Climate change vulnerability assessments for communities in six Pacific Island countries: Fiji, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu

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Abbreviations

CCA	Climate change adaptation
CHICCAP	Choiseul Integrated Climate Change Adaptation Programme
FAD	Fish aggregating device
FAO	Food and Agriculture Organization of the United Nations
GIZ	German Agency for International Development Cooperation
HIES	Household income and expenditure survey
LRD	Land Resources Division (of SPC)
NGO	Non-governmental organisation
PRA	Participatory rural appraisal
SPC	Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
V&A	Vulnerability and adaptation
WHO	World Health Organization

Executive summary

This report captures the participatory rural appraisal (PRA) process used to assess climate change vulnerability and develop proposed adaptation interventions for a number of communities in Fiji, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu. It is intended for climate change and agriculture practitioners, policy-makers and researchers in the Pacific region.

Vulnerability analyses of the selected communities in the six project pilot countries were carried out using three main methods: land use surveys, participatory rural appraisals (PRAs), and household and income expenditure surveys (HIES). These were followed by food security analyses. The findings informed the development of proposed adaptation interventions.

Prior to work being carried out with the communities, consultations were held with sector experts on vulnerability indicators, data needs and appropriate methods of assessment. In addition, previous research, field assessments, policies and reports relating to climate change, disasters and development in the countries were reviewed.

Measuring a community's vulnerability requires an assessment of a set of parameters. Using the PRA tools, quantitative and descriptive information was collected from communities on three tenets of vulnerability – exposure, sensitivity and adaptive capacity, and these were used to determine overall vulnerability. The higher the index, the more vulnerable the community is to projected climate change effects.

In general, the PRAs for the various project sites found relatively high exposure and high sensitivity indices and these, combined with relatively low adaptive capacities, produced high vulnerability assessments for the selected communities. Household income and expenditure surveys found a trend of increasing reliance on imported foodstuffs. With impacts of climate change inevitable, the selected communities face an uncertain future where food security and sustainable livelihoods may be compromised. As a next step, work plans for adaptation strategies for these sites are being developed in a participatory process, while the communities are finalising land and labour requirements for the demonstration farms and construction of nurseries.

1. Introduction

The project 'Vegetation and land cover mapping and improving food security for building resilience to a changing climate in Pacific island communities', undertaken by the Pacific Community (SPC) and the United States Agency for International Development (USAID), ran from January 2012 to February 2016. The main goal of the USD 4 million regional project was to evaluate and implement innovative techniques and management approaches to increase climate change resilience of terrestrial food production systems for communities in selected Pacific Island countries (Fiji, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu).

In each country, a number of national climate change vulnerability and adaptation assessment studies had already been carried out in the past and incorporated into reports such as the national reports for the United Nations Framework Convention on Climate Change (UNFCCC). These national reports offer broad guidelines on impacts, vulnerabilities and adaptation measures required at the sectoral level. However, whilst providing context and guidance, they are too general to adequately inform adaptation implementation at the community level. The vulnerability assessments reported here focused on a community approach in order to ensure relevance and ownership of issues at the community level. This recognises that people and communities are the ones that must adapt.

Pilot project site(s) in each country were selected by the national governments based on the following criteria:

- high population (>100 people);
- geophysical factors (low-lying, unsheltered coastline or close to a river);
- already experiencing environmental degradation and over-exploitation of natural resources;
- stressed coastal fisheries, degraded forests and coral reefs;
- experiencing reduced crop yields;
- has experienced destruction of food crops, coastal erosion, severe storm surges and/or inundation as a result of tropical cyclones;
- is an organised community (from previous experience and opinion) which would support a climate change programme.

Detailed vulnerability assessments were carried out on land-based agricultural production systems in the selected communities in the six countries, to identify appropriate adaptation measures to the impacts of climate change. More specifically, the project set out to:

- assess the degree of vulnerability to climate change of food production systems in the selected communities;
- assess their food security situation; and
- identify adaptation measures to improve resilience of their food production systems.

The project worked with selected rural communities in Fiji, Samoa, Tonga and Vanuatu. In Kiribati and Solomon Islands, where a whole-of-island approach is being implemented by multiple development partners in conjunction with national and local governments, vulnerability assessments relating to food security formed part of a much broader vulnerability assessment spanning multiple sectors and multiple agencies. These integrated assessments were carried out with all communities on Abaiang Atoll in Kiribati and Choiseul Province in Solomon Islands under the whole-of-island climate change programmes. A number of other villages were also investigated in these countries. This approach is driven by national governments to facilitate a coordinated and sustainable approach for climate change and disaster-related projects and programmes.

In order to develop successful adaptation strategies, it is important to also understand the governance and social structures that drive current trends and relate them to people's ability to adapt. Therefore, future assessments would greatly benefit from the inclusion of a social scientist in the assessment team.

Figure 1.1. Ms Maria Elder-Ratutokarua of the Land Resources Division of SPC conducting a participatory session with the women of Sepa Village, Choiseul Province, Solomon Islands.

2. Methodology

Vulnerability analyses of the selected communities in the six project pilot countries were carried out using three main methods: land use surveys, participatory rural appraisals (PRAs), and household and income expenditure surveys (HIES). These were followed by food security analyses. The findings informed the development of proposed adaptation interventions.

Prior to work being carried out with the communities, consultations were held with sector experts on vulnerability indicators, data needs and appropriate methods of assessment. In addition, previous research, field assessments, policies and reports relating to climate change, disasters and development in the countries were reviewed.

Land use surveys

The main objective of the land use assessments was to collect biophysical and baseline data on soils, land use capability, land tenure and current land uses. Satellite images (1:10,000) were used to identify land use types, while field surveys were carried out to clarify land use types. The field findings were integrated into a geographic information system (GIS) which was used to prepare soil, land capability, land tenure and land use maps.

Participatory rural appraisal

Participatory rural appraisal (PRA) was chosen as the main method for assessing the vulnerability of food security of the selected communities to the impacts of climate change. PRA is an approach widely used by non-governmental organisations (NGOs) and other agencies involved in sustainable development. The approach aims to incorporate the knowledge and opinions of rural people in the planning and management of development projects and interventions. Without community commitment, participation and engagement, these projects and interventions have less chance of achieving their goals.

PRAs place emphasis on empowering local people to assume an active role in analysing their own living conditions, problems and potential in order to seek a change in their situation. These changes are supposed to be achieved by collective action and the communities are invited to assume responsibility for implementing activities. Figure 2.1 shows the steps and tools used in the PRA process.

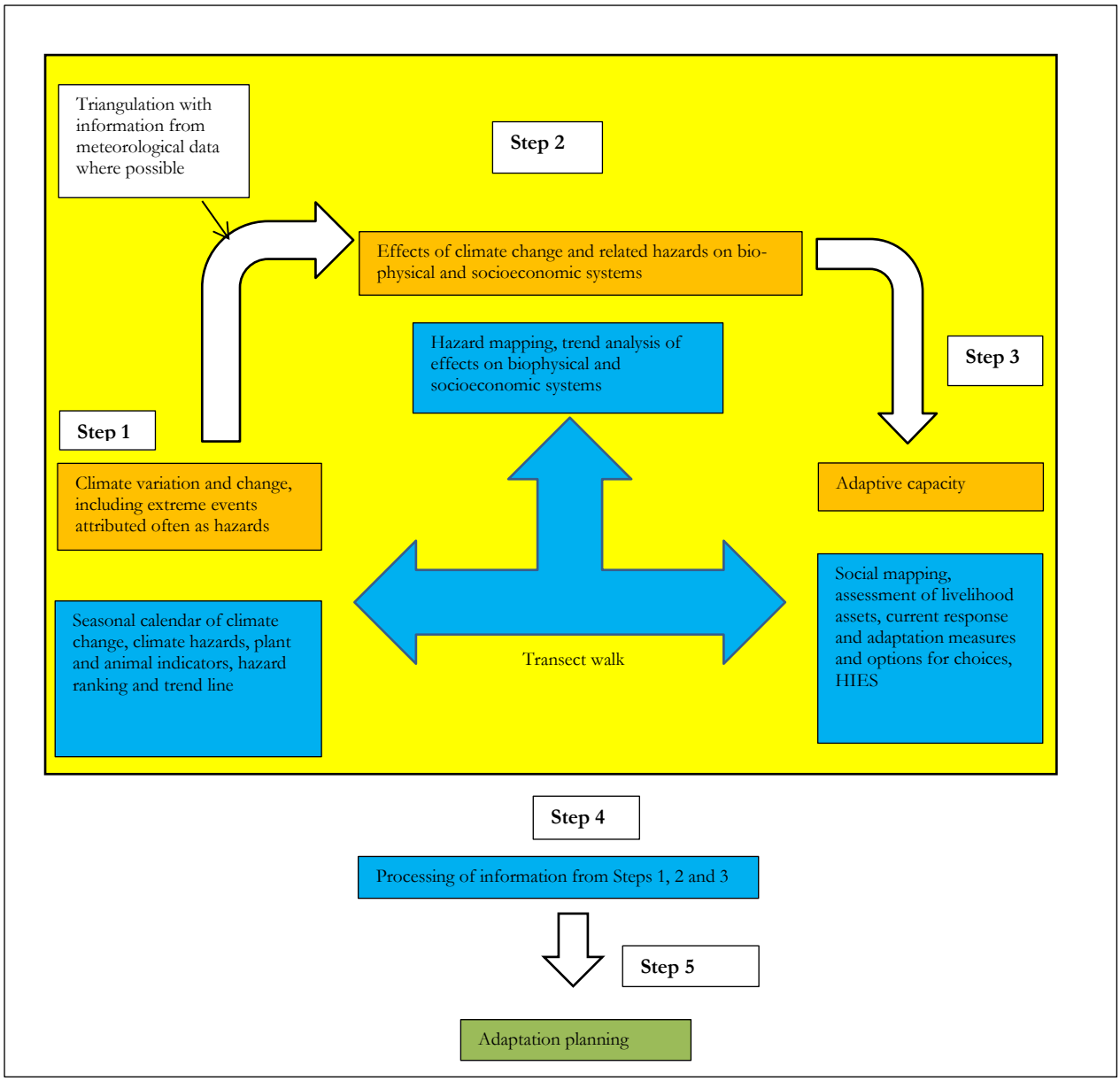

Figure 2.1. The PRA framework and process.

In each village or community, participants were divided into groups of men, women and youth. Facilitators recorded the perceptions of the different groups in the communities during each step and the information was collated for analysis. Separating the communities into groups helped overcome cultural barriers and ensure that women's and youth's points of view and specific needs were captured.

The following participatory appraisal tools were used in different combinations to gather information on aspects of vulnerability:

- seasonal calendar;
- hazard prioritisation;
- cause and effect analysis;
- historic time line assessment;
- hazard mapping;
- resources mapping;
- livelihood assessment (via HIES);
- institutional assessment.

Assessing vulnerability

Using the PRA tools, elements of exposure (E), sensitivity (S) and adaptive capacity (A) were assessed by the communities. Each element was judged as low (numerical value 1), medium (2), high (3) or very high (4), and the results for the elements were combined to arrive at an overall score for the E, S and A indices.

The vulnerability assessments were based on the concept that vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, the system's resulting sensitivity, and its adaptive capacity[1]. This definition is described in the following equation:

$V = E \times S/A$

where V = vulnerability, E = exposure, S = sensitivity and A = adaptive capacity.

Vulnerability is defined as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

Exposure is defined as the nature and degree to which a system is exposed to significant climatic variations. Climate variation includes average climate change and extreme climate variability. Exposure as used in this document is the character, magnitude and rate of climate variation at the local level. The more the local climate has changed or deviated from its historical condition or trend, the higher the exposure value (E) will be; and the higher the value of E, the more the system is exposed to new climate, leading to high vulnerability. E is assessed through assessment of change in elements of climate over time – temperature, precipitation, and the hazards that can affect whole or part of the system on which community livelihoods are dependent or linked.

Sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate-related factors. The effect may be direct, e.g. a change in crop yield in response to a change in the mean, range or variability of temperature; or indirect, e.g. damages caused by an increase in the frequency of coastal flooding due to sea-level rise, floods, landslides, etc. Sensitivity as used in this document is the effect of local climate change and related hazards on local systems, both biophysical and socio-economic. Highly sensitive systems (high value of S) will be more impacted compared to less sensitive systems, even with the same level of climate change or hazards. Therefore the more the system is sensitive to climate change and related hazards, the more the system is vulnerable to climate change. Sensitivity of a system is measured through assessment of effects or impacts or damages of the system from climate change and related hazards.

Adaptive capacity is defined as the ability of a system (in this case the community) to adjust to climate change (including climate variability and extremes), to mitigate potential damages, to take advantage of opportunities, or to cope with the consequences.

Climate change vulnerability assessment assesses E, S and A and their elements through community tools and methodologies.

Following participatory assessment, a transect walk was carried out to validate the findings of the assessments. A transect walk is a systematic walk along a defined path (transect) across the community/project area together with the local people to explore the resources in question by observing, asking, listening, looking and producing a transect diagram.

The findings from the transect walk were combined with the assessment results to conduct food security analyses for each community, which in turn guided the formulation of proposed adaptation strategies in consultation with communities.

[1] From the Participatory Rural Appraisal Manual developed for the project by Dr Siosiua Halavatau of SPC.

3. Fiji: Korobebe, Nagado, Naboutini, Koroiyaca and Narokorokoyawa villages (Sabeto catchment)

3.1. Pilot site

The Sabeto catchment close to Nadi on Fiji's main island of Viti Levu was selected as the pilot site, based on the following criteria:

- The catchment enabled a 'ridge-to-reef' approach.
- There are a range of farming systems and climate change, food security and land management issues.
- Demonstration sites could be established in the upper, middle and lower catchments, which are characterised as follows:
  - the upper catchment is dominated by forestry and grazing;
  - the middle catchment has a lot of farming/agricultural activities, leading to issues on food security, climate change adaptation, land tenure, agriculture leases and land degradation;
  - the lower catchment is being developed for tourism and is also the main outlet to the sea/reefs.
- There was a need to establish the land care concept/land care groups in the catchment.
- Baseline data existed for the catchment in areas such as soils, land use capability and land use.

Five villages were selected to represent the upper, middle and lower catchments: Korobebe, Nagado, Naboutini, and Koroiyaca and Narokorokoyawa (the latter two are together known as Sabeto Village).

Sabeto catchment covers 13,819 ha and is located halfway between Nadi and Lautoka (Figure 3.1). The Sabeto road turnoff is about 10 minutes north of Nadi international airport. The catchment is located in the Ba Province in the Western Division of Viti Levu and comprises Sabeto, Nalotawa, Nadi, Vuda and Vaturu districts.

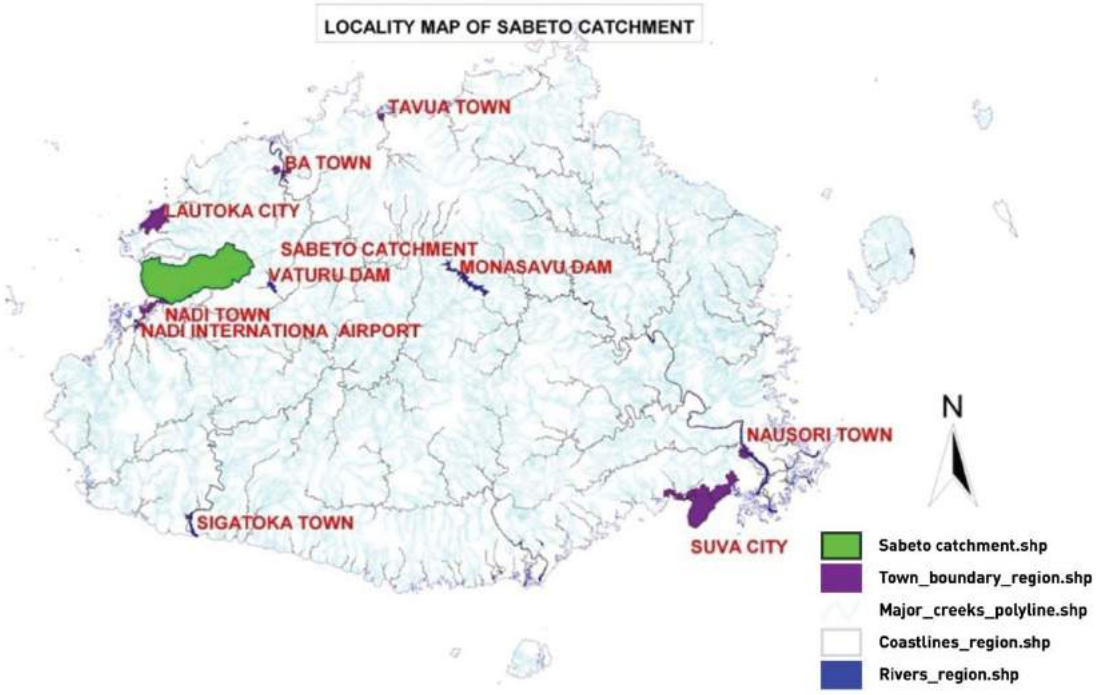

Figure 3.1. Sabeto catchment in western Viti Levu. Source: LRD, SPC (2014).

A prominent feature of the landscape is a mountainous area known as the Sleeping Giant, which lies to the northwest. There are two mountain ranges – one, the Sabeto range, includes the peaks Drelaga (618 m) and Koroyanitu (1195 m) and leads into the other, the Mt Evans range. The Sabeto River has its source at Koroyanitu peak and flows through the hills of Naivilawa down to Korobebe, Naboutini, Natalau and Koroiyaca and out towards Naisoso Island and Lomolomo beach.

