Implementing Climate Change Adaptation in the Pacific Islands: Adapting to Present Climate Variability and Extreme Weather Events in Navua (Fiji)

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AIACC Working Paper No. 34
June 2006

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An electronic publication of the AIACC project available at www.aiaccproject.org.

AIACCWorking Papers

Distributed by:
The AIACC Project Office
International START Secretariat
2000 Florida Avenue, NW
Washington, DC 20009 USA
www.aiaccproject.org

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The AIACC project is funded by the Global Environment Facility, the Canadian International Development Agency, the U.S. Agency for International Development, and the U.S. Environmental Protection Agency. The project is co-executed on behalf of the United Nations Environment Programme by the global change SysTem for Analysis Research and Training (START) and The Academy of Sciences for the Developing World (TWAS).

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Implementing Climate Change Adaptation in the Pacific Islands: Adapting to Present Climate Variability and Extreme Weather Events in Navua (Fiji)[1]

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1. Introduction

Climate change[2] is one of the most pressing issues for the Pacific Island countries (PICs). The impacts of climate variability and extreme events (cyclones, floods, droughts, sea level rise, and other natural disasters) are rapidly pushing people beyond their coping range. The already strained economies are being drained trying to keep up with the impacts of these changes on livelihoods. In the 1990s alone, the Pacific Island region bore up to $U.S.1 billion costs related to climate extremes (Campbell, 1999; Feresi et al., 2000), and the costs are expected to rise even further with a rise in the frequency and intensity of extreme events.

Climate scenarios predict up to 14% loss of coastal land due to sea level rise and flooding by 2050 (Feresi et al., 2000), and these are the prime areas (coastal) for economic

[1] The research reported in this paper was supported by grant number SIS09 from Assessments of Impacts and Adaptations to Climate Change (AIACC), a project that is funded by the Global Environment Facility, the Canadian International Development Agency, the U.S. Agency for International Development, and the U.S. Environmental Protection Agency and co-executed on behalf of the United Nations Environment Programme and by the Global Change SysTem for Analysis, Research and Training and The Academy of Sciences for the Developing World. Correspondence regarding this paper should be directed to Melchior Mataki, mataki_m@usp.ac.fj.

[2] The Intergovernmental Panel on Climate Change (IPCC) definition is used through this paper: Climate Change refers to any change in climate over time, whether due to natural variability or as result of human activity.

activities and human settlements. In some areas, the demand for water resources is expected to outstrip supply by 5-8% by 2050 (Feresi et al., 2000). Agriculture, human health, and fisheries are also expected to be impacted negatively because of climate change, and, in turn, have a negative impact on PIC economies. With a "do-nothing" option, a small island such as Viti Levu (Fiji) could incur a cost equivalent to 2-4% of Fiji's GDP (U.S.$23-52 million) by 2050 in damages associated with climate-related disasters (World Bank, 2000).

The capacity to mitigate the impacts of climate change and extreme events is generally beyond most PICs. It is widely accepted by the scientific community that even if the developed nations reach the target of reducing emissions as proposed by the Kyoto Protocol, climate will continue to change, and the Pacific Islands, among other poor countries of the world, will have to bear the consequences. The only logical option for PICs is to learn to adapt to these changes through adapting to climate variability and extreme events.

Several adaptation options have been implemented in PICs through the actions of individuals, national governments, and climate change adaptation projects. The most common step being taken is the construction of seawalls to protect settlements against coastal erosion and storm surges. However, some of the options have proven to be unsuccessful in solving the underlying problems because of the lack of proper evaluation of adaptation options. For example, in Qoma (Fiji), the community reported experiencing frequent inundation further downstream after the construction of a sea wall upstream

(World Bank, 2000). Given the uncertainties regarding impacts and adaptation strategies, varying approaches have been experimented in PICs. For example, the Secretariat of Pacific Regional Environment Program (SPREP) executed the project "Capacity Building for the Development of Adaptation Measures in Pacific Island Countries" (CBDAMPIC), focused on community and national capacity building, and identification and implementation of adaptation measures through community participation (Nakalevu et al., 2005). On the other hand, the Asian Development Bank (ADB) and Canadian Cooperation Fund for Climate Change funded project, Climate Change Adaptation in the Pacific (or CLIMAP), focused on developing case studies that demonstrate climate change adaptation through risk reduction (Assessments of Impacts and Adaptations to Climate Change (AIACC, 2005). The case studies cover the spectrum from project level (immediate) to national level development planning (long term).

This paper presents some of the lessons learned from SIS09 pilot study implemented as part of AIACC initiative aimed at developing a "second-generation" integrated model for climate change vulnerability and adaptation assessment incorporating both natural and human systems (socioeconomic). The lessons learnt are mainly from the observations and assessments made by the SIS09 team of prevailing physical, socioeconomic, and political conditions, which ultimately affect the ability of Navua residents to autonomously adapt to river flooding triggered by intense and/or prolonged rainfall. The lessons learnt will be used to inform and articulate a possible process of implementing climate change adaptation in PICs. The rest of the paper highlights some of the challenges pertaining to implementing climate change adaptation in PICs with reference to our studies in Navua.

