of seagrass out of the five occurring in Fiji (McKenzie & Yoshida, 2007) were found in Taveuni and Yanuca, namely *Halodule pinifolia*, *H. uninervis*, *Syringodium isoetifolium* and *Halophila ovalis* ssp. *bullosa*. It was encouraging to see extensive seagrass meadows at many sites, mostly of *Halodule uninervis* and *Syringodium isoetifolim*, as they reflect on the health of the local ecosystems. A guide to the species is given in Appendix 4.

Seagrass are photosynthetic flowering plants which have returned to a marine environment, and they are specially adapted to grow in salty, wave-washed habitats. They stabilize, purify and enrich coastal sediments. Through their extensive root system they oxygenate and fertilize the sediments, hold nutrients from being washed out to sea, and trap fine soil particles from land runoffs, enabling coral reefs to thrive in clear waters.

Mollusks on Halodule uninervis

Seagrass are also an important food source for marine animals such as turtles, and the periphyton (diatom ooze) on their leaves are food for mollusks and other invertebrates. It has been reported that one hectare of seagrasses can support as many as 100 000 fish and 100 million invertebrates (Littler *et al.*, 2008). The presence of seagrass meadows on Taveuni greatly increases the biodiversity of the ecosystem, as they provide a habitat for a range of other plant and animal species, as well as a sheltered place for the laying of egg masses. For instance in Naselesele, numerous large foraminifera (*Marginopora vertebralis*) and invertebrate egg masses were seen within the seagrass beds. Foraminifera are very important contributors to carbonate sediments of marine ecosystems, along with calcified green algae such as *Halimeda macroloba*, which were abundant within seagrass beds in Taveuni.



Halodule pinifolia

Halophila ovalis

The biggest threat to seagrass being a reduction in light penetration brought about by turbidity of the water, the destruction of coastal mangroves would have a negative impact, covering the seagrass in silt from land runoffs and coastal erosion. Similarly, excessive use of fertilizers overloads the water with nutrients, increasing turbidity and favoring the bloom of opportunistic algal species which can displace seagrass from their habitats.

5.5.4. Foraminifera and marine algae

Halimeda macroloba

One main species of foraminifera and 35 common species of marine algae were noted at the Taveuni sites, and 11in Yanuca. While sampling effort was limited owing to the lack of time for a detailed survey of the coral reefs for algae, the rapid assessment survey of the supra littoral to intertidal areas gave a fairly good indication of the state of health of the ecosystems. Algae are at the base of the food chain in marine ecosystems, and calcified forms such as *Halimeda* and foraminifera such as *Marginopora vertebralis* are part of the diet of parrotfishes and important contributors to marine carbonate sediments. Sites such as Yanuca were typically vibrant with a diversity of algal species, while at Naselesele in Taveuni the extensive seagrass meadows offered a refuge and nutrients for a range of macroalgae which were in turn part of the food chain for other marine organisms. However at extensively damaged sites such as Vunitarawau, heavy siltation from coastal erosion and land runoffs had a noticeable impact on the algal biodiversity and distribution, with plants occurring in small isolated clumps, often exhibiting stunted growth possibly due to lack of nutrients and poor light intensity. Locally polluted sites with domestic waste runoffs (Naselesele) had blooms of indicator green algae such as *Boodlea composita* and *Ulva intestinalis* near drain and culvert outlets. Collected voucher of 77 specimens of algae and seagrass are deposited in the marine collection, South Pacific Regional Herbarium at USP (SUVA-A). A complete listing of inventoried algae and seagrass is provided in Appendix 5, while Figure 7 and Table 5 below show the distribution of the four classes of algae and seagrass among the sites studied.

Marginopora vertebralis

Padina boryana,

5.5.5. Site-specific observations

5.5.5.1. Naisogo Point

The Naisogo Point site (left) was affected by siltation from the coastal erosion taking place along the shoreline, and no mangroves were present at the study area. The dominant marine plants were clumps of *Halimeda opuntia* intermixed with brown algae such as *Padina boryana* and *Dictyota bartayresiana*, with isolated patches of seagrass (three species, *Halodule uninervis*, *H. pinifolia* and *Syringodium isoetifolium*). No holothurians or other invertebrates were seen in any numbers, and the overall site appeared poor in marine biodiversity, although species richness was locally high, with a total of 13 algae and 3 seagrass species found in isolated clumps. The dynamic nature of the area, with erosion occurring in one place and accretion of sand in another, would explain the paucity of established marine plant colonies. The fine seagrass *Halodule pinifolia* was seen to colonize rapidly new sandy areas with ripple and dune patterns west of the study site.

Halimeda opuntia *clumps*

Naisogo area in 2005 (Google Earth photo) and in 2011 (inset) showing how much the coastline has been eroding following recent cyclones. The accretion of sand west of Naisogo Point is also evident.

5.5.5.2. Naselesele

Naselesele was the richest site seen in terms of biodiversity, most likely accounted for by the wide expanses of seagrass meadows. Four seagrass species and 18 algal species were observed, as well as numerous invertebrates and mollusks taking refuge and spawning within the seagrass beds. The sediments were mostly carbonate in nature. Oyster beds occurred near the shoreline (rock boulders). The distribution of seagrass beds was fairly uniform about 100 meters from the shoreline, although zonation was observed, with the dominant seagrass being *Halodule uninervis*, followed by *Syringodium isoetifolium*.

Boodlea composita

Sand dunes colonized by seagrass species

Accretion of sediments from the Naisogo Point coastal erosion area was noticed, forming small sandy dunes colonized by seagrass. This may smother any corals growing in tidal pools, cause necrosis of seagrass beds near the shoreline, and reduce fisheries in the area. Near the shore, freshwater effluents from the village and river were seen to cause eutrophication and mortality among seagrass beds, as well as fostering the growth of blooming green algae (*Boodlea composita*, *Ulva intestinalis*). Such blooms can displace normal populations of seagrass and algae, and altering the ecological balance of the area. Holothurians such as *Stichopus horrens* or 'caterpillar' have a ready market, and villagers harvest large amounts of these organisms for commercial purposes, not necessarily paying attention to size or leaving enough reproductive stock in the natural populations. The only holothurian seen during the survey was the non-commercial species *Synapta maculata*. Other invertebrates included small marine gastropods feeding on seagrass periphyton, and a starfish (*Linckia* sp.). A diversity of marine algae was found beneath the seagrass cover, including the calcified greens *Halimeda macroloba* and *H. opuntia*, both a source of food for herbivorous fishes such as parrotfish, and major contributors to carbonate sediments of the reef flats when the plants die

Synapta maculata

Linckia sp.

Stream outlet at Naselesele

Caulerpa sertularioides

Halimeda macroloba

or are ingested. The elegant green alga *Caulerpa sertularioides* was also seen only at the Naselesele site, along with a number of red algae such as *Hypnea* spp. and *Laurencia* spp. This richness in biodiversity depicts the fertility of the ecosystem, which needs to be preserved as it is under threat from domestic effluents, siltation and overfishing.