3.2. Vulnerability analysis methods

A 20-member team consisting of 10 Pacific Community (SPC) staff and 10 Ministry of Agriculture staff was formed to undertake the vulnerability analysis of the community at the Sabeto catchment. Three methods were used in the analysis:

- land use surveys, as follows:
  - 1:10,000 satellite images were used to identify land use types;
  - field surveys were carried out to clarify land use types;
  - field findings were integrated into a geographic information system (GIS); and
  - GIS was used to prepare soil, land capability, land tenure and land use maps;
- participatory rural appraisals (PRAs); and
- household income and expenditure surveys (HIES).

The land use survey was carried out by staff of the Ministry of Agriculture and SPC's Land Resources Division (LRD). The field work provided a description of the land resources and their availability, limitations and potential. The main objective of the land use assessment was to collect biophysical and baseline data for the catchment in areas such as soil, land use capability, land tenure and current land uses, and to prepare soil maps and land use capability maps for the catchment.

During the PRA sessions with the communities, a presentation was made on climate change, which used appropriate language and visual aids to explain the science of climate change, evidence for climate change and observed trends, and climate projections and possible impacts. The feedback from the participants varied between the communities, but subjects of discussion that were common to all communities related to seasonality of crops (in particular breadfruit) and behaviour of some animals, along with changes in landscapes caused by landslides and flooding. For many participants, it was the first time they had heard about climate change. It was noted that the median age of the participants was mid-fifties, and that only a few youths participated.

3.3. Results of the land use survey

Soil types

The most common soils of the catchment are nigrescent soils (covering 36% of the area) (Figure 3.2). These are dark soils (black or dark grey) that are moderately fertile to fertile. They are frequently cultivated and support a diverse range of crops. These soil types occur mostly on the foothills of the Sabeto range, close to Naboutini, Keolaiya and Nadele.

Red/yellow podzolic soils occur mostly on the rolling and hilly lands of Naivilawa and Korobebe and Votualevu and cover 17% of the area. These are yellow-brown sandy soils and support mainly shrubs and grassland.

Humic latosols (red soils) occur mostly in the forested areas in Naivilawa and the foothills of Keolaiya, Votualevu, Naboutini and Legalega. This soil type covers 26% of the catchment. These are highly leached, acidic soils and not very fertile.

Soils of the coastal and river flats make up 18% of the catchment soils. These include saline soils of the marine marsh that occur at the Sabeto river mouth and support mangroves or have been reclaimed for hotel development; soils of the floodplains (alluvial soils) which are deep, well-drained and fertile soils, and are used mainly for vegetable and sugarcane farming; and gley soils which are soils with high clay content and poorly drained.

Ferruginous latosols or talasiga soils cover only 1% of the area. These are degraded humic latosols and occur mostly in Korobebe area. They are highly weathered and low in cation exchange capacity and show evidence of erosion.

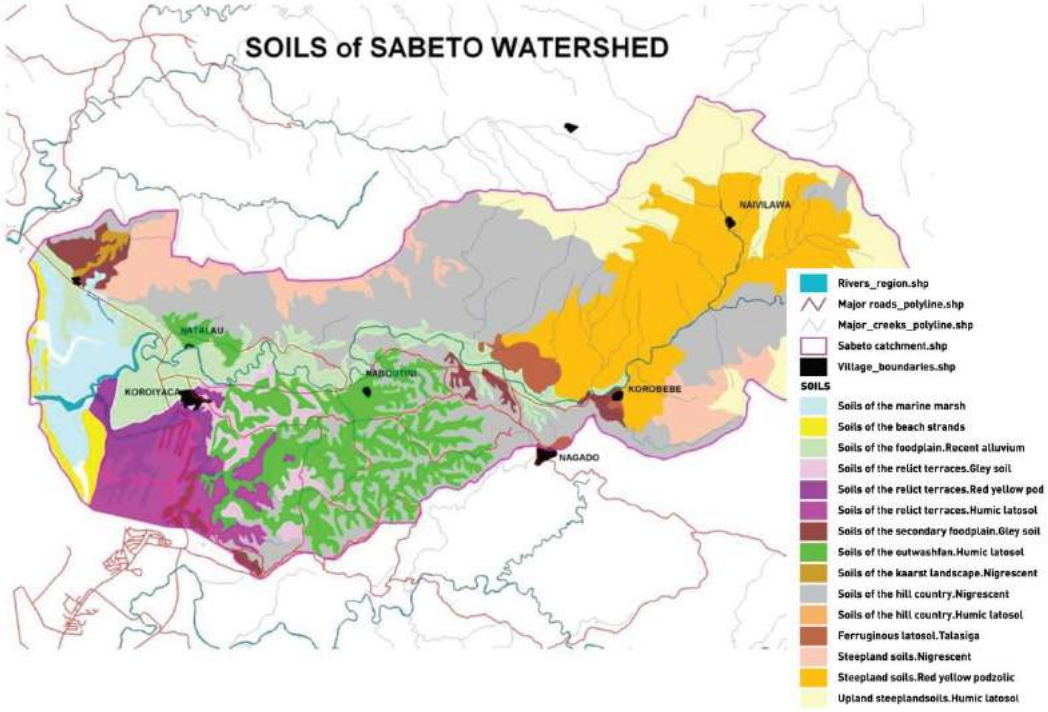

Figure 3.2. Soils of the Sabeto watershed. Source: LRD, SPC (2014).

Land use capability

Land use capability is a system of classification of land according to properties that determine its suitability for productive use. Figure 3.3 shows the land use capability of the Sabeto catchment area.

Land class II covers 22% of the catchment. This is good arable land (0–7° slope), well drained to moderately drained, deep to slightly shallow and fertile to moderately fertile. Class II land is confined mainly to alluvial areas and floodplains. The land can be used for arable cultivation.

Land class III (10%) is fair arable land with moderate limitations restricting the choice of crops that can be grown. The land is gently sloping, and subject to frequent flooding. Class III land occurs mainly in areas of gley soils, secondary floodplains and relict terraces. The land maybe used for arable cultivation, pasture or forestry.

Land class IV (7%) is marginal arable land with severe limitations that restrict the choice of crops grown or necessitate intensive conservation treatment and very careful management.

The largest area of land is categorised as class VI (33%), which describes areas of fans and outwash surfaces, with infertile soils with very low moisture-holding capacity. This is marginal pastoral land with moderate to severe limitations. Pasture should be suitable on this land class but its management will require special attention.

Land class VII (23%) occurs mainly in the hill country, and includes nigrescent, humic latosol and ferruginous latosol soils. This land class is generally unsuitable for pastoral use, but may be suitable for forestry. It comprises land that is either very steep or highly susceptible to erosion. Commercial forestry or protection forestry may be practised, or the land may be best left untouched in its natural state.

Class VIII land (4%) is generally unsuitable for productive use in either agriculture or forestry. It is very steep mountainous land and includes peat and mangrove swamps. Class VIII land is best protected in its natural state for watershed and wildlife conservation.

The catchment has some good arable land (classes II–IV, 40%) with slope ranging from 4° to 15° (flat to rolling slopes). More than half of the land (56% or 7775 ha) is in classes V–VII with slope ranging from 16° to 35° (strongly rolling slopes/steep/very steep slopes). This land is not suitable for arable cultivation, but it is suitable for pastoral or forestry use. The remaining land, in class VIII, has extremely steep slopes (more than 35°) and is suitable only for protective purposes.

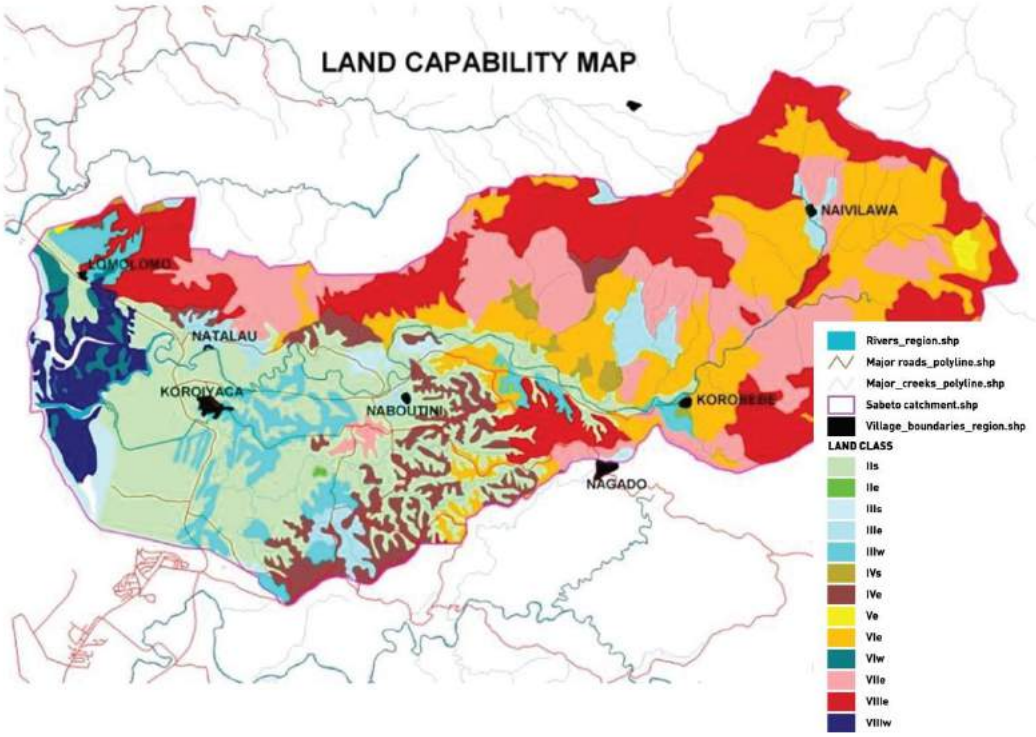

Figure 3.3. Land capability map of Sabeto catchment. Source: LRD, SPC (2014).

Land tenure

Almost 96% of the catchment is native land while the remaining 4% is freehold. Consultation with landowners is vital before any development takes place in the catchment.

Land use

Much of the catchment is under forest (40%). Grassland and shrubs cover 26% of the catchment area. Parts of the lower and middle reaches of the catchment are cultivated with sugarcane (15%) and other crops and vegetables (2%). Cropland is located mainly on the gentle slopes, but there is also some cropland on the steeper slopes. Uncultivated lands make up only 1% of the catchment area. Urban uses (residential, commercial, hotels and recreation) occupy 7% of the catchment.

3.4. Vulnerability assessments

Vulnerability assessment for Korobebe village

Table 3.1 presents the results of the analysis of Korobebe village's exposure to climate change. The average score for exposure is high (3.18). Changes in rainfall patterns and the frequency of landslides were ranked very high.

Table 3.1. Assessment of elements of exposure (E) for Korobebe village.

Parameter	Indicator	Perceived change	Score
Temperature	Numbers of hot days increased	High (4)	3 (High)
	Number of cold days decreased	Medium (2)	
Precipitation	Rainfall has become increasingly unpredictable	Very high (4)	4 (Very high)
Plant and animal behaviour	Changes in flowering and fruiting of fruit trees like breadfruit and mango	High (3)	3 (High)
	Changes in animal behaviour such as egg laying by chickens	High (3)	
Climate-induced disasters	Landslide	Very high (4)	2.75 (High)
	Drought	Medium (2)	
	Fire	Medium (2)	
	Cyclone	High (3)	
Average exposure score			3.18 (High)

Table 3.2 shows that the sensitivity of Korobebe village to the adverse impacts of climate and related effects is medium to high (2.47). The highest perceived sensitivities to climate change were in the areas of agriculture and food security, forest and biodiversity, water resources and human health.

Table 3.2. Assessment of elements of sensitivity (S) for Korobebe village.

Parameter	Hazard	Indicator	Perceived change	Score
Agriculture and food security	Landslides	Loss of productive lands	High (3)	2.33 (High)
	Drought	Loss of crop production	Medium (2)	
	Outbreak of diseases	Production decline	Medium (2)	
Forest and biodiversity	Landslides	Loss of forest cover	High (3)	2.5 (High)
	Fire	Loss of biodiversity	Medium (2)	
Infrastructure	Landslides	Trails and roads damaged	Medium (2)	2 (Medium)
Water resources and energy	Landslides	Loss of fresh water (buried)	High (3)	2.5 (High)
	Drought	Reduction of fresh water	Medium (2)	
Human health	Landslides	Emergence of water-borne diseases	High (3)	3 (High)
Overall sensitivity score				2.47 (High)

Table 3.3 shows the adaptive capacity of Korobebe village to climate change impacts in relation to agricultural systems and livelihoods. The adaptive capacity is medium.

Table 3.3. Assessment of elements of adaptive capacity (A) for Korobebe village.

Parameter	**Indicator**	**Criteria**	**Perceived change**	**Score**
Human assets	Demography	Old age and children	High (3)	2 (Medium)
	Education	Secondary education and awareness of climate change	Medium (2)	
	Skilled labour	Trained workers	Low (1)	
Natural assets	Land	Land ownership and productivity	High (3)	2.66 (High)
	Forest	Availability of products and services	Medium (2)	
	Water	Availability of drinking water	High (3)	
Financial assets	Financial institutions	Banks, cooperatives	Medium (2)	2 (Medium)
	Household incomes	Sufficiency for household needs	Medium (2)	
Social assets	Social institutions	Community affiliations to formal and non-formal institutions	Medium (2)	1.5 (Low)
	Service providers	Engagement of government and non-governmental organisations (NGOs) with community	Low (1)	
Physical assets	Infrastructure for services	Access to schools, houses, bridges, roads, electricity, health posts; vehicle availability	Medium (2)	2 (Medium)
	Information and communication sources	Access to mobile phones, radio, TV, newspapers, and internet	Medium (2)	
Overall adaptive capacity score				2.03 (Medium)

Vulnerability = E × S/A

= 3.18 × 2.47/2.03

= 3.87

Vulnerability for Korobebe village is therefore high.

Vulnerability assessment for Nagado village

Table 3.4 shows the results for the analysis of community exposure to climate change. The exposure for Nagado village is high (3.18).

Table 3.4. Assessment of elements of exposure (E) for Nagado village.

Parameter	**Indicator**	**Perceived change**	**Score**
Temperature	Numbers of hot days increased Number of cold days decreased	High (4) Medium (2)	3 (High)
Precipitation	Rainfall has become increasingly unpredictable	Very high (4)	4 (Very high)
Plant and animal behaviour	Changes in flowering and fruiting of fruit trees like breadfruit and mango Changes in animal behaviour such as egg laying by chickens	High (3) High (3)	3 (High)
Climate-induced disasters	Landslide Drought Fire Cyclone	Very high (4) Medium (2) Medium (2) High (3)	2.75 (High)
Overall exposure score			3.18 (High)

Table 3.5 shows the sensitivity of Nagado village to climate change impacts. The overall sensitivity score is high (2.43).

Table 3.5. Assessment of elements of sensitivity (S) for Nagado village.

Parameter	**Hazard**	**Indicator**	**Perceived change**	**Score**
Agriculture and food security	Landslides	Loss of productive lands	High (3)	2.5 (High)
	Drought	Loss of crop production	Medium (2)	
	Outbreak of diseases	Production decline	Medium (2)	
	Cyclones	Damage to crops	High (3)	
Forest and biodiversity	Landslides	Loss of forest cover	High (3)	2.33 (High)
	Fire	Loss of biodiversity	Medium (2)	
	Cyclones	Damage to trees	Medium (2)	
Infrastructure	Landslides	Trails and roads damaged	Medium (2)	2 (Medium)
Water resources and energy	Landslides	Loss of fresh water (buried)	High (3)	2.33 (High)
	Drought	Reduction of fresh water	Medium (2)	
	Cyclones	Damage to infrastructure	Medium (2)	
Human health	Landslides	Emergence of water-borne diseases	High (3)	3 (High)
Overall sensitivity score				2.43 (High)

Table 3.6 shows the adaptive capacity for Nagado village to climate change. The overall adaptive capacity is medium (2.06).

Table 3.6. Assessment of elements of adaptive capacity (A) for Nagado village.

Parameter	**Indicator**	**Criteria**	**Perceived change**	**Score**
Human assets	Demography	Old age and children	High (3)	2 (Medium)
	Education	Secondary education and awareness of climate change	Medium (2)	
	Skilled labour	Trained workers	Low (1)	
Natural assets	Land	Land ownership and productivity	High (3)	2.33 (High)
	Forest	Availability of product and services	Medium (2)	
	Water	Availability of drinking water	Medium (2)	
Financial assets	Financial institutions	Banks, cooperatives	Medium (2)	2 (Medium)
	Household incomes	Sufficiency for household needs	Medium (2)	
Social assets	Social institutions	Community affiliations to formal and non-formal institutions	Medium (2)	2 (Medium)
	Service providers	Engagement of government and NGOs with community	Medium (2)	
Physical assets	Infrastructure for services	Access to schools, houses, bridges, roads, electricity, health posts; vehicle availability	Medium (2)	2 (Medium)
	Information and communication sources	Access to mobile phones, radio, TV, newspapers, and internet	Medium (2)	
Overall adaptive capacity score				2.06 (Medium)

Vulnerability = E × S/A

= 3.18 × 2.43/2.06

= 3.75

Vulnerability for Nagado village is therefore high.

Vulnerability assessment for Naboutini village

Table 3.7 shows the results for the analysis of community exposure to climate change. The exposure for Naboutini village is high (2.96).