Navua is one of the SIS09 project sites in Fiji. Another project site in Fiji is Natadola beach, wherein a large resort is currently being developed. This paper is based on Navua, as it typifies communities in PICs.

2. Methods

Primary information and data were obtained from two surveys of randomly selected homes within the study site (see Figure 1). The following information and data were gathered:

1. socioeconomic data (population, economic activities, and income level);
2. building types;
3. depth of water in properties during five recalled floods; and
4. their views of the factors contributing to flooding, adaptive measures taken by residents to cope with flooding, the barriers to implementing the adaptive measures, and their perception of about climate change in general.

In 2003, 113 properties comprising 45 business properties (private and government) and 68 residential properties (homes) in the project site were surveyed. However, the emphasis of this paper will be on the 68 residential property owners, because they typify average communities in PICs. All interviewees were adults present at the properties during the survey. A second survey was carried out in 2004, where 65% of homes initially surveyed in 2003 were reassessed to ascertain the data and information collected in 2003 and to record flood data relating to a flash flood in April 2004. Interviews were

also held with officials from the Navua Rural Local Authority and persons familiar with flooding in Navua. In addition, secondary information and data were obtained from the literature to augment findings from the surveys and interviews.

Archived rainfall data of Navua was obtained from the Fiji Meteorological Service to determine the trends in observed rainfall behavior in the past 43 years.

2.1 The case study site (Navua)

Navua town (not yet legally recognized) is located on the southeast of Fiji's main island, Viti Levu. The SIS09 study site covers a land area of 16.76 km^2 with a maximum elevation of 31.41 m and a minimum elevation of less than 0.6 m above sea level. A section of Navua River measuring about 163 m wide and 5.81 km in length runs along the town, where in some homes, including the "central business district" of Navua are only a few meters from the river banks. The greater Navua area, including the study site, is also crisscrossed by a network of irrigation channels and flood gates at the coast, previously used to distribute and control water needed for commercial rice farming (see Figure 1).

3. Results and Discussion

3.1 Rainfall trends in Navua

Navua has experienced frequent flooding in recent decades (Fiji Meteorological Service, 2004), and flooding is the major threat to the livelihood of Navua residents. Flooding in Navua is positively associated with prolonged and/or intense precipitation (Fiji Meteorological Service, 2004). Navua receives on average 3500 mm (regarded as the rainfall normal based on 30 years: 1961–1990) of rainfall per year. Analysis of observed rainfall in the past 43 years (1960–2003) did not show any discernable increasing or decreasing trend, as indicated by Figure 2. This observation was consistent with a similar analysis of rainfall patterns for Suva and Nadi carried out by Mataki and others (2006). However, there were large interannual variations to as much as 40% on both sides of rainfall normal, mainly because of the movements of the South Pacific Convergence Zone[3], and the presence and absence of El Niño Southern Oscillation and La Niña (Matacki et al., 2006). El Niño has been recognized as the major cause of interannual variability in rainfall in Fiji and associated droughts. Conversely, during La Niña episodes, rainfall is enhanced across the Western Equatorial Pacific, including Fiji.

Furthermore, an analysis of extreme rainfall events in the two wettest months of the year (March and April) for the past 43 years indicated a marginal reduction in the average return period[4] of intense rainfall from approximately 2 to 3 years during the recent decade[5] (see Figure 3). However, the marginal reduction was found statistically insignificant, which further reinforces the overall "normality" of rainfall events in the past 43 years demonstrated in Figure 2. Nevertheless, the study site had been flooded in the recent decade more frequently than in the past although rainfall patterns have not

[3] The main rain-producing system.
[4] Based on the time difference between the *maximas* (distance between peaks).
[5] From 1994 onwards.

significantly changed. These results underscore the complex interplay between climatic and nonclimatic factors in influencing the vulnerability of Navua to flooding.

Anecdotal evidence based on residents' recollection of past flooding episodes indicated that 21–90% of the study site was flooded (see Table 1) during the recalled episodes. Four of the flooding episodes were initiated by intense and prolonged rainfall associated with tropical cyclones; however, the fifth and most extensive flooding episode was due to intensive rainfall associated with two consecutive tropical depressions. The wet season is from November to April, and it is the tropical cyclone season, which reinforces the potential for flooding. However, from Figure 1, the strong variability in annual daily rainfall also indicates the potential for flash floods in the dry season (May–October), especially with prolonged rainfall.

