Pacific Community
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RESCCUE

CLIMATE CHANGE IMPACTS IN RA AND KADAVU PROVINCES, FIJI

AGENCE FRANÇAISE DE DÉVELOPPEMENT

FONDS FRANÇAIS POUR L'ENVIRONNEMENT MONDIAL

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1. INTRODUCTION

RESCCUE is designed to contribute to increasing the resilience of Pacific island countries and territories to global changes through the implementation of integrated coastal management (ICM). In particular, it plans to develop innovative funding mechanisms to ensure the economic and financial sustainability of the work carried out. This regional project operates at one or two pilot sites in each of the following countries and territories: Fiji, New Caledonia, French Polynesia and Vanuatu.

RESCCUE is funded primarily by the French Development Agency (AFD) and the French Global Environment Facility (FGEF/FFEM in French) for a period of five years (01/01/2014-31/12/2018). The overall cost of the project has been estimated at EUR 13 million. SPC will receive total funding of some EUR 6.5 million: an AFD grant allotted in two parts (in 2013 and in 2016 of EUR 2 and EUR 2.5 million, respectively), and a EUR 2-million grant from the French Global Environment Facility (FFEM). RESCCUE will also receive other co-funding. Project management is provided by SPC, with the assistance of the government offices and agencies of the countries and territories involved.

RESCCUE is divided into five components:

Component 1 – Integrated coastal management: This involves implementing ICM from "ridge to reef" by developing ICM plans, setting up ad-hoc committees, carrying out actual field activities on both land and sea, building capacity and developing alternative income-generating activities.

- **The report is a synthesis of climate change impacts and adaptation actions in Ra and Kadavu which form part of this component.**

Component 2 – Economic analyses: This component supports the use of a wide range of economic analyses designed to both quantify the costs and economic benefits related to ICM activities and support a wide range of management measures, public policies and the introduction of economic and financial mechanisms.

Component 3 – Economic and financial mechanisms: This involves supporting the introduction of additional sustainable economic and financial mechanisms for ICM implementation: identifying possible options (e.g. payments for ecosystem services, fees, taxes, trust funds, quota systems, offsetting, certification); feasibility studies; implementation; monitoring.

Component 4 - Communication, capitalising on and disseminating the project's results in the Pacific: This component goes above and beyond the pilot sites to ensure an impact at the national and regional levels by promoting exchanges of experience between project sites, cross-sectoral expertise and sharing the project's results, particularly during events for regional decision-makers.

Component 5 – Project management: This component provides the means to ensure project supervision and management, hold steering committee meetings, carryout evaluations and audits

2. BACKGROUND

The Republic of Fiji is an island nation with an estimated population of 837,271 people (2007) and an annual population growth of 0.8%. There are an estimated 330 islands, of which approximately one third are inhabited. Fiji has a total land mass of 18,333 km^2, with Viti Levu (10,429 km^2) and Vanua Levu (5,556 km^2) constituting 87% of the total. Fiji has an exclusive economic zone of 1.26 million km^2. The climate of Fiji is generally categorized as an oceanic tropical marine climate.

In the past 37 years, Fiji reported a total of 124 natural disasters, affecting almost all parts of the country. tropical cyclones accounted for 50 per cent of the events, followed by floods (33 per cent) and earthquakes (8 per cent) (Holland 2009; Lal et al. 2009; Tokalau 2014). These natural disasters had a considerable impact on the lives and livelihoods of the people of Fiji. the total direct cost associated with disaster events in Fiji between 1970 and 2007 was an estimated US$532 million (Lal et al. 2009). Only 17 per cent of all the events accounted for 86 per cent of this total cost. These statistics reflect only the 104 disaster events (51 per cent) for which the government reported cost estimates. Cyclones were the highest contributor to the total costs reported during 1970 to 2007, reflecting their dominance in terms of number and frequency (Lal et al. 2009).

Fiji's single worst natural disaster occurred in 1931, when a hurricane led to the highest recorded flood in the Ba River catchment (Brown et al. 2014). History nearly repeated itself in 2009, when a severe monsoonal trough caused significant damage, loss of life, and widespread flooding, particularly in Ba town. In January 2012, however, a flood of similar magnitude followed a tropical rain depression, leading to widespread flooding of both the Ba River and the Penang River which affected Rakiraki town in the Ra province (McGree et al. 2010). In March of that same year, severe rains cause additional flooding throughout the two catchments. Cyclone Evan struck the same areas in December 2012, causing additional damage and exacerbating the challenges of recovery (Brown et al. 2014).