Table 3.7. Assessment of elements of exposure (E) for Naboutini village.

Parameter	**Indicator**	**Perceived change**	**Score**
Temperature	Numbers of hot days increased Number of cold days decreased	High (4) Medium (2)	3 (High)
Precipitation	Rainfall has become increasingly unpredictable	High (3)	3 (High)
Plant and animal behaviour	Changes in flowering and fruiting of fruit trees like breadfruit and mango Changes in animal behaviour like egg laying by chickens	High (3) Medium (2)	2.5 (High)
Climate-induced disasters	Flood Fire Cyclone	Very high (4) Medium (2) Very high (4)	3.33 (High)
Overall exposure score			2.96 (High)

Table 3.8 shows the sensitivity of Naboutini village to climate change impacts. The overall sensitivity score is high (2.9).

Table 3.8. Assessment of elements of sensitivity (S) for Naboutini village.

Parameter	**Hazard**	**Indicator**	**Perceived change**	**Score**
Agriculture and food security	Floods	Loss of productive lands and farm animals	High (4)	3 (High)
	Outbreak of diseases	Production decline	Medium (2)	
	Cyclones	Loss of crops	High (3)	
Forest and biodiversity	Floods	Loss of forest cover	High (3)	2.5 (High)
	Fire	Loss of biodiversity	Medium (2)	
Infrastructure	Floods	Trails, roads and settlements are damaged	High (3)	3 (High)
	Cyclones	Damage to buildings and public utility	High (3)	
Water resources and energy	Floods	Loss of fresh water (contaminated)	High (3)	3 (High)
	Cyclones	Damage to water infrastructure	Medium (3)	
Human health	Floods	Emergence of water-borne diseases	High (3)	3 (High)
Overall sensitivity score				2.9 (High)

Table 3.9 shows the adaptive capacity for Naboutini village to climate change. The overall adaptive capacity is medium (1.97).

Table 3.9. Assessment of elements of adaptive capacity (A) for Naboutini village.

Parameter	**Indicator**	**Criteria**	**Perceived change**	**Score**
Human assets	Demography	Old age and children	High (3)	2 (Medium)
	Education	Secondary education and awareness of climate change	Medium (2)	
	Skilled labour	Trained workers	Low (1)	
Natural assets	Land	Land ownership and productivity	Medium (2)	2.33 (High)
	Forest	Availability of product and services	Medium (2)	
	Water	Availability of drinking water	High (3)	
Financial assets	Financial institutions	Banks, cooperatives	Medium (2)	1.5 (Medium)
	Household incomes	Sufficiency for household needs	Low (1)	
Social assets	Social institutions	Community affiliations to formal and non-formal institutions	Medium (2)	2 (Medium)
	Service providers	Engagement of government and NGOs with community	Medium (2)	
Physical assets	Infrastructure for services	Access to schools, houses, bridges, roads, electricity; vehicle availability	High (2)	2 (High)
	Information and communication sources	Access to mobile phones, radio, TV, newspapers, and internet	Medium (2)	
Overall adaptive capacity score				1.97 (Medium)

Vulnerability = E × S/A

= 2.96 × 2.9/1.97

= 4.35

Vulnerability for Naboutini village is therefore very high.

Vulnerability assessment for Sabeto village

Table 3.10 shows the results for the analysis of community exposure to climate change. The exposure for Sabeto village is high (3.12).

Table 3.10. Assessment of elements of exposure (E) for Sabeto village.

Parameter	**Indicator**	**Perceived change**	**Score**
Temperature	Numbers of hot days increased Number of cold days decreased	High (4) Medium (2)	3 (High)
Precipitation	Rainfall has become increasingly unpredictable	Very high (4)	4 (Very high)
Plant and animal behaviour	Changes in flowering and fruiting of fruit trees like breadfruit and mango Changes in animal behaviour like egg laying by chickens	High (3) Medium (2)	2.5 (High)
Climate-induced disasters	Flood Drought Fire Cyclone	Very high (4) Medium (2) Medium (2) High (4)	3 (High)
Overall exposure score			3.12 (High)

Table 3.11 shows the sensitivity of Sabeto village to climate change impacts. The overall sensitivity score is high (2.78).

Table 3.11. Assessment of elements of sensitivity (S) for Sabeto village.

Parameter	**Hazard**	**Indicator**	**Perceived change**	**Score**
Agriculture and food security	Floods	Loss of productive lands and farm animals	High (4)	2.75 (High)
	Drought	Loss of crop production	Medium (2)	
	Outbreak of diseases	Production decline	Medium (2)	
	Cyclones	Loss of crops	High (3)	
Forest and biodiversity	Floods	Loss of forest cover	High (3)	2.5 (High)
	Fire	Loss of biodiversity	Medium (2)	
Infrastructure	Floods	Trails, roads and settlements are damaged	High (3)	3 (High)
	Cyclones	Damage to buildings and public utilities	High (3)	
Water resources and energy	Floods	Loss of fresh water (contaminated)	High (3)	2.66 (High)
	Drought	Reduction of fresh water	Medium (2)	
	Cyclones	Damage water infrastructure	Medium (3)	
Human health	Floods	Emergence of water-borne diseases	High (3)	3 (High)
Overall sensitivity score				2.78 (High)

Table 3.12 shows the adaptive capacity for Sabeto village. The overall adaptive capacity is medium (2.23).

Table 3.12. Assessment of elements of adaptive capacity (A) for Sabeto village.

Parameter	**Indicator**	**Criteria**	**Perceived change**	**Score**
Human assets	Demography	Old age and children	High (3)	2 (Medium)
	Education	Secondary education and awareness of climate change	Medium (2)	
	Skilled labour	Trained workers	Low (1)	
Natural assets	Land	Land ownership and productivity	High (3)	2.66 (High)
	Forest	Availability of product and services	Medium (2)	
	Water	Availability of drinking water	High (3)	
Financial assets	Financial institutions	Banks, cooperatives	Medium (2)	1.5 (Medium)
	Household incomes	Sufficiency for household needs	Low (1)	
Social assets	Social institutions	Community affiliations to formal and non-formal institutions	Medium (2)	2 (Medium)
	Service providers	Engagement of government and NGOs with community	Medium (2)	
Physical assets	Infrastructure for services	Access to schools, houses, bridges, roads, electricity; vehicle availability	High (3)	2.5 (High)
	Information and communication sources	Access to mobile phones, radio, TV, newspapers, and internet	Medium (2)	
Overall adaptive capacity score				2.23 (Medium)

Vulnerability = E × S/A

= 3.12 × 2.78/2.23

= 3.98

Vulnerability for Sabeto village is therefore high.

3.5. Discussion

The finding for all the communities was that their vulnerability to climate change is high, or very high in the case of Naboutini village. Changes in the local climate were noted by the communities, and exposure was high for all villages. Sensitivity was medium to high; and adaptive capacity was medium for all villages. These results indicate that adaptation measures are needed to reduce the impacts of climate change. Communities also need to improve their adaptive capacities by improving awareness of climate change impacts, improving income sources, improving relationships with government and non-government organisations, and improving some of their infrastructure and services.

The four villages were also found to be vulnerable in terms of food security. When energy and protein were analysed, it was found that around 50% of calories in the average villager's diet came from imported sources (rice, flour and noodles) and more than 60% of the protein came from imported sources (tinned fish, frozen chicken, and dhal). The results suggest that the communities should promote the production and consumption of local foods, which would also improve household incomes from savings on buying imported foods.

To develop appropriate adaptation strategies, a survey of the food production systems was carried out. It was found that farmers in Korobebe and Nagado were cultivating on rather steep slopes with shallow soils over soapstone. These soils are highly vulnerable to slipping under high or intense rainfall. A soil erosion problem was observed (Figure 3.4), which farmers in Korobebe had unsuccessfully tried to address with contour barriers made from bamboo. A better solution was the planting of borders of corn to form live barriers as practised by farmers in Nagado.

Figure 3.4. Poor agricultural practices, particularly on steep slopes in villages around the Sabeto catchment, are creating a major soil erosion problem.

Throughout the four villages, the team found nutrient deficiencies within the crop systems, especially of phosphorus and potassium. It was also found that the communities depend to some extent on wild foods for food security. Another finding was that a key problem for livestock production in the villages is not having a reliable water supply.

It was clear from the food production systems survey that the production environments are currently constrained both by non-climate as well as climate factors. The issues and problems elucidated through the land use surveys, PRAs and HIESs were used to develop a logical framework for improving resilience of food production systems in the villages.

3.6. Adaptation interventions

Based on the findings of the assessments and the food production systems survey, the following adaptation interventions were proposed by the assessment team in consultation with the communities.

- Establish village coordination committees;
- Facilitate tree planting on hilltops;
- Establish contour barriers on farmed hill slopes;
- Promote the planting of local staples – taro, cassava, sweetpotato, yams;
- Promote the planting of vegetables;
- Promote the planting of rice;

- Develop local chickens/ducks/broilers in villages for eggs and meat;
- Develop pig production in the villages;
- Develop honeybee production in the villages;
- Develop appropriate technologies to support adaptation strategies;
- Identify and record incremental benefits arising from the new technologies (using cost–benefit analysis);
- Promote the use of locally produced foods;
- Conduct training on preparation of locally produced foods;
- Support development of new livelihood options;
- Conduct agribusiness skills training;
- Make available information on appropriate technologies in a form suitable for the communities;
- Establish and implement a training programme on climate change threats and adaptation measures related to food insecurity at community level; ensure a gender focus in all training;
- Identify sources of climate risk information at the local level; disseminate information and ensure that vulnerable households and schools have access to relevant information;
- Design a participatory method for developing community adaptation plans;
- Ensure participatory development of adaptation plans;
- Design and implement early warning systems to enable the dissemination of information on the main threats for the communities;
- Provide training for all the necessary personnel to operate and maintain the early warning system;
- Engage primary and secondary school authorities in the Sabeto area to agree on climate change input into the appropriate curriculum;
- Develop and distribute awareness and education materials to Sabeto area schools and communities.

Each village will establish a coordination committee consisting of the village head, a farmers' representative, a women's representative, a youths' representative and a Ministry of Agriculture representative. The committee's role is to coordinate activities, set planting targets and livestock objectives, and also monitoring and evaluation of progress on activities. At the time of writing, two of the villages have established their coordination committee, and work plans for adaptation strategies have been developed while communities finalise designated land and labour for demonstration farms and construction of nurseries.

4. Kiribati: Tabontebike, Takarano and Tuarabu villages (Abaiang Atoll)

A whole-of-island (WoI) integrated vulnerability assessment (IVA) was conducted on Abaiang Atoll in Kiribati in September 2013. The WoI approach to vulnerability assessment and resilience development was initiated by the Government of Kiribati, and Abaiang Atoll was selected as the first site to trial this approach. The 2013 vulnerability assessment was guided by the first draft of the WoI IVA framework, which was conceptualised and developed by the Kiribati National Expert Group (KNEG) in collaboration with the Pacific Community (SPC), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), and the Secretariat of the Pacific Regional Environment Programme (SPREP).

Figure 4.1. A group discussion during the integrated vulnerability assessment conducted on Abaiang Atoll in Kiribati in 2013.

The IVA assessed the socio-ecological context of Abaiang Atoll in relation to climate change and disaster risks, and examined the capacity of the atoll community to reduce risks and adapt to the impact of environmental change. Thus, an understanding of the atoll's vulnerability was developed by identifying Abaiang's key socio-ecological features and the experienced and anticipated pressures stemming from demographic, developmental and climatic change. The gradual impact of climate change is expected to have a 'multiplier effect' on the impacts of population growth, land-use practices and resource extraction. Abaiang's adaptive capacity is determined by the natural, infrastructural, financial and human resources the atoll community has to adapt, and the ability of local institutions to utilise the resources efficiently and effectively to adequately meet livelihood needs (settlement, water, food, income) on a daily basis, as well as in periods of climatic and disaster-related stress (Office of *te Beretitenti*).

4.1. Vulnerability analysis methods

The IVA approach is a shift from the more sector-based vulnerability assessments. The term 'integrated' implies integration between sectors, scales, disciplines and space. A continuous and dynamic process of decision-making linked at multiple levels and scales reflects the learning of lessons over the long term that is necessary to successfully adapt to climate change. The key principles of the IVA framework include:

1. inter-connectedness of social and ecological systems and sectors (e.g. water, forestry, agriculture, fisheries) and livelihood assets (natural, infrastructural, human, financial and institutional);
2. long-term and continuous lessons being learned based on knowledge of co-production between local communities and technical practitioners, and the incorporation of lessons learned into island-level decision-making;
3. an emphasis on participatory learning and action tools that value, draw and build on traditional and local knowledge and experience so as to give local communities 'ownership' and empowerment; and
4. facilitation of inclusive decision-making to create opportunities for engaging vulnerable groups.

These principles incorporate the value of local and traditional knowledge and promote the full engagement and ownership of the procedures and projects by beneficiaries in all stages of the development process.

A variety of assessment methods was used to address the aims of the Abaiang WoI IVA:

- a national consultation with sector experts on vulnerability indicators, data needs and appropriate methods of assessment;
- reviews of previous research, field assessments, policies and reports relating to climate change, disasters and development in Kiribati and Abaiang;
- consultations with men, women and youths in eight villages on Abaiang to gather information about local perceptions of climate and disaster risks and effects on livelihood assets;
- a household survey of 17 of Abaiang's 18 villages, covering 10% of the island's 425 households; and
- a rapid technical assessment of the eight consulted villages whereby housing, water and local food production systems were assessed via field observations and soil and water quality testing.

Data sourced via these various methods were compiled and analysed by a team comprising members from KNEG, SPC, SPREP and GIZ.

4.2. The pilot site and community

Abaiang is one of the northern islands of the Gilbert group, and is situated 44 km north of Tarawa, the capital of Kiribati. The mainland of Abaiang extends from the northern village of Takarano to the southern village Tabontebike, where project sites were based, along with Tuarabu, another southern village.

Over 5000 people live on Abaiang, and it is the fourth largest populated atoll in the nation. As a result of limited external influences, the unique culture of Kiribati is evident on Abaiang and the traditional way of life and village governance are largely intact.

Abaiang is a low-lying atoll with soil originating from the reef. Over time, a range of plants have been introduced to Abaiang. Coconut trees, breadfruit, pandanus and giant swamp taro are common and found on almost all available land. Several native birds are found on the island, such as the common noddy (*te io*), ringed-bill gull (*te taarariki*), reef heron (*te kaai*) and frigate birds (*te eitei*), the latter two being listed as endangered species. In and near the villages, fauna mostly comprises introduced pigs, chickens, dogs, rats and cats. About 1160 ha (or 71% of Abaiang) are covered by vegetation, mainly coconut trees.

The people of Abaiang face many challenges in daily life. Human habitation on the atoll is only possible because of the presence of an underground freshwater lens. But this water supply is easily contaminated and rapidly becomes too salty for consumption during periods of drought, and is also extremely vulnerable to saltwater intrusion caused by storm surges, king tides and sea level rise. Atoll soils are among the poorest in the world, making agriculture difficult. The lagoon, reefs and ocean waters contain a diversity of fish and invertebrate species that are relied on as the main source of protein in the local diet. However, the pressure on fisheries is ever increasing. At the time of the assessment, no community-based fisheries management practices existed and recent surveys found that these resources are being depleted at an unsustainable rate.

Copra is a key source of cash income on Abaiang, and is mostly sold through a cooperative system. Income from copra can vary greatly due to factors such as market prices and low production due to events such as droughts. Farmed seaweed and harvested sea cucumbers are other sources of cash income. The main employers are the Island Council and schools although temporary labour work is also available when required for construction, maintenance and logistical work for development projects.

4.3. Analysis of land-based food systems

Crops grown on Abaiang include giant swamp taro (*bwaibwai*), breadfruit, bananas, pawpaw, wild fig (*te bero*) and pandanus (*te kaina*), all of which are harvested mainly for subsistence. However, Abaiang currently faces challenges to producing enough quality food to feed its people. Successfully addressing this will require making small farmers on the atoll more productive.

Food production on atolls, including Abaiang, is influenced by many factors. Based on findings from the field visit as well as secondary data, these factors include the following.