5.5.5.3. Vunitarawau

A lone Bruguiera *tree attesting to the former limits of the shoreline*

Seagrass beds

The extreme desolation of the coastal area at Vunitarawau, likely due to erosion of the area following the building of the Laucala Island jetty, created a distinctive marine ecosystem dominated by seagrass beds of the genera *Halodule uninervis*, *H. pinifolia* and *Halophila ovalis* subspecies *bullosa*. A total of 11 algae species were found, dominated by brown algae such as *Padina boryana* and green calcified algae such as *Halimeda borneensis*, which favor soft-sediment habitats. The intensity of erosion exposed fossil coral reefs in some places, colonized by turf algae. *Bruiguiera gymnorhiza* mangrove plants were seen in the middle of the mudflats, attesting to the fact that the shoreline has been receding widely due to recent erosion. The presence of peat on the beach, normally associated with mangrove swamps, and coconut stumps surrounded by seagrass on the mud flats further confirm that the area was once a vibrant coastal mangrove community dominated by *Bruguiera* and coconut trees. Because of the very high rate of siltation, no corals were seen. The replanting of mangrove species such as *Rhizophora* spp. could help restore the area by mitigating coastal erosion, although an engineering solution might be needed to counteract the effects of the Laucala jetty. Womenfolk were seen fishing on the reef flats, possibly for mollusks such as *Anadara* spp.

Peat remnants on the beach

Exposed fossil reef colonized by turf algae

5.5.5.4. Yanuca Island

The Yanuca marine sites were the most pristine encountered during the survey, likely due to the isolation of this small island, and the low population density. The reefs were mostly fringing, with numerous *Acropora* corals. Eleven algal species and two seagrass species (*Halodule uninervis*, and *Halodule pinifolia*) were found, including two brown algae (*Hydroclathrus clathratus* and *Colpomenia sinuosa*) not seen on mainland Taveuni. A more thorough investigation of the reefs will likely increase the number of marine algae from this preliminary survey. No evidence of damage from siltation was seen, although plans by the local villagers to log forest trees for building material on outer islets of Yanuca could pose a threat to the fragile fringing coral reefs in the future due to sediment runoffs from eroded slopes.

Acropora coral on the fringing reef

Hydroclathrus clathratus

5.5.6. Environmental concerns in the marine area

On Taveuni, four main problems were noticed that affected marine ecosystems, one being climate-change induced and the others anthropogenic in origin:

1. Siltation of coastal areas from erosion and land runoffs. This was most pronounced at the Naisogo Point and Vunitarawai sites. The increased turbidity will negatively affect the ability of seagrass beds to stabilize sediments and trap nutrients, which in turn will affect the coral reefs further out, and reduce fishery catches. The planting of mangroves and trees such as *Casuarina* and *Dilo* along the coastline could reduce this problem.

Necrosis of the seagrass Halodule uninervis *at Naselesele, possibly due to excessive siltation and nutrient-rich runoffs from the village and river*

Bloom of green algae near the culverts at Naselesele village

2. Pollution from domestic freshwater effluents and rivers affecting coastal marine ecosystems, leading to localized algal blooms and necrosis (mortality) of seagrass beds. In front of Naselesele Village, these effluents, as well as runoffs from agricultural lands where excessive fertilizers are likely used, was seen to cause necrosis of large areas of seagrass

beds close to shore and near the culvert. It also leads to important blooms of green algae such as *Boodlea composita*, *Ulva flexuosa* and *U. intestinalis*, which are well-known indicator species for excessive-nutrient-polluted coastal waters. Proper disposal of kitchen, laundry and washroom wastewater as well as a reduced use of fertilizers, could mitigate this problem.

3. Indiscriminate disposal of domestic waste in coastal areas

Used batteries, electronic goods, cans and diapers were seen to be dumped indiscriminately along the shoreline and on beaches at the Taveuni sites. These practices are very harmful to marine life. Toxic chemicals from batteries and electronic components slowly leak, while diapers and plastic bags can be ingested by turtles and dolphins, mistaking them for jellyfish and other prey. Discarded fishing nets can entangle fish, sharks and turtles. Educational campaigns among the communities are needed to teach them good waste disposal practices.

Household refuse seen on Taveuni shores which are toxic to marine life

4. Overfishing of marine resources (holothurians)

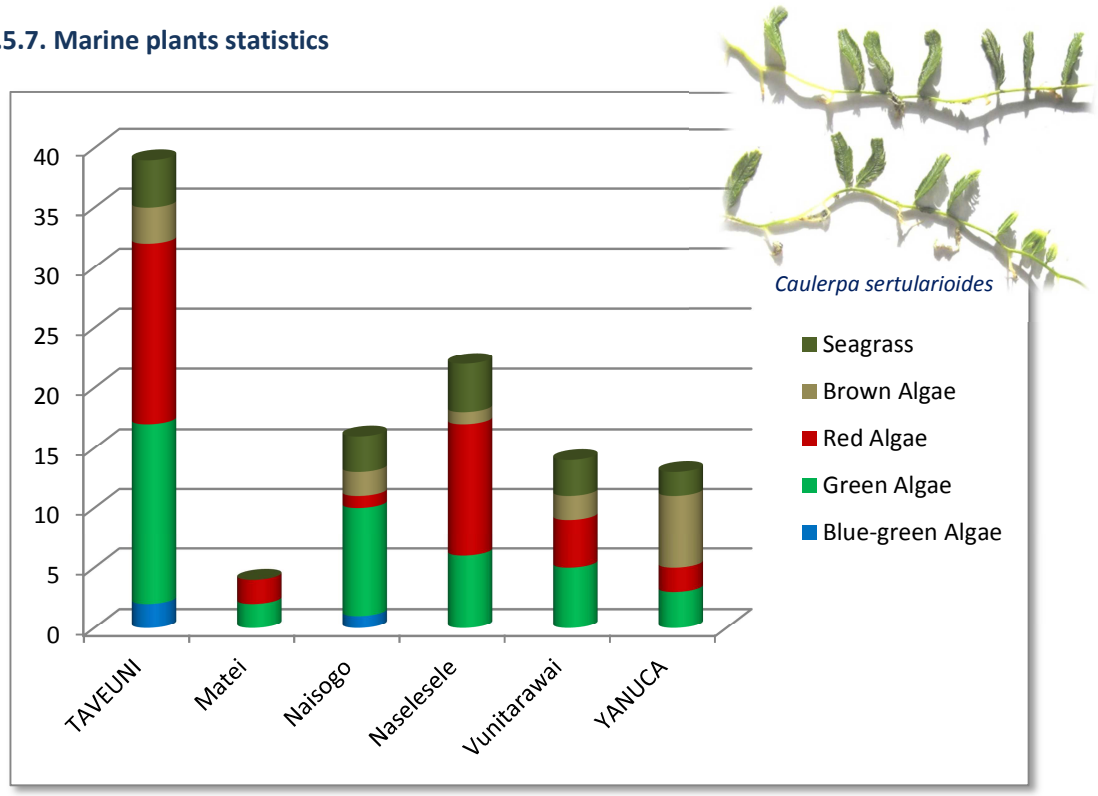
Stichopus horrens *('caterpillar')*

At Naselesele, informants confided to us that recently, the fishing of Holothurians ('caterpillar', or *Stichopus horrens*) was a very popular activity as there was a ready market for these. However, the catches were getting less as the population of these mostly nocturnal holothurians were being overfished (no specimens could be seen during our survey of Naselesele flats). In Yanuca, evidence was seen of intensive fishing for bêche-de-mer (sandfish). The depletion of holothurians can have disastrous effects on fisheries, as they are vital for enhancing the fertility and health of the seagrass ecosystems, from which a host of other marine organism depend. The local communities need to be informed about catch limitations (protected species, size, and numbers) and the setting up of marine protected areas (MPAs) to conserve their marine resources.