The January 2012 flood caused FJ$36.4 and FJ$12.2 in damages in the Ba River and Penang River catchments (Brown et al. 2014). This was followed with another major flood in March caused FJ$24.1 and FJ$8.4 in damages in these two catchments as well (Brown et al. 2014). Crop damages were especially pronounced, accounting for well over 80% of the total damages recorded for both floods as well as for Cyclone Evan. Direct damage to housing and durables – although by no means negligible – was modest in comparison. Losses to livestock were also modest in comparison to crop losses (Brown et al. 2014).

3. OBJECTIVE

This report on Climate Change Impacts and Adaptation actions for the provinces of Ra and Kadavu at aim in providing a review and synthesis of current knowledge and practices about climate change impacts and adaptation actions in Ra and Kadavu: existing models/predictions on climate change for Fiji and Ra and Kadavu Provinces if available ; predicted/anticipated impacts on ecosystems, ecosystem services and populations in Ra and Kadavu; existing frameworks for adaptations actions in Fiji and Ra and Kadavu, and existing adaptation actions; implications for the RESCCUE project and activities in Ra and Kadavu.

4. PROCESS OF COMPILATION OF REPORT

The findings from the 2014 Pacific-Australia Climate Change Science and Adaptation Planning Program Technical Report provided data on climate variability and Climate Change projections for Fiji which would include Kadavu and Ra. However, has been very little documented on the climate change adaptation initiatives that have been implemented in Ra and Kadavu provinces. For this reason insights of impacts of climate change and adaptation measure undertaken at the community in these two

provinces were captured from Vulnerability Reduction Assessment (VRA) carried out in these two provinces

5. CLIMATE VARIABILITY

The climate of Fiji varies over different timescales; major features that drive our climate are:

- the El Nino Southern Oscillation (ENSO) phenomenon (occurs every two to seven years, four years on average);
- the South Pacific Convergence Zone; and
- the trade winds.

The **El Nino-Southern Oscillation (ENSO)** cycle is one of the most important drivers of inter-annual climate variations in the Pacific. El Nino (warm phase) and La Nina (cold phase) are opposite phases of ENSO. Since Fiji lies within the transition zone of the southern oscillation, the effects of ENSO events are not always distinct. An El Nino event usually results in drier and hotter conditions in Fiji during the wet and hot season, particularly from December to February, and drier and cooler conditions in the cool and dry season, particularly between June and August. The most serious effect of strong El Nino events in Fiji is the reduction in rainfall and increased likelihood of drought. There is a significant (4–6 month) delay between El Niño indicators and the onset of damaging drought (e.g. in 1982 and 1997). However, El Niño events beginning in the dry season may show up earlier in reduced rainfall (Kaloumaira 2002).
The opposite event – La Niña – can bring heavier rainfall in the wet season and occasionally above normal precipitation in the dry season. These events usually result in river flooding. The relationship between La Niña and rainfall is strongest in the dry zones of the island.

Historical data show that the risk of Fiji being affected by tropical cyclones during an El Niño event remains more or less the same as during a normal year, though the chances of high intensity tropical cyclones tend to increase. The data show more off-season tropical cyclones have occurred during El Niño years. The chance of a tropical cyclone affecting Fiji during a La Niña event has been shown to be low (Pahalad and McGree 2003).

The **South Pacific Convergence Zone (SPCZ)**, a zone associated with high rainfall, fluctuates northeast and southwest of Fiji. During the southern hemisphere wet season, the heaviest rainfall occurs in the South Pacific Convergence Zone, which includes Fiji. During the southern hemisphere dry season, the heaviest rainfall occurs in the monsoon region and the Inter-Tropical Convergence Zone. With Fiji in the SPCZ transition zone, there may be a delay between the onset of an ENSO event and the impact on the climate of Fiji, depending on when the SPCZ begins to shift eastward.

The **trade winds** bring orographic rainfall to the eastern parts of the country. Fiji experiences a distinct wet season from November to April and a dry season from May to October. The seasonal cycle is strongly affected by the relative position of the SPCZ, which is most intense during the wet season and close to the country. Approximately 70% of the national annual average rainfall, over the period 1961 to 2010, occurred during the wet season.

6. CLIMATE CHANGE IMPACTS

Climate change is likely to affect the coastal resources of Fiji in a variety of ways. Sea-level rise may lead to increases in coastal erosion and coastal inundation, increased exposure to wave action (as coral growth lags behind sea-level rise), and, in some cases, the retreat of mangroves. Projected increases in sea surface temperature may lead to a rising incidence of coral bleaching. Coral bleaching, together with the lag in coral growth, may lead to a reduction in sediment production necessary for maintaining shoreline stability. Coral bleaching is also likely to have adverse effects on coastal biological diversity and fisheries. Changes in the patterns of storms, such as an increase in the frequency or intensity of

tropical cyclones, may cause greater incidence of coastal inundation and erosion events. These processes may be exacerbated by reduced reef protection. Below are the major climate change impacts that have been highlighted in Fiji's National Climate Change Policy, 2012 as well as findings from the 2014 Pacific-Australia Climate Change Science and Adaptation Planning Program Technical Report.