- Poor soils: Because atoll soils originate from the reef (coral), they are generally shallow, highly permeable and highly alkaline. These soils are considered to be some of the poorest in the world, and make agriculture very difficult. There is a high reliance on composting and the use of organic matter to improve the soils. On Abaiang, soils are generally typical atoll soils, with coral rock outcrops in some places, and many stones. Soil tests conducted in Abaiang during the September 2013 IVA gave the following results:
  - pH of the water ranged from 8.19 to 9.04;
  - electrical conductivity ranged from 155 µS/cm to 451 µS/cm;
  - phosphorus and nitrate content ranged from traces to medium, with a few soil samples having high content;
  - potassium in soil samples ranged from low to high (more than 70% of the samples had low available potassium);
  - salinity ranged from 150 µS/cm to 750 µS/cm;
  - the physical texture of the soil was sandy; bulk density was low at <1 g/cm^3, with a high infiltration rate; and
  - the soil showed low biological activity.
- Limited availability and quality of water: Competition for water for different uses (crops, drinking water for animals and humans, etc.) is putting pressure on the already limited water resources on the atoll. During PRAs, community members reported that water is getting increasingly brackish and unsuitable for growing crops. Many houses have thatched roofs, making rainwater harvesting difficult. Many families must cart water from wells that are far from the households. The trend to move giant swamp taro pits into villages may have negative impacts on the freshwater quality, but research is needed to verify this.
- Narrow genetic base of food plants: There are a few food plants that are native to atolls and are tolerant of atoll conditions, such as pandanus. Coconut, taro, banana and breadfruit were introduced by indigenous people, and the cultivation of these plants requires modification of the environment. Most of the introduced food plants and tree species are not very tolerant of salinity and atoll conditions. This is compounded by the fact that some varieties of pandanus, taro, breadfruit, coconut, dwarf banana, local fruits and some traditional medicinal plants are now considered endangered.
- Limited and decreasing access to fruits and vegetables: Only 5% of households have access to cabbage, 43% to banana and 45% to pawpaw. The share of households growing cabbage decreased by 3% from 2005 to 2010, and pawpaw by 23%. Household access to pandanus has been decreasing since 2005. Shops do not offer any fruits or vegetables. The household survey showed that the consumption of vegetables and fruits is very low, which correlates with high incidences of vitamin and mineral deficiencies.
- Pests and diseases: A major problem with introduced crops is their susceptibility to pests and diseases, but traditional crops such as coconuts and breadfruit are also at risk. During PRAs communities reported, for example, that rats feed on coconuts and giant swamp taro pits are damaged. Most communities also reported that pigs are more prone to diseases than they were in the past.
- Challenges for livestock: There are limited choices for livestock production on atolls, with the most viable being pigs and poultry. Households mainly have access to local pig and chicken breeds; only very few have access to cross-breeds or exotic breeds. Cross-breeds are said to be more productive and are potentially more adaptable to heat stress and water scarcity. More than half of households on Abaiang do not have access to chickens. The production system for local chickens is based on 'wild scavenging', which means there are little or no management inputs. Local chickens are small and less productive, which is likely due to inbreeding. Dogs, cats and rats eat eggs laid in the bushes. Feeds for chickens are nutritionally inadequate.

Communities reported that pigs nowadays give birth to fewer piglets compared to the past. All households reported increasing animal pests and diseases. The scarcity of food and water is another challenge for livestock production, and communities also have issues with managing waste from livestock.

During PRAs the following were identified as threats to land-based food production on Abaiang:

- a decline in the number of trees and palms and loss of productivity (especially pandanus, mangroves and coconuts), caused by overuse, cutting down without replanting, and slash and burn practices as a means of land clearing;
- improper waste disposal;
- limited availability of land for planting of trees;
- an increase in the demand for timber due to an increase in the number of buildings and houses on the islets;
- banana and frangipani (plumeria) dieback was observed in Ubwanteman;
- rats feeding on and destroying coconut trees; and
- polluted water: water quality testing found pollution from human, animal and plant sources.

Sensitivity of land-based food systems

From the community perspective, agricultural food production on Abaiang is being affected by the following climatic changes and risks:

- plant growth is stifled by extended drought periods and brackish groundwater;
- fruits are more prone to pests due to changes in fruiting seasons;
- decline in copra productivity (reduced coconut size, numbers and nuts becoming oval shaped due to increased temperature and water stress);
- loss of productive land due to coastal erosion;
- pigs are smaller and slower growing due to reduced wild plant pig feed as a result of droughts;
- soil fertility appears to be decreasing.

Both men and women in all communities on Abaiang have observed an increase in the frequency of droughts over the last three decades, which is consistent with their perception of decreased rainfall. Weather records also show decreasing amounts of rainfall. Communities also reported impacts on the productivity and physical structure of fruit plants such as coconut, pandanus and breadfruit. Women from Ribono reported that tilapia ponds and taro pits often dry out during these periods.

Scientific studies suggest that:

- outbreaks of invasive species, pests and diseases may intensify with increasing temperatures and changing rainfall;
- death of crops and livestock may be caused by soil salinisation, which is a result of rising sea level; and
- reduced livestock productivity may be caused by heat stress, increased susceptibility to diseases, periodical lack of fresh water, and water-borne diseases.

4.4. Analysis of marine-based food systems

Abaiang Atoll possesses a wide variety of marine habitats, various coral reef types, and a rich marine biodiversity, and has been identified as an atoll of environmental significance. A biodiversity assessment of globally threatened species prioritised Abaiang as the atoll in the Gilberts group with the greatest potential for protecting two endangered and three vulnerable lagoon species. Reefs, lagoons and ocean waters hold a wide variety of fish and invertebrate species, many of which are relied upon for the diet of Abaiang people. Fresh fish is consumed almost every day and is the primary source of income and protein for the atoll's villages. The quality of the atoll's fisheries is determined by the health of the surrounding coral reefs and mangroves. The men usually fish from boats, while women are more engaged in invertebrate fishing, reef gleaning and fish processing. Gleaning is mostly done on foot but sometimes canoes or sailboats are used to reach particular fishing grounds. Invertebrate fishing is mostly limited to reef habitats and some intertidal and soft benthos areas, while finfish fishing targets

the sheltered coastal or outer reef and lagoon area. Finfish species such as bonefish (*te ikarii*), spangled emperor (*te morikoi*) and humpback red snapper (*te ikanibong*) are caught for consumption.

4.5. Adaptation interventions

The following proposed adaptation options were developed by the IVA assessment team and the local communities at the IVA results presentation and the participatory response planning workshop, attended by community members, line ministries and partners. The USAID project focused on land-based food production systems, while the GIZ Coping with Climate Change in the Pacific Island Region programme also supported fisheries.

Proposed adaptation options for land-based food systems

- Improve soil health by adding green and animal manure (including composting), using boiled water (as a soil disinfectant), planting on mounds and mulching.
- Promote appropriate water management practices, for example new irrigation methods such as biodiscs, wicking-bed and drip irrigation, and increased shading of crops.
- Test and evaluate adaptable crop varieties and livestock breeds, and introduce those that appear promising.
- Promote more locally grown food, especially vegetables and fruits.
- Collaborate with the health sector to ensure local food with sufficient vitamins and minerals is grown.
- Collaborate with the fisheries sector to seek opportunities for processing and marketing locally grown produce on Tarawa. In agriculture, there is the potential for value-added products such as breadfruit flour, and exporting fresh agricultural produce to Tarawa.
- Collaborate with the water sector to ensure that sufficient and adequate water is available for irrigation, for example through harvesting rainwater; and reduce the risk of freshwater contamination by inappropriate waste management and other agricultural practices.
- Trial the use of plant-derived pesticides and *Bacillus thuringiensis*.
- Provide training on animal health as well as plant and livestock disease control.
- Promote giant swamp taro as a food reserve and return to the old practice of positioning the pits outside of the village.

Proposed adaptation options for marine-based food systems

- Foster the care of coastal fisheries resources and habitats by establishing protected areas and prohibiting fishing or harvesting activities in the lagoon and local habitats of importance.
- Strengthen the management of the island's fisheries resources by developing island bylaws with community support.
- Develop other livelihood and income-generating alternatives to reduce pressure on marine and coastal ecosystems.
- Implement mangrove rehabilitation programmes with communities (these are already ongoing in some villages).
- Encourage communities, users and landowners to take ownership of managing and caring for their fisheries resources and the marine environment.
- Develop coastal plans that facilitate mangrove migration with sea level rise.

5. Samoa: Sapapali'i village (Savai'i) and Savaia village (Upolu)

5.1. Project team

The community vulnerability assessment was carried out by a project team that consisted of SPC Land Resources Division (LRD) staff and representatives from a number of government and non-government stakeholder groups, i.e. Faasao i Savai'i (a local NGO whose CEO is from Sapapali'i), the Ministry of Agriculture and Fisheries (MAF), the Ministry of Natural Resources and Environment (MNRE), the Ministry of Women and Community and Social Development (MWCSD), and the University of the South Pacific (USP)'s Global Climate Change Alliance (GCCA). A half-day PRA training session was held for the project partners ahead of the PRA activities.

5.2. Project sites

The two sites chosen for Samoa were selected by a group of stakeholders in climate change services and the agriculture sector during an initial visit and consultation carried out by SPC LRD officers in March 2013. The sites are Sapapali'i village in eastern coastal Savai'i, and Savaia village on the southwest coast of Upolu island. Both communities are exposed to extreme rainfall and drought risk, and both have recently experienced strong winds and tropical cyclones. Both villages also share some food security risks, for example, both practice monocropping and have a low diversity of root crops.

Figure 5.1. From left: Rulia Papalii, Sesa Fiu and Penina Poutoa, and three of the women beneficiaries of the Food Security Project at Sapapali'i.

Sapapali'i

Sapapali'i is a coastal village and shares a large interior catchment with neighbouring communities (Figure 5.2). Within its customary boundaries, the land slopes gently from the interior to the coast, and includes secondary forest inland, moving down to extensive plantations, and to the village settlements on the coast, which are spread along the main coastal road. Two, mostly seasonal, rivers wind their way through the Sapapali'i lands from the interior valley, and have a number of tributaries. The main road has a slightly elevated ford at one river crossing and a well-built bridge at the other. Population statistics from the most recent census (2011) give Sapapali'i's

population as 952 people (509 males, 443 females) in approximately 200 households. No further details on demographics are given.

Figure 5.2. Google Earth image showing Sapapali'i village and the surrounding land and coast.

The area has an exposed eastern coast, and the community and the surrounding environment are often exposed to damaging winds during tropical cyclones, as well as associated storm surges. During regular seasons, rainfall in the area is good (verified by meteorological data), including during the dry season as south-easterly trade winds dominate in the area during this time. During the dry season, streams and rivers in the area are at risk for flash floods in high intensity rainfall events.

Savaia

Savaia is also a coastal village sharing a large interior catchment with neighbouring communities (Figure 5.3). Within its customary boundaries, the land area includes secondary forest inland, plantation predominantly of coconut and taro, and the village settlement spread along the coastal front. Some households have relocated inland along the main south coast road. A river to the northwest flows persistently reflecting the well-watered windward catchment. A deep lagoon is protected to the south by a fringing/barrier reef system. Population statistics from the most recent census (2011) gives Savaia's population as 399 people (221 males, 178 females) in approximately 70 households. No further details on demographics are given.

Figure 5.3. Google Earth image of the Savaia area showing its southwestern coast and inland areas of forests and plantations.

The Savaia area is sheltered to some degree by a low ridge of hills to the west, and to the north by the spine of volcanic mountains that lie northwest to southeast along the island. Nonetheless, damaging winds of tropical cyclones can cause damage to the community infrastructure. Similar to Sapapali'i, rainfall in the area is normally good (verified by meteorological data), including during the dry season. There is also orographic rainfall due to the nearby hills.

Soils at the project sites

A detailed soil analysis was undertaken by the University of the South Pacific at both sites.

The soils of the two sites are referenced from the Soil Maps of Western Samoa by A.C.S. Wright of the Soils Bureau of DSIR, NZ, and Survey Department of Western Samoa, published in 1962. The Savaia site soils are described as 'latosolic soils from basalt', and more locally as Lefaga clays, stony and bouldery. At the coast are more recent soils of calcareous sand, locally described as Fusi sands. The Sapapali'i site soils are similarly described as 'latosolic soils from basalt', and locally as a combination of A'ana clay loams and clays, stony and bouldery, and Tafatafa loams and clay loams, stony and bouldery. A stream at the southern boundary produces a basic alluvium type of Sauniatu sandy clay, with the rivermouth containing typical marine marsh soils of Loga sandy clay and peaty sand.

5.3. Vulnerability analysis of Sapapali'i and Savaia communities

Exposure

The Sapapali'i community scored 3.09 for exposure (Table 5.1). The community feedback collected from the PRA indicates that observed weather and extremes tend to be in line with historical meteorological records. Climate and weather extremes were consistently ranked high and this raised the exposure value. Plant and animal indicators had medium values, indicating that these may be exhibiting resilience. Climate-induced disasters were ranked high to very high.

The Savaia community recorded a 3.45 score for exposure (Table 5.2). This community similarly recorded high values for observed weather and climate extremes, noting increasing variability in rainfall and temperatures. Plant and animal indicators had much higher values than in Sapapali'i, with changes noted in seasonality, availability, taste and size of fruits and other crops. Animal health and reproduction proxies were variable, with some expressing higher incidences of mortality from diseases and lower reproduction rates and numbers. Changes in pests and diseases also featured strongly. The community similarly ranked recent climate-induced disasters as high, and raised concerns related to human health (the remoteness of the community to a health centre has some influence on this).

Table 5.1. Exposure assessment for the Sapapali'i community.

Parameters	Indicators	Perceived changes/remarks	Score index/remarks
Temperature	• Numbers of hot days increased • Number of cold days decreased	High to Very High	**3.5**
Precipitation	• Rainfall has become increasingly unpredictable	High to Very High	**3.5**
Plant and animal indicators	• Breadfruit, mango, citrus, eggplant are similar in either being available all year round, produce being bigger in size, while some are reduced in season and smaller fruit • Some observed diseases increasing in chicken during dry season, more stillborn animals/reduced litter sizes	Medium	**1.8**
Climate induced disasters	• Landslides do not affect community • Drought often occurs and has many impacts • Fire is a lesser risk • Tropical cyclones are the main concern • Concern for human health is also very high	High to Very High	**3.5**
	Average Exposure index (1 Low – 4 Very High)		**3.085**

Table 5.2. Exposure assessment for the Savaia community.

Parameters	Indicators	Perceived changes/remarks	Score index/remarks
Temperature	• Numbers of hot days increased • Number of cold days decreased	High to Very High	**3.6**
Precipitation	• Rainfall has become increasingly unpredictable	High to Very High	**3.0**
Plant and animal indicators	• Common fruits and root crops share some similarities in either being available all year round, produce being bigger in size, while some are reduced in season and smaller fruit • There is definite observation of more pests and diseases increasing in some vegetable and some root crops, however still edible	Medium	**3.7**
Climate induced disasters	• Landslides do not affect community directly though road access sometimes hampered by landslides • Drought seems to be more frequent • Fire risk is low • Tropical cyclones and human health risks are the main concern	High to Very High	**3.5**
	Average Exposure index (1 Low – 4 Very High)		**3.45**

Sensitivity

The Sapapali'i community scored a high sensitivity value of 3.1 (Table 5.3). Extreme weather and climate events have high impact on various aspects of community life. The community noted that natural resources are being impacted, with comments about the link between water resources, river and inshore siltation, and reduced/damaged forest cover. Recent tropical cyclone events were fresh in the minds of the community, with damage to infrastructure such as the road, bridges and water and electricity supply. Human health was also mentioned by the women's group, who said there was little support for community health programmes from the local government.

The Savaia community scored a high sensitivity value of 3.2 (Table 5.4). Extreme weather events similarly have a high impact on the community. Disease outbreaks were given a very high value. Tropical cyclone Evan in December 2013 caused significant damage to infrastructure, and while the recovery seemed quick, the community reported that significant effort was required to return the community to a near pre-Evan state. Human health had a similarly strong focus in this community.

Table 5.3. Sensitivity assessment for the Sapapali'i community.

Parameters	Hazards	Indicators	Perceived changes/ Remarks	Score index/ remarks
Agriculture and food security	Flash floods	Loss of productive lands due to soil erosion, destroyed crops, pests and disease outbreaks	High	3.5
	Drought	Loss of crop production	Very High	
	Outbreak of diseases	Crops particularly are suffering from increased pests and diseases despite now being available year round	Very High	
Forest and biodiversity	Floods	Loss of soils and trees near river during heavy rains	Very High	3.5
	Tropical cyclones	Loss of forest cover	High	
Infrastructure	Tropical cyclones	Housing damaged from winds, and road and bridges from flooding	High	3
Water resources and energy	Water supply	Cut off from water supply during flooding events, and unknown if water quality is met for safety	Medium	2.5
	Floods	Erosion of soil for farming, also polluting and blocking up springs	High	
Human health	Prevalence of diseases	Average of respondents say about 20% of population ill at any one time	High	3
Average Sensitivity Score (1 Low – 4 Very High)				3.1

Table 5.4. Sensitivity assessment for the Savaia community.

Parameters	Hazards	Indicators	Perceived changes/ Remarks	Score index/ remarks
Agriculture and food security	Flash floods	Loss of productive lands due to soil erosion, destroyed crops, pests and disease outbreaks	High	3.5
	Drought	Loss of crop production	Very High	
	Tropical cyclone	Extensive crop damages and long recovery times	Very High	
	Outbreak of diseases	A lot of significant crops are suffering from increased pests and diseases	Very High	
Forest and biodiversity	Floods	Loss of soils and trees during heavy rains	Very High	3.5
	Tropical cyclones	Loss of upland forest cover	High	
Infrastructure	Tropical cyclones	Housing damaged from winds, and road from flooding	High	3
Water resources and energy	Water supply	Cut off from water supply during flooding events, water quality safety is unknown	High	3
	Floods	Erosion of soil for farming, significant amount of freshwater from rain impacting inshore fishery	High	
Human health	Prevalence of diseases	High incidence of population ill at any one time recorded	High	3
Average Sensitivity Score (1 Low – 4 Very High)				**3.2**

Adaptive capacity

The Sapapali'i community scored 2.2 for adaptive capacity (Table 5.5) while Savaia scored 2.04 (Table 5.6).

Typically, community infrastructure assets are valued highly in these types of assessments. However for this PRA, these were given medium scores. This is likely due to recent experiences of the community during periods of extreme weather and climate events, such as a recent flash flood event that damaged a bridge, and damage to the coastal road during storm surges and coastal floods. Community frustrations with time taken before repairs were made may have affected this score.

