
Article:
Currenti, R, Pearce, T, Salabogi, T et al. (5 more authors) (2019) Adaptation to Climate Change in an Interior Pacific Island Village: a Case Study of Nawairuku, Ra, Fiji. Human Ecology, 47 (1). pp. 65-80. ISSN 0300-7839

https://doi.org/10.1007/s10745-019-0049-8

Adaptation to climate change in an interior Pacific Island village: a case study of Nawairuku, Ra, Fiji

Abstract

We examine how people living in Nawairuku, an interior village in Ra, Fiji are experiencing and responding to climate change in the context of recent social and ecological changes. An analysis of data collected using semi-structured interviews with 27 households reveals that household adaptability – the competency or capacity to adapt to climatic stimuli or their effects or impacts – depends on access to livelihood assets. All households have access to social capital through familial networks, which lessens the burden of extreme weather events, namely cyclones and flooding. The households with access to tangible assets such as land and the equipment and resources to utilize it, together with intangible assets like motivation, labor, and knowledge are better positioned to adapt their agricultural practices to changing climatic conditions, than other households. Households with a strong leader were also better positioned to adapt. We conclude that remoteness promotes self-sufficiency and initiative, and livelihood assets influence household adaptability.

Keywords: adaptation; natural hazard; Pacific Islands Region; vulnerability

1. Introduction

The Pacific Islands Region (PIR) is widely regarded as a "hot spot" for global climate change (Farbotko and Lazrus, 2012). Biophysical changes including sea-level variations, coastal erosion, ocean acidification and increasing water and surface air temperatures have already been recorded and are expected to continue, and accelerate, in the future (Nurse et al., 2014). The risks of climate change for the Pacific Islands are significant, challenging livelihoods, health and well-being, and food security (Barnett and Campbell, 2010). It is recognized that despite even the most aggressive greenhouse mitigation strategies, current emissions commit the Earth to some degree of change, with effects requiring communities to undertake adaptations (IPCC 2014). Adaptation is particularly important in the PIR where climate change is already affecting the local environment and human livelihoods.

To date, however, most climate change research in the PIR has focused on measuring biophysical changes, like sea-level rise, with less known about how these changes translate to affect the lives and livelihoods of people and their capacity to adapt. Other research has projected potential future climate change impacts using climate models and future emission scenarios (Carson et al., 2016; Hanich et al., 2018). When the human system has been considered in these studies it has usually been included at the end of the study, with vulnerability measured as a residual of projected climate change impacts minus assumed adaptations (Woodward et al., 1998). Climate impact studies have improved our broad understanding of how people living in the PIR might experience and respond to future climate change, but they do not explicitly address adaptation.

The realization of the inevitability of climate change has stimulated adaptation research, which seeks to understand how human systems respond to climate stimuli or their effects or impacts to moderate harm and exploit beneficial opportunities (Berrang-Ford et al., 2011). This research is conducted at local community-scales and focuses on climatic stimuli that are relevant and important to people, beyond those identified by researchers or in climate models (e.g. temperature, precipitation, sea-level), and adaptive responses. This scholarship has developed several key insights, indicating that climate change is being experienced in the context of other social, economic, political, cultural and environmental forces that affect communities (McCubbin et al. 2015; O'Brien et al. 2004);

adaptations are most effective when mainstreamed with existing development, disaster preparedness and resource management initiatives (Nurse et al., 2014; Robinson, 2017); adaptation measures are seldom undertaken in response to climate change alone (Pearce et al. 2010); current vulnerability is influenced by the past (Brooks, 2011; Taylor, 2013); some adaptations can become maladaptive in the longer-term (Dilling et al. 2015; Fazey et al. 2011); and reactive adaptations are more likely in absence of government intervention (Tompkins and Adger, 2005). Despite these achievements, however, our current understanding of human adaptation to climate change in the PIR is incomplete, limited by a handful of case studies conducted with people living in urban or near-urban areas in the coastal zone (e.g. Nolet, 2016; Sutherland et al. 2005). Less is known about the experiences of people living in geographically remote locations, particularly rural, inland areas. Here, remoteness is defined in terms of geography and access to mainstream health, education, markets, energy supply, and other public and private services and characterized by poor infrastructure such as roads (Maru et al. 2014). As a result, the dominant discourse on climate change adaptation in the PIR has centered on the issue of sea-level rise and coastal communities. This gap in understanding limits the efficacy of adaptation efforts in the PIR and risks falsely characterizing all Islanders as the same despite diverse physical and human geographies.

In this paper, we respond to this knowledge need and examine how people living in Nawairuku, an interior village in Ra, Fiji are experiencing and responding to climate change in the context of recent social and ecological changes. We build upon existing climate change impacts, vulnerability and adaptation scholarship that identifies access to livelihood assets as a key determinant of adaptability and consider the roles of tangible and intangible assets in adaptation (e.g. Ellis, 2000). The following sections describe Nawairuku and outline the research approach and methods used. Next, the results are presented for current and future vulnerability, including factors and processes that influence adaptability, followed by a conclusion in which opportunities to support adaptation are discussed.

2. Nawairuku Village

Nawairuku is an interior village of approximately 320 people (62 households) (100% iTaukei[1]) located in Ra Province, Viti Levu, Fiji, at an elevation of 51 metres above sea level and approximately 24 km away from the coast (17°38'15.52"S, 178°12'51.66"E) (Fig. 1). Ra province is positioned in the north-east quadrant of Viti Levu and is known as one of Fiji's "salad bowls", because of the high production of root crops and yaqona (kava plant) (Davetta, 2017). Ra province covers an area of 1340km^2 and has two major towns, Rakiraki and Vaileka, and 89 villages, of which Nawairuku is one (Davetta, 2017).

Nawairuku is situated in a riverine valley surrounded by steep forested and cultivated hills (up to 30 degrees in places which is classified as 'very steep' by the Department of Agriculture (2014)). The land directly surrounding the village is traditionally owned by the paramount chief of the Tikina (Nalawa)[3], who does not reside in the village. Given that ownership of the land of the village is held outside of Nawairuku, decision-making and ability to cultivate certain areas is limited and complex, restricting peoples' autonomy and ability to plan ahead. The mataqalis[4] of the village own land approximately five kilometres away which was the initial village site before several relocations to the current site, established here around five generations ago.

All families rely on farming and small-scale animal husbandry for subsistence and income. Commonly harvested foods include root crops (cassava, dalo (taro), kumala (sweet potato), uvi (yam), yaqona (kava plant), fruits (niu (coconut), jaina (banana), meleni (watermelon), vudi (plantain), uto (breadfruit), moli (mandarin), papaya (pawpaw)), and vegetables (tomata (tomato), kiukaba (cucumber), baigani (eggplant), papukeni (pumpkin), bele (edible greens), dalo leaves, rokete (chillies) and kaveti olo (Chinese cabbage)). Cassava, dalo and banana are the main cash crops. In recent years, cash crops have become a greater focus of agricultural production in the village as people try to keep up with the increasing costs of changing lifestyles (dietary preferences, technologies, etc.) and living expenses. Several middlemen service the village by purchasing produce

[1] iTaukei = Indigenous Fijian people
[3] Tikina = District consisting of 18 villages including Nawairuku
[4] Mataqali = A clan; subdivision of a tikina; primary Indigenous land-owning unit

from villagers, which they transport by truck and sell at the market in Rakiraki or Lautoka. While this is the most convenient way to sell crops, villagers receive less money for their produce than if they were to sell the crops at the market themselves which is restricted by transportation costs, limiting overall profits.