Currently the following is Fiji's climate condition.

- Annual and half-year maximum and minimum temperatures have been increasing at both Suva and Nadi Airport since 1942 with trends significant at the 5% level in all cases except Nadi Airport November–April maximum temperature. Minimum air temperature trends are greater than maximum air temperature trends.
- The annual numbers of Cool Days and Cool Nights have decreased and Warm Nights have increased at both sites. Warm Days have increased at Suva. These temperature trends are consistent with global warming.
- Annual, half-year and extreme daily rainfall trends show little change at Suva and Nadi Airport since 1942.
- Tropical cyclones affect Fiji mainly between November and April, and occasionally in October and May during El Niño years. An average of 28 cyclones per decade developed within or crossed Fiji's Exclusive Economic Zone (EEZ) between the 1969/70 and 2010/11 seasons. Twenty-five out of 78 (32%) tropical cyclones between the 1981/82 and 2010/11 seasons became severe events (Category 3 or stronger) in Fiji's EEZ. Available data are not suitable for assessing long-term trends.
- Wind-waves around Fiji are typically not large, with wave heights around 1.3 m year-round. Seasonally, waves are influenced by the trade winds, location of the South Pacific Convergence Zone (SPCZ), southern storms, and cyclones, and display little variability on inter-annual time scales with the El Niño–Southern Oscillation (ENSO) and Southern Annular Mode (SAM) . Available data are not suitable for assessing long-term trends.

The following are the climate projections for the period to 2100, based on the latest global climate model (GCM) projections and climate science findings:

- El Niño and La Niña events will continue to occur in the future (very high confidence), but there is little consensus on whether these events will change in intensity or frequency;
- Annual mean temperatures and extremely high daily temperatures will continue to rise (very high confidence);
- There is a range in model projections in mean rainfall, with the model average indicating little change in annual rainfall but an increase in the November– April season (low confidence), with more extreme rain events (high confidence);
- The proportion of time in drought is projected to decrease slightly (low confidence);
- Ocean acidification is expected to continue (very high confidence);
- The risk of coral bleaching will increase in the future (very high confidence);
- Sea level will continue to rise (very high confidence); and
- Wave height is projected to decrease across the Fiji area in the wet season, with a possible small increase in dry season wave heights (low confidence).

Below are the major impacts the Fiji Government have prioritized to be addressed.

- **Sea flooding** is usually associated with the passage of tropical cyclones close to the coast. However, heavy swells, generated by deep depressions and/or intense high pressure systems some distance away from Fiji have also caused flooding to low-lying coastal areas. At times, heavy swells coincide with king tides and cause flooding and damage to coastal areas (Government of the Republic of Fiji 2012).

- **Large-scale flooding** in Fiji is mostly associated with prolonged heavy rainfall during the passage of a tropical cyclone, tropical depression and/or enhanced, slow moving convergence zone. Localized flash flooding during the wet season (November to April) is quite common (Government of the Republic of Fiji 2012).

- **Major droughts** in Fiji have been associated with El Niño events. During moderate to strong El Nino events, the annual rainfall is reduced by as much as 20–50% over most parts of Fiji as experienced during the 1982/83, 1986/87, 1992/93 and 1997/98 events (Government of the Republic of Fiji 2012, p. 23) and presently experienced in some parts of Fiji (Western part of Viti Levu and the outer islands).

- **Tropical cyclones** usually affect Fiji from November to April but have occurred in October and May. On average, one or two cyclones affect some part of Fiji every season, with the greatest risk during the El Niño season which is currently being experienced in Fiji at the moment (2015). There have been seasons when Fiji has had no cyclones and seasons with four cyclones (1984/85) and five cyclones (1992/93) (Government of the Republic of Fiji 2012). A decreasing trend in both the number of tropical cyclones and cyclones with hurricane intensity affecting Fiji has been observed in the last four decades(Government of the Republic of Fiji 2012, p. 23).

- **Ocean acidification** impacts the growth of corals and organisms that construct their skeletons from carbonate minerals. These species are critical to the balance of tropical reef ecosystems. Data show that since the 18th century the level of ocean acidification has been slowly increasing in Fiji's waters (Australian Bureau of Meteorology and CSIRO 2014).