Access to information on weather and climate was said to be poor (for example drought monitoring or rainfall forecasts). At the household level, incomes were considered fairly low (confirmed by HIES data) contributing to lower adaptive capacity at the household level within the Sapapali'i community. The score for income is medium in the Savaia community, reflecting a smaller more 'well off' community whose farmers have a longer history of market access.

Table 5.5. Assessment of adaptive capacity for the Sapapali'i community.

Parameters	Indicators	Criteria	Perceived changes/ remarks	Score index/ remarks
Human assets	Demography	Old age and children	High	2
	Education	Secondary education and awareness of climate change	Very High	
	Skill labour	Trained workers	Medium	
Natural assets	Land	Land ownership and productivity	Very High	2.5
	Forest	Availability of product and services	Low	
	Water	Availability of drinking water	High	
Financial assets	Financial institutions	Banks, cooperatives,	Medium	2
	Household incomes	Sufficiency for household needs	Low	
Social assets	Social institutions	Community affiliations to formal and non-formal institutions	High	2.5
	Service providers	Engagements of NGOs and GOs with community	Medium	
Physical assets	Infrastructure for services	Access to school, house, bridge, road, electricity, health posts, vehicle availability	High	2
	Information and communication sources	Access to mobile phones, radio, TVs, papers, and internet	High	
Average Adaptive Capacity Score (1 Low – 4 Very High)				2.2

Table 5.6. Assessment of adaptive capacity for the Savaia community.

Parameters	Indicators	Observations	Perceived changes/ remarks	Score index/ remarks
Human assets	Demography	Youth and children populations are high and outward migration is high also	High	2.0
	Education	Education is valued highly but older groups feel education standards are not good enough today	High	
	Skill labour	Trained workers, formal employment, knowledge workers, RSE opportunities	Medium	
Natural assets	Land	Land ownership and productivity	Very High	2.0
	Forest	Availability of product and services	Medium	
	Water	Availability of drinking water	High	
Financial assets	Financial institutions	Banks, cooperatives,	Low	1.5
	Household incomes	Sufficiency for household needs	Medium	
Social assets	Social institutions	Community affiliations to formal and non-formal institutions	High	2.7
	Service providers	Engagements of NGOs and GOs with community	Medium	
Physical assets	Infrastructure for services	Access to school, house, bridge, road, electricity, health posts, vehicle availability	Very High	2.0
	Information and communication sources	Access to mobile phones, radio, TVs, papers, and internet	Very High	
Average Adaptive Capacity Score (1 Low – 4 Very High)				**2.04**

Final vulnerability scores for Sapapali'i and Savaia communities

For Sapapali'i:

Vulnerability (V) = E × S/A

= 3.09 × 3.1/2.2

= 4.35

For Savaia:

Vulnerability (V) = E × S/A

= 3.45 × 3.2/2.04

= 5.4

5.4. Transect walk

Transect walks of both communities were conducted by the PRA team, assisted by community representatives. The transects revealed very close similarities between both communities. In both, there is a focus on root crops in plantations (taro being the main crop), and only a few plots of vegetables and a few fruit trees. The primary and secondary forest areas inland form the boundaries of the village farmlands, community forests, and catchment of the respective districts.

An observation from the transects was the limited agrobiodiversity in both communities (Figure 5.4). Only two or three varieties of taro are being grown in most plantations, with very little evidence of other root crops (e.g. cassava or sweetpotato) or vegetables. Fruit trees were mainly older trees planted many years ago, with very few new trees, except for banana and papaya. Citrus fruits are fairly common and seem to be doing well (observations from locals are that they are fruiting year-round), though there is a citrus disease affecting plants,

which is a risk. The limited taro diversity is close to that before the outbreak of taro leaf blight, and this presents a risk if a new disease outbreak was to occur.

Figure 5.4. High Chief of Savaia, Tusani, explains the variety of seedlings in the nursery. From the transects conducted, it was found that there was limited agrobiodiversity at the sites.

5.5. Household survey results

Household income

Eighty per cent of households surveyed indicated insufficient income for their household needs. Church obligations had the greatest financial impact on families, followed closely by food purchase. Both communities indicated very strong interest in the project assisting them from a livelihood perspective. The team leaders made clear that the intervention purpose of the project was food security and not livelihoods, but this finding could guide the project to consider livelihood aspects of crops that may be brought in to increase agrobiodiversity for the communities.

Housing

Table 5.7 describes the housing situation in Sapapali'i and Savaia, and availability of facilities.

Table 5.7. Housing statistics for Sapapali'i and Savaia communities.

Village	Living Quarters	Water sources		Toilet Facilities	Power & Light	Cooking
		Drinking	Washing			
Sapapalii	• Independent (100%) • Concrete (90%) • Timber(10%)	• Government water supply (100%)	• Government supply (80%) • Unprotected well, Spring, river lake (20%)	• Waterseal & Flush (90%) • Outdoor (10%)	• Govt Electricity (100%)	• Gas(6-0%) • Open Fire (100%) • Kerosene (50%)
Savaia	• Independent (100%) • Concrete (90%) • Timber(10%)	• Government water supply (100%)	• Government supply (70%) • Unprotected well, Spring, river lake (30%)	• Waterseal & Flush (90%) • Outdoor (10%)	• Govt Electricity (100%)	• Gas(90 %) • Open Fire (100%) • Kerosene (30%)

Food consumption

Questions on household food consumption in both communities indicated that, on average, the energy intake per capita per day is better than the FAO/WHO minimum daily requirement for food security. There was also found to be a reliance on imported food (rice, flour and noodles) in the communities, similar to other Pacific Island countries.

5.6. Discussion of the PRA findings

The PRA exercise found high vulnerability of both the Sapapali'i and Savaia communities, based on their high exposure to weather extremes, high sensitivities to these events when they occur, and a low adaptive capacity with the current collective assets of the communities. The household surveys indicate that vulnerability is sustained down to the individual household level.

The climate and geography of the two communities increase their exposure – both share high flood and drought risk – and projections of increased climate variability will likely exacerbate the situation. The study found that landslides frequently occur during high rainfall, affecting agricultural lands and communities. Pests and diseases are increasing and also coincide with high rainfall. All five sectors assessed appear to be highly impacted by climate change and natural disasters.

The study found that the adaptive capacity of the communities to the impacts of climate change is low. All sectors assessed were ranked medium to low. While there is modern brick and concrete housing in the main part of the villages, on the outskirts of the village homes are of less solid construction. This is linked to lower income households. These houses are well maintained, but would be easily damaged by a tropical cyclone; these households have lower adaptive capacity because of low income.

For both communities, public transportation is available and the road infrastructure provided by the government is good. However, communities noted that other elements of access to public resources are less effective, such as medical centres and advisory services for agriculture and fisheries.

There was a noted difference in the two communities at the leadership level. Savaia is a smaller community, and the traditional *matai* council seems to have a higher presence and reach throughout the community. It was also noted that many members of the Savaia council are leading businessmen and academics in public and private sectors in Samoa. The PRA team speculated that this may lead to better decision-making, compared with the larger and more dispersed Sapapali'i community. For example, the PRA team had some initial difficulty in arranging the PRA and other community-based interactions at Sapapali'i.

Figure 5.5. Men of the village of Savaia, Upolu maintain the village nursery.

5.7. Food security

The four determinants of food security (food availability, food access, food utilisation and food stability) were assessed to determine the communities' food security situation.

Food availability

The food consumption analysis indicated that the energy supply per person per day is meeting the FAO/WHO minimum daily requirement for food security. Protein availability for the communities was also found to be sufficient, though some 30–45% was poor quality sourced from stores. The main protein source for both communities is poultry, both locally bred and cheap, poor quality imported chicken (which is high in fat and treated with many chemicals). Food availability is not hindered by transportation as most families have cars, and public transportation by bus is also available. Household gardens and plantations are a source of root crops and other carbohydrate-rich crops such as breadfruit and bananas. In both communities, households still hold very strong agricultural traditions and all families surveyed had a garden or plantation. Subsistence agriculture is still strong in these communities, and remains vital for food security and supplementing livelihoods. The transects in both communities revealed that both communities grow only a few, market-favoured varieties. This low crop diversity in plantations and gardens was the greatest risk observed for food security. Livestock interventions would have a strong role in improving the availability of protein.

Food access

Food access is determined by the household's and individual's access to resources to either produce the food or to purchase a sufficient amount of safe food. As mentioned above, most households in both communities have access to land to grow their own food; however, the quality and topography of the land affects this, in particular when heavy rains occur. Transportation is relatively accessible by both communities so access to store-bought foods is relatively easy. For access to plantations, roads are regularly maintained by the community providing easy transport to and from farms. Sharing of food is common as part of traditional practice and community members commented that those in need of food are supported by others in the community.

Food utilisation

Food utilisation is linked to local food production; however there is a need to strengthen food production in the villages to reverse the tendency to rely on imported foods. Diversification of food production systems will help improve the variety and types of food being consumed in the villages.

Food stability

In terms of stability of food supply, it is clear from the analysis that food production is already impacted by climate change, and also non-climatic factors such as taste preferences and relatively easy access to store-bought foods. The behaviour of plants and animals is changing and this may be causing the switch to non-traditional food sources.

Income generation

While the focus of the project is not to enhance livelihoods, it would pay to have some idea of the economic impact of the work of the project in the agricultural interventions it may seek to implement (e.g. introduction of varieties of other types of root crops such as sweetpotatoes, yams and cassava) for improved uptake.

5.8. Adaptation strategies

The findings from the vulnerability assessment show that food security in these two communities is at risk from the impacts of climate change. Observations of past extreme climate events indicate that future climate change will place stress on agricultural systems (in addition to non-climatic pressures such as increasing population). The resilience of both communities is considered to be medium while the sensitivity to climate extremes is high. Agricultural interventions focused on enhancing the food security resilience of these communities are appropriate for climate change adaptation.

The following adaptation strategies were identified by the PRA team in consultation with the two communities.

- Develop post-harvest technologies such as chipping;
- Develop appropriate technologies to support adaptation strategies:
  - Identify problems and potential solutions;
  - Establish on-farm and on-station experiments;
- Identify and record incremental benefits arising from the new technologies (using cost–benefit analysis);
- Establish integrated cropping systems:
  - Identify appropriate cropping systems and sourcing of planting material (fruit trees, root crops, vegetables, forestry trees);
  - Establish community nurseries;
  - Carry out nursery management training;
  - Set up demonstrations on field planting and crop management;
  - Carry out pest management training;
  - Obtain *Mucuna* seeds and establish *Mucuna* trials;
  - Hold an extension field day on *Mucuna;*
- Carry out research on drought-tolerant sweetpotato:
  - Multiply planting materials in the nursery;
  - Set up trials: plant sweetpotato at demo sites and involve farmers in data collection; harvest sweetpotato and analyse data;
- Promote planting of vegetables:
  - Obtain seeds, seed trays, poly bags;
  - Distribute seedlings at nominal cost;
  - Carry out varietal screening for yield, pest and diseases;
- Promote local chickens for supplementary protein:
  - Decide with community on the model to adopt – community or household based;
- Develop pig production in the villages:
  - Decide with community on the model to adopt – community or household based;
- Promote utilisation of locally produced foods:
  - Demonstrate preparation and cooking methods of local produce in community workshops;
- Improve adaptive capacity of communities: carry out education and awareness raising activities;
- Support ways to increase household incomes: identify farm and non-farm income-generating opportunities;
- Conduct agribusiness skills training: work with MAF and Women in Business Development (WIBD) to plan and carry out training workshops;
- Make information available on appropriate technologies in a form suitable for the communities:

  - Review existing information products from MAF, LRD and other sources (WIBD, Red Cross) to identify appropriate information sources, and most suitable and appropriate forms of communicating and providing access for use of these at local communities;
- Establish and implement a training programme on climate change threats and adaptation measures related to food insecurity at the community level (ensure gender focus in all trainings):
  - Develop training materials on climate change and disaster risk management;
  - Conduct training in the communities and for other stakeholders;
  - Identify sources of climate risk information at local level; disseminate information and ensure that vulnerable households and schools have access to relevant information;
- Ensure ownership of adaptation plans in targeted communities:
  - Use participatory methods for developing community adaptation plans;
  - Develop a training toolkit for the community;
  - Conduct training in the communities for developing adaptation and disaster management plans;
- Increase knowledge to manage climate change risk, including climate variability affecting food security:
  - Design and implement early warning systems, and carry out training for necessary personnel to operate and maintain the early warning system;
  - Engage primary and secondary school authorities in Sapapali'i and Savaia districts to agree on climate change inputs into the curriculum;
  - Develop and distribute awareness and education materials to Sapapali'i and Savaia district schools and communities.

At the time of writing, work plans for adaptation strategies have been developed and communities are finalising designated land and labour for the demonstration farms and construction of nurseries.

6. Solomon Islands: Sepa and Loimuni villages (Choiseul Island)

6.1. Project sites

The Solomon Islands government identified Choiseul Province as a demonstration area for the ridge-to-reef programme, where donor activity would be concentrated to deliver 'whole-of-province' support for climate change.

Choiseul Province (Figure 6.1), located in the northwest of the Solomon Islands archipelago, consists of three major islands, Choiseul, Vaghena and Rob Roy. The main island Choiseul is home to Taro, the main town. There are also several islets in the Province, most of which lie off the south and northeastern coasts of Choiseul Island. During the last census in 2009, the population of Choiseul was 26,372 people with 4712 households and an average household number of 5.5 people.

Figure 6.1. Map of Choiseul Island showing the communities selected for the vulnerability and adaptation assessment.

Subsistence agriculture remains important for food security and livelihoods in Choiseul. Root crops such as taro, sweetpotato, yam, pana (*Dioscorea esculenta*), kakake (giant swamp taro) and cassava, as well as banana, are the main crops grown by most households. A few families keep indigenous pigs and chickens.

Land access and ownership in Choiseul is based on tribal landownership, connecting tribe (*sinaqi*), sub-tribe (*jojolo*) and clan (*pupu*) as the communal unit that holds the right and authority over a piece of land. There are more than 300 tribal landowners recognised in the province. In the indigenous context, the land, sea, reefs, forests, rivers and other natural resources within a tribal land boundary are strongly connected to the tribes.

In 2012, a team was formed comprising stakeholders including government officers from ministries such as agriculture, forestry, health and climate change, and regional organisations SPC, GIZ, SPREP and the Nature Conservancy. The team conducted a climate change vulnerability and adaptation assessment (V&A) under the Choiseul Integrated Climate Change Adaptation Programme (CHICCAP) in 27 villages around Choiseul. Based on the results of the V&A, five villages were identified as potential demonstration sites for climate change adaptation projects. Of the five villages, Sepa and Loimuni were recommended as pilot sites for the current SPC/USAID project. Villages were selected based on the following criteria:

- high population (>100 people);
- geophysical factors (low-lying, unsheltered coastline or close to a river);
- already experiencing environmental degradation and over-exploitation of natural resources;

- stressed coastal fisheries, degraded forests and coral reefs;
- experiencing reduced crop yields;
- has experienced destruction of food crops, coastal erosion, severe storm surges and/or inundation as a result of tropical cyclones;
- is an organised community (from previous experience and opinion) which would support a climate change programme.

6.2. Vulnerability analysis methods

The main objective of the current project was to conduct a participatory rural appraisal (PRA) in the selected communities, to give a more detailed assessment of the vulnerability of land-based agricultural production systems, and to identify appropriate adaptation measures to the impacts of climate change. More specifically, the project set out to:

- assess the degree of vulnerability to climate change of food production systems in Sepa and Loimuni villages;
- assess the food security situation in Sepa and Loimuni villages; and
- identify adaptation measures to the impacts of climate change on food production systems in Loimuni and Sepa villages.

The project team

The assessment was conducted in May 2013 by a team consisting of SPC technical staff, SPC-GIZ Choiseul-based staff, Choiseul Province agriculture staff, UNDP staff, and Ministry of Agriculture and Livestock staff along with two SPC Regional Media Centre staff. The team met in Taro to familiarise team members on the assessment tools including the household survey questionnaires prior to the assessment. They also reviewed data from previous assessments and synthesis materials; hence, this assessment builds on the results of previous V&A assessments.

Household income and expenditure survey (HIES)

The primary objective of the survey was to collect information on household income and expenditure, household food consumption and housing characteristics including living conditions. The survey covered 50% of the households in each village.

Participatory rural appraisals

In each village, participants were divided into three groups (men, women and youths). Team facilitators from SPC, Choiseul-based staff and the Ministry of Agriculture helped guide the group work. The facilitators recorded the perceptions of the communities, and the results were collated for analysis.

Transect walk

After completing the PRA and household survey, the team did a transect walk to validate the findings of the assessment. The transect walk findings were then combined with the assessment results to guide the formulation of adaptation strategies.

6.3. Vulnerability assessment for Sepa village

Exposure

Table 6.1 presents the results of the analysis of Sepa village's exposure to climate change. The average score for exposure is high (3). Changes in behaviour of plants was ranked very high.

Table 6.1. Sepa village exposure to climate change.

Variable	Description	Community perception	Score
Temperature	Numbers of hot days increased	High	2.67
	Number of cold days decreased	Medium	
Precipitation	Rainfall increased	High	3
Plant and animal indicators	Productivity of sweetpotato reduced due to pests and diseases Change in soil texture and fertility	Very high	4
	Taro leaf blight has affected taro production	Very high	
	Pest and disease problems on slippery cabbage and sweetpotato	Very high	
	Reduced productivity of pigs and chickens (low survival rates)	Very high	
Climate-induced and other natural disasters	Landslide	Medium	2.33
	Tsunami	Medium	
	Flooding	High	
Average exposure score			3

Sensitivity

Table 6.2 shows that the sensitivity of Sepa village to the adverse impacts of climate and related effects is medium to high (2.98). The highest perceived sensitivity to climate change was in the area of agriculture and food security, particularly relating to outbreaks of pests and diseases on crops.