Navua River is silted more intensely than before because of accelerated human activities such as logging, aggregate mining, and haphazard agricultural practices in the upper Navua River catchment (Sinclair Knight Merz, 2000; Ba, 1993; SOPAC, 2003). Siltation raises the riverbed and therefore increases the river's potential to burst its banks during prolonged and/or intense rainfall episodes (Central Division Disaster Management Council Operation Centre, 2004; National Institute of Water and Atmospheric Research Ltd., 2004). The homeowners interviewed also recognized this as a major contributor to increasing flooding potential; moreover, they claimed that accumulated silt/sediments at the river mouth act as barrier to the free flow of water during floods. The Navua floodplain is characteristically low lying, naturally increasing the potential for flooding

during intense and/or prolonged rainfall episodes. Navua residents interviewed attributed the extensive nature of flooding in April 2004 to dysfunctional irrigation channels and floodgates. A scrutiny of the data in Table 1 indicated that the two most extensive floods occurred in 1993 and 2004 after commercial rice farming was abandoned. Consequently, the irrigation channels and floodgates were poorly maintained, giving rise to blockages and uncontrolled movement of floodwater. On the other hand, the assertion by respondents that the rainfall pattern has changed could not be verified by our brief analysis of the rainfall pattern in the past 43 years and within the two wettest months in Navua.

Seventy five percent of homes surveyed were raised above ground level, while the remaining 25% were built on the ground level (see Table 2). Homes that were raised (on pillars or have concrete porch) were observed to be less affected by flooding, barring factors such as the location of the home, the intensity of flooding, and the strength of the building. The depth of water in homes that were flooded varied considerably, in most cases, both raised, and unraised homes were flooded. As expected, unraised homes experienced higher levels of water within them during floods, which also suggests that these homeowners generally sustain greater property losses. Nevertheless, even some homes raised nearly 2 m above the ground level were also flooded during the five flooding episodes. The data in Table 2 also suggest that houses in Navua (especially those within a few meters from river, confluence points of irrigation channels, and near previous flood water routes) may need to be raised by more than 2 m to minimize the potential of being flooded in the future.

3.2 Respondents' opinion on their vulnerability to flooding and climate change

Interviewees were asked of their opinion on the factors that contribute to increased potential for flooding in Navua. Listed below is a summary of their responses:

- Increased silt/sediment input to the river, which raises the river bed;
- The buildup of silt/sediments at the river mouth, impeding movement of water;
- The presence of dysfunctional and disused irrigation channels previously used in rice farming and nonfunctioning floodgates, especially those at the coast;
- As of 2004, it has been 10 years since Navua River was last dredged (Plans are under way in 2006 to dredge the river.); and
- Rainfall patterns have changed.

Nearly all of the interviewees and officials from the Navua RLA recommended the dredging of the river as an important measure to reduce their vulnerability to flooding, in addition to building raised and sturdy homes. On the other hand, adaptive measures, such as taking insurance cover, relocation, maintaining irrigation channels, and floodgates are beyond their financial capacity. However, they also recognized that as individuals, they have a role to play in reducing their vulnerability to flooding in collaboration with the government and its agencies.

Nearly 95% of the interviewees and Navua RLA officials have heard about climate change mainly through the media. However, most of them are unaware of the human and

natural factors responsible for climate change. They also associated the recent floods with climate change, which is an indication of their limited understanding of climate change science.

3.3 Socioeconomic status

Navua is a typical PIC town, characterized by rapid urbanization, meager economic activities, and people within the low- to middle-income bracket. The 1996 census recorded the residential population as 4220, which was 52% higher than population in 1986 (Sinclair Knight Merz, 2000). The current population is projected to be near 7,000 because of urbanization and resettlement of displaced sugar cane farmers following the expiry of their land leases. Most people in the project site live in and around Navua town. SIS09 surveys showed that on average a Navua resident earns $U.S.35-46 per week, which was comparable to the average weekly earning recorded by a consulting firm in 2000 (Sinclair Knight Merz, 2000). This indicated that the socioeconomic status of average Navua residents had not improved within the past five years. Consequently, they also rely on subsistence farming and fishing for sustenance and to supplement their incomes.

Before 1990, commercial rice farming was an important economic activity in the greater Navua area. However, commercial rice farming has been abandoned because of competition from cheaper rice imports from Asia, floods, and pest infestation (Sinclair Knight Merz, 2000). Nowadays, small-scale commercial and subsistence farming of

temporary root crops (cassava and dalo[6]) and vegetables, as well as animal grazing (mainly cattle and goats) are the main agricultural activities. Logging in the upper catchment of Navua River is another significant activity, which was popular in the past and is anticipated to increase, as some of Fiji's largest mahogany forests are found there and harvesting has started (Mataki et al., 2006; Ba, 1993). Aggregate mining in the Navua River is also an ongoing activity (SOPAC, 2003).

The latest flooding episode (within the study period) occurred in April 2004, and the national government incurred close to U.S.$65,426 in emergency food rations for a 30-day period for the greater Navua area. Apart from this, damages to homes were estimated at U.S.$110,200 (SOPAC, 2003). More than 2,700 people representing about 40% of Navua's population were displaced from their homes because of flooding and temporarily relocated to evacuation centers (Central Division Disaster Management Council Operation Centre, 2004). Obviously, ordinary citizens may not be able to improve their standard of living if they are to sustain damages of the above magnitude on an annual basis. The net flooding impact experienced by the residents on their homes will depend on adaptive measures taken, such as building sturdy and raised homes, and shifting to less flood-prone areas within Navua. However, the full social and economic impacts of previous floods (which was beyond the scope of this paper) are currently unknown. However, their impacts are deemed substantial, taking into consideration, destruction of root crops, loss of income and properties, diseases, and in some cases, death. Apart from the business houses and a few middle-class residents, most of the homes and properties in

[6] Taro

Navua area are not insured because of obvious financial constraints and because they cannot meet basic insurance requirements.