7. POLICIES AND ACTIONS FOR CLIMATE CHANGE ADAPTATION

The *People's charter for change, peace and progress* (December 2008) serves as the umbrella framework for national development. The *Roadmap for democracy and sustainable socio-economic development 2009–2014* defines the implementation framework for the charter. The National Climate Change Policy served as an implementing tool for many of the strategies outlined in the charter, such as:

- environmental protection, sustainable management and utilisation of natural resources;
- strengthening institutional capacity for environmental management; and
- strengthening food security.

7.1 Fiji's Climate Change Policy

In 2007, Cabinet endorsed Fiji's National Climate Change Policy Framework, which defined the position of government and other stakeholders on issues of climate change, climate variability and sea level rise. It also defined the various responsibilities of each stakeholder in the short and long term. The framework underwent review in 2011 to reflect current and emerging climate change issues at the local, national and international level. The reviewing and updating of the framework led to the development of this National Climate Change Policy, in accordance with the 2011 Corporate Plan of the Department of Environment under its Climate Change Program. The policy provides a platform for coordination among sectors, and direction on national positions and priorities regarding climate change mitigation and adaptation.

Under this Framework, primary government responsible for climate change program shifted form Department of Environment to the Ministry of Foreign Affairs and International Cooperation. In 2016 it is now shifted to the Ministry of Finance and National Planning. In 2013 the government submitted its Second National Communication to the UNFCCC Secretariat.

The policy recognizes the need for constructive co-operation among all relevant sectors. This interdisciplinary and multi-sectoral approach is emphasized in Agenda 21 of the 1992 United Nations Conference on Environment and Development held in Rio de Janeiro. In the Pacific region, intergovernmental organizations such as the South Pacific Regional Environment Program (SPREP), the Secretariat of the Pacific Community (SPC) and the University of the South Pacific (USP) are implementing regional climate change programs that support the development of national programs and policies.

Policies have been developed in the areas of agriculture, land use, forestry, fisheries and water. They focus on the sustainable management of Fiji's natural resources and the establishment of appropriate institutional arrangements for effective implementation and monitoring. A major component is the incorporation of environmental management in order to address issues that emanate from natural hazards and unsustainable resource management and utilization. These policies play an important role in supporting efforts to reduce adverse impacts of climate change on Fiji's economic and social development.

Adaptation as specified in Fiji's Climate Change Policy aims to reduce the vulnerability and enhance the resilience of Fiji's communities to the impacts of climate change and disasters (Government of the Republic of Fiji 2012). The following are 9 of the 15 national strategies that have been identified in the Fiji Climate Change Policy that are embedded in RESCCUE goals, objectives and activities (e.g. component 1 on Integrated coastal management).

i. Integrate related disaster risk reduction and climate change adaptation strategies and actions into national and sectoral planning to streamline responses.
ii. Include vulnerability assessments and climate change impact projections into resource management planning, such as integrated coastal and watershed management plans.
iii. Incorporate climate change impact projections into infrastructure and urban and rural planning.
iv. Develop sustainable adaptation technologies and systems that take traditional knowledge into account and are culturally acceptable.
v. Support the ecosystem-based approach throughout Fiji, recognizing that ecosystem services, such as food security, natural hazard mitigation and physical coastal buffer zones, increase resilience.
vi. Use appropriate consultation mechanisms for the participation of all members of the community in the planning, management and implementation of adaptation measures.
vii. Mobilize resources and all sectors to support the implementation of relevant national adaptation strategies and plans, such as the National Climate Change Adaptation Strategy, the planned joint national action plan for CCA and DRM and the National Disaster Risk Management Plan.
viii. Implement best practice adaptation measures, based on sound scientific research, and lessons learnt from local, regional and international experiences.
ix. Undertake national research to identify effective adaptation measures to support sector-specific adaptation and disaster risk reduction responses.

7.2 Existing Interventions

Fiji's adaptation to climate change is varied and complex. Many projects, either internally or externally funded, may not have climate change adaptation as a primary focus but achieve goals mentioned as part of climate change adaptation strategy. As mainstreaming is also an important goal of climate change policy, the sectorial strategic planning of Fiji's government ministries are also meant to be incorporating climate change adaptation activities. In terms of external funding, the Global Environment Facility every 4 years allocates funds to Fiji from which it may apply for climate change projects. For GEF-STAR 4 the focus is on the forestry sector and for GEF-STAR 5 ridge to reef-to-reef

watershed management at six sites.