Table 6.2. Sepa village sensitivity to climate change.

Sector	Hazard	Indicator	Community perception	Score
Agriculture and food security	Landslides	Loss of productive lands	High	3.38
		Soil fertility reduced	High	
	Floods	Loss of crop production	Very high	
		Affected soil texture and fertility	High	
	Outbreak of pests and diseases	Production decline (sweetpotato, slippery cabbage and taro)	Very high	
		Taro production reduced (taro leaf blight)	Very high	
		Low survival rates and slow growth rate of livestock (pigs and chickens)	High	

Sector	Hazard	Indicator	Community perception	Score
Forest and biodiversity	Landslides	Loss of forest cover	High	2.5
		Emergence of new plant species	Medium	
Infrastructure	Landslides	Trails damaged/flooded	High	3
		Damaged farm structures and copra sheds	High	
Water resources and energy	Landslides	Loss of fresh water (flooding)	High	3
	Floods	Reduced water quality	High	
Human health	Landslides and floods	Emergence of water-borne diseases in children (diarrhoea)	High	3
Average sensitivity score				2.98

Adaptive capacity

Table 6.3 shows the adaptive capacity of Sepa village to climate change impacts in relation to agricultural systems and livelihoods. The adaptive capacity is low.

Table 6.3. Sepa village adaptive capacity to climate change.

Parameter	Indicator	Criteria	Perceived change	Score
Human assets	Demography	Old age and children	Medium	2
	Education	Secondary education and awareness of climate change	Medium	
	Skilled labour	Trained workers	Medium	
Natural assets	Land	Land ownership and productivity	Medium	1.67
	Forest	Availability of products and services (however, threats exist from logging and cultivation)	Medium	
	Water	Availability of drinking water and water quality	Large	
Financial assets	Financial institutions	Access to banks, cooperatives	Large	1.5
	Household incomes	Sufficiency for household needs	Medium	
Social assets	Social institutions	Community affiliations to formal and non-formal institutions	Medium	2
	Service providers	Engagement of NGOs and GOs with community	Medium	
Physical assets	Infrastructure for services	Access to schools, houses, bridges, roads, electricity, health posts, vehicle availability, boats	Medium	1.5
	Information and communication sources	Access to mobile phones, radio, TV, newspapers and internet	Low	
Average adaptive capacity score				1.55

Vulnerability score for Sepa village

Vulnerability (V) = E × S/A

= 3 × 2.98/1.98

= 5.77 (very high)

6.4. Vulnerability assessment for Loimuni village

Exposure

Table 6.4 shows the results for the analysis of community exposure to climate change. The exposure for Loimuni Village is high (3.21).

Table 6.4. Loimuni village exposure to climate change.

Variable	**Description**	**Community perception**	**Score**
Temperature	Numbers of hot days increased	High	3
	Number of cold days decreased	Medium	
Precipitation	Rainfall increased	Very high	4
Plant and animal indicators	Productivity of sweetpotato reduced due to pests and diseases Change in soil texture and fertility	Very high	3.5
	Taro leaf blight has affected taro production	Very high	
	Pest and disease problems on slippery cabbage and sweetpotato	Very high	
	Reduced productivity of pigs and chickens (low survival rates)	Medium	
Climate-induced and other natural disasters	Landslides	Low	2.33
	Tsunami	High	
	Flooding	High	
Average exposure score			3.21

Sensitivity

Table 6.5 shows the sensitivity of Loimuni village to climate change impacts. The overall sensitivity score is medium (2.04).

Table 6.5. Loimuni village sensitivity to climate change.

Parameter	**Hazard**	**Indicator**	**Community perception**	**Score**
Agriculture and food security	Landslides	Loss of productive lands	High	3.25
		Soil fertility reduced	Very high	
	Floods	Loss of crop production	High	
		Affected soil texture and fertility	High	
	Outbreak of diseases	Production decline (sweetpotato, slippery cabbage and taro)	Very high	
		Taro production reduced (taro leaf blight)	Very high	
		Low survival rates and slow growth rate of livestock (pigs and chickens)	Medium	
Forest and biodiversity	Landslides	Loss of forest cover	Medium	2
		Emergence of new plant species	Medium	
Infrastructure	Landslides	Trails damaged/flooded	Medium	2.5
		Damaged farm structures and copra sheds	High	
Water resources and energy	Landslides	Loss of fresh water (flooding)	High	2.5
	Floods	Reduced water quality	Medium	
Human health	Landslides and floods	Emergence of water-borne diseases on kids (diarrhoea)	Medium	2
Average sensitivity score				2.04

Adaptive capacity

Table 6.6 shows the adaptive capacity for Loimuni village to climate change. The overall adaptive capacity is low (1.5).

Table 6.6. Loimuni village adaptive capacity to climate change.

Parameter	Indicator	Criteria	Perceived change	Score
Human assets	Demography	Old age and children	Medium	2
	Education	Secondary education and awareness of climate change	Medium	
	Skilled labour	Trained workers	Medium	
Natural assets	Land	Land ownership and productivity	Low	1.33
	Forest	Availability of product and services (but threats exist from logging and cultivation)	Medium	
	Water	Availability of drinking water and water quality	Low	
Financial assets	Financial institutions	Access to banks, cooperatives	Low	1
	Household incomes	Sufficiency for household needs (limited income – distance from market)	Low	
Social assets	Social institutions	Community affiliations to formal and non-formal institutions	Low	1
	Service providers	Engagement of NGOs and GOs with community	Low	
Physical assets	Infrastructure for services	Access to schools, houses, bridges, roads, electricity, health posts, vehicle availability, boats	Medium	2
	Information and communication sources	Access to mobile phones, radio, TVs, papers, and internet	Medium	
Average adaptive capacity score				1.5

Vulnerability score for Loimuni village

$$\text{Vulnerability} = E \times S/A$$
$$= 3.21 \times 2.04/1.5$$
$$= 4.37 \text{ (very high)}$$

6.5. Results of the HIES

Household income

On average, 63% of households surveyed in Sepa and 81% in Loimuni indicated insufficient income for their household needs. The analysis also showed that food security and traditional/church obligations have the biggest impact on household finances.

Housing and facilities

The survey showed that the majority of households live independently with most living in houses made of thatch. Only 12% of the households live in timber/tin roof housing. In Sepa, more than 80% of households have access to the community water supply as their main source of drinking and washing water, while in Loimuni household tanks and protected wells are the common water sources. The majority of households lack proper toilet facilities. Most households have solar panels as their main source of lighting while all use open fire for cooking.

Land access and land use

While over 90% of households have access to land, the majority of households surveyed indicated that soil quality is not suitable for agriculture. The average amount of land per household is about 2.89 acres for Sepa and 1.24 acres for Loimuni. The majority of the households surveyed (70–89%) indicated they grow their own food and expressed interest in training on agriculture production techniques. There was also high interest in growing fruit and timber tree species, while a small proportion of the surveyed households indicated a lack of interest for tree species due to lack of access to land or land with good quality soil.

Food consumption

The survey results indicated that, on average, the energy intake per capita per day is higher than the FAO/WHO minimum requirement for food security. However, there is an established tendency for reliance on imported food such as rice, flour and noodles and sources of protein for both villages.

6.6. Transect walk findings

In both villages, the farmlands are located about half a kilometre from the main village or residential areas, stretching inland for about 1.5 kilometres. Trails are the main access to these farmlands, which are quite muddy and not well built. Livestock are mainly kept in subsistence production systems, with some confined in wooden stalls while other families keep their pigs in free-range systems. There is quite limited poultry (chickens) kept in free-range systems. There are no other forms of livestock in the villages.

The main cropping system is mixed cropping within agroforestry systems. Plots of root crops are found within the agroforestry systems. The common staple crops being grown include coconut, sweetpotato, pineapple, banana, cassava, cocoa, Polynesian chestnut (ivi), carambola, soursoup, citrus (lemon, pomelo), pawpaw, guava, taro, yam, giant swamp taro, local yam and vegetables such as bele, ferns, corn, beans and eggplant.

Several problems were observed. There is a lack of proper spacing and limited knowledge on mixed cropping. The community indicated their interest in training on farming techniques, especially spacing requirements for different crops within agroforestry and mixed cropping systems, intercropping techniques, and soil management. Significant nutrient deficiencies and pests and diseases were observed on crops, especially sweetpotatoes, slippery cabbage and taro (taro leaf blight). There are also significant problems of soil erosion and landslides in the farmlands. These erosion problems are mainly due to cultivation on sloping areas and near riverbanks, with more awareness required on sustainable farming techniques.

6.7. Discussion of the vulnerability assessments for Sepa and Loimuni

The results of the analysis showed that both villages are vulnerable to climate change impacts. The communities' exposure to climate change is high. During the assessment, community members indicated that they have observed more prolonged and more intense rainy seasons, which have impacted their agriculture production. Community members perceived that the behaviour of crops and livestock is also changing. The growth and survival rates of livestock have reduced. Community members also indicated that soil texture and fertility was changing due to frequent flooding in croplands.

The study found that the sensitivity of both communities was medium to high. There were concerns raised during the exercise that flooding frequency is increasingly; during flooding most agriculture lands are damaged. The incidence of pests and diseases is believed to be increasing. Community members stated that taro production has been reduced due to taro leaf blight problems. The main type of leafy green vegetable grown, slippery cabbage (*Hibiscus manihot*), has been affected by insects boring the leaves. Discussions also noted soil texture change (hardening of soils) after heavy rainfall and after long periods of sun, which affects sweetpotato tubers, the most common and preferred root crop. Water quality is also being affected by flooding.

The adaptive capacity of both communities is low. It was noted that loss of forest cover is increasing, leading to soil erosion which in turn affects water sources and water quality. Soil erosion at riverbanks is mainly due to poor agricultural practices too close to the banks. Hence it is highly important to establish a management plan for the watershed or water catchment area to ensure availability of water and water quality for the community.

The results indicated that water-borne diseases are common during heavy rainfall and flooding. In terms of village infrastructure, the survey found that 88% of households are living in thatched houses that are vulnerable to natural and climate-induced disasters. The lack of infrastructure and transportation for the villages is reported to be a major concern in accessing farmlands and markets to sell produce. Taro, which is the main market outlet for the village, is some two hours away by motor boat. Existing health clinics in the villages are unstaffed due to lack of qualified personnel. There is no telephone or mobile coverage in the villages. The main communication service available to the villages is two-way radio and access to service providers is low.

6.8. Food security

The four determinants of food security (food availability, food access, food utilisation and food stability) were assessed to determine the communities' food security situation. The results of the analyses indicated that both villages are vulnerable to climate change impacts on food production systems. Taro production has been reduced significantly due to taro leaf blight. There is an urgent need to provide training on good agriculture practices, availability of resistant crops, crop diversity, and pest and disease control.

Food availability

The analysis of food consumption indicated that both villages are food secure from a food availability point of view, however reliance on imported food sources (rice, flour and ramen noodles) is quite high, ranging from 40% to 65%. This may be at least partly due to the production problems faced by the communities.

The analysis found that food production is declining, due to both climate factors and non-climate factors, such as low crop diversity and limited markets. The study also found that food preservation is not practised by households.

Food access

Food access is determined by the household's and individual's access to resources to either produce food or to purchase sufficient amounts of safe food. Most households in both villages have access to land, however with the tribal tenure system land access can become a contentious issue. The quality of land is also a concern for the villagers: soil fertility is becoming a problem in both villages. The limited access to transportation and the distance of both villages to markets is resulting in low household income. Other income-generating opportunities are limited for both communities.

Food utilisation

The limited choice of crops, and reliance on imported food, is resulting in poor diversity of diets. There is also limited availability of local livestock products (meat and eggs). It has been well reported that nutritional diseases in the Pacific are mainly due to the consumption of unhealthy imported foods. Hence there is a strong need to promote production and consumption of local food. Both communities indicated that they need capacity building and awareness on nutrition, food preparation and preservation.

Food stability

In terms of stability of food supply, it is clear from the exercise that food production is affected by natural disasters, pests and diseases and other climate-related impacts. Given the reliance on imported food and the considerable distance from markets, the lack of transportation options is a hindrance to food stability.

6.9. Adaptation interventions

The following adaptation strategies were identified for Choiseul in the previous V&A exercise.

1. Minimise damage to village infrastructure. Adaptation options include community and infrastructure planning to include sea-level and flooding projections, and relocating buildings and infrastructure.
2. Manage and protect intertidal and coastal areas. Adaptation options include planting coastal trees/shrubs for protection, mangrove reforestation, creating vegetation buffers on river banks, and maintaining existing ecosystem functions.
3. Increase food security and improve livelihoods. Adaptation options include providing technical agricultural assistance (crop rotation, crop diversity, and agricultural techniques), agroforestry of cash crops and fruit trees, reforestation of previously logged areas with valuable timber species, contour planting and terracing, improved pest and disease control and increased livestock production.
4. Protect water resources. Adaptation options include protection and/or restoration of water catchment areas, riparian and freshwater ecosystem management, increasing water storage capacity, sediment control of freshwater streams and water quality testing.
5. Manage marine areas and fisheries. Adaptation options include coral reef and mangrove ecosystem management, minimising fishing pressure on key species, trials of fish aggregating devices, locally managed marine management areas and monitoring.
6. Increase disaster preparedness. Adaptation options include emergency management procedures for landslides, tropical cyclones, flooding or tsunamis and planning for food shortages caused by disaster events, and introducing aquaculture interventions options for villagers to increase fish availability.

The proposed adaptation options following the current PRA include diversifying vegetable and root crop varieties; providing training on farming, food safety and nutrition; establishing seedling nurseries and a demonstration contour farming site; and improving piggery and poultry farming and introducing honeybees.

7. Tonga: Houma village (‘Eua), Tefisi village (Vava’u) and Kolonga village (Tongatapu)

> Food security assessments carried out by the Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (CGPRT Centre) in 2000 showed that provincial and household food security are of more serious concern than national food security in Tonga. Unfortunately, there are major gaps in regular and detailed reporting of food insecurity in Tonga, with the Food and Agriculture Organization of the United Nations (FAO) unable to report any statistics on per capita food supply, food aid shipments or the prevalence of undernutrition in Tonga as of 2012. Other statistics, such as a decrease in agricultural productivity per capita between 2006 and 2011, give reason for concern. Yet for geographically isolated Tonga, with 41 inhabited outer islands, productivity is only one piece of the puzzle; formalizing systems of access to locally produced food is essential for long-term food resilience. Food access, availability, utilization and source stability must be considered as a whole.
>
> The Tonga Food Road Map 2014–2064

7.1. Project sites

Three village sites were selected in Tonga by the technical committee of the Tonga Joint National Action Plan on Climate Change Adaptation and Disaster Risk Management (JNAP). The sites are Houma village in the northwest of ‘Eua, which is exposed and prone to winds and has rather droughty soil; Tefisi village on the western side of Vava’u, which has agricultural land mostly on sloping lands, which are very prone to soil erosion; and Kolonga village in the northeast of Tongatapu, which is exposed to strong coastal winds.

Figure 7.1. The SPC/USAID team discussing project activities with a Tongan farmer.

The soils of the three sites are described below, taken from soil survey reports of the islands by the Soil Bureau of the Department of Scientific and Industrial Research of the New Zealand Government in the 1970s to the 1980s.

Houma

Houma soil series, named after Houma village, occurs on undulating to strongly rolling and hilly slopes along the central parts of ʻEua, at elevation between 60 m and 300 m, within the northern half of the island. Houma series are formed from between 50 cm to 2.5 m of andesitic tephra overlying either old foraminiferal limestone or older tuffaceous sediments and in a few places, coral limestone. The presence of small weakly weathered lapilli in A horizons, as within most of the soils of ʻEua, suggests that upper horizons of Houma series have formed from recent accretions of tephra.

Houma series has reddish coloured silty clay textured A horizons with moderate to strongly developed structure, over reddish brown and red, friable to firm, clay and silty clay textured B horizons with strongly developed blocky structure. Bt horizons have sticky and plastic wet consistency and well-developed continuous clay coatings with some distinct manganese patches. Houma soil series are mapped on mainly undulating and easy rolling slopes to hilly slopes.

Houma soils are considered to have severe limitations for cropping but moderate limitations for fruit trees and minimal limitations for forestry.

Tefisi

Longomapu soils have been mapped along the western side of Vava'u including Tefisi village, except the very steep slopes which are mapped as Panagaimotu soils. Longomapu soils are developed from a deep cover of a younger brown tephra overlying older tephra or limestone. The profile shows some 20 cm of very dark brown friable silt loam to clay loam A horizon, with moderately developed medium nut and fine granular structure, resting on a dark brown friable clay loam with strongly developed coarse blocky structure. These soils are suitable for producing a wide range of crops except on sloping lands where soil erosion is a threat. Pangaimotu soils on the steeper slopes are similar but more developed soils than Longomapu which can grow a wide range of crops. On the slopes, the limitation is potential soil erosion.

Kolonga

The predominant soil in Kolonga is the Lapaha series. Profiles are characterised by an A horizon, about 30 cm thick, of a dark reddish brown, dark brown friable clay, containing few weathered lapilli and few hard black lapilli. The B horizon is a brown, firm heavy clay with a moderately blocky structure with thin clay coatings on ped surfaces. This soil is normally well drained but, because of a lower percentage of large pores in B horizons, permeability is likely to be slower than other volcanic ash soils in Tonga, and aeration of the soil could be reduced during wet periods. With higher content of clay it would also be more difficult to work during wet periods so that the Lapaha soils are regarded as slightly less versatile than the other volcanic ash soils (Vaini and Fahefa soils).