Dried sandfish at Yanuca

Fish catch in Yanuca, including a highly protected species

5.5.7. Marine plants statistics



Caulerpa sertularioides

Figure 7. Graphical representation of the number of marine plant species at the study sites

Table 5. Distribution of marine plant species at the sites studied

	Groups of Marine Plants (algae and seagrass)					
Locality	**Cyanobacteria (Blue green algae)**	**Chlorophyceae (Green algae)**	**Rhodophyceae (Red algae)**	**Phaeophyceae (Brown algae)**	**Magnoliophyta (Seagrass)**	**Total N° species**
TAVEUNI	2	15	15	3	4	**39**
Matei	0	2	2	0	0	**4**
Naisogo	1	9	1	2	3	**16**
Naselesele	0	6	11	1	4	**22**
Vunitarawai	0	5	4	2	3	**14**
YANUCA	0	3	2	6	2	**13**

Green alga: Halimeda borneensis

Pressing herbarium vouchers in the field

Seagrass: Halodule uninervis

6. General Conclusions and Recommendations

The general impression from our preliminary Rapid Assessment Survey was that the various communities in Taveuni and Yanuca were quite responsive to learning about the issues of climate change and how it affects their livelihoods and security, and were willing to take adaptive measures. Some communities (as in Yanuca Village) already took some initiatives on their own (building of a seawall, obtaining solar panels, making rain catchments). We recommend the following measures to be implemented:

- Replant mangroves and shore tree such as *Nokonoko* and *Dilo* in areas affected by coastal erosion (Naisogo, Vunitarawau).
- Restrict the overfishing of holothurians ('caterpillar') to maintain healthy seagrass bed ecosystems and preserve the fishery livelihoods of communities.
- Reforestation of native trees in deforested areas.
- Do not authorize farming within 200m of watersheds (policy by Ministry of Lands).
- Have proper disposal of human and household wastes.
- Do not allow farming and animal husbandry above the water catchment levels.
- Implement proper farming practices.

7. References

Denis, B. & Brookfield, H.C. 1983. Taveuni. *In*: *The Eastern Islands of Fiji* (Latham, M. & Brookfield, H.C., eds.), pp. 63-79. Travaux et Documents de l'ORSTOM N° 162. ORSTOM – UNESCO/UNFPA, Paris.

Fiu, M., Areki, F., Rounds, I. & Ellison, J. 2010. Assessing vulnerability of coastal mangroves to impacts of climate change: case studies from Fiji. Report. WWF South Pacific Programme, Suva, Fiji.

Littler, D.S., Littler, M.M. & Hanisak, M.D. 2008. *Submersed Plants of the Indian River Lagoon*. OffShore Graphics, Inc., Washington. 286 p.

Lovelock, C.E., Ruess, R.W. & Feller, I.C. 2011. CO_2 Efflux from Cleared Mangrove Peat. *PLoS ONE* 6: e21279.

McKenzie, L.J. & Yoshida, R.L. 2007. Seagrass-Watch: guidelines for monitoring Seagrass habitats in the Fiji Islands. *Proceedings of a Training Workshop, Corpus Christi Teachers College, Laucala Bay, Suva, Fiji, 16th June 2007*. Seagrass-Watch HQ, Cairns. 42p.

Nature Fiji. 2009. *Strengthening Taveuni's Protected Areas: A Conservation Awareness Campaign, Final Report*. *Unpublished.* National Trust of Fiji, Birdlife International. Conversation International, UNDP, GEF, Darwin Initiative and Critical Ecosystem Partnership Fund. Suva, Fiji.

PACE-SD. 2011. *European Union's Global Climate Change Alliance (GCCA) Project at USP*. Report to donors. PACE-SD, The University of the South Pacific. 7 p.

Appendix 1 - Participatory Approach – Community Awareness [1]

Group Activities:

A. **Naselesele Village** (Date: 25th of October, 2011)

Question	Men	Women	Youth
1. What are the community perceptions on climate change?	o Increase in the intensity of cyclones from 1950s till today. o Change in weather conditions (during the hot season it is cold, and vice-versa) o Sea level rise o The sun is becoming hotter	o Emissions from factories affect the ozone layer and have a lot of impacts on the environment o Clearing of forests o New diseases o Overfishing and destructive fishing method are killing corals o Sea level rise o Change in soil fertility affecting crops o Change in weather patterns o Time change (Daylight Saving)	o Strong winds o The Ozone layer is thinning o More rainfall o More droughts
2. How do communities prepare themselves for cyclones, especially concerning food security and traditional method of food preservation?	o Put up hurricane shutters for the houses o Prepare food o Prune cassava branches o Release livestock o Store drinking water o Have all the people in the village stay together in	o People's lives should be protected o Planting of cyclone-resistant crops such as sweet potatoes (kumara) and yams (tivoli) o Store food in pits o Store water	o Wrap the food nicely and put into the deep freezer o Prune cassava branches o Store water o Prepare firewood o Clean cassava properly for long-lasting storage o Cook dalo, cassava and

[1] *Compiled and translated from Fijian by Mr. Ame Tuisavusavu, PACE-SD*

	one secure place	o Stock up on food o Future houses should be well planned taking into account cyclones and sea level rise o Prepare basic emergency items such as lamps, lighters, torches, batteries and first-aid kits.	breadfruit in earth ovens *(lovo)*
3. Have the communities seen any major changes in the environment such as invasive species, loss of certain important plants or animals, changes to the shoreline and coast?	o Seawater has infiltrated the front of the village. o Beach erosion is taking place o Loss of large coastal trees like *Tavola, Dilo* and *Vutu*. o There are no more native trees around because of agricultural activities o Decrease in mangroves on the coastline	o Change in the weather patterns (climate change) o Droughts o Loss of native trees o Decrease in marine life o Our planet is becoming hotter o Clearing of mangrove forests o Pollution of the beachfront o Change in lifestyle	o Birds such as Magpies becoming rare o Clearing of forests o Soil erosion o Clearing of mangroves and coastal erosion o Lots of dead corals due to fish poisoning e.g. *Duva* o Migration of native birds due to disturbances o Drop in the level of freshwater springs
4. What is the main source of income and alternative sources?	o Cultivated crops: - Taro - Cassava o Copra o Fishing o Tourism o Handicraft o Land lease o Canteen	o Selling vegetables o Handicraft o Tourism o Small business o Land lease o Selling flowers o Fishing o Office job o Fundraising o Canteen o Entertainment	o Cultivated crops: - Taro - Cassava o Yaqona o Copra o Fishing o Handicraft

1. Naselesele Village

A.