People in Nawairuku have strong Christian faith of varying denominations including Christian Mission Fellowship International, Methodist, and Seventh Day Adventist churches. The introduction of Christianity has changed traditional practices and influences decision-making in the village.

3. Methods

3.1 Research approach

The research employed a vulnerability approach described by Smit and Wandel (2006) and consistent with McCubbin et al. (2015) and Pearce et al. (2017). Here, vulnerability is conceptualized as a function of exposure to biophysical changes, sensitivity to these exposures and adaptive capacity to deal with exposure-sensitivities (Smit and Wandel, 2006). The term "adaptation" refers to adjustments in human systems in response to actual or expected climate stimuli or their effects or impacts, that moderate harm or exploit beneficial opportunities (Smit and Wandel, 2006). The vulnerability approach is applied in two stages: (1) identify the conditions, climatic and non-climatic, to which the individuals in a community are currently exposed and sensitive, and to document the adaptive strategies employed to deal with these conditions, and (2) consider possible future changes in climatic conditions and the capacity of the community to adapt to such changes. This approach shares commonalities with the sustainable livelihoods literature and we draw upon this work to better understand the underlying determinants of adaptability (Gutierrez-Montes et al. 2009).

The research was guided by consideration for conducting research with Indigenous peoples described by Nabobo-Baba (2006; 2008) and Pearce et al. (2009) and regulations for conducting research in Fiji outlined by the Department of Immigration (Fiji Department of Immigration, 2017). Early communication was first established in February 2017 by phone and e-mail with the Chairman of the Village Development Committee, the turaga-ni-koro (village spokesperson), Office of the

Commissioner Western in Lautoka and Ra Provincial Council to introduce the research idea. Then, on invitation from the Ratu (chief), the researchers, together with village relatives, visited Nawairuku for two days in April 2017 to conduct a sevusevu[2] and discuss the proposed research. Upon confirming support for the research, the researchers returned to Australia and prepared applications for a research license and ethics approval. Approval for the research was granted by the Fiji Department of Immigration (#I7497899) and study protocols were approved by the Human Research Ethics Boards at the University of the Sunshine Coast (A/15/751) and University of the South Pacific.

3.2 Data collection

Data were collected over a 10-week period between June and August 2017 through semi-structured interviews using open-ended questions with 30 participants from 27 households, focus groups (n=2), participant observation, and analysis of secondary sources. A recent tertiary graduate from Fiji National University (Diploma of Forestry Management) originally from Nawairuku, Teresia Salabogi, was employed as a local research partner for the duration of the project and helped to conduct the interviews. Key informant and snowball sampling techniques were used to identify interview participants starting with key informants (village head person, local research assistant) who then assisted in identifying a cross-section of the adult population in Nawairuku (Table 1) (Patton, 2014). In particular, long-term residents of the community or those who are particularly knowledgeable about history of change were identified; typically, people over the age of 55 years held the most in-depth knowledge. To overcome bias of key informants and others guiding the research, data were triangulated (individual interviews, focus groups, participant observation), and interpretations of data were checked by Fijian research partners.

Interviews were semi-structured with open-ended questions to minimize researcher bias and allow participants to openly discuss issues they felt to be of genuine concern (supplementary data). Semi-structured interviews are a standard method of data collection used in ethnographic research for gathering information in an open-ended format and has been widely used in community-based

[2] Sevusevu = A traditional yaqona presentation made when something is requested

research with Indigenous populations (Berg and Lune, 2012). In keeping with Pacific values and research standards (Nabobo-Baba, 2008), semi-structured interviews were set up informally in a location suitable for the participant, were conducted as a talanoa-style[6] conversation, and were conducted in the chosen language of the research participant (English or Fijian (Ra dialect)). The interviews conducted in Fijian were translated during the interview and transcripts were later verified by the local research partner. Interviews were voluntary and interviewees had the option of remaining anonymous or having their information attributed to them. Most participants (26 of 30) consented to having their information attributed to them. Four people who wanted to remain anonymous have not had their name attributed to the quotes presented in text. Likewise, references to other people in quotes has been consented accordingly. Participants also had the option of having their interview audio recorded. 30 interviews were audio recorded and later transcribed. After each interview, transcripts were reviewed and verified by the interview team. The interview quotations provided in the text are from both audio recordings and hand-written transcripts.

Two focus group talanoa sessions were conducted with community members during the research period. One had an agricultural focus (approx. 12 participants) while the other focused on factors that aid or constrain adaptation to changing conditions (approx. 15 participants). Both focus groups were conducted in Ra dialect and English in the community hall, as chosen by the participants and were led by the researcher and local research partners. Both sessions were audio recorded and transcribed. Complementary data gathered from participant observation and secondary sources of information were used to contextualize the information from the interviews and focus groups.

3.3 Data Analysis

Data from the semi-structured interviews were analysed following the principles of latent content analysis to identify recurring or common themes related to the broad categories of the vulnerability approach and the research questions (Bernard, 2012). Rather than analyzing interview transcripts based on exact wording as is the case with manifest content analysis, latent content

[6] Talanoa refers to a process in which two or more people talk together, or where one person tells a story while the others listen (Nabobo-Baba, 2006).

analysis considers underlying themes or messages within the interview conversation and participatory observation (Berg, 2004). Focus group data were analysed similarly with themes emerging from the transcripts. Information collected about participants was used to group participants in broad categories by gender, age, and livelihood activities. NVivo 11.4.0 software was used to organize interview data, observations and field notes.

4. Results

4.1 Changing exposure-sensitivities

In Nawairuku, a combination of changing climatic conditions and changing socio-economic conditions manifest to affect lives and livelihoods. Table 2 presents a list of conditions identified by participants, the frequency with which each was mentioned, a brief description, and a sample quote from participants. It is noteworthy that the village was directly impacted by Tropical Cyclone (TC) Winston in February 2016 and endured a record-breaking flood the following December. As such, it is to be expected that participants frequently referred to these events during interviews and focus groups.

