Doctoral Thesis

博士論文

ADAPTATION TO SEA-LEVEL RISE FOR COASTAL