Naselesele Village elders during the group discussion

B.

Women's group presentation of perceptions

C.

Naselesele Youths presenting perceptions

D.

Men's group presenting perceptions

B. Qeleni Village (Date: 26th of October, 2011**)**

Questions	Men	Women	Youth
1. What are the community perceptions on climate change?	o The weather experienced daily differs from that which is forecasted in the media o Changes in the intensity and pathways of cyclones o Sea level rise o Increase in temperature o More rainfall in the middle of the year	o Increase in heat and cold o Favorable weather o Lots of rainfall o Drought o Lots of birds in the air are a sign of an impending cyclone. Increase in the frequency of cyclones o Flooding o Drying-up of freshwater springs o Change in wind direction	o Coastal erosion o Hot and cold conditions o Drought - planting material is affected - well/stream dried up o Root crops mature quickly o Lots of rainfall
2. How do communities prepare themselves for cyclones, especially concerning food security and traditional method of food preservation?	o Secure houses well o Pruning of crops like cassava & yaqona o Release livestock such as horses and cows o Prepare food and lights o Move to the evacuation center within the village o Use damaged crops after the cyclone o Village clean-up o Repair the houses if any damage sustained o Use long-lasting crops	o Secure houses well o Move to the evacuation center o Prepare food o Prepare basic items such as kerosene, batteries, lamps and lighters. o Prune cassava branches o Store shop-bought food well in containers o Root crops are harvested and kept in a small house built at the plantation o Cutting down of tree branches if trees are too close to the house o Wrap household items in plastic o Secure roofing irons o Store water and food	o Pruning of cassava and yaqona branches o Prepare food, kerosene, batteries and water o Store food o Root crops are cooked in earth oven *(lovo)* o Bury cassava
3. Have the communities	o Corals are dying o More sedimentation on	o Increase in invertebrates like sea cucumber, clams and sea urchins	o Corals are dying o Decrease in fish population

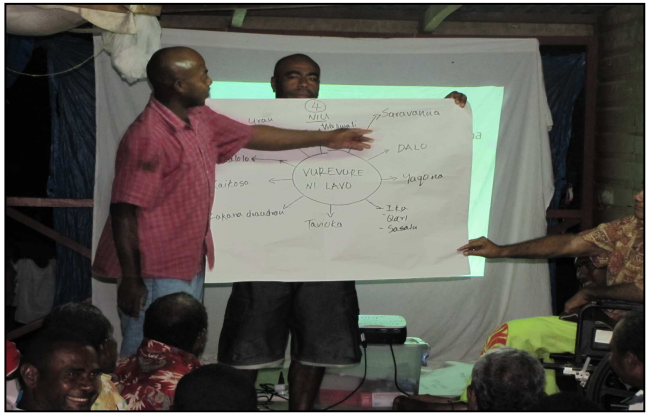
seen any major changes in the environment such as invasive species, loss of certain important plants or animals, changes to the shoreline and coast?	the sea grass bed o Lots of litter on the beach o Coastal erosion observed, with waves eating away parts of the beach; uprooting of coastal plants o Loss of marine life o Drought/sea level rise o Invasive plants are seen in the forest	on the shore. o Land is unfertile o Increase in invasive species o Vegetables look greener o High water mark is moving closer inland o Corals are dying o Plenty of snakes in the plantations	o Increase in invasive plants o Loss of mangrove plants o Crabs are decreasing in number o Coastline is moving inland o Increase in Whitefly o Various weeds are increasing in number o Decrease in freshwater prawns and bivalves
4. What is the main source of income and alternative sources?	o Cultivated crops: • Taro • Yaqona • Yams o Fishing o Selling prawns o Handicraft o Selling vegetables	o Cultivated crops: • Taro • Yaqona • Yams o Vegetables o Fishing o Handicraft o Tourism o Selling food o Canteen o Driving o Rugby 7s tournament held in the village	o Cultivated crops: • Taro • Cassava o Yaqona o Copra o Fishing o Handicraft o Tourism o Selling freshwater prawns o Vegetables o Coconut oil o *Vakalolo*

2. Qeleni Village

A.

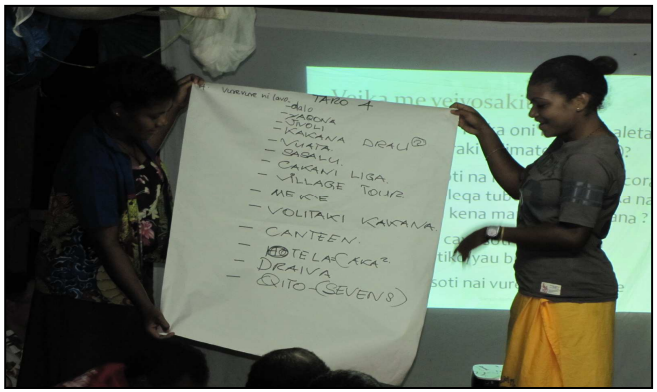
Men's Group presenting their findings to the crowd.

B.



Qeleni Youth Group

C.



Women's Group

D.

Mr. Naushad Yakub (PACE-SD staff) showed to the villagers the current state of their coastline and explained the impacts of wave action during storm surges and cyclones.

C. Yanuca Village (Date: 28th of October, 2011**)**

Question	Men	Women	Youth
1. What are the community perceptions on climate change?	o Increase in the intensity of cyclone o Sea level rise o Seasonal changes; drought instead of expected rainfall o Temperature increase o Fruiting time of trees is changing o Village now experiences storm surge and is flooded by seawater o Wind and wave direction are changing from the forecasted values	o Change in the cyclone season o Weather pattern is changing (hot & cold) o Sea level rise o Decrease in marine biodiversity	o Temperature increase o Frequent cyclones o Tsunami o Less Rainfall o More droughts o Sea level rise o Change in wind direction o Earthquakes o Changing environment
2. How do communities prepare themselves for cyclones, especially concerning food security and traditional method of food preservation?	Before the Cyclone o Store water o Prepare firewood, food o Secure houses well o Prune cassava branches o Take boats inland o Release animals and livestock o Have a village gathering and identify evacuation centers After the cyclone o Deception at seeing all the damage done by the cyclone	Tsunami o Prepare canned food, lamps, torches, radios, Lighters o Move to higher ground Cyclone o Put up hurricane shutters o Store drinking water o Cut down trees that are too close to homes o Pack all belongings o Prune cassava branches	o Pack all belongings o Put up hurricane shutters o Cut down trees beside houses o Have food supplies ready (root crops, rice, flour) o Prepare firewood o Fill water from Taveuni o Bath in the sea