4.1.1 Changing socio-economic conditions

Many socio-economic conditions were identified as factors, which together with climatic stressors, are affecting lives and livelihoods in Nawairuku. 93% of participants (n=28) identified rising living costs as a driving force of stress. Rising living costs have put financial pressure on families in Nawairuku prompting people to find new, off-farm income sources to meet demands. For example, some people make handicrafts like mats and fans to sell at the market, some families run small canteens from their homes to make a wage, and others relocate to urban centres for work and send remittances home. Rapid population growth and localized development has increased pressure on a limited natural resource base. For example, increased demands for food has led some people to use agrochemicals directly in river system to stun fish and prawn for easier collection. Changes in

house building styles from traditional one-roomed thatched bures[7] to modern timber and iron houses has implications for comfortability and durability in the face of extreme weather events. Traditional bures could regulate ambient temperatures to suit the tropical climate of Fiji, keeping houses cool during hot weather and retaining heat during cooler weather. Modern architecture does not have these features and some building materials like roofing iron are a hazard during cyclones.

The geographic isolation of the village from urban centres results in some challenges not experienced by near-urban villages including, physical distance from markets, goods and services, education and employment opportunities, and lack of rubbish collection services. This restricted access limits villagers' ability to partake in some livelihood activities such as personally selling goods at the market or purchasing grocery items from the store, attending workshops and training, engaging in wage employment while retaining family presence, and accessing basic health care services.

4.1.2 Changing climatic conditions

In many instances, existing climatic stressors have intensified and become more common in recent years. 90% of participants, (n=27) described changes in the timing and intensity of cyclones. Notably, recent cyclones have inflicted greater damage on infrastructure and agricultural assets (land, crops) than past cyclones. Older participants (>50 years) shared that recent cyclones (e.g. TC Winston (2016)), and the damage that they caused, were of a magnitude that they had never experienced before. 70% of participants, (n=21) observed changes in the timing of seasons. In Nawairuku, seasons refer to the wet season, dry season, and cyclone season. Older participants (>50 years) described that in the past seasons came at the “right time”; the time that they expected based on past experiences. Now, seasonal characteristics – precipitation, temperature and humidity variations – occur at any time of year and are increasingly unpredictable. Participants recalled seeing too much rain in dry seasons, and vice versa. While some older people still rely on traditional knowledge to forecast weather, some participants explained that this knowledge is becoming less reliable due to changing conditions. 70% of participants (n=21) observed changes to local rivers. It was noted that the river through the village

[7] Bure = traditional Fijian house made of locally sourced natural materials (wood, vines, leaves)

has changed course and is now shallower than it was 10+ years ago, with implications for built infrastructure, agricultural land and aquatic food sources. The structural integrity of riverbanks is jeopardized by erosional processes and houses built atop these banks are at risk. There are fewer fish to eat and the water quality has declined posing health risks to people who use the river to bath.

Approximately ten months after TC Winston (February 2016), Nawairuku endured a record-breaking flood associated with a slow-moving tropical depression (TD04F), the first of the 2016/17 cyclone season (Fiji Ministry of Communications, 2016). Floodwaters rose rapidly on 17 December 2016 at a time when the community was rebuilding homes and re-establishing farmland. Flooding caused widespread destruction; it damaged infrastructure and transportation routes to the village, and ruined cultivated land.

The freshwater system for the village has a limited capacity and is sensitive to changes in precipitation and extreme weather events. Water for the village is sourced from a reservoir created by a small concrete dam in an upper valley approximately 2.8 km from the village and accessible only by horseback and foot. Water is piped to a central water tank near the village before being distributed by pipes to individual households. During dry periods, water supply is often cut to the village due to limited water in the communal village tank. In addition, severe weather events often cause structural damage to the distribution system and there is limited ability (parts, expertise, labor) to make necessary repairs. This is a new stress because in the past there was a smaller population and less demand on water supply, and more consistent rainfall.

4.2 Key Exposure-Sensitivities

This section describes the ways in which climatic stressors are interwoven with other socio-economic stressors affecting people in Nawairuku. Key vulnerabilities can be organized as: agricultural productivity, human health and well-being, and built infrastructure (Fig. 2).

4.2.1 Agricultural productivity

Agricultural productivity is measured as a ratio of agricultural outputs to agricultural inputs. Traditionally in Nawairuku, people grew root crops, fruits and vegetables for subsistence and did not

sell any produce. It was considered tabu (taboo) to sell root crops and the forefathers never engaged in this practice. Today, however, people are intensifying agricultural production and selling root crops to middlemen and, periodically, directly to customers at the Rakiraki and Lautoka markets. Some older participants claim this new practice of selling root crops is the cause of decreased tuber sizes and reduced overall productivity due to traditional protocols (of not selling root crops) being ignored. Cassava, dalo, banana and vudi are the most common cash crops. Other root crops, fruits and vegetables are grown primarily for subsistence and small volumes are sold.

Agricultural productivity is exposed and sensitive to extreme weather events, changing seasonal patterns, and new farming practices such as the commercialisation and intensification of agriculture and increased use of agrochemicals. The move towards agricultural intensification and commercialisation was pushed by the desire to increase yields to feed a rising population, increase sales to meet rising living costs, and an overall decrease in land productivity. Increased intensity of extreme weather events has damaged agricultural land through erosion of nutrient-rich soil, and destruction of crops. Most recently, TC Winston, a category 5 cyclone, caused immense damage to agricultural land when it passed over Nawairuku on the 20th of February 2016. Winds approaching 300km/hr, heavy rainfall and flash flooding (NASA, 2016) caused physical damage to agricultural land, including triggering landslides and waterlogging, which destroyed most crops. Participants reported losing whole harvests of dalo, cassava, and vudi, and the expected income they would have earned by selling the produce. Similarly, during the December 2016 flood, some villagers lost plots of land that were simply washed away by floodwaters. The fertile, moist soils near the river are an attractive location to plant short-term crops such as meleni, and dalo; however, plots located there and near village drainage systems are especially sensitive to flooding.

Slope stability and landslides are also an issue of concern for villagers. The first reported landslide occurred in 2004 and there is no memory of landslides in the area prior to that event. In recent years, intensive forest clearing has occurred on the slopes surrounding the village site through the process of agricultural intensification and commercialisation discussed above, reducing the stability of the slopes. During TC Winston, landslides were triggered by heavy rainfall which saturated the relatively loose soils and prompted weakness in slope stability. Agricultural plots were

completely lost following landslide events and fertile soil was stripped from the hillside. Areas that had never flooded before were inundated and some crops were washed away by floodwaters or damaged by rainfall-triggered landslides. Damaged roads further restricted access to markets and services. The flood destroyed the bridge on Nasau Road that crosses the Wainibuka River to access the village from the east, forcing villagers to use small boats to cross or to take the inland alternative route, which is three hours longer, to Rakiraki.

Participants reported shifting seasonal patterns (rainfall, temperature, and humidity) disrupting growing seasons and, in most cases, reducing agricultural productivity and related income. Short-term crop failures have been observed in response to unseasonal rainfall damaging new crop shoots or waterlogging soils causing root rot. Participants have observed wet and dry seasons becoming less distinct, recalling that in the past seasons were separate and they could predict wet and dry periods at given times of year. As a result, farmers are increasingly losing confidence in their planting schedules and expected yields.