Fiji also has national CCA projects of part of regional projects to the Pacific such as the European Union Global Climate Change Alliance and the United States Coastal Climate Change Adaptation Project, both working in multiple PICs. SPREP and SPC also obtain regional funding which is then allocated to Countries for climate change adaptation. SPREP under GEF-PAS 4 carried out the Pacific Island Climate Change Adaptation Program and SPC had the SPC "Climate Change and disaster risk management support activities in Pacific Island countries and territories" project that initiated work in Kadavu. Other bilateral donors have national and/or regional CCA projects in Fiji. Germany is especially active through GIZ and has 4 regional projects active in Fiji:

- Management of marine and coastal biodiversity.
- Climate protection through forest conservation.
- Pacific mangrove initiative for climate change adaptation and mitigation.
- Natural solutions to climate change in Pacific Islands regions implementing ecosystem based adaptation.

AUSAID through bilateral funding has also funded numerous community based CCA projects.

Of particular relevance to RESCCUE are:

- Projects operating in Ra and Kadavu or which could be encouraged to do so (e.g. Coral Triangle Pacific);
- Projects such as USAID Coastal Community Adaptation Project (C-CAP) and EU Global Climate Change Alliance (GCCA) one which have specific outputs related to best practice approaches to CCA for specific interventions;
- Pacific Ecosystem-Based Adaptation to Climate Change which is funded by the German Government and implemented by the Secretariat of the Pacific Regional Environment Program (SPREP) with the focus of promoting ecosystem-based options for adapting to the impacts of climate change; and
- Projects that have a pacific interest in economic tools such as BIOFIN (financing biodiversity financing) or the Pacific Cost-Benefit Analysis Initiative (P-CBA). Of particular interest are Fiji government interests in relocation policy and how cost benefit analysis can best be used. Fiji Government is currently working towards developing a systematic approach in applying benefit-cost analysis to relocation options through the National Planning Office.

Furthermore, Fiji's involved in the World Health Organization's "Piloting Climate Change Adaptation to Protect Human Health" project. This project helps Fiji address one of its four priority areas of adaptation, with human health being the least represented within on-going initiatives. Additionally there is a new project funded by the Adaptation Fund entitled: "Enhancing Resilience to Flood-and Drought-Related Risks in Fiji". The others that have been implemented are the European Union Global Climate Change Alliance (EU-GCCA) Project with the focus of implementing vulnerability assessments (V &A), Mangrove Ecosystems for Climate Change Adaptation & Livelihoods (MESCAL) Project. One of the very recent adaptation initiatives launched this year (2016) in Fiji is the Pacific Ecosystem Based Adaptation to Climate Change (PEBACC) project. PEBACC is coordinated by SPREP working on ecosystem based adaptation. On the whole, Fiji is actively engaged in addressing climate change at both the policy and project level.

It is critical that RESCCUE through its governance mechanisms and communication strategy ensures maximum synergies with relevant national and regional projects.

8. CLIMATE CHANGE IMPACTS AND ADAPTATION IN KADAVU AND RA

In Kadavu the VRA was conducted in Matasawalevu, Galoa and Nabukelevu-i-ra villages and also with a team representing the Kadavu Yaubula Management Support Team (KYMST). In the Ra province the VRA was conducted in Drauniivi, Nativi, Nawairuku, Rewasa, Nabukadra and the Ra ICM/ Yaubula Management Team.

8.1 Kadavu Province

Sea flooding

In all villages in Kadavu, king tides are usually observed between November to February. Huge waves that cause inundation in some villages are seasonal (only seen when rain coincides with high tide).There has been regular incidence at least twice a month of strong storm surges accompanied with king tides which is causing major coastal erosion.

Coastal plants important to the livelihood of the communities such as coconut trees, pandanus and those that have medicinal value such as dabi (*Xylocarpus granatum*), dilo (*Calophyllum inophyllum*) , are constantly washed away. There has been incidence of the disappearance of the common marine food such as land-crabs (*Cardisoma carnifex)* or lairo in the local language, bivalves such as *Anadara antiquate (kaikoso in the local language)* as reported in the district of Nakasaleka. In most villages inundation affects low-lying farming areas. This has also forced community members to swim across the flooded roads. Moreover, domestic household rubbish and debris are washed out which poses a health hazard.

Sea flooding has been also reported by communities in the western coast of Kadavu that resulted to coconut trees washed out to sea due to storm surges. In addition, salt water intrusion has affected coconut trees ability to consistently bear fruits.

Some communities have observed that the absence of the annually harvested edible sea-worm (Balolo *Eunice viridis*) can also be caused by the impact of climate change. This is in line with the study conducted by NOAA in Samoa (Kendall et al. 2011). A key factor that has contributed to coastal erosion is the depletion in mangrove.