	o Village clean-up o Search for animals and livestock o Store and use available food (e.g. breadfruit is ground and buried; after 4 days it is unearthed, the central stalk removed and it is buried again. It can then be used anytime when needed) o Replant the damaged crops o Plant sweet potato (matures quickly) o Wild yams o Planting of vegetables	o Do not use electrical appliances	
3. Have the communities seen any major changes in the environment such as invasive species, loss of certain important plants or animals, changes to the shoreline and coast?	o Dying of corals o Decrease in fish population o Coastal erosion o Sea level rise o Soil erosion o Cutting down of trees o Burning of forest o A native plant of the island (*Sevua*) is now getting smaller.	o Sea level rise o Change in the weather o Land becoming bare and dry o Root crops such as yams and sweet potatoes are not planted by the farmers	o Seasonal changes o Sea level rise o Fish within the fishing are (*qoliqoli)* are decreasing o Coral reefs are dying o Boat engines are replacing paddles o Native trees of the island are diminishing o Land and coastal erosion o Level of Education has improved o Over-exploitation of marine life o Fiji now has more than

			one hundred Church congregations
4. What is the main source of income and alternative sources?	o Fishing has replaced Copra cutting o Handicraft o Canteen o Tourism	o Fishing o Handicraft o Canteen	o Jobs o Fishing o Copra o Handicraft o Canteen o Tourism o Boat fee

3. Yanuca Village

A.

Women's group presenting their findings to the villages.

B.

Jack (Laucala District Representatives) presenting on behalf of the Men's Group at Yanuca Village.

C.

Dr. N'Yeurt presenting on climate change and the marine environment at Yanuca Village

Youth presenting their views on climate change issues at Yanuca Village

APPENDIX 2 - INTERVIEWS

Naselesele Village

Interview 1: Ratuwei (60 years)
Naselesele Village

- Naselesele village is situated on the leeward side of the island and receives less rainfall throughout the year.
- The village is facing water problem. The grievances have been taken up to the government but nothing has been done. However, the government has promised them that the responsible authorities will liaise with the villages and *Turaga ni Koro's.* The problem lies with the water source, when there is rain in the village it gets contaminated (dirty) and becomes unfit for consumption.
- This is the first time that research has been conducted in Naselesele village focusing on Climate Change Adaptation, which is something new to them. They are happy that the research covers all sectors. The only research that was conducted before was from the Department of Fisheries regarding their reef.
- Another problem is flooding, during heavy rainfall water comes through their village and it was noticed that it happened after they built a new road (back road) that goes to the village school. Also during high tide seawater enters through a culvert that has been built at the front of the village and is now affecting families living beside it.
- After seeing the problems, elders have decided that future houses should move further inland and far from the sea.
- The village beachfront was raised after the government built the new tar-sealed road with a seawall (rock boulders) in front of the village.

Interview 2: Maraia Melania (Age – 88 years)
Naselesele Village

- Weather is changing everyday (hot and cold) which is not new to her.
- Naisogo Point is their picnic spot and also a historical place where they believe their Ancestral Gods live. They could see signs of coastal erosion along the beach.
- Root crops like yams and sweet potatoes are kept on a shelter built at their plantation to be preserved in case of any cyclone.
- Fish is smoked and can be kept in a cardboard box for a week.

Interview 3: Salome Tuvi (Age – 76 years)
Naselesele Village

- The village lifestyle is changing compared to the past, especially as far as village youths are concerned.
- Marine life is over-exploited. People from outside come to harvest sea cucumber (*Stichopus* spp.) on their reef.
- Land reclamation has affected their beach, causing loss of mangroves and erosion at Naisogo Point which is at the far end of their beach

- Cutting down of trees for agriculture purposes is a big problem for the village as most native plants are no longer found within the village boundary.
- Root crops like taro and cassava are affected during cyclones.
- The village hardly faced any flooding problem until the seawall and the new tar-sealed road were built; they alter the wave movements and cause water to enter through the opening at the far end of the village.
- The old village location was on the beach, but recently they have to move further inland.

Qeleni Village

Interview 1: Roselia Valewa (Age – 74 years)
Qeleni Village

- The reef flat was rich in seagrass beds, but recently is completely covered with sediments.
- The beach is not the same as it was before, with the loss of mangroves and other coastal plants. Before there were lots of crabs found in the mangrove swamps, but nowadays they have significantly decreased.
- The reef structure and composition is also changing due to the impacts of cyclones. More corals are dying and fish that used to be found on the reef are now no longer present or have migrated to nearby reefs.
- Flooding is a big issue in Qeleni village. During heavy rainfall, most of the houses that are situated near the river and on lower ground get flooded.
- The surrounding marine environment has been changing for the past 5 years after the development of the new bridge and Laucala Landing. The village foreshore was rich in marine life with clams and fish, but due to the recent development women now have to travel long distances to fish.
- During cyclones, fish is smoked and can be kept for many days, root crops and vegetables are used in small amount only to meet family needs. Before a cyclone, root crops such as taro and cassava are cooked in the earth oven *(lovo)* so that they can last longer.
- The village population has been increasing in recent years and the village is extending to cater for the new families.

Interview 2: Lusiana Maimereke (Age – 86 years)
Kocoma, Qamea Island

- There have been a lot of changes in the village since the time when she came there 70 years ago. At that time, only a few people were living there and all homes consisted of traditional Fijian *bures* or thatched housed.
- The village foreshore was rich in marine life with fish, clams and crabs. Women only needed to travel short distances to fish. The land was also rich in biodiversity, and elders had a passion for nature.
- The village boundary has increased due to the increasing population, and most of the main farming areas have been utilized for housing purposes, forcing people to travel far away to be able to farm.

Interview 3: Anare (Youth Ambassador)
Qeleni Village

- There was a big drought in the village in 1998, when the Qeleni River was totally dry and villages had to rely on the spring for drinking water. During that time, people from other village and resorts came to collect water from the spring.
- The village electricity grid was built in 2003 with the help of the Government under the Rural Electrification scheme, where villages have to pay one tenth of the amount allocated.
- The village water tank and piping was built in 1991 as a project by the Village Women's Organization. Before they used to drink from the springs around the village.
- The Agriculture Department has introduced coconut farming in the village, and parts of the forest were cleared. However, the project was not successful, with most of the lands left idle and unfertile.
- The last major flooding that happened in the village was at 1994, when water reached 2.5 miles inland. People's livelihood was affected with the loss of livestock and damages to farm.

Interview 4: Farasiko Misika (Age – 69 years)
Qeleni Village

- When the young generation hears about how people used to live in the past, they can only dream about it. People lived in harmony with nature, with only a few houses and a small population. Today the village is growing; many have moved in to settle on their own piece of land.
- The natural surrounding is changing; waves have been eroding parts of their beach and the effect is made worse by the cyclones. However, after the Department of Environment visited them they started planting mangroves along the coast, but it was not successful.
- Most of their forest was cleared for coconut farming as a form of government subsidy, and now they have learnt their lesson. The villages are planning to plant trees again (re-forestation) with the support of the Government. This is also a way to conserve and manage their watershed.
- Weather is changing, the intensity of cyclones is increasing every year from 1960s, 70s, 80s, 90s till today.
- Invasive plants can be seen everywhere.
- The Laucala Island landing in Na Kai (an area near Vunitarawau, opposite the village) has been in existence for the last 5 years
- There are three water sources and these were all suppressed and damaged during the last flooding.
- The village has had a generator for the last 10 years.