> They have the months for the seasons – *wet and dry. Before, when the seasons come, it doesn't* affect the crops. But now, the changes of the weather, it changes the crop especially the size of the crop. (Male participant, Sanaila Vakaravia 67 years, July 2017)

The use of agrochemicals has intensified in response to these and other changes affecting agriculture with possible consequences for human health and longer-term soil productivity. Villagers are unsure of the long-term impacts of agrochemical use but opt for a short-term solution to declining yields, rising living costs, and declining labor force as young men migrate to urban centres

> I use *chemicals for the weeds because we can't do weeding on 1 or 2 acres because it's a lot of* land. We want to use plenty lands like that so we have to use the chemicals. Or if you want to earn the big money you use the chemicals to help the farm. (Male participant, Masake Baisagale, 51 years, July 2017)

4.2.2 Health and well-being

Health and well-being in Nawairuku have been affected by both rapid and gradual climatic changes. Extreme weather events such as cyclones and floods have resulted in increased incidences of

illness, injury and mental health concerns; gradual changes such as biodiversity loss, prolonged dry periods, and extreme heat have contributed to declines in food availability.

There were several instances of illness and injury in Nawairuku during TC Winston and recent flood events. Following TC Winston, one woman fell sick and was bedridden for a week with boils rising on her skin due to unhygienic conditions of being constantly wet from cleaning, poor nutritional intake, and lack of clean drinking water. She believed the main reason people got sick was because of damaged water pipes and the related inability to access clean water for drinking and bathing. Others suffered cuts from roofing iron that was torn from housing by high winds. Flood events negatively affected people's health due to a shortage of clean drinking water and exhaustion from extensive clean-up efforts.

> I got sick. Just fell sick, exhausted. Just had to stay home again for another week. And I had all this, this is from Winston, all these black marks. They are just small sores like a boil all under my breast. That was after cleaning up, the week after Winston. Just from cleaning up and due to unhygienic and being wet and because our lives were changed. And most of the time we were washing and not eating properly and being wet. And the water was, the taps were down but lucky the creeks and the streams were flowing so we were using that. (Female participant, Kalara Veramu, 40 years, August 2017)

Recent cyclone and flood events also inflicted an emotional and mental toll on villagers. The shortage of fresh and non-perishable food following TC Winston and flood events affected people's health and well-being by reducing access to nutritious foods and causing food-stress. Households depended on each other to ration and share existing food supplies for the month before food aid arrived following TC Winston. An elderly man suffered a stroke the day after the flood upon visiting his house and seeing the severe damage throughout. He passed away in May 2017, several months after his first stroke. His daughter explains how it happened:

> He just came, came from that door, the one that you entered I think he just saw everything all over the place and he lied straight down… That*'s* where they start, one side, something like a stroke, all the left side of his body gets like shocked. *That's* when his sickness started. He just

goes down slowly and lied *down…* They said it was the first stage of a stroke. (Female participant, 30 years, July 2017)

Cumulative changes in the river have resulted in an overall loss in productivity with negative implications for food security. The river is a vital source of food and water and even minute physical changes affect the lives of villagers. Several aquatic animal species were recorded to be living, or once having lived, in the river flowing through Nawairuku, including maleya (tilapia), freshwater eel and prawn. Participants noted the absence or lower abundance of fish (maleya), prawns and eels as well as the reduced size of remaining stock. One participant explained that ten years ago one could catch fish the size of a forearm but now the biggest fish are around the size of an adult hand. Similarly, ten years ago it was possible to lift large stones from the river edge and uncover "plenty" of prawns but now it is uncommon to see any prawns at all.

Before, it was very deep and plenty *fishes here but it's getting dry now… Nowadays it's very hard. People go to the big river now. You can't get the big ones in this river now. Now only small ones.* (Female participant, Viniana Salabogi, 52 years, July 2017)

4.2.3 Built infrastructure

Built infrastructure in Nawairuku, including houses, community dwellings, water and power distribution systems, roads and bridges are exposed and sensitive to cyclones and floods throughout Fiji. The traditional one-roomed, thatched roof, earth floor bure proved its ability to withstand the elements of extreme weather events such as high velocity winds and heavy rainfall (Fujieda and Kobayashi, 2013). The move towards Western housing styles, however, saw the replacement of traditional bures with contemporary houses constructed from newly introduced materials (iron roofing and walls, treated pine framing timber) in the latter half of the 20th century (Fujieda and Kobayashi, 2013). In Nawairuku, this transition saw the complete loss of bures and with it, the comfortable, climate-suitable design that was more resilient to extreme weather events. One participant shared how his "iron roof was torn away like paper" during TC Winston (M, 58 years). Modern building materials, like roofing iron, can become lethal hazards as they are blown around, potentially causing serious harm or death.

> It was really dangerous during the cyclone. You see the iron roof flying from this side, hitting another house, just flying around. They peel of the roof. This happened here. (Male participant, Epeli Raisevu, 58 years, July 2017)

Most houses (sixty-two) sustained damage during TC Winston that was significant enough to be eligible for government funds for rebuilding. The Fiji Government offered vouchers of varying values to purchase construction materials. 42 houses were "fully destroyed", 9 houses sustained "full roof damage" and 11 houses sustained "partial roof damage". These homeowners received FJD$7000, FJD$3000 and FJD$1500, respectively. This dataset was obtained from records kept by the turaga-ni-koro (village headman) who reported the damage to authorities for recovery compensation. Landslides on the cultivated slopes surrounding the village also caused damage to school infrastructure including the headmaster's quarters and boarding dormitory.

Many residents were in the final stages of rebuilding their houses after TC Winston when floodwaters ravaged the village in December 2016. While the floodwaters caused no structural damage to houses, the clean-up effort was considerable. Layers of mud up to two feet thick carpeted the inside of houses, smothering whitegoods, kitchen tools, woven mats, bedding, clothes, and other household belongings. Flooding compromized the integrity of the river bank and erosion threatens 16 houses.

5. Current adaptive strategies

The people of Nawairuku have a long history of coping with change; however, past adaptation strategies are decreasing in effectiveness for a number of reasons including weather patterns becoming less predictable and the intensification of extreme weather events. Some of their response strategies are tangible in a practical and measurable sense whereas one (religious belief) is of a more intangible meta-physical nature with the validity and outcomes difficult to measure empirically.

The Naiwaruku villagers are all Christians of one denomination or another. Interviews revealed that belief in the Bible and Divine providence is a factor influencing attitudes towards dealing with changes in climate and socio-economic conditions. While the Bible was seen by some as

the authority for the inevitability of change, attitudes informed by Christian beliefs can be interpreted as supportive of, or, a barrier to, adaptation activity. Some people were comfortable praying for bountiful harvests, for good weather, for cyclones to miss the village and for flood waters to subside but also to take tangible action such as planting fruit trees around houses and installing bracing on houses to help them withstand strong winds (Table 3). Such people saw both approaches as equally valid even if they attributed success more to Divine intervention. Some villagers, however, preferred to rely exclusively on Divine Providence to save them from the impacts of climate change rather than take any action. This echoes some of the findings from research elsewhere in Fiji (Lata and Nunn, 2012) and Tuvalu (Mortreux and Barnett, 2009).