3.4 Navua within Fiji's government and institutional structure

The government activities within Fiji are undertaken through four distinct systems: the National Government Administration, the Fijian Administration (which exclusively looks after the indigenous Fijian Affairs), the Municipal Administration (incorporated towns and cities), and Rural Local Authorities (RLA). Navua has not been incorporated as a town under the Local Government Act and is therefore governed as a RLA. The RLAs are essentially public health authorities responsible for public health, building construction, and other matters under the Public Health Act. However, most functions and services are consolidated on a national basis for efficiency and economy of scale, and, as a result, RLAs have relatively limited powers.

As a RLA, the residents of Navua do not have local-level political representatives, as it is within incorporated town and city councils, although the Navua RLA officials work tirelessly to provide services and represent Navua residents with minimum financial and human resources. This ultimately means that local-level concerns about river flooding are often inadequately dealt with at the political and administrative levels. Certain officials with the Navua RLA interviewed expressed their intention to legally incorporate Navua as a town as a means to have local-level political representation and improve the services and economic activities in Navua.

3.5 Adapting to climate change

According to the Intergovernmental Panel on Climate Change Third Assessment Report, adaptive capacity is defined as the ability of a system to adjust to climate change, including climate variability and extremes, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. On the basis of the above definition, adaptive capacity in the context of PICs refer to the "net resources" (e.g., financial, human, technological) available to national governments, communities, and individuals to implement adaptation measures. Resource allocation and use are strongly influenced by issues, such as governance, fiscal policies, tradition and culture, levels of poverty and hardship,[7] and prevailing socioeconomic and environmental conditions. On the basis of our studies, a majority of the residents in Navua lack sufficient net resources, as well as capacity to enable them to autonomously adapt to climate change/variability and extreme events to any significant extent without the government's intervention.

Adapting to present climate variability and extreme weather events is an early opportunity to enhance the resilience and the adaptive capacity of Navua residents to future climate change. Moreover, adaptation to climate change in a socioeconomically disadvantaged community such as the one in Navua will better approached from a broader development framework. This approach is conducive in this case, so that government can oversee (management structure for adaptation) the implementation of

[7] ADB defined it as (i) low income, limiting their ability to provide for family needs,(ii) lack or limited access to basic services, particularly education and utilities, (iii) landlessness

adaptation measures and incorporate adaptation measures in the development plans for that particular area. In addition to this, autonomous adaptation initiated by individuals and communities should be encouraged with appropriate incentives and clear demarcation of responsibilities of government and communities in planning and implementing adaptation measures. Furthermore, government can also engage development partners (including funding agencies) through bilateral and multilateral arrangements to provide technical and financial support for the implementation of adaptation options. This is quite crucial for PICs, given the diminishing Overseas Development Aid, invariable "wish lists" usually given by PICs to donors and the taut donor conditions.

The adaptation measures, however, must be evaluated against the three pillars of sustainable development (environment, economic, and social) for effectiveness and suitability. Several adaptation options for a case like Navua are suggested. However, this paper will only refer to these adaptation options to facilitate discussion about a possible process of adaptation, and constraints to adaptation implementation in PICs.

A lesson learnt from this study is that a system embracing both "top-down and bottom-up" approaches to the adaptation process has the best chance to improve the adaptive capacity of Navua residents or residents of other towns in the Pacific with similar geographic features and socioeconomic backgrounds. This system of approach is also aligned with current regional efforts under the CBDAMPIC project to mainstream climate change adaptation into national development planning and concurrently engage

and empower local communities and nonstate actors to develop and implement effective and appropriate adaptation options. The two approaches are discussed separately in this paper for clarity purposes only.

3.6 Top-down approach

This approach recognizes the weak adaptive capacity of the Navua population (and other PIC communities) perpetuated by their socioeconomic status and the need to mainstream adaptation to climate change in national development plans. Capital intensive measures such as dredging and maintenance of irrigation channels and floodgates are beyond the capacity of Navua residents and should remain the responsibility of government and its agencies. Incentives should be judiciously developed in consultation Navua residents to enable them to afford flood-proof homes, take out insurance policies, and to relocate elsewhere in the country.

The onus is, therefore, on the national government and its agencies to take appropriate actions such as developing (or improving) national policies to regulate developments in climate-sensitive sectors and geographic areas under a national adaptation policy framework. More importantly, such policies should be climate proof. Climate proofing[8] at the national policy level is one of the major ways to mainstream adaptation. Although it's application at the sector level, for example, climate proofing of building codes, tourism and land-use plans can yield immediate positive results. Climate proofing at the national policy level is also essential to strengthen the enabling environment for

[8] A risk-based approach to adaptation is shorthand for reducing, to acceptable levels, the risks due to climate variability and change including extreme events (Assessments of Impacts and Adaptations to Climate Change, 2005).

adaptation, and set the foundation for the integration of climate change adaptation into development plans and policies (AIACC, 2005).