Yanuca Village

Interview 1: **Jack (District Representatives)**
Yanuca Village

- The villagers are planning to build their houses further inland due to tsunami and storm surges which are the current problems they are facing. During Cyclone Tomas in 2010, the village was flooded with seawater. Now people are well aware of the problem and these are often discussed during village meetings. Early this year, they built a seawall on their beachfront as a form of protection for the village.
- The village population has decreased as many people have left the island for a better education.
- Goats have destroyed most of the terrestrial plants on the island and also the forests have been cleared by villagers for agricultural purposes. During heavy rainfall, top soil is being washed down the slopes and ends up in the sea, endangering the fringing coral reef and marine life.
- Traditional knowledge in terms of seasonal changes (Fijian Calendar) is also affected by climate change.
- In 2009, Yanuca village supplied one and a half tons of fish per week to Laucala Island Resort. The village was getting $7,000 to $8,000 a week. After six months the villages realized that the fish they caught has decreased in sizes so they decided to stop that venture until today.

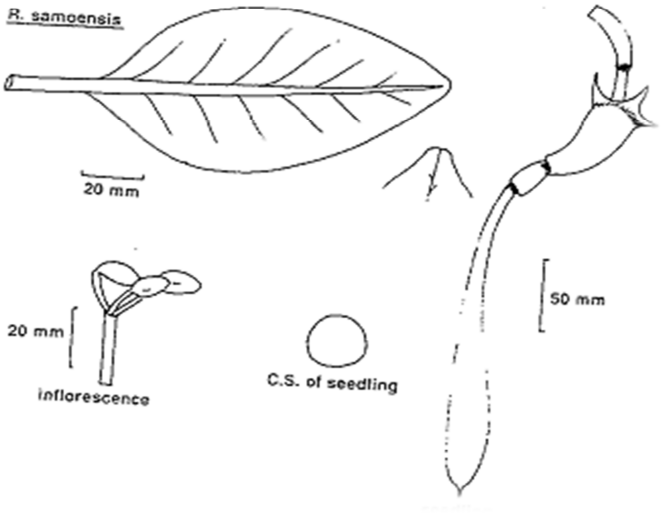
Interview 2: **Isoa (Fisherman)**
Yanuca Village

- The island is only served by small open fiberglass boats and all materials are transported via this means. For instance, cement is brought from Taveuni in these boats, 20 bags / 1 ton at a time.
- It can cost villagers up to $100 per day just to bring supplies from Taveuni.
- Main source of livelihood is fishing and bêche-de-mer.
- Recently, logging has started by the villagers on the small outer islets surrounding Yanuca, and the locally dressed timber is used for building and maintaining houses. There are concerns about land erosion resulting from this deforestation.
- The village generator was brought on the island on small boats in several trips, and assembled locally.
- About 25 liters of diesel per week is used for the generator.
- Cyclone Amy in 2003 washed away many homes in the village, and people took refuge in the concrete church.
- All solar panels on the island are either purchased by the villagers themselves, or have been found at sea (from drifting net locator buoys).

APPENDIX 3 – FIELD GUIDE TO MANGROVE SPECIES OF TAVEUNI

Photos by Mr. Naushad Yakub, PACE-SD with diagrams from Mr. Marika Tuiwawa, SPRH-USP

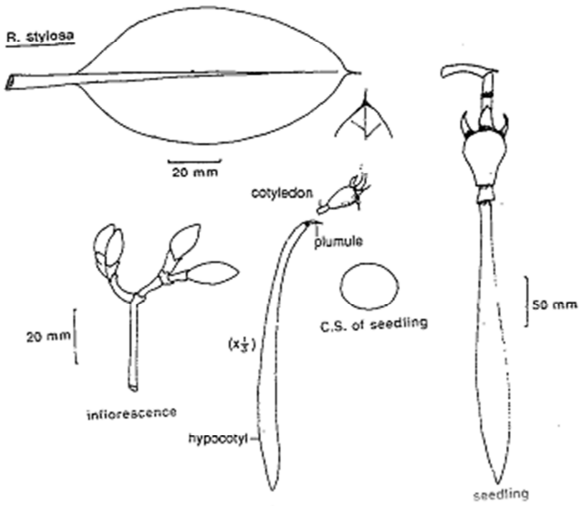
I. *Rhizophora samoensis* (Tiriwai)



Key Features:

A. Leaf tip is blunt
B. Single flowers from a common stalk
C. Seeds are round in cross-section
D. Stilted prop root system (1-2m deep)

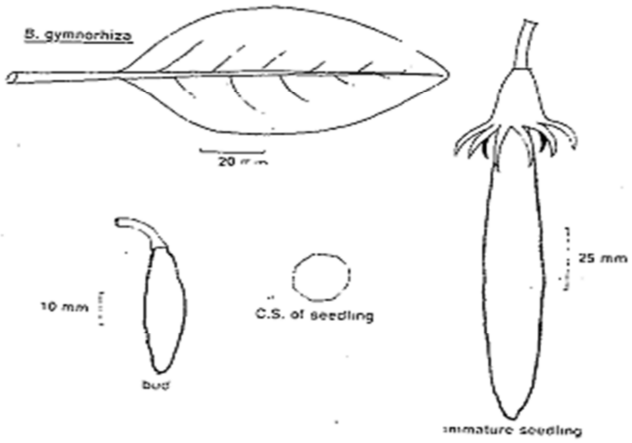
II. *Rhizophora stylosa* (Tiri)



Key Features:

A. Leaves have a pointed tip
B. Flowers in pairs from a single stalk
C. Seeds are round in cross-section
D. Horizontally extended prop roots