Christian values no doubt also play a role in justifying and reinforcing village support networks and communal action, including in respect of adaption to climate and other change. But religion may also undermine cooperative inclinations when small communities become divided by loyalties to different Christian denominations.

5.1 Agricultural productivity

Maintaining a sustainable agricultural production system is the key to food security in Nawairuku and includes planning ahead and new innovations in planting. A sustainable agricultural system is essential to ensure long-term viability and productivity of available land to enhance food security and associated incomes. In terms of planning ahead, some people are planting more fruit trees around their houses to provide food and shelter in the future. A newly developed planting program, initiated during workshops by the Ministry of Agriculture, includes practices such as intercropping, crop-rotation, drainage, timing of operations and strategic land use (Table 3). Villagers have also relocated agricultural plots from flood-prone areas to the steep slopes of the surrounding hills. This has reduced the exposure of agricultural land to flooding but has created new problems through landslides, which have already damaged roads and buildings, and resulted in the loss of arable land.

5.2 Health and well-being

Familial relationships and sharing networks are key sources of adaptive capacity to cope with and recover from cyclone and flood events. Fellow villagers and kin within Fiji provide material assistance and help in the form of food, shelter and labour to affected families while expatriate kin (military personnel, professional rugby players) tend to send money. The village supports elderly residents and once a person can no longer physically tend to their farm themselves, direct and indirect relatives provide food and give assistance for home maintenance. Informal sharing networks facilitate the sharing of equipment such as fishing nets, with the borrower sharing part of the catch with the lender. Participants are also using new ways to earn income to meet rising living costs and have savings to buffer themselves against agricultural losses and/or damage to infrastructure from natural hazards. These include: crop diversification, capturing high market prices for off-season crops, engaging in off-farm activities (sale of handicrafts), rural-urban migration to obtain paid work in urban centres, and holding community fundraising events.

5.3 Built infrastructure

A key lesson learnt following the extensive damage and destruction to most of the houses in Nawairuku during TC Winston was the inability of buildings to withstand the force of a Category 5 cyclone. In response to this, government and non-governmental organisation (NGO)-led carpentry workshops have been held in the village focusing on enhancing carpentry skills to build more resilient structures. Village carpenters now consider the direction of trade winds and position houses to minimize exposure to strong winds during cyclones. While increasing people's knowledge of building techniques is a positive step, participants noted that due to financial constraints, adequate materials could not be purchased to operationalize learnt skills. In addition to new building techniques, some houses have been relocated outside of the flood-plain to reduce their exposure to flooding.

6. Determinants of adaptability

Participants identified several actions that could be taken to operationalize their livelihood resources to enhance their capacity to cope with current and future climate exposures.

Economic capital: accessing financial resources enables people to invest in alternative solutions if, and when, existing or past methods of practice fail. For example, families who farm sloped areas susceptible to landslides are hesitant to relocate due to the potential loss of income because of the increased amount of work required to prepare new plots and likely decreased productivity. Without the resources to move elsewhere, people continue to cultivate the steep slopes, and continue to put their assets and people's well-being at risk. Furthermore, a lack of financial resources has prevented some people from rebuilding their homes to disaster-resilient standards despite their desire to do so. Limited access to finances was perceived to be a major barrier to implementing desired adaptation strategies. At present, the village often waits for a donor NGO to provide funds to implement actions. "When they come, it *is positive what they bring to the village… I* think money is the major cause of things not happening in the village" (Group talanoa participant, August 2017).

Physical capital: ownership or access to vehicles, farming equipment and livestock enhances the ability of individuals and households to adapt to change. Private vehicles are a very sought-after commodity for households but owning one is unimaginable for many people due to the costs involved to purchase, operate and maintain a vehicle. At the time of the research, two households owned carriers[8]. These families can deliver agricultural goods to market or to preferred middlemen and secure higher sale prices. Owners of horses and bullocks are advantaged by having access to local transportation, and the ability to power manual farming equipment (ploughs and tillers). Farmers travel by horseback to access plots that are located up to 5 km away from the village up steep terrain. Bullock pairs are a highly desired asset and most commonly used for land preparation (pulling ploughs, tills and spike harrows) and for transportation of heavy construction items such as felled logs and other materials (corrugated iron sheets, timber slabs). Approximately 10 working bullock pairs were in use during the research period which were considered to increase the ease and speed of farming.

[8] Carrier = 3-tonne or 1-tonne truck with a tarpaulin-covered tray-back used for passenger and cargo transport around Fiji

Natural capital (land, forests, water, biodiversity): the ability to draw upon and utilize land, water and biodiversity resources expands the coping range to deal with climate stresses. Some participants have implemented strategies to increase their income by growing specific crops in their respective off seasons. The position of Naiwairuku offers a geographical advantage as densely forested and higher-altitude land and riverbanks have moist soils that can be used to cultivate wet-season crops even through the dry season but the topography also presents challenges. The land surrounding the village is steep (greater than 30 degrees in some places), which limits its agricultural use, and if cultivated, is prone to landslides. The uneven distribution of land between mataqali results in some families being more advantaged than others. One individual with very limited land is fortunate to be in position to pay for leased land that he and his immediate family cultivate for subsistence and income.

Social capital (networks and connectedness): the traditional Fijian way of life benefits all people in times of stress as burdens are shared and individual pressures eased. The custom of kerekere in Fiji is when a relative or neighbor requests something that is needed, which is willingly given with no expectation of repayment. This custom is currently practiced in Nawairuku and is frequently used when households run low on finances or household items (e.g. flour, oil) or when farming equipment is required (wheelbarrow, bullock pair, etc.). Individuals are not left to struggle alone. Instead, the community supports and assists in times of need, knowing the act is reciprocal in the future if circumstances change.

Human capital (do-it-yourself attitude): some people of Nawairuku have adopted a ‘do it yourself’ attitude, partially due to the limited trust in government systems and the physical isolation and distance from external sources of support. There are strong leaders in Nawairuku, both within and outside chiefly lineages, including many who draw on experiences obtained outside of the village, notably in the military and international sport. Some of these leaders hold a level of influence over other people in the village and are leading them towards sustainable adaptation (e.g. developing planting programs, agroforestry techniques). People have learnt that assistance from the government and NGOs takes a lot of time and negotiation, and can result in maladaptive outcomes, prompting self-sufficiency and initiative.

> *We can't just sit down like this and wait for the government or the NGOs to come and do the* work. We have to stand up and take action in order to prevent climate change. (Group talanoa participant, August 2017)

Still, there are some who expressed their reluctance to adapt, for example, by refusing to relocate away from flood-prone areas nearby the river despite repeatedly suffering damage to property from floods.