Dredging of rivers should be revitalized under a national program for all rivers after a comprehensive assessment of communities and localities vulnerable to flooding. It was obvious from the case study that the dredging of the river can dampen the severity and extent of flooding; however, funds earmarked for dredging of the Navua river in 2000 were diverted without proper consultation with the Ministry of Finance. In this case, the programs for dredging of rivers are already in place, but dredging projects are implemented in an ad hoc manner; consequently, some rivers are not dredged even several years after the due date. Furthermore, the lack of adequate dredging equipment and faulty equipment were also partly responsible for the delay, and these factors are prevalent in PICs, especially with projects requiring specialized equipment.

3.7 Bottom-up approach

Facilitating autonomous adaptation by focusing on the positive aspects of cultural and communal-based societies in the Pacific should underpin this approach. Secondly, this approach also recognizes the need to engage all stakeholders, such as nongovernment organizations (NGOs) and regional organizations (e.g., USP and SPREP), which are intergovernmental in the Pacific Region. Furthermore, current adaptive options implemented by individuals will need to be encouraged with proper support and incentives by the government.

An important aspect of Pacific Island communities, including those in Fiji, is the strong communal nature of living and working together, although at times, this is also viewed by some as an obstacle to development (Duncun and Toatu, 2004). The communal nature of living in the Pacific especially in the rural and urban hinterlands brings forth an opportunity to consolidate appropriate resources (e.g., finance and local expertise) required for adaptation, that is, to pool the diverse and often scanty resources and channel the efforts of communities for a common cause. Therefore, the adaptation process should be taken within the context of the community as a whole, although consideration should also be given to the needs of individuals.

NGOs and regional organizations with mandates in line with climate change/variability adaptation have played significant roles in community-based development and advocacy for climate change in the Pacific. Their experience with community-level development, provision of technical advice, and carrying out research on climate change issues will complement efforts by the national government and individuals to promote climate change adaptation. The engagement of regional organizations has been proven to be effective in the sharing of adaptation lessons learnt elsewhere in the Pacific and also to engender a consolidated stand on climate-related issues in the international fora.

Autonomous adaptation has been observed within Navua town, especially in the construction of homes; discussions held with officials of the Navua RLA indicated that the number of newly approved buildings raised above the ground has been on the rise,

especially after the recent floods. Residents were encouraged by Navua officials to build higher than the previous flood level. Such autonomous adaptation needs to be properly encouraged, as it will contribute to reducing the vulnerability of the Navua residents to flooding and reduce financial obligations of the national government during flooding disasters.

Our assessment of the situation in Navua, and the results from the CBDAMPIC project, indicated that local communities should be actively engaged in the full adaptation process, from planning to implementing and monitoring adaptation measures. Their involvement in this process is irrespective of whether the technical advice on adaptation to climate change originates from local or international experts (Nakalevu, 2005). This approach will also contribute to heightening the community's responsibility to sustain adaptation to change and to proactively internalize the adaptation process. It is anticipated that by internalizing and sustaining the adaptation process, the communities' dependence on external assistance to implement adaptation options will progressively reduce over time.

3.8 Challenges to implementing adaptation in PICs

In this paper, we have identified four challenges to implementing adaptation to climate change in the Pacific: (1) climate change perception and competing government and individual priorities, (2) weak government institutional frame work, (3) prevailing weak

socioeconomic conditions, and (4) cross-cutting issues like available capacity and good governance.

3.9 Climate change perception and competing government and individual priorities

The perception held by the public but especially decision makers in the Pacific about climate change will influence the actions they take to deal with climate change risks. On the basis of the SIS09 surveys, most of the people (especially local and government officials) interviewed demonstrated a low level of awareness on climate change and in most cases were influenced by media reports, which are seldom accurate. Only a few of them acknowledged the influence of human activities on the climate. This implied that many people are unable to make concrete relations between climate change and the contribution humans make in aggravating climate change/variability. Consequently, when one advocates for the implementation of climate change adaptation, it is often perceived as attempts to prepare for a future "unlikely adversity," which is not as pressing as the need to meet basic daily needs such as food and shelter. Climate change is often viewed as a futuristic phenomena and does not align well with the decision time frame (invariably short, 1-5 years,[9] depending on the duration of national parliament) of governments and individuals. Consequently, the notion of adapting to climate change is seldom regarded as a high priority by governments and individuals and thus loses out in terms of funding and institutional support. In some cases, such misconstrued perceptions are reinforced by poor and limited climate change awareness. A study in the Cayman Islands (Caribbean) also showed that policy makers seldom regard climate change as a

priority environmental concern and therefore see little need to make policy responses to cater to climate change (Tomkins and Hurlston, 2003).