Adaptation measures

Entire villages in western and southern coast of Kadavu may need to be relocated to higher grounds. This is due to current incidence of inundation events that most of them experience occasionally at least six times in a year. In terms of relocation wooden houses tend to be easier to dismantle and rebuild than concrete ones. This was highlighted by all of village headman in the four villages covered during the VRA process.

In some villages they identified important buildings that needed to be relocated apart from residential houses. These are the community village hall, dispensary and the village church which is also are also their main disaster evacuation center.

Some of the coastal plant and tree species suggested by the village headman and also stated by the village development committee to rehabilitate the coastal areas are Dilo (*Calophyllum sp*), Dabi (*Xylocarpus sp*) and the coastal almond, Tavola (*Terminallia sp*).

Mangroves have provided protection from storm surges in those villages both in the eastern and southern coast of the islands. It may also reduce the impact of inundation related to sea-level rise.

Other villages in Kadavu that could be enormously affected by sea level rise include Solodamu, Levuka I Yale, Levuka Nabukelevu, Wailevu, Nasegai, Tabuya, Muaninuku, Dravuwalu, Daku, Gasele, Rakiraki, Navotu, Drue, Tavuki, Mokoisa, Waisomo, Vabea, Naqara, Buliya and Dravuki

Large-scale flooding

The issue of flooding affects a few villages in Kadavu and namely Nakoronawa, Lomanikoro, Nakaugasele, Nakaunakoro, Tabuya and Muaninuku. During flood events in 2013 debris are washed into the village and it pose high risk to the villagers especially the children. Food gardens are destroyed with root crops are the worst affected. Edible invertebrates such as bivalves and other marine lives are also destroyed. With shortage of both staple and supplementary food there is a reliance and high dependence on imported processed food.

Soil erosion from farms when washed into inshore areas disrupts engine powered boats. Siltation makes gleaning difficult with heavy mud accumulating on the finding reef.

As in most flood incidence there is always a risk of water-borne diseases because of the contamination of water sources.

With roads getting flooded it poses a major constrain for transport in particular for school children going to school.

Adaptation measures

Most of the villagers are working towards improving the drainage system in the village and their gardens. Few of the villagers are working towards enhancement riparian tree planting along the waterways. Along the coast there have been plans to replant mangrove trees in degraded mangrove habitats.

Drought

Villages that have few water sources are affected the worst during prolong drought periods in 1990 and recently in 2014. Villages that affected were Drue, Navuatu, Namuana and Tavuki.

Drought affects kava, taro and vegetable plantations and dries out the Tilapia fish farm. This in turn affects household income earnings in meeting financial household and village obligations.

Burning land areas for cultivation is still a common practice. Most often these burnings are not well controlled or managed and it spreads to other areas and becomes a huge hazard during drought periods.

More health issues, more people will get sick people struggle to find alternative means of survival. Children and the elderly tend to be mostly affected

Adaptation measures

Using traditional food preservation practices would ensure that there is enough food in stock during such an event. Applying traditional environmental knowledge such as using a dish called in the local language "*Jivikea*" (*Acanthurus triostegus*) as biological indicator for an upcoming drought event is also criticial. An overwhelming abundance of *Acanthurus triostegus* is a warning for a dry weather spell.
In addition, farming of more drought-resistant root crops such as the Pacific wild yam (local language known as "tivoli") and cocoyam (local language known as "dalo-ni-tana") would improve the abundance of food stock during drought periods.

A halt to indiscriminate burning would enhance community resilience to the impacts of drought. Farming is intensive in the districts of Ravitaki and Nabukelevu. These are marked by an increase of degraded land areas over the last decade compared to other districts in Kadavu. Hence, there is a need for forest restoration initiatives in these two districts.

Tropical Cyclone

Tropical cyclone is always devastating in all the villages in Kadavu (Campbell 1984). This is because tropical cyclone comes with very strong hurricane winds, heavy rain and storm surges. All of the villages in Kadavu are very prone to the impact of tropical cyclone because they are all located along the coast without much inland shelter. It has devastating impact on vegetable and root crop farms. Fatality amongst domesticated livestock is alarmingly high. People are left homeless.

It affects socioeconomic wellbeing of most villagers. Most if not all do struggle to meet their family needs and community obligations. Often it creates a very volatile social environment where conflict in most cases is inevitable.

Reefs are destroyed and it takes a long time to fully recover. Normally post-tropical cyclone period fish and invertebrates decline in abundance which affects the community's main source of protein and cash income.