> He still wants to build his house here even though it is in the red zone. He wants to stay here because of the access of water. Here he has the tap here and it is easy to get the water. That side *they still don't have the water pipes coming up to them so i*t is very difficult. (Male participant, Jone Sokiveta, 51 years, August 2018)

Political capital: Fiji's limited institutional capacity inhibits the implementation of adaptive policies and was frequently identified as a constraining factor to adaptation effectiveness. Among the interview participants and wider village community there was a perceived disconnect between the village, Provincial Council and Fiji Government. Village-level requests that arise from village meetings must be submitted in written form to the Ra Provincial Council (PC) who then pass them on to relevant bodies. This process is slow and stifled by politics, and grassroots issues struggle to reach the top levels of the Fiji Government.

> [The] big issue is that the PC is not doing their job. That really happens. PC officials can sit in *council for years and years. They sit there, and start fooling us. When there's a sound, or when there's a smell. They* just *sniff* or give their ear but nothing happens. (Group talanoa participant)

Furthermore, a challenge for geographically remote villages is the tendency for government and non-government representatives to make only very short visits. This is likely due to the long travel times to and from the village from Suva or other urban centres. Typically, a government official will come to the village for a prearranged talanoa session at the community hall where all village residents can attend. Unfortunately, the short duration of interaction means that there is limited opportunity for villagers to communicate their priorities; consequently, government decisions often fail to meet the expectations and needs of the village.

> They are not doing what is according *to the plan for what the community needs… NGOs and Governments think they are doing the right thing but they are not… They have to listen to us* from our experience. [They need] to do the job properly rather than cause more problems. (Male participant, 54 years, July 2017)

In some instances, well-intentioned initiatives to improve infrastructure in the village have proven to be maladaptive. For example, despite villagers raising concerns about the potential of sewage leakage from the proposed donation of metal septic tanks, drawing on their knowledge of what happened previously in the village, an NGO insisted that this was the best way forward. The village leadership had two options, accept the septic tanks or not; they chose to accept. The septic tanks started to leak less than a year after their installation posing health risks to villagers and creating a new problem that the village now must deal with. This made evident that, although well-intended, initiatives to increase capacity in the present may increase future vulnerability.

7. Future vulnerability

Without access to informed climate models and projections, it is difficult for people to envisage what future climatic and geophysical scenarios might look like. Participant's outlooks on the future are based on past events, government updates, bible verses and existing knowledge of future climate change impacts. Participant predictions include more intense cyclones, more landslides, the continuation of the river becoming drier, increased population and development, more land clearing to build new houses and people's attitudes will continue to change to be more reflective of Western cultures (i.e. individualism, money-driven).

Several of the future conditions identified by participants are supported by science-based future climate change models. Key sources of future climate change projections are the IPCC 2013 reports (Stocker et al., 2013) and the Australian Bureau of Meteorology and Commonwealth Scientific and Industrial Research Organisation's scientific assessment of climate change in the Pacific (Australian Bureau of Meteorology and CSIRO, 2011). These projections are for the broader geographic region in which Nawairuku is located and include the Fiji Islands and surrounding oceans. Projected changes in rainfall in the PIR will significantly alter the hydrological cycle affecting the

pattern, frequency and intensity of rainfall events. While wet-season rainfall is projected to increase, dry-season rainfall is projected to decrease and there is a high confidence that extreme rainfall events will increase (Australian Bureau of Meteorology and CSIRO, 2011; Stocker et al., 2013). Surface air temperatures are projected to increase as are days of extreme heat (Australian Bureau of Meteorology and CSIRO, 2011). While the frequency of cyclones is projected to remain stable or decrease, the intensity of cyclones is likely to increase. These climatic changes could have several implications for many communities in the PIR, and in the case of Nawairuku, for the current exposure-sensitivities identified in this paper.

Extreme weather events in the PIR have already resulted in the loss of agricultural land and crops in the wake of cyclones, floods and landslides. A projected increased occurrence of intense rainfall events would further contribute to the degradation of agricultural land by escalating overland flow and surface runoff (Nelson et al., 2009). Furthermore, increased temperatures and enhanced moisture deficits could increase stress on crop production, income and food security (Nelson et al., 2009). Similarly, increases in inter-annual variability and intensity of extreme weather events could impact agricultural productivity and may result in further complete crop failures, significantly affecting household food security. In Nawairuku, the community's seasonal vulnerability to potable water scarcity would become more exaggerated if projected decreases in dry-season rainfall materialize. Intense rainfall events will provide more rain over a shorter period but will be of no assistance in potable water accumulation as the village dam can only hold so much water at a given time. Additionally, high-rainfall events in the past have proven to do damage to the water pipelines and distribution grid. The projected increased frequency and intensity of extreme weather events will threaten the integrity of built infrastructure including houses, community buildings, water and power distribution systems, and roads. Damage from floods, landslides and cyclones has already been experienced and is likely to occur again under future projections, particularly if residents do not apply lessons learned and climate-proof the infrastructure.

Changes in climatic conditions will be experienced together with changes in political, economic and social conditions that will condition exposure-sensitivities and adaptability. An expected increase in population will put further pressure on the local natural resource base raising

questions about village carrying capacity under current agricultural practices and water supply system. The potential stress on food and water sources, together with other societal factors, could increase the incidence of illness and nutrition-related diseases. Changes in exposure-sensitivities in a future climate scenario will likely have a detrimental effect on the financial situation and overall well-being of residents as household income sources are reduced.

8. Conclusion

The research findings suggest that a remote interior village experiences and responds to climatic stressors differently than a near urban village located in the coastal zone as described in existing literature. This is not surprising, given the differences in physical and human geographies, but it does draw attention to the importance of investigating climate change impacts, vulnerability and adaptation at the local scale and with people living outside the coastal zone. This investigation reveals the existence of strategic policy entry points to support Nawairuku's adaptation to current and expected future climate change, many which are rooted in access to capital resources.

The finding that climate change is being experienced in the context of multiple climatic and non-climatic stressors is consistent with the findings of McCubbin et al. (2015) in Tuvalu, Chandra and Gaganis in Fiji, Pearce et al. (2016) and Lede (2018) in the Canadian Arctic, O'Brien et al. (2004) in India, and McDowell and Hess (2012) in Bolivia. This finding highlights the complexity of social-ecological systems and the need to consider the socio-economic and cultural factors, which influence how people experience and respond to climatic stressors. For example, carpentry workshops that share methods for building more resilient structures to cyclones are only effective if the necessary building materials are accessible. This however, is often not the case, and people in Nawairuku, despite having the knowledge of more resilient building techniques, are unable to operationalize this knowledge. This finding shows that adaptation to a climate stress, in this instance, more intense cyclonic winds, is rooted in having access to a capital resource. Enhancing access to capital resources, in this case building materials, represents a strategic policy entry point that improves building standards and makes buildings more resilient to current and expected future cyclones.