Misconstrued perceptions about climate change necessitates the need to discuss climate change adaptation in the context of climate variability and extreme weather events, since people can visualize the link between the impacts of the extreme weather events on climate variability and their livelihood. However, this approach to climate change discussion must be taken with care because extreme weather events frequent Pacific islands (especially tropical cyclones, 1-2/year); as such, communities may perceive them as "normal" events, and consequently downgrade adaptation to extreme weather events and climate change. The need for caution is also pertinent because national governments usually provide relief assistance during and after tropical cyclones, and this can accentuate the local community's dependence on the national governments and may therefore dissuade them from actively participating in the adaptation process. Proper public awareness about climate change adaptation should aim to unravel the above misconceptions.

3.10 Absence of a strong institutional framework at the national level

As per earlier discussions, planning and implementing climate change adaptation needs to be driven by the national governments. To drive this process, the institutional and governance structures need to be reinvigorated/strengthened and made aware of the significance of adapting to climate variability and extreme weather events to better

[9] Barring change of government, in the duration of the legislature, normally 1–5 years

prepare for changing climate patterns. For example, in Navua, the immediate adaptation options are dredging and enforcement of the appropriate building codes. However, the absence of a stronger political framework in Navua (Duncan and Toatu, 2004) gave way for the easy diversion of funds earmarked for dredging in 2000 (Auditor General of the Republic of Fiji, 2001). There is also a lack of communication and coordination between relevant governmental departments (Duncan and Toatu, 2004; Raj, 2004), an institutional setback apparent in many government departments in PICs. The fragmented jurisdictions over related areas reinforce the lack of communication in some circumstances. For example, in Fiji, the Land and Water Resources Management of the Ministry of Agriculture is responsible for river engineering, drainage, and irrigation, whereas the Public Works Department is responsible for flood control, watershed management, and flood forecasting. Although there is an amicable working relationship between the two government departments (Raj, 2004), regular communication on matters of mutual interests cannot be guaranteed, as they go about their day-to-day operations. Furthermore, there is no central authority for flood management and the National Disaster Management Office only plays a coordinating role during disasters.

3.11 Prevailing weak socioeconomic background

Large adaptation projects are usually costly, especially for socioeconomically disadvantaged communities in the Pacific, such as those in Navua. An average income of $U.S.35-46 per week barely helps meet their basic needs let alone afford flood-proof homes, relocate elsewhere, or afford insurance. On the other hand, there are also certain

individuals who are already implementing autonomous adaptation measures to the risks posed by flooding in Navua and coastal erosion and storm surges in Samoa (Nakalevu, 2005).

3.12 Crosscutting issues

Two of the most important crosscutting issues that pose a challenge to implementing adaptation in the Pacific are the lack of capacity and good governance at various levels of the country, including at the community level. The lack of capacity (e.g., in climate science and adaptation), especially at the individual level, is pervasive throughout PICs. The lack of capacity is also evident at the systemic and institutional levels and therefore affects PICs' ability to properly plan and implement climate change adaptation within a development framework. Under the CBDAMPIC project, the cost-benefit analysis of adaptation options identified in their project sites had to be contracted out to a consultant because of the lack of expertise at the national level to carry out such analysis.

Governments in most PICs are often challenged internally and externally to demonstrate good governance by establishing appropriate institutions with proper checks and balances to optimize the delivery of goods and services to the country as a whole. National governments can no longer afford to maintain rigid decision-making structures if they are to be effective and efficient with the goal of enhancing the adaptive capacity of the people to climate change. The need to promote participatory approaches to planning and decision making taken in respect of climate change adaptation is pertinent to ensure the

internalization and sustainability of the adaptation process. However, such changes by national government toward participatory and decentralized decision making should be judiciously implemented with national interests at the core to avoid unnecessary delays and the dominance of the national stand by a few stakeholders. Good governance is needed to enable climate change concerns to permeate all levels and sectors of the society, including the local communities.

4. Conclusions

Climate-related disasters put a lot of strain on the sustainable livelihoods of communities in PICs. It is anticipated that with climate change, ongoing climate variability coupled with extreme weather events will increasingly threaten people's livelihood. The climate driver (rainfall) of river flooding in Navua has not shown any significant increase in its pattern or intensity to suggest it as the dominant driver of vulnerability. This indicates that nonclimatic drivers do have an important role in influencing the vulnerability of Navua residents to flooding.

A way forward is to implement climate change adaptation embracing a connective top-down and bottom-up approach underpinned by lessons learnt through their experiences with climate variability and extreme weather events with guidance of climate-proof development plans. Moreover, there should be clear responsibilities of all stakeholders involved in planning, implementing, and monitoring adaptation measures. Navua also typifies local communities in PICs, which are “locked” into a vulnerable situation

because of their poor socioeconomic conditions coupled with limited input to government decision-making processes, access to financial resources, and therefore need assistance to properly adapt to climate change.

Acknowledgment

The authors gratefully acknowledge the support of the Fiji Meteorological Services for providing relevant archived rainfall data for part of this study, the people of Navua who freely gave information during SIS09 surveys, and former SIS09 Research Assistants, Roshni Lata, Lusiana Ralogaivau, Jyotishma Rajan, and Ashwini Fernando.