Lapaha soils are considered to have slight limitations of workability and aeration for subsistence food crops, ground cash crops, and urban uses and minimal limitations for tree cash crops and pastoral use. The Lapaha soils, rolling phase which are on the Kolonga exposed site, have limitations for pastoral use, slight limitations for ground cash crops, and moderate limitations for subsistence food crops, tree cash crops and urban uses.

7.2. Vulnerability analysis methods

The community vulnerability analysis was conducted with representatives from the three communities in April 2013. It involved the use of participatory rural appraisal (PRA) tools, household income and expenditure surveys (HIES), and transect walks. Over 30 people attended the PRA workshop in ʻEua, Houma with the HIES conducted the following day. Only male farmers (24) attended the PRA in Tefisi due to a miscommunication that the PRA was for farmers. However, the opinions of women were sought on issues raised at the PRA during the HIES the next day. In Kolonga, the PRA was attended by 30 men, women and youths, followed by the HIES the next day.

7.3. Vulnerability assessments

Exposure

Tables 7.1 to 7.3 give the results of the community assessments of the different elements of exposure for Houma, Tefisi and Kolonga villages, respectively. It was evident from the exercise that the community perceived a change in climate over the last three decades, and consequent changes in the behaviour of plants and animals. They drew a correlation between climate change and shifts in the planting dates of yams, as well as the incidence of pests and diseases.

Table 7.1. Assessment of elements of exposure (E) for Houma village.

Parameter	**Indicator**	**Perceived change**	**Score**
Temperature	Numbers of hot days increased	High	3.3
	Number of cold days decreased	High	3.3
Precipitation	Rainfall has become increasingly unpredictable	Very high	4
Plant and animal indicators	Change in flowering and fruiting of fruit trees like breadfruit and mango	Medium to high	2.66
	Change in animal behaviour like egg laying by chickens	Very high	4
Climate-induced disasters	Drought	Medium	2.33
	Cyclones	Medium to high	2.66
	Pests and diseases	Medium to high	2.66
	Overall exposure score		3.11 (High)

Table 7.2. Assessment of elements of exposure (E) for Tefisi village.

Parameter	**Indicator**	**Perceived change**	**Score**
Temperature	Numbers of hot days increased	High	3.3
	Number of cold days decreased	High	3
Precipitation	Rainfall has become increasingly unpredictable	High	3.3
Plant and animal indicators	Change in flowering and fruiting of fruit trees like breadfruit and mango	High	3.6
	Change in animal behaviour like egg laying by chickens	Medium to high	2.6
	Yam season (pests and diseases)	High	3
Climate-induced disasters	Drought	Medium to high	2.6
	Cyclone	Medium to high	2.6
	Overall exposure score		3.2 (High)

Table 7.3. Assessment of elements of exposure (E) for Kolonga village.

Parameter	Indicator	Perceived change	Score
Temperature	Numbers of hot days increased	High	3.16
	Number of cold days decreased	High	3.16
Precipitation	Rainfall has become increasingly unpredictable	High	3.33
Plant and animal indicators	Change in flowering and fruiting of fruit trees like breadfruit and mango	High	3.66
	Change in animal behaviour like egg laying by chickens	Medium to high	2.66
	Yam season (pests and diseases)	High	3
Climate-induced disasters	Drought	Medium to high	3.33
	Cyclone	Medium to high	2.33
	Overall exposure score		3.04 (High)

Sensitivity

The groups discussed past climatic hazards and impacts on their communities. The focus was on five sectors: agriculture and food security, forest and biodiversity, water and energy, infrastructure, and human health. Once impacts were decided, the groups ranked them as low, medium, high or very high (Tables 7.4–7.6).

All communities perceived that the five sectors are being impacted by climate variability and climate-induced disasters (cyclones and drought). Many of the farmers indicated that farming is becoming more difficult as the climate is changing and affecting the environmental parameters important for food production.

Table 7.4. Assessment of elements of sensitivity (S) for Houma village.

Parameter	Hazard	Indicator	Perceived change	Score
Agriculture and food security	Cyclone	Loss of productive lands	High	3
	Drought	Loss of crop production	Medium to high	2.6
	Outbreak of diseases	Production decline	Medium	2
Forest and biodiversity	Drought	Loss of forest cover	Medium to high	2.67
Infrastructure	Cyclone	Trails and roads damaged	High	3.33
Water resources and energy	Cyclone	Loss of quality fresh water	Medium	2.33
	Drought	Reduction of fresh water	Medium to high	2.67
Human health	Cyclone	Emergence of water-borne diseases	Medium	2.33
Average sensitivity score			Medium to high	2.64

Table 7.5. Assessment of elements of sensitivity (S) for Tefisi village.

Parameter	Hazard	Indicator	Perceived change	Score
Agriculture and food security	Cyclone	Loss of productive lands	High	3.6
	Drought	Loss of crop production	Very high	4
	Outbreak of diseases	Production decline	High	3
Forest and biodiversity	Cyclone	Loss of forest cover	Medium to high	2.6
	Drought	Loss of biodiversity	Medium	2.3
Infrastructure	Cyclone	Trails and roads damaged	High	3.6
Water resources and energy	Cyclone	Loss of quality fresh water	High	4 3
	Drought	Reduction of fresh water	High	3
Human health	Cyclone	Emergence of water-borne diseases	Medium to high	2.8
Average sensitivity score			High	3.06

Table 7.6. Assessment of elements of sensitivity (S) for Kolonga village.

Parameter	Hazard	Indicator	Perceived change	Score
Agriculture and food security	Cyclone	Loss of productive lands	High	3
	Drought	Loss of crop production	Very high	3.33
	Outbreak of diseases	Production decline	High	3
Forest and biodiversity	Cyclone	Loss of forest cover	Medium to high	2.33
	Drought	Loss of biodiversity	Medium	2.33
Infrastructure	Cyclone	Trails and roads damaged	High	3.6
Water resources and energy	Cyclone	Loss of quality fresh water	High	3
	Drought	Reduction of fresh water	High	3
Human health	Cyclone	Emergence of water-borne diseases	Medium to high	2.8
Average sensitivity score			High	2.81

Adaptive capacity

The adaptive capacity is a measure of how well the communities are able to respond to the effects of climate change. Assessment of adaptive capacity looks at the assets of the community, including the human, natural, physical, financial and social assets.

A resources map was developed showing natural and physical resources available to the communities. The resources were then assessed in terms of quantity, quality and availability. Adaptive capacities were then ranked

by communities as low (1), medium (2), high (3) or very high (4). Low numbers mean that adaptive capacity is poor and must be addressed to improve resilience to climate change.

The data from this exercise were combined with data on livelihood assets from the HIES and used to generate the spider webs in Figure 7.2. The results show that the communities clearly do not have the capacity to withstand climate change trends or extreme events.

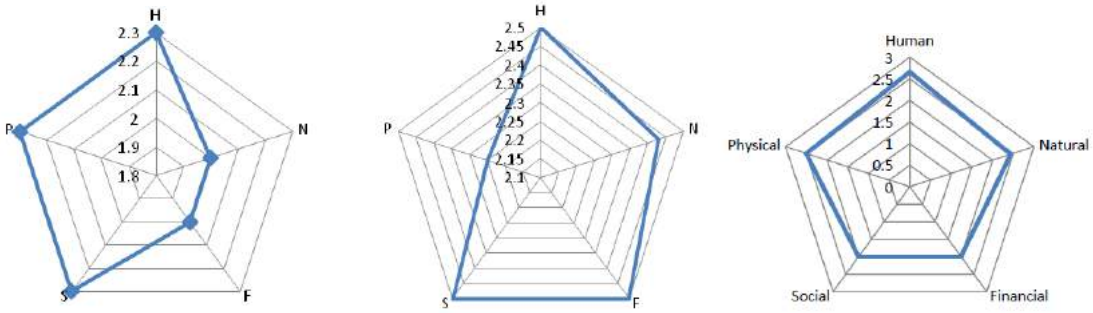

Figure 7.2. Adaptive capacity of Houma (left), Tefisi (middle) and Kolonga (right).

For Houma the critical assets that need addressing are natural and financial assets; for Tefisi the most critical assets that need improvement are physical assets; and for Kolonga the most critical assets are social and financial assets.

Vulnerability

Using the formula V = E × S/A, the vulnerability score for Houma was 3.77, for Tefisi it was 3.98, and for Kolonga 3.63. They are all rated as high.

7.4. Food consumption

At the time of the survey the majority of food consumed was locally produced, but this is under threat from an increasing reliance on imported foods such as rice and flour. Households in Houma and Kolonga source more than 50% of protein from imported sources while Tefisi households are consuming more local proteins such as seafood. In general, the food security situation of the three communities is quite vulnerable given that their food production systems are vulnerable to the impacts of climate variability and climate-induced disasters.

Figure 7.3. A woman in Kolonga village, Tongatapu, tending her home garden.

7.5. Adaptation interventions

The following proposed adaptation options were developed as a result of the PRA.

- Provide training on climate change threats and adaptation measures to reduce vulnerability, in particular food security.
- Increase crop areas, yield per area and livestock.
- Generate research results to support adaptation strategies.
- Promote backyard gardens and the production of varieties of foods for food security and income generation.

8. Vanuatu: Divers Bay village

8.1. Project site

Divers Bay village on Ureparapara Island was the project site selected for Vanuatu. Ureparapara is the third largest island in the Banks archipelago, which together with the Torres group of islands forms Torba Province in the northern part of Vanuatu (Figure 8.1). The capital of Torba Province is Sola on Vanua Lava, the second largest island in the Banks group. Ureparapara has three villages with a total population of 436 people (2009 census). Of the three, Divers Bay is the largest village, located on the eastern part of the island within Ureparapara Bay. The village is situated in a valley, on a flat strip of land near the coast. About a half kilometre from the village lies a steep cone-shaped mountain that runs through the island. Ureparapara is accessed by boat, taking some three to four hours from Sola on Vanua Lava.

Ureparapara was selected as the project site for the following reasons: (i) the island is extremely isolated in terms of service access; (ii) it is highly vulnerable to the impacts of climate change and natural disasters as well as having an increasing population; and (iii) it is highly dependent on agriculture for subsistence and livelihoods and is experiencing a lot of food production problems.

The main types of crops grown include root crops (taro, sweetpotato, yam, cassava), fruits (breadfruit, mango, banana, citrus, pawpaw, coconut) and vegetables (bele and eggplant). A few families keep indigenous pigs and chickens. Most or all livestock are kept in subsistence production systems.

Figure 8.1. Map of Vanuatu showing Ureparapara Island. Source: Government of Vanuatu.

The Government of Vanuatu recommended 10 islands as potential sites for the project. However, due to the limited amount of funding available for implementation activities, a single site was chosen based on the following criteria.

- Accessibility: For effective delivery of on-the-ground project activities, accessibility was identified as a key criterion for project implementation.
- Socio-economics: A trend of increasing population is a proxy indication of climate change vulnerability.
- Food production systems: Characteristics such as water/irrigation problems and low use of agricultural management practices such as soil improvement indicate vulnerable food production systems.
- Biodiversity/agrobiodiversity: Low agrobiodiversity indicates vulnerability.
- Topography: Floodplains and soil erosion problems are indications of vulnerability.
- Climate change impacts: Whether the area was vulnerable to the impacts of climate change such as salinity, drought, flooding, prolonged high rainfall, as well as changes in crop and livestock productivity.
- Non-climatic factors: Problems of pests and diseases, reduced crop yields, soil fertility problems.

8.2. Vulnerability analysis methods

The main objectives of the assessment were to conduct climate change vulnerability assessments of the land-based agricultural production systems, and identify adaptation measures to the impacts of climate change. More specifically, it assessed the degree of vulnerability to climate change of food production systems on Ureparapara; assessed the food security situation on Ureparapara; and identified adaptation measures to the impacts of climate change on food production systems.

The assessment was conducted in June 2013 by SPC technical staff, Department of Agriculture and Rural Development staff and Department of Fisheries staff. A briefing and refresher training on the assessment tools including household survey questionnaires preceded the assessment.

The analysis included a participatory rural analysis (PRA), a household survey, and a transect walk. For the PRA, community participants were divided into three groups (men, women and youths). Further analysis of food security was carried out, and finally adaptation interventions were proposed.

8.3. Vulnerability assessment for Divers Bay village

Exposure

Table 8.1 presents the results of the analysis of exposure of Divers Bay village to climate change. The overall exposure score is high (3.08). Changes in the local climate ranked from high to very high. The behaviour of plants and animals was also assessed as a proxy indicator of climate change and showed that most were changing. Mango has not fruited for about 10 years. Cassava and yam productivity has declined with the taste of cassava becoming more bitter. It was also noted that livestock numbers are decreasing due to high mortality and this is a concern for the community given their dependency on local production due to their isolation.

Table 8.1. Assessment of exposure (E) for Divers Bay village.

Variable	Description	Community perception	Score
Temperature	Number of hot days has increased	Very high	4.00
	Number of cold days has decreased	High	3.00
Rainfall	Rainfall has become increasingly unpredictable (more frequent)	High to very high	3.67
Climate-induced disasters	Occurrence of landslides has increased and sea level rise	Medium to high	2.67
	Occurrence of drought has decreased	High	3.00
Mango	Not fruiting for about ten years	Very high	4.00
Breadfruit	Unlike before, fruiting all year round	High	3.00
Yam	Shorter season but smaller tubers and more diseases (anthracnose)	High	3.00

Variable	Description	Community perception	Score
Cassava	Smaller and harder tubers, and taste changed (bitter); rat problems	Medium	2.00
Banana	Fruits are smaller and taste changed (saltier); more damage from fowls	Low	1.00
Pigs	Higher mortality; fewer pigs now; slow growth; low survival rate	High	3.00
Chicken	Lowered egg production = fewer chickens; eye disease	High	3.67
Fish/crabs	Fewer fish, inconsistent catches	Very high	4.00
Total			40.00
Average exposure score			3.08 (High)

Sensitivity

Table 8.2 shows the analysis of sensitivity of Divers Bay village to climate change. Five sectors were selected for the assessment (agriculture and food security, forest and biodiversity, water, settlement and infrastructure, and human health). The scores for the various elements of sensitivity range from high to very high, with an overall score of 3.55. The highest values were assigned to infrastructure and human health; this is due to the absence of proper infrastructure and a health clinic on the island. All other sectors were ranked highly sensitive.

Table 8.2. Assessment of sensitivity (S) for Divers Bay village.

Sector	Hazards	Indicator	Community perception	Score
Agriculture and food security	Landslides and cyclones	Agricultural land damaged	High	3.67
	Cyclones and landslides	Loss of croplands	High	3.33
Forest and biodiversity	Cyclones	Loss of forest cover	High	3.00
	Cyclones	Loss of forest products	High	3.33
Water	Cyclones and landslides	Reduced quantity of water	High	3.33
	Cyclones and landslides	Six months to recover water quality	High	3.33
	Cyclones and landslides	Reduced quality of water	High	3.67
Settlement and infrastructure	Cyclones and landslides	Damaged infrastructure	Very high	4.00
	Cyclones	All infrastructure (houses) damaged	Very high	4.00
Human health	Cyclones and landslides	Outbreak of malaria and diarrhoea	High	3.33
	Cyclones and landslides	Number of people (majority of the population)	Very high	4.00
Overall sensitivity score				3.55 (High)

Adaptive capacity

Table 8.3 shows the analysis of adaptive capacity of Divers Bay village. The analysis investigated five types of assets that support adaptive capacity (natural, physical, social, financial and human assets). Each scored low, indicating limited capacity to adapt to climate change impacts. All social institutions and service providers are off the island, which further limits adaptive capacity.

Table 8.3. Assessment of adaptive capacity (A) for Divers Bay village.

Parameter	Indicator	Criteria	Community perception	Score
Natural assets	Agricultural land	Land use and productivity	Medium	2.00
	Forests land and forest products	Availability of products and services	Medium	2.00
	Water	Availability of drinking water and water quality	Low	1.67
Physical assets	Infrastructure for services	Trails	Low	1.67
		Drinking water and electricity	Low	1.67
		Settlements and community hall	Medium	2.00
		Housing standards	Medium	2.00
		Access to transportation (land, air, sea)	Low	1.33
		Access to health post	Low	1.67
		Access to schools	Medium	2.00
	Information and communication sources	Access to mobile phone, radio, TV, newspapers, and internet	Low	1.33
Social assets	Social institutions and service providers	Community affiliations to formal/non-formal institutions and engagement of NGOs and gOs with community	Low	1.00
Financial assets	Financial institutions and sufficiency of incomes	Access to banks, cooperatives and sufficiency of income for household needs	Low	1.00
Human assets	Demography, education, skilled labour	More elderly and young (lack of trained or skilled labour and low education levels)	Low	1.00
Total				22.33
Overall adaptive capacity score				1.60 (Low)

Vulnerability of Divers Bay village

Vulnerability (V) = E × S/A

= 3.08 × 3.55/1.60

= 6.84 (very high)

8.4. Results of the household survey

The survey covered 24% of households and collected information on income and expenditure, consumption and housing characteristics.

Population characteristics

Diver's Bay village has a total of 94 households and a population of 226 males and 211 females. Only 15.4% of those surveyed attended high school while the level of education for the remaining 84.6% was pre-school and elementary.