Adaptation measure

The community members in most villagers are planning to grow more foods crops which are more resilient to natural disasters such as tropical cyclone. These crops are the Pacific wild yam, Cocoyam and Sweet potato (*kumala* as known in the local language). There has not been any specific planning on other measures for adapting to tropical except in the building of new evacuation center as being provided by the USAID Coastal Community Adaptation Project (C-CAP) and the cyclone proofing existing ones such as schools and churches.

Ocean Acidification

Most villagers are not aware of ocean acidification and its impact on their marine environment. However, they know and have observed the impact of some their land use practices in particular the impact of fertilizer run-off on their coral reef in particular algal bloom. With ocean acidification the damage it will exacerbate harmful algal blooms which cause on their coral reefs (including their MPA and no-take zones) will be extremely devastating and irreversible (Turner 2014).

There is lack of awareness of the ridge to reef connectivity. The village Fisheries committee as well as qualified experts in this field has been providing information and advice accordingly for the reduction of the impact of climate change.

Adaptation measure

More capacity building in terms of enhancing the awareness and knowledge of communities on causes and impacts ocean acidification is vital.

8.2 Ra Province

Sea level rise

Nabukadra village always experience inundation during spring and king tides despite having a seawall. So far there are no gauges installed along the coastal areas in Ra to measure sea-level variability. For houses the wooden floors are getting rotten due to frequent inundation of sea-water during king tides and occasional storm surges. Wave action has also damaged septic tanks at least five house sin Malaki village. This has resulted to the sewage waste directly flowing out to the sea.

Coastal erosion is occurring in number of the coastal villages. Root crops planted on coastal flat areas are destroyed due to salt intrusion.

Adaptation measure

People are forking out more from their pockets so that they can hire machinery to put soil and stones at to fill places that are frequently flooded by sea water. They have lost some low flat wetland that they usually use for planting taro from frequent sea water inundation events and salt water intrusion.

Replanting of mangrove is an option in some parts of coastal where used to have mangrove forest. Relocation is an expensive adaptation strategy and probably appropriate to have the relocation process in phases whereby young married couples are encouraged to move to the new site

Large scale flooding

Heavy rain increases the volume sediments that are washed into waterways. Creek and river are murky and turbidity is high. In the interior part of Ra province the communities have experienced landslides which have completely destroys their plantations.

Other impacts from large scale flooding are:

- Unavailability of transport;
- School children finding it impossible to attend their schools due to treacherous road conditions and walkways;
- Stagnant water breeds mosquitoes; and
- Trees are uprooted such as fruit trees and coconut trees.

Adaptation measure

There has been suggestions aired in village meetings for the current village site to be relocated on higher grounds but so far no action has been undertaken by any of the villages that have been affected most by large-scale flooding.

Other measures identified by the communities are:

- Relocating plantations;
- Prevent planting root crops close to the river banks;
- Stop cutting down trees close to the river;
- Improve drainage;
- Plant more trees around water source;
- Gravel extraction to be halted because it damages habitats where fish breed; and
- Improve knowledge on how to decrease the impacts of flooding.

Drought

With long drought periods such as the one in 2014 most plantations are adversely affected in particularly sugarcane farms. Other agricultural products such as mangoes, citrus such as mandarin oranges and lime are badly affected. Root crops such as taro have low tolerance level compared to cassava and sweet potatoes which tend to survive better during long ought periods.

Other indirect factors that are of high risk during drought season are uncontrolled and indiscriminate. In severe cases deep cracks appear on dry soil which makes it impossible for any agricultural subsistence or commercial crop cultivation. Thus it has significant negative impact in their livelihood.

Potable drinking water source is affected such as wells and dams. Villagers are not well equipped/informed on what to do during drought events. Some communities do not know what food crop to plant during longer periods of drought. A lot of sicknesses arise because of the water shortage such skin diseases such as ringworm, infections, itchiness, high incidence of dehydration cases. In Daruniivi village school children often fill up the sick bed.

Livestock often die from shortage of water and food. Just recently in Yaqara in the Rakiraki district, cattle broke their fenced ranch in search of water.

Adaptation measures

The following are some adaptation measures identified by the communities in the Ra province:

- Village community to be informed well in advance about future weather/climate forecast;
- Villagers want to be educated on the types of crops to plants during drought events
- Water tanks to be installed in each household. For instance in Nativi village about 68 households are sharing just four large water tanks. Hence there is not enough water to be supplied to the whole village; and
- Awareness and community education program drought resilient food crops.

Tropical Cyclone

Some villages in the interior of Ra province did not experience severe damages from tropical cyclone other than crops losses. For the coastal communities however, houses, crop and pine plantation are destroyed from the impact cyclone. On average according to the three headmen of the three villages about 50 percent of the houses were completely destroyed in each of the village. Food crops such as taro and sweet potatoes were completely destroyed.