Changes in agricultural practices in the village are mostly driven by people's desire to acquire more income to meet rising living costs and feed a growing population in the face of a declining labor force as young men migrate to urban centres. Until the 1980s, people grew root crops, fruits and vegetables for subsistence and it was considered tabu (taboo) to sell root crops. This has since changed with most farmers engaging, to varying degrees, in commercial agriculture. Farmers have been able to increase yields and profits through the intensification of agriculture and the use of agrochemicals, but not without consequences for the longer-term health of soils and slope stability. Effective management of the natural resource base that supports agriculture is vital to longer-term productivity. This finding is noteworthy because it shows that despite emerging climate stressors like changing seasonal patterns and extreme weather events, if people do not sustainability manage the soil and slope stability, future agricultural productivity will be negatively impacted. Efforts are needed to make knowledge of how to sustainably manage agriculture accessible to villagers. This means, for example, creating plain-language documents that are translated into the local dialect, and are made available in hard-copy as most people do not have access to a computer or the Internet.

The finding that people in Nawairuku take the initiative to prepare and respond to extreme weather events like recent cyclones and floods is noteworthy. Some people in Nawairuku have a do-it-yourself mentality and are motivated to take actions to sustain and improve their livelihoods regardless of whether they receive support from outside government or non-government sources. The community proved this ability in their prompt post-TC Winston clean-up efforts, cleaning the village compound and fixing the water distribution system much faster than other villages. A key factor in getting things done in the village is the presence of strong leaders including some who operate outside of the traditional village hierarchy. This initiative differs from what has been found in other Fijian villages, where people tend to wait for government or NGO assistance rather than taking actions to address a sustainability issue themselves (Pearce et al., 2017). People in Nawairuku are not short of motivation or initiative but they are often short of financial and material resources important for adaptation.

This research underscores the need to understand religious and other belief systems at the local level and the potential impacts (both positive and negative) on adaptation outcomes. It also

shows that an intangible factor such as religious faith cannot be excluded a priori as a potentially positive element. 'Win-win' scenarios, can be created through the combined efforts of the tangible and the intangible, and attribution of respective contributions to successful outcomes should be sensitively handled.

As previous research has outlined, when discussing opportunities to support adaptation, it is important to understand the interconnectedness of socio-economic and environmental factors and recognize local culture and context. Only then is it feasible to support adaptation strategies that meet the needs of local people in a culturally appropriate manner. The findings of this research are intended to expand the current narrative of climate change impacts, vulnerability and adaptation in the PIR generally and in Fiji specifically to include the experiences of people living in rural and remote areas. Future work in Nawairuku and elsewhere in Fiji must attend to these important cultural and contextual factors if we are to better understand how best to support villages to adapt to current and expected future climate change.

References

Adger, W.N. (2006) Vulnerability. Global Environmental Change 16, 268-281.

Australian Bureau of Meteorology, CSIRO (2011) Climate Change in the Pacific: Scientific Assessment and New Research. Volume 2: Country Reports.

Barnett, J., Campbell, J. (2010) Climate Change and Small Island States: Power, Knowledge and the South Pacific. Earthscan, London, UK and Washington, DC, USA.

Berg, B.L., Lune, H. (2012) Qualitative Research Methods for the Social Sciences, 8th ed. Pearson, Boston, USA.

Bernard, H.R. (2012) Social Research Methods: Qualitative and Quantitative Approaches. SAGE Publications.

Carson, M., Köhl, A., Stammer, D., Slangen, A., Katsman, C., Van de Wal, R., Church, J., White, N. (2016) Coastal sea level changes, observed and projected during the 20th and 21st century. Climatic Change 134, 269-281.

Cvitanovic, C., Crimp, S., Fleming, A., Bell, J., Howden, M., Hobday, A., Taylor, M., Cunningham, R. (2016) Linking adaptation science to action to build food secure Pacific Island communities. Climate Risk Management 11, 53-62.

Davetta, S., (2017) Provinces and Villages of Fiji. Ra Province, Suva, Fiji.

Department of Agriculture, (2014) Fiji Farm Management Budget Manual. Department of Agriculture, Suva, Fiji.

Duerden, F. (2004) Translating Climate Change Impacts at the Community Level. Arctic 57, 203-212.

Farbotko, C., Lazrus, H. (2012) The first climate refugees? Contesting global narratives of climate change in Tuvalu. Global Environmental Change 22, 382-390.

Fazey, I., Kesby, M., Evely, A., Latham, I., Wagatora, D., Hagasua, J.-E., Reed, M.S., Christie, M. (2010) A three-tiered approach to participatory vulnerability assessment in the Solomon Islands. Global Environmental Change 20, 713-728.

Fiji Bureau of Statistics, (2018) 2017 Population and Housing Census: Release 1. Age, Sex, Geography and Economic Activity, Suva, Fiji.

Fiji Department of Immigration, (2017) Research Permit. Fiji Department of Immigration, Suva, Fiji.

Fiji Ministry of Communications, (2016) Help for Homes Initiative - Information Background. Fiji Government, Ministry of Communications, Suva, Fiji.

Ford, J.D., Keskitalo, E., Smith, T., Pearce, T., Berrang-Ford, L., Duerden, F., Smit, B. (2010) Case study and analogue methodologies in climate change vulnerability research. Wiley Interdisciplinary Reviews: Climate Change 1, 374-392.

Ford, J.D., McDowell, G., Pearce, T. (2015) The adaptation challenge in the Arctic. Nature Climate Change 5, 1046-1053.

Ford, J.D., Smit, B. (2004) A Framework for Assessing the Vulnerability of Communities in the Canadian Arctic to Risks Associated with Climate Change. Arctic 57, 389-400.

Fujieda, A., Kobayashi, H. (2013) The Potential of Fijian Traditional Housing to Cope with Natural Disasters in Rural Fiji.

Hanich, Q., Wabnitz, C.C., Ota, Y., Amos, M., Donato-Hunt, C., Hunt, A. (2018) Small-scale fisheries under climate change in the Pacific Islands region. Marine Policy.

Hewitt, K., (1998) Excluded perspectives in the social construction of disaster, in: Quarantelli, E. (Ed.), What is a Disaster? Routledge, London, UK, pp. 75-91.

Lata, S., Nunn, P. (2012) Misperceptions of climate-change risk as barriers to climate-change adaptation: a case study from the Rewa Delta, Fiji. Climatic Change 110, 169-186.

Lede, E., (2018) Adaptation to Climate Change in the Context of Multiple Stressors in the Canadian Arctic, Faculty of Arts, Business and Law. University of the Sunshine Coast, Sippy Downs, Australia, p. 114.

Leonard, S., Parsons, M., Olawsky, K., Kofod, F. (2013) The role of culture and traditional knowledge in climate change adaptation: Insights from East Kimberley, Australia. Global Environmental Change 23, 623-632.

Magee, A.D., Verdon-Kidd, D.C., Kiem, A.S., Royle, S.A. (2016) Tropical cyclone perceptions, impacts and adaptation in the Southwest Pacific: an urban perspective from Fiji, Vanuatu and Tonga. Natural Hazards and Earth System Sciences 16, 1091.