III. *Bruguiera gymnorhiza* (Dogo)

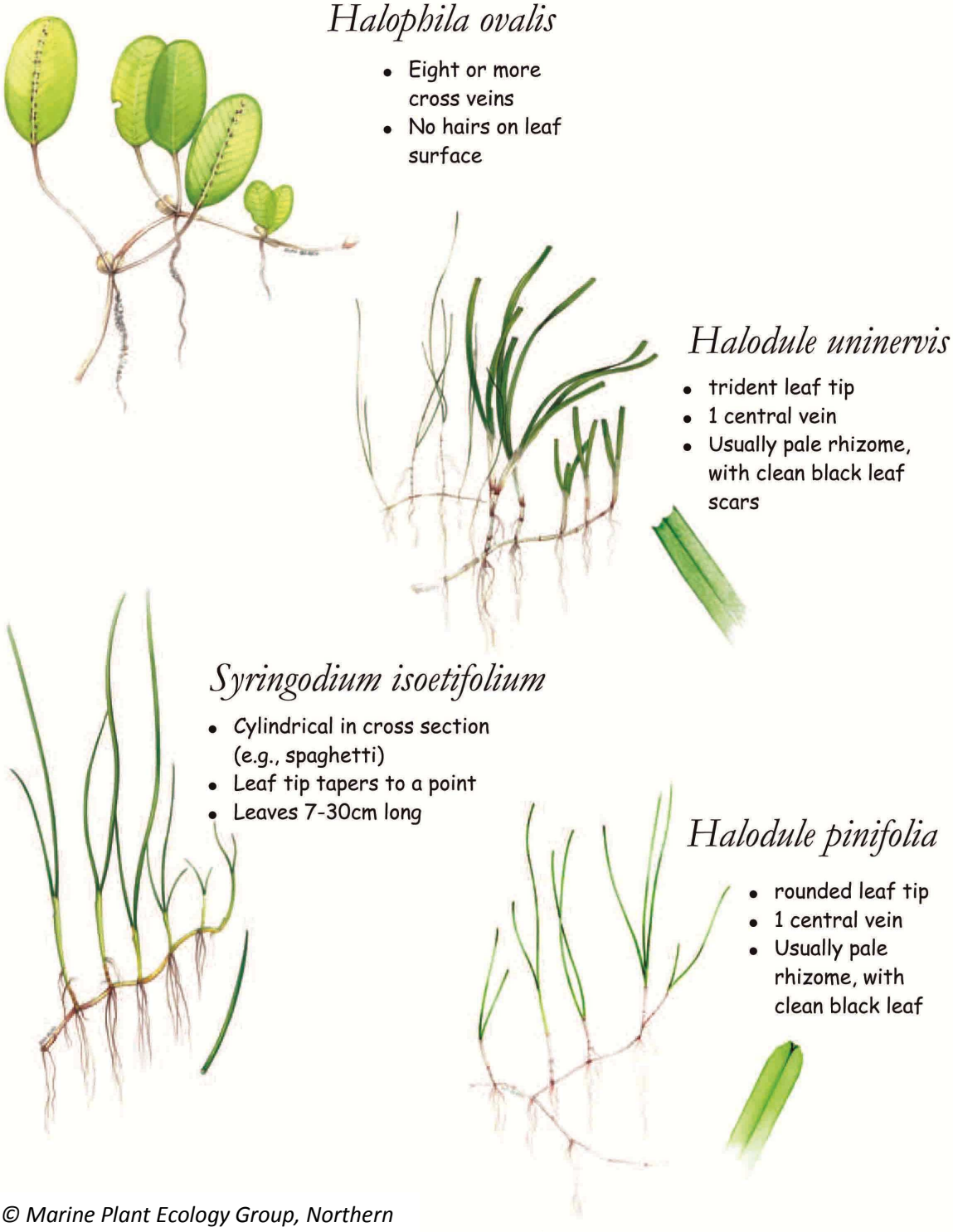


Key Features:

A. Leaves larger than *Rhizophora* spp.
B. Single flowers from a common stalk
C. Fruits hexagonal in cross-section
D. Pneumatophores (knee-roots) present

APPENDIX 4 – FIELD GUIDE TO SEAGRASS SPECIES OF TAVEUNI

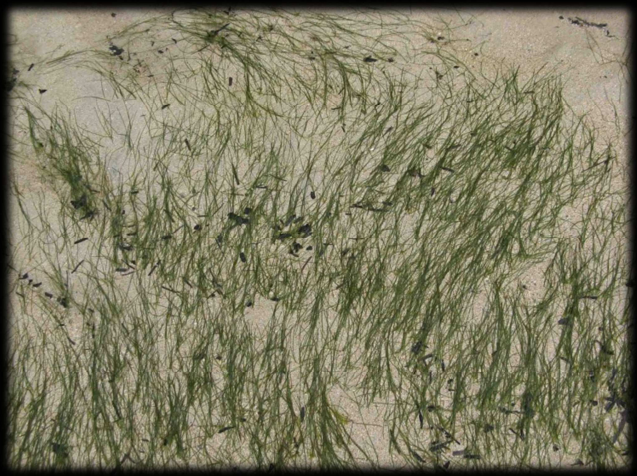
Photos by Dr. Antoine D.R. N'Yeurt, PACE-SD with diagrams © Seagrass-Watch, Cairns, Australia



© Marine Plant Ecology Group, Northern Fisheries Centre, Cairns, Australia

Halodule uninervis
Naselesele

Syringodium isoetifolim
Naselesele



Halodule pinifolia
Vunitarawau

Halophila ovalis
Vunitarawau

APPENDIX 5 – Listing of Marine Plants from Taveuni and Yanuca

Field#	Genus	Species	Authority	Phylum	Locality	Island	Coll-Date	Lat	Lon	Habitat
T11-20	*Acanthophora*	*spicifera*	(Vahl) Borgesen	Rhodophyta	Matei	Taveuni	24/11/2011	16.69873°	179.86440°	Drain next to Bula Bhai shop
T11-21	*Centroceras*	*clavulatum*	(C. Agardh) Montagne	Rhodophyta	Matei	Taveuni	24/11/2011	16.69873°	179.86440°	Drain next to Bula Bhai shop
T11-19	*Rhizoclonium*	*africanum*	Kützing	Chlorophyta	Matei	Taveuni	24/11/2011	16.69873°	179.86440°	Drain next to Bula Bhai shop
T11-22	*Ulva*	*intestinalis*	Linnaeus	Chlorophyta	Matei	Taveuni	24/11/2011	16.69873°	179.86440°	Drain next to Bula Bhai shop
T11-18	*Boodlea*	*composita*	(Harvey) F. Brand	Chlorophyta	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand flats
T11-07	*Bryopsis*	*pennata*	Lamouroux	Chlorophyta	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand flats
T11-06	*Caulerpa*	*cupressoides*	(Vahl) C. Agardh	Chlorophyta	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand flats
T11-11	*Chaetomorpha*	*linum*	(O.F. Müller) Kützing	Chlorophyta	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand flats
T11-16	*Dictyota*	*bartayresiana*	Lamouroux	Phaeophyceae	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand flats
T11-03	*Grateloupia*	*filicina*	(J.V. lamouroux) C. Agardh	Rhodophyta	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-s and flats
T11-04	*Halimeda*	*opuntia*	(Linnaeus) Lamouroux	Chlorophyta	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand f lats
T11-10	*Halimeda*	*distorta*	(Yamada) Hillis-Colinvaux	Chlorophyta	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand flats
T11-15	*Halimeda*	*borneensis*	W.R. Taylor	Chlorophyta	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand flats
T11-09	*Halodule*	*uninervis*	(Forsskål) Ascherson in Boissier	Magnoliophyta	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand flats
T11-12	*Halodule*	*pinifolia*	(Miki) den Hartog	Magnoliophyta	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand flats
T11-05	*Microdictyon*	*umbilicatum*	(Velley) Zanardini	Chlorophyta	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand fla ts
T11-13	*Padina*	*boryana*	Thyvi	Phaeophyceae	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand flats
T11-17	*Padina*	*boryana*	Thyvi	Phaeophyceae	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand flats
T11-14	*Symploca*	*sp.*		Cyanobacteria	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand flats
T11-08	*Syringodium*	*isoetifolium*	(Ascherson) Dandy	Magnoliophyta	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Intertidal mud-sand flats
T11-02	*Ulva*	*lactuca*	Linnaeus	Chlorophyta	Naisogo	Taveuni	24/11/2011	16.69873°	179.86440°	Sandy beach splash zone
T11-44	*Acanthophora*	*spicifera*	(Vahl) Borgesen	Rhodophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-27	*Boodlea*	*composita*	(Harvey) F. Brand	Chlorophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	River mouth, on rocks
T11-41	*Boodlea*	*composita*	(Harvey) F. Brand	Chlorophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-45	*Caulacanthus*	*ustulatus*	(Turner) Kützing	Rhodophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-29	*Caulerpa*	*sertularioides*	(S.G. Gmelin) Howe	Chlorophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	In pools, flats in front of vi llage
T11-23	*Centroceras*	*clavulatum*	(C. Agardh) Montagne	Rhodophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in f ront of village
T11-40	*Chondrophycus*	*parvipapillatus*	(C.K.Tseng) Garbary et J.T.Harper	Rhodophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-28	*Dasya*	*sp.*		Rhodophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	River mouth, on rocks
T11-31	*Dictyota*	*bartayresiana*	Lamouroux	Phaeophyceae	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-35	*Halimeda*	*opuntia*	(Linnaeus) Lamouroux	Chlorophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-38	*Halimeda*	*macroloba*	Decaisne	Chlorophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-32	*Halodule*	*uninervis*	(Forsskål) Ascherson in Boissier	Magnoliophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-34	*Halodule*	*pinifolia*	(Miki) den Hartog	Magnoliophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-33	*Halophila*	*ovalis*	(R. Brown) J.D. Hooker	Magnoliophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-24	*Hypnea*	*sp.2*		Rhodophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-25	*Hypnea*	*pannosa*	J. Agardh	Rhodophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	River mouth, on rocks