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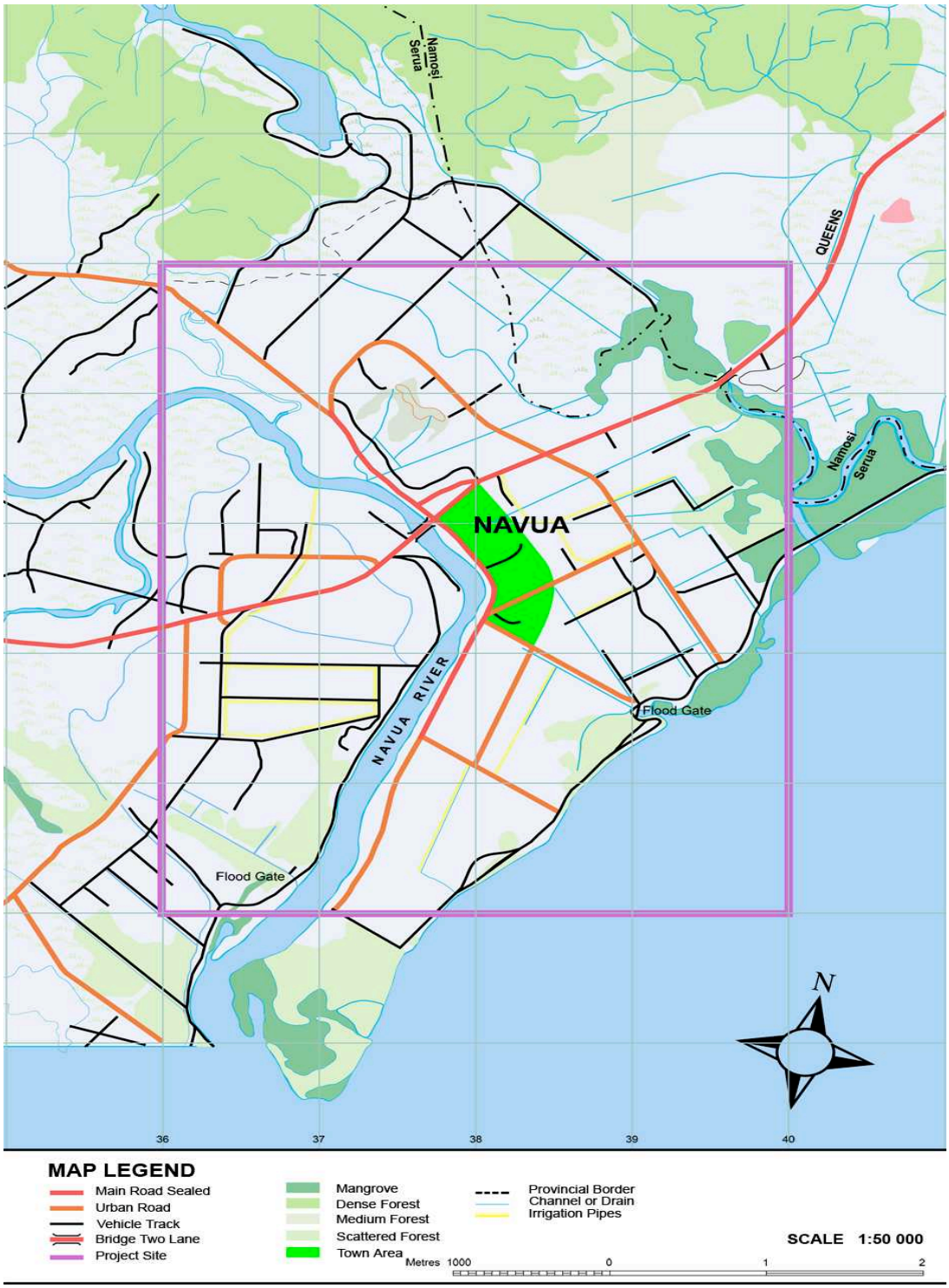

Figure 1. Detailed map showing SIS09 Navua project site.