McCubbin, S., Smit, B., Pearce, T. (2015) Where does climate fit? Vulnerability to climate change in the context of multiple stressors in Funafuti, Tuvalu. Global Environmental Change 30, 43-55.

McDowell, J.Z., Hess, J.J. (2012) Accessing adaptation: Multiple stressors on livelihoods in the Bolivian highlands under a changing climate. Global Environmental Change 22, 342-352.

McIver, L., Kim, R., Woodward, A., Hales, S., Spickett, J., Katscherian, D., Hashizume, M., Honda, Y., Kim, H., Iddings, S. (2016) Health impacts of climate change in Pacific island countries: a regional assessment of vulnerabilities and adaptation priorities. Environmental Health Perspectives 124, 1707.

Mortreux, C., Barnett, J. (2009) Climate change, migration and adaptation in Funafuti, Tuvalu. Global Environmental Change 19, 105-112.

Nabobo-Baba, U. (2006) Knowing and Learning: An Indigenous Fijian Approach. Institute of Pacific Studies, University of the South Pacific, Suva, Fiji.

Nabobo-Baba, U. (2008) Decolonising Framings in Pacific Research: Indigenous Fijian Vanua Research Framework as an Organic Response. Alternative 4, 140-154.

NASA, (2016) Tropical Cyclone Winston Slams Fiji. NASA, Houston, Texas, USA.

Nelson, G.C., Rosegrant, M.W., Koo, J., Robertson, R., Sulser, T., Zhu, T., Ringler, C., Msangi, S., Palazzo, A., Batka, M. (2009) Climate change: Impact on agriculture and costs of adaptation. Intl Food Policy Research Institute.

Nolet, E. (2016) 'Are you prepared?' Representations and management of floods in Lomanikoro, Rewa (Fiji). Disasters 40, 720-739.

Nunn, P.D. (2013) The end of the Pacific? Effects of sea level rise on Pacific Island livelihoods. Singapore Journal of Tropical Geography 34, 143-171.

Nurse, L.A., McLean, R.F., Agard, J., Briguglio, L.P., Duvat-Magnan, V., Pelesikoti, N., Tompkins, E., Webb, A., (2014) Small Islands in: Field, C., Barros, V., Dokken, D., Mach, K., Mastrandrea, M., Bilir, T., Chatterjee, M., Ebi, K., Estrada, Y., Genova, R., Girma, B., Kissel, E., Levy, A., MacCracken, S., Mastrandrea, P., White, L. (Eds.), Small islands. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, USA, pp. 1613-1654.

O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., Tompkins, H., Javed, A., Bhadwal, S., Barg, S., Nygaard, L. (2004) Mapping vulnerability to multiple stressors: climate change and globalization in India. Global Environmental Change 14, 303-313.

Patton, M.Q. (2014) Qualitative Research & Evaluation Methods: Integrating Theory and Practice. SAGE Publications.

Pearce, T., Currenti, R., Mateiwai, A., Doran, B. (2017) Adaptation to climate change and freshwater resources in Vusama village, Viti Levu, Fiji. Regional Environmental Change 18, 501-510.

Pearce, T., Ford, J.D., Smit, B., Duerden, F., Furgal, C.M., Dawson, J., B, B., (2016) Chapter 10 Factors of Adaptation: climate change policy responses for Canada's Inuit, in: Stern, G.A., Gaden, A. (Eds.), ArcticNet IRIS I Regional Impact Assessment, ArcticNet, Laval University, Canada, pp. 403-427.

Pearce, T., Smit, B., Duerden, F., Ford, J.D., Goose, A., Kataoyak, F. (2010) Inuit vulnerability and adaptive capacity to climate change in Ulukhaktok, Northwest Territories, Canada. Polar Record 46, 157.

Pearce, T.D., Ford, J.D., Laidler, G.J., Smit, B., Duerden, F., Allarut, M., Andrachuk, M., Baryluk, S., Dialla, A., Elee, P., Goose, A., Ikummaq, T., Joamie, E., Kataoyak, F., Loring, E., Meakin, S., Nickels, S., Shappa, K., Shirley, J., Wandel, J. (2009) Community collaboration and climate change research in the Canadian Arctic. Polar Research 28, 10-27.

Pecl, G.T., Araújo, M.B., Bell, J.D., Blanchard, J., Bonebrake, T.C., Chen, I.-C., Clark, T.D., Colwell, R.K., Danielsen, F., Evengård, B. (2017) Biodiversity redistribution under climate change: Impacts on ecosystems and human well-being. Science 355, eaai9214.

Robinson, S.-a. (2017) Mainstreaming climate change adaptation in small island developing states. Climate and Development, 1-13.

Smit, B., Pilifosova, O. (2003) Adaptation to climate change in the context of sustainable development and equity. Sustainable Development 8, 9.

Smit, B., Wandel, J. (2006) Adaptation, adaptive capacity and vulnerability. Global Environmental Change 16, 282-292.

Stocker, T., Qin, D., Plattner, G., Tignor, M., Allen, S., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P., (2013) IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 1535 pp. Cambridge University Press, Cambridge, UK, and New York.

Sutherland, K., Smit, B., Wulf, V., Nakalevu, T. (2005) Vulnerability in Samoa. Tiempo 54, 11-15.

Woodward, A., Hales, S., Weinstein, P. (1998) Climate change and human health in the Asia Pacific region: who will be most vulnerable? Climate Research 11, 31-38.

Berrang-Ford, L., Ford, J. D., & Paterson, J. (2011). Are we adapting to climate change?. Global environmental change, 21(1), 25-33.

Brooks, N. (2003). Vulnerability, risk and adaptation: A conceptual framework. Tyndall Centre for Climate Change Research Working Paper, 38(38), 1-16.

Duvat, V. K., Magnan, A. K., Wise, R. M., Hay, J. E., Fazey, I., Hinkel, J., ... & Ballu, V. (2017). Trajectories of exposure and vulnerability of small islands to climate change. Wiley Interdisciplinary Reviews: Climate Change, 8(6), e478.

Smit, B., & Pilifosova, O. (2003). Adaptation to climate change in the context of sustainable development and equity. Sustainable Development, 8(9), 9.

Smit, B., and O. Pilifosova. 2001. "Adaptation to Climate Change in the Context of Sustainable Development and Equity." In Climate change 2001: Impacts, Adaptation and Vulnerability. Contribution of Working Group III to the 3rd Panel on Climate Change, edited by J.J. McCarthy and O.F. Canzianim, 877–912. Cambridge: Cambridge University Press.

Taylor, M. (2013). Climate change, relational vulnerability and human security: rethinking sustainable adaptation in agrarian environments. Climate and Development, 5(4), 318-327.

Tompkins, E. L., & Adger, W. N. (2005). Defining response capacity to enhance climate change policy. Environmental Science & Policy, 8(6), 562-571.