T11-37	*Hypnea*	*sp.1*		Rhodophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-39	*Hypnea*	*cf. saidana*	Holmes	Rhodophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-43	*Hypnea*	*pannosa*	J. Agardh	Rhodophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-47	*Laurencia*	*dasyphylla*	(Woodward) C. Agardh	Rhodophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-42	*Spyridia*	*filamentosa*	(Wulfen) Harvey	Rhodophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-30	*Syringodium*	*isoetifolium*	(Ascherson) Dandy	Magnoliophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-26	*Ulva*	*intestinalis*	Linnaeus	Chlorophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	River mouth, on rocks
T11-36	*Ulva*	*flexuosa*	Wulfen	Chlorophyta	Naselesele	Taveuni	25/11/2011	16.69579°	179.86605°	Mud-sand flats in front of vil lage
T11-62	*Phormidium*	*sp.*		Cyanobacteria	Qeleni	Taveuni	26/11/2011	16.75990°	179.85921°	Entrance of freshwater spring
T11-54	*Boodlea*	*composita*	(Harvey) F. Brand	Chlorophyta	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-61	*Chaetomorpha*	*linum*	(O.F. Müller) Kützing	Chlorophyta	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-52	*Chondrophycus*	*parvipapillatus*	(C.K.Tseng) Garbary et J.T.Harper	Rhodophyta	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-51	*Halimeda*	*borneensis*	W.R. Taylor	Chlorophyta	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-59	*Halodule*	*pinifolia*	(Miki) den Hartog	Magnoliophyta	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-60	*Halodule*	*uninervis*	(Forsskål) Ascherson in Boissier	Magnoliophyta	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-48	*Halophila*	*ovalis*	(R. Brown) J.D. Hooker	Magnoliophyta	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-53	*Hincksia*	*mitchelliae*	(Harvey) P.C. Silva	Phaeophyceae	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-58	*Laurencia*	*sp.*		Rhodophyta	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-49	*Neomeris*	*vanbosseae*	Howe	Chlorophyta	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-50	*Padina*	*boryana*	Thyvi	Phaeophyceae	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-56	*Polysiphonia*	*sp.*		Rhodophyta	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-55	*Tolypiocladia*	*glomerulata*	(C. Agardh) F. Schmitz	Rhodophyta	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-57	*Ulva*	*intestinalis*	Linnaeus	Chlorophyta	Vunitarawai	Taveuni	26/11/2011	16.74774°	179.86157°	Sandy flats in front of eroded area
T11-74	*Halodule*	*pinifolia*	(Miki) den Hartog	Magnoliophyta	Qilo	Yanuca	28/11/2011	16.49742°	179.69647°	Fringing reef flat
T11-77	*Turbinaria*	*ornata*	(Turner) J. Agardh	Phaeophyceae	Qilo	Yanuca	28/11/2011	16.49742°	179.69647°	Fringing reef flat
T11-76	*Caulerpa*	*antoensis*	Yamada	Chlorophyta	Village	Yanuca	28/11/2011	16.50234°	179.69157°	Fringing reef flat
T11-65	*Colpomenia*	*sinuosa*	(Mertens ex Roth) Derbès er Solier	Phaeophyceae	Village	Yanuca	28/11/2011	16.50234°	179.69157°	Fringing reef flat
T11-72	*Dictyota*	*bartayresiana*	Lamouroux	Phaeophyceae	Village	Yanuca	28/11/2011	16.50234°	179.69157°	Fringing reef flat
T11-67	*Halimeda*	*borneensis*	W.R. Taylor	Chlorophyta	Village	Yanuca	28/11/2011	16.50234°	179.69157°	Fringing reef flat
T11-75	*Halodule*	*uninervis*	(Forsskål) Ascherson in Boissier	Magnoliophyta	Village	Yanuca	28/11/2011	16.50234°	179.69157°	Fringing reef flat
T11-70	*Hydroclathrus*	*clathratus*	(C. Agardh) M.A. Howe	Phaeophyceae	Village	Yanuca	28/11/2011	16.50234°	179.69157°	Fringing reef flat
T11-68	*Liagora*	*sp.*		Rhodophyta	Village	Yanuca	28/11/2011	16.50234°	179.69157°	Fringing reef flat
T11-69	*Padina*	*boryana*	Thyvi	Phaeophyceae	Village	Yanuca	28/11/2011	16.50234°	179.69157°	Fringing reef flat
T11-73	*Padina*	*boryana*	Thyvi	Phaeophyceae	Village	Yanuca	28/11/2011	16.50234°	179.69157°	Fringing reef flat
T11-66	*Rhizoclonium*	*africanum*	Kützing	Chlorophyta	Village	Yanuca	28/11/2011	16.50234°	179.69157°	Fringing reef flat
T11-71	*Sargassum*	*polycystum*	C. Agardh	Phaeophyceae	Village	Yanuca	28/11/2011	16.50234°	179.69157°	Fringing reef flat
T11-64	*Tricleocarpa*	*fragilis*	(Linnaeus) Huisman et Townsend	Rhodophyta	Village	Yanuca	28/11/2011	16.50234°	179.69157°	Fringing ree f flat