Household income

Ninety per cent of households surveyed indicated sufficient income for their household needs, with school fees and church obligations found to have the biggest impact on household finances, followed by food security. However, it was noted that students from Ureparapara had been expelled from high school in Gaua due to unpaid tuition fees, resulting from their parents' limited income. It is likely that the households had indicated that their incomes were sufficient on the survey due to their isolated location (where there is less use for cash) and subsistence lifestyle.

Land access and land use

The survey showed that all households have access to land with each household having access to about 6.42 acres. All households surveyed grow their own food, with the majority indicating an interest in diversifying their fruit and timber tree species. In terms of land quality for agriculture production, 77% indicated that their land was of average quality while the remaining 23% indicated that their land was of good quality.

Housing situation, housing types and facilities

The majority of households surveyed have living quarters made of predominantly local thatch materials. It was found that community water supply is not evenly distributed to all households. About 77% of the households have water tanks. All households use outhouse pit toilets; and all use battery lamps as the main source of lighting.

Food consumption

The survey indicated that on average, the energy intake per capita per day is less than the FAO/WHO minimum daily requirement for food security. There is also an established tendency for reliance on imported food such as rice, flour and noodles. A similar trend was observed for protein sources in both villages, with a tendency to rely on imported food. This is a concern for the community given their isolation and limited shipping to the islands (one ship every quarter).

8.5. Transect walk

The transect walk findings (Table 8.4) were used to validate the results of the assessment. Several issues or problems were observed during the transect walk through the croplands, which are described in the table.

Table 8.4. Transect walk findings, Divers Bay village.

Village and farming systems	Main crops	Livestock
The village: The village is located on a strip of the coastal area within the bay Croplands: • Croplands are situated about half a kilometre from the village • Mixed cropping/agroforestry • Flatland is about 0.5 km from coast to steep slopes • Plots of root crops within agroforestry	Main fruit trees • Breadfruit • Banana • Coconut • Great orange/lemon/citrus • Pawpaw Main root crops • Sweetpotato • Cassava • Taro • Yam	Main types of livestock • Chicken • Pigs • Cattle Issues: • Very small livestock numbers observed • Communities indicated that livestock numbers

Village and farming systems	Main crops	Livestock
• Cropping on sloping land Issues: • Village is located in valley near the coastal area, vulnerable to natural disasters and sea level rise • Limited access to communication and basic services • Need for diversification of agroforestry species • Needs proper spacing recommendations • Area is vulnerable to landslides due to steep slopes (needs proper farming systems for sloping land)	Main vegetables • Bele • Eggplants Issues: • Copra is the main source of income but limited transport limits access to markets • Limited crop diversity • Nutrient, pest and disease problems observed on root crops • Fruit fly on citrus fruits • Anthracnose disease affecting yams • Limited diversity of vegetables; insect boring on bele leaves	are decreasing, resulting in low availability of land based protein • Need to increase land-based protein

8.6. Discussion of the vulnerability assessment of Divers Bay village

The study found that the Divers Bay community has high exposure and sensitivity to climate change while their adaptive capacity is low. As a result, the community's climate change vulnerability is very high.

The analysis indicated that rainfall is increasingly unpredictable, and the number of hot days is increasing. The communities indicated that the observed changes in the local climate are responsible for observed changes in the behaviour of plants and animals. Mangoes are flowering but have not reached fruiting stage in the past ten years. The taste of bananas and cassava is also changing, but the cause of this is unknown. The mortality rate for livestock is also increasing and is observed to be high during high rainfall.

The study also recorded that landslides are occurring more frequently during high rainfall periods causing agricultural lands and communities to be impacted. Pest and disease incidences are increasing and coincide with high rainfall. All five sectors assessed were shown to be highly impacted by climate change and natural disasters.

The study also found that the adaptive capacity of the community to the impacts of climate change is low. All types of assets were ranked low. The community is situated within a valley of Ureparapara Bay with no access to modern communication technologies. Housing is made mainly of thatch while some have bamboo walls; this makes them especially vulnerable to cyclones and other types of natural disasters. Further, the community is located on a very low-lying coastal area, and therefore particularly vulnerable to tsunamis and sea-level rise.

There is limited transportation to the islands, and the community did not have many boats with engines at the time of the assessment, although a fibreglass boat with two engines had recently been donated to them. With small boats it is difficult to travel during rough weather. The Vanuatu national boat comes to the island once every quarter. There is neither a medical clinic nor a bank on the island – the nearest services are in Sola, which is a 3–4 hour boat ride. In terms of schools, there is only one primary school located on the island; the older children go to a high school on Gaua. All social institutions and service providers are on neighbouring islands. There are very few income-generating opportunities; some local food and handicrafts are sold to visiting vessels and yachts.

8.7. Food security situation for Divers Bay village

The four determinants of food security (food availability, food access, food utilisation and food stability) were assessed to determine the food security situation of the community.

Food availability

The food consumption analysis indicated that the energy supply per person per day is lower than the FAO/WHO minimum daily requirement for food security. Protein availability for the village population is also low (41.8 g/day). The main protein source for the community is fish, with limited protein from land-based sources. Despite the isolation of the community, there is a tendency to rely on food imports; given the limited income opportunities this is a serious concern for the community. Nonetheless, subsistence agriculture remains vital for the food security and livelihoods of the community. Proxy indicators showed that the productivity of most staple crops and livestock is decreasing. It is important to devise interventions to boost food production systems for the community.

Food access

Food access is determined by the household's and individual's access to resources to either produce food or to purchase a sufficient amount of safe food. Most households in both villages have access to land to grow their own food, however much of the land is vulnerable to landslides. Income-generating opportunities for the community are very few. The main income source for the villagers is copra, however irregular shipping (once a quarter) to the island means that most of the copra rots before it is shipped. The villagers indicated the need to establish a proper copra house to store copra for a minimum of three months. If the quantity and consistency of copra supply from the island improves, it may stimulate more frequent shipping to the island to pick up the copra.

Food utilisation

Food utilisation is still very reliant on local food production. However, there is a need to strengthen food production for the village population to reverse the reliance on imported foods. Diversification of food production systems will help improve the variety in diets.

Food stability

In terms of stability of food supply, it is clear from the exercise that food production is already impacted by climate change and non-climatic factors. The behaviour of plants and animals is changing. Fruit trees such as mango have not been fruiting for about 10 years. Income opportunities for the households are low.

8.8. Adaptation interventions

The results of the study showed that Divers Bay village is already impacted by climate change and that the food security of the community is challenged. From the results of this assessment, the following adaptation strategies are proposed.

- Institutional and social strengthening;
- Diversification of food production systems in order to diversify diets;
- Introduction of hardy crop varieties;
- Introduction of hardy livestock breeds;
- Development of demonstration farms (for both crops and livestock);
- Capacity building in all areas of intervention including climate change and disaster risk reduction programmes.

9. Conclusions and recommendations

In general, the PRAs for the various project sites found relatively high exposure and sensitivity indices and these, combined with relatively low adaptive capacities, produced high vulnerability assessments for all the selected communities. Household income and expenditure surveys (HIES) found a trend of increasing reliance on imported foodstuffs. With impacts of climate change inevitable, the communities face an uncertain future where food security and sustainable livelihoods may be compromised.

As a next step, at the time of writing work plans for adaptation strategies for these sites are being developed, while the communities are finalising land and labour requirements for demonstration farms and construction of nurseries.

Future PRAs could benefit from consideration of the following recommendations.

9.1. Gender

It is recommended that gender be integrated into the PRA design at the outset. While gender differences in climate change impacts and the implementation of adaptation interventions are known, there is a lack of sex-disaggregated data to verify these differences. Collection of data is important to determine specific gender differences and will be useful in the design and implementation of future interventions. Overall, there is a need for more gender-sensitive approaches and strategies with a focus on empowering women. Further, education and training relating to gender should inform future work in all communities given the disparity in gender roles and the considerable responsibilities women carry not only in their homes but in all sectors.

9.2. Livelihoods

While the project's primary focus was food security, communities repeatedly raised the need for income-generating activities. This suggests that including a livelihoods component in food security interventions could contribute to long-term sustainability. For example, communities are more likely to adopt crops for food security if they also generate income. During feedback sessions, communities were made aware of the range of crops available from SPC, such as early harvest sweetpotatoes and drought-tolerant yams and bananas. An economic analysis of these and other crops being introduced for food security purposes would be highly beneficial.

9.3. Social dynamics

In many of the communities visited, it was noted that the population mainly comprises the elderly and very young as those between 15 and 50 move to commercial centres to earn a living. This rural to urban drift has a marked impact on the food production and therefore food security of rural communities. Future PRA efforts could greatly benefit from the inclusion of social scientists to further investigate the causes and impacts of this trend.

9.4. Climate change awareness

Education and awareness materials in English and in the vernacular languages will assist in better understanding of climate change and its impact at the community level.

9.5. Traditional knowledge

Communities were also made aware of the importance of guarding their traditional knowledge for use by future generations in a changing world. The proper documentation of traditional knowledge will facilitate its survival and its sharing.

Appendix 1. Vulnerability and adaptation survey form

USAID CC Project

Vulnerability and Adaptation Survey

Section1: Background information

1.1 Household No.: ☐

1.2 Village:
……..

1.3 Respondent name:
…….USAID

1.4 Interviewer name:
……

1.5 Date: ……..… /……. / ……..

1.6 Time: ……..USAID

Section 2: Household and housing

2.1: Household composition

Household member No.	Ethnicity	Relationship to H/H	Sex	Age (years)	Marital status	Highest level of education completed

CODES

Ethnicity	R'ship to HH	Sex	Marital status	Education
1. Fijian	1. HH head	1. Male	1. Never married	0. None
2. Indian	2. Spouse	2. Female	2. Married	1. Kindergarten
3. Chinese	3. Child		3. Widowed	2. Elementary
4. Others	4. Parent		4. Separated	3. High school
	5. Grandchild		5. Divorced	4. College
	6. Other relation		6. Other	5. University
	7. Not related			6. Vocational

Section 2.2: Dwelling structure and amenities

2.2 MAIN type of living quarters

1 – Independent
2 – Shared building
3 – Other

2.3 MAIN type of material for walls of the house

1 – Concrete
2 – Corrugated iron/tin
3 – Timber/wood
4 – Thatch
5 – Other
6 – None

2.4 MAIN source of drinking water

1 – Public utility water supply
2 – Community water supply
3 – Household tank
4 – Protected well
5 – Unprotected well
6 – Other

2.5 MAIN source of washing water

1 – Public utility water supply
2 – Community water supply
3 – Household tank
4 – Protected well

5 – Unprotected well
6 – Spring, river, lake
7 – Other

2.6 MAIN toilet facility

1 – Flush toilet
2 – Water seal
3 – Outhouse, pit toilet
4 – Other

2.7 MAIN form of sewage disposal

1 – Connected to sewer line
2 – Connected to septic tank
3 – Use other means

2.8 MAIN source of power you have access to

1 – Public utility
2 – Generator
2 – Solar panels
3 – Other
4 – None

2.9 MAIN source of lighting

1 – Public utility
2 – Generator
3 – Solar panel
4 – Kerosene lamp
5 – Battery lamp
6 – Other
7 – None

3.0 MAIN cooking facility

1 – Electric range
2 – Gas stove
3 – Portable electric stove
4 – Kerosene stove
5 – Microwave oven
6 – Wood stove
7 – Open fire
8 – Other

Section 3: Income

3.1: Income sources

In the table below, please provide the average annual income of the household as a whole, for each of the categories provided below (please leave the total as blank)

Sources of income	**Av. income/week ($)**
Selling farm produce	
Selling cooked foods	
Salary/wages	
Selling handicrafts	
Remittances	
Others (small business etc.)	
Total weekly income	

3.2: Income sufficiency

Is the total weekly income sufficient for the household?

Yes (Go to Q 3.3)

No (Provide the MAIN method the household meets their basic needs)

1 – Assisted by extended family members
2 – Borrow from neighbours
3 – Barter exchange
4 – Other
5 – None

3.3: Financial impact

Please rank from 1 to 6 (1 being 'most impact') the impact of the following obligations on the household's financial situation?

	Rank from 1 to 6 (1 = most impact)
Traditional obligations	
Church obligations	
Food security (meals, preserved food, etc.)	
School fees	
Health care	
Shelter, clothing, etc.	

Section 4: Land access/use

4.1: Land access

Do you have access to land?

Yes – my own land (Go to Q 7.3)

Yes – leasing from someone else

No

4.2–4.5: Land use

4.2 How much do you pay a year for the land? $_____

4.3 How much land do you have access to? _____m (length) x _____m (width)

4.4 Do you grow your own food on this land? Yes / No

4.5 How would you describe the quality of land?

1 – Good

2 – Average

3 – Poor

4.6: Trees in agroforestry systems

1. What does a forest or a tree mean to you?
2. Do you know what benefits you can derive from forests and trees?
3. Do you have trees in your farm? Are they planted or part of the natural stand? If the trees are planted, how were they selected?
4. What are the trees currently planted at your farm (species/local names and nos. of trees)?
   - Fruit/nut trees
   - Timber trees
   - Ornamental trees
   - Fuelwood trees
   - Medicinal trees
   - Others (fodder, soil conditioner/protection, etc.)
5. How are the trees planted (positioning) within the farm lot? Are they integrated with food crops?
6. What benefits have you derived so far from the existing trees?
7. Are you interested to plant more trees in your farm? What kind of trees would you prefer to grow?
   - Fruit/nut trees
   - Timber trees
   - Ornamental trees
   - Fuelwood trees
   - Medicinal trees
   - Others (fodder, soil conditioner/protection, etc.)
8. Do you already have the skills to propagate trees?
   - From seeds (including seed collection seedling production and maintenance
   - Vegetative propagation (cuttings, grafting, marcotting, etc.)
   - Field planting and maintenance
9. Do you have existing facilities (including labour) to raise your planting materials?

Section 5: Food availability

5.1: Crops

In a typical WEEK how much of the following crops does your household consume, give away, sell, receive as gifts and purchase?

Crop	Total produced by the household (weight, lbs)						Received as gift (lbs)	Purchased from another household/ store	
	Total = a+b+c+d	Household consumption (a)	Preserved (b)	Given Away (c)	Sold (d)	Sold ($ value)		Amount (lbs)	$ Value
Taro (*Colocasia*)									
Cassava									
Banana									
Yams									
Taro (*Xanthosoma*)									
Coconut									
Sweetpotato									
Breadfruit									
Other									
Total									

5.2: Livestock harvest

In a typical WEEK how much of the following livestock types does your household consume, give away, sell, receive as gifts and purchase?

Livestock	Total produced by the household (weight, lbs)					Received as gift (lbs)	Purchased from another household/store	
	Total = a+b+c	Household consumption (a)	Given away (b)	Sold (c)	Sold ($ value)		Amount (lbs)	$ value
Pigs								
Beef								
Mutton								
Chicken								
Ducks								
Other								
Total								

5.3: Seafood harvest

In a typical WEEK how much seafood produce does your household consume, give away, sell, receive as gifts and purchase

Seafood	**Total produced by the household (weight, lbs)**						**Received as gift (lbs)**	**Purchased from another household/store**	
	Total = a+b+c+d	Household consumption (a)	Preserved (b)	Given away (c)	Sold (d)	Sold ($ value)		Amount	$ value
Tuna and other deep sea fish									
Reef fish									
Shellfish									
Crab									
Lobsters									
Coconut crab									
Other									
Total									

5.4: Frequency of consumption (staple foods)

How many days in a typical week does your household consume the following produce? Check (✓)

Food item	**Most (5+)**	**Sometimes (2–4)**	**Rare (once or less)**	**None**
Taro				
Cassava				
Banana				
Yams				
Coconut				
Sweetpotato				
Breadfruit				
Other				

Section 6: Imported foods

6.1: Amount and value of imported foods

In the following table, please provide details of the amount of each imported food item the household purchases in a typical MONTH. Also provide an estimate of the value of this food.

Imported food	**Quantity imported (quantity in numbers, e.g. cases)**	**Total cost ($ value)**
Rice		
Flour		
Ramen noodles		
Canned fish		
Canned meat		
Soft drinks		
Chicken		
Mutton		

6.2: Frequency of consumption (imported foods)

How many days in a typical week does your household consume the following produce? Check (✓)

Food item	**Most (5+)**	**Sometimes (2–4)**	**Rare (once)**	**None**
Rice				
Flour				
Ramen noodles				
Canned fish				
Canned meat				
Chicken				
Mutton				

Section 7: Information, communications and extension

7.1: Rank the following media formats in their usefulness for receiving information.

Format	Most useful	Useful	Not useful
Posters/leaflets			
Radio programme			
Newspaper			
Video programme			
Mobile phone			
Internet			

7.2 Do you own a mobile phone? Yes/No

7.3 If you own a mobile phone, which service provider ___ Digicel ___ TCC ___

7.4 Do you own a smartphone? Yes/No

7.5 Do you know someone who owns a smartphone? Yes/No

7.6 Do you want to receive useful farming tips using text messages? Yes/No

If Yes, are you willing to pay for the text messages at 20 cents a message? Yes/No

7.7 Does your household have a computer? Yes/No

7.8 Do you have access to the internet? Yes/No

7.9 Do you know your extension officer? Yes/No

When did you last meet your extension officer? In the last six months? Yes/No

7.10 Do you belong to a farmer network group? Yes/No

Name: _____

7.11 Do you belong to village group? Yes/No

Name: _____

Sustainable Pacific development through science,

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