They experience a decline in the abundance and size of fish. Their water source is contaminated or block by debris and sediments.

As in most cases access from their village to other villages or to Rakiraki town is difficult due to damages of bridges and roads. Most of the inner land villages have hanging bridges which can be easily damaged by falling trees. Livestock mainly horses and cattle are killed from the last flash flood.

Adaptation measures

The following are some adaptation measures identified by the communities in the Ra province:

- more awareness on how to prepare for tropical cyclone;
- have an evacuation center which is easily accessible;

- training on natural disaster preparedness and emergency response;
- Improve housing condition so that it can be cyclone proof; and
- Develop a disaster management plan.

Ocean acidification

Most of the coastal villages have witnessed and observed that there have been low fish yield. This could be related to overfishing or coral bleaching. They also reported that dull looking corals could be the result of excessive nutrients run-off from sugar cane farms. Similar to Kadavu there has not been a study on the impact ocean acidification on the coastal environment and the fisheries. These detrimental environmental issues will be exacerbated by the full brunt impact of ocean acidification.

Adaptation measures

The following are some adaptation measures identified by the communities in the Ra province:

- Plant corals;
- Have other options as a source of protein and livelihood such as fish ponds;
- More awareness on what ocean acidification is and its impact to inshore fishing ground; and
- Reduce nutrients run-off from the agricultural farms to water ways and the marine environment.

9. POTENTIAL RESCCUE INTERVENTIONS

9.1 Kadavu Province

Activities to be undertaken in Kadavu Province may include:

- Coastal and hillside erosion control measures through forestry:
    - Enhance riparian tree planting along the waterways.

- Soil enhancement and composting:
    - Promote use of composting;
    - Kadavu is currently working towards to be a nationally declared organic island and there is a current pilot project in Naikorokoro village on the use of nitrogen fixing plants to enrich agricultural intensive land areas. RESCCUE may help evaluating this initiative using a cost-benefit analysis framework to compare it with use of imported fertilizers;

- Enhance food security and develop alternative income opportunities:
    - Promote crops such as the Pacific wild yam, Cocoyam and Sweet potato in terms of subsistence food security and potential major commercial food crop.

- Enhance resilience of coral reefs and coastal fisheries to climate change and ocean acidification:
    - Identification of resilient areas to protect in priority;
    - Development of small scale coral garden;
    - Development of fish aggregating devices;
    - Technically support and facilitate capacity building in terms of enhancing the awareness and knowledge of communities on causes and impacts ocean acidification.

- Assist in the decision making process of relocation of communities or critical infrastructure (and contribution to national relocation guidelines:
    - Examine options using cost-benefit analysis framework as one of the primary decision

making process. As stated earlier there is a likelihood that entire villages in western and southern coast of Kadavu may need to be relocated to higher grounds.

- Mainstream climate change and adaptation measures at various administrative levels

- Education materials on climate change and adaptation:
    - Provide appropriate information packages on process of screening climate change impacts and various adaptation measures.

9.2 Ra Province

Activities to be undertaken in Ra Province may include:

- Coastal and hillside erosion control measures:
    - Prevent planting root crops close to the river banks and water ways;
    - Stop cutting down trees close to the creeks and river;
    - Improve drainage in the village and nearby food gardens;
    - Plant more trees around water source specifically those native trees such as *Bischofia javanica*, locally known as Koka.
    - Work closely with the authorities on halting gravel extraction because of irreversible damages fish habitats and breeding ground.

- Enhance food security and develop alternative income opportunities:
    - Have other options as a source of protein and livelihood such as fish ponds;

- Enhance resilience of coral reefs and coastal fisheries to climate change and ocean acidification:
    - Identification of resilient areas to protect in priority;
    - Development of small scale coral garden (plant corals);
    - Development of fish aggregating devices;
    - More awareness on what ocean acidification is and its impact to inshore fishing ground; and
    - Reduce nutrients run-off from the agricultural farms to water ways and the marine environment by applying organic farming techniques.

- Assist relocation of communities or critical infrastructure and contribution to national relocation guidelines;
    - Assisting communities and the relevant authorities of selecting the appropriate evacuation center using a cost-benefit framework ;
    - Facilitating communities in their decision making process on relocation particularly in communities experiencing frequent inundation or flooding from torrential rainfall or king tides;Relocating plantations.

- Use existing and develop Ra specific education materials on climate change and adaptation:
    - More awareness on how to prepare for tropical cyclone;
    - Facilitate communities who do not have a disaster management plan; and
    - Improve knowledge on how to decrease the impacts of flooding specifically based on ecosystem based approach or the use of soft measures.

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