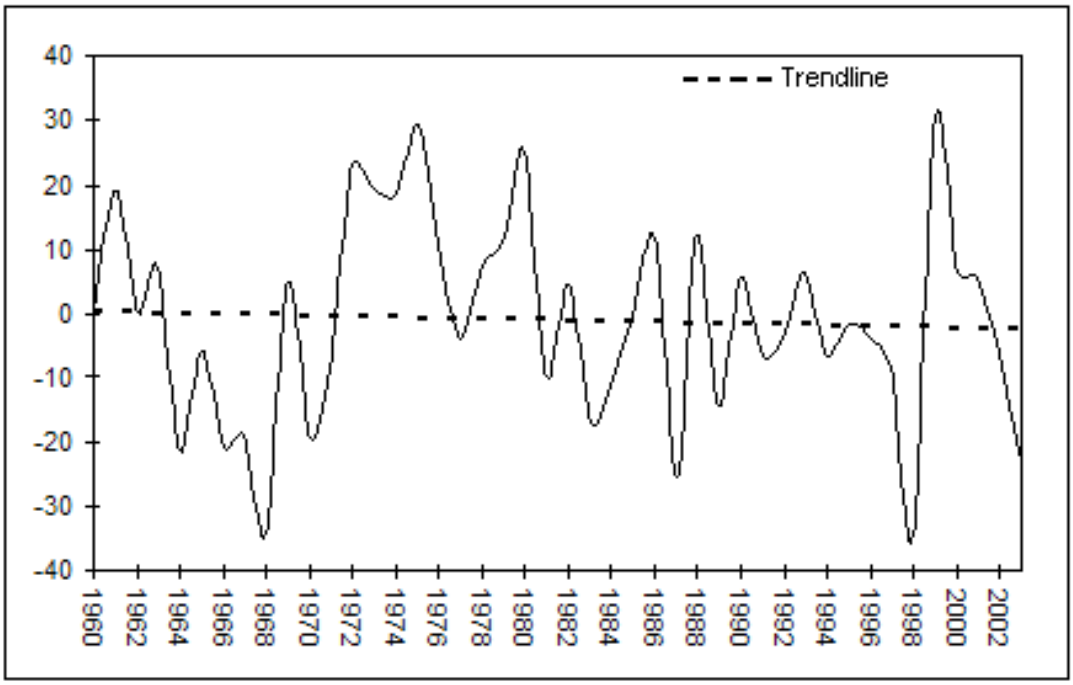

Figure 2. Trend in observed rainfall anomaly (%) for Navua (1960–2003).

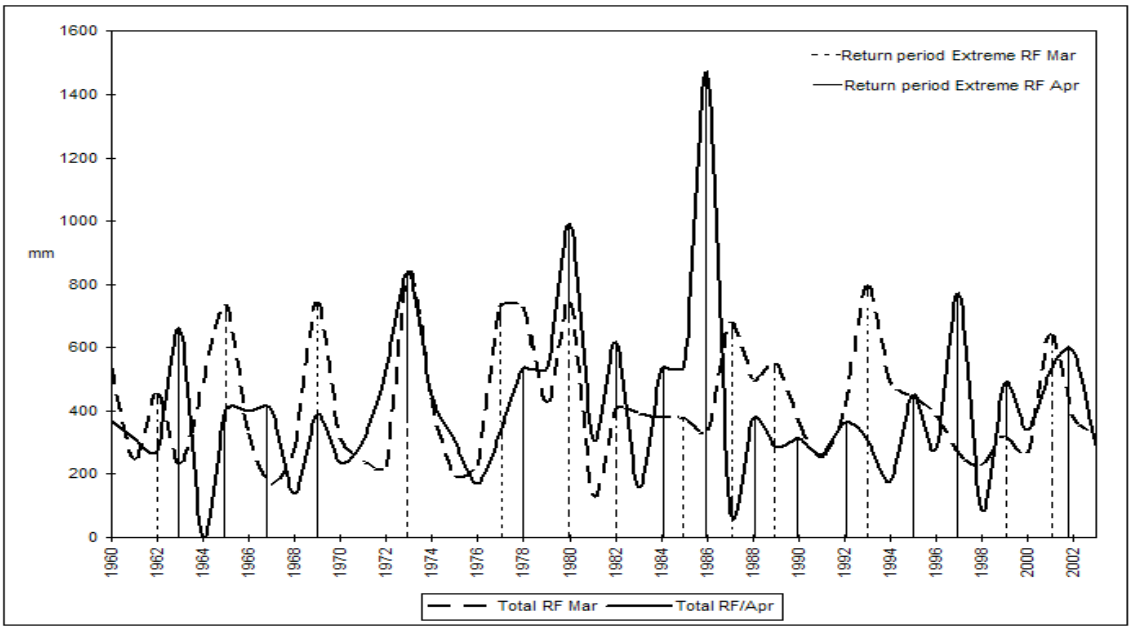

Figure 3. Maximum daily rainfall during March and April from 1960–2003.

Table 1. *Flood extent, duration, and rainfall in five recalled flooding episodes in Navua*

Climate Extreme (Tropical Cyclone or Depression*)	**(Duration of Event) Date**	**Percentage of Study Site Flooded**	**(Total Rainfall) and Average Rainfall/day (mm) and mm/day**
Bebe	(19 days) 19/10/72 – 06/11/72	86	(652) 34
Wally	(6 days) 01/04/80 – 06/04/80	22	(682) 113
Oscar	(3 days) 28/02/83 – 02/03/83	21	(412) 19
Kina	(11 days) 26/12/92 – 05/01/93	89	(537) 6
April*[10]	(10 days) 06/04/04 – 15/04/04	90	(592) 59

Source: The respondents were asked to recall at the most five flooding episodes and the information was cross-checked with information held by the Fiji Meteorological Service

[10] Caused by two tropical depressions

Table 2. *Depth of water in homes flooded in 5 episodes, surveyed in 2003 and 2004*

Type of Building Foundation	**% of Homes (*n* = 68)**	**Height above Ground Level**	**Depth of Water**
A[10]	75	A: 10cm – 196cm B: 0 cm	20cm – 220cm (especially B)
B[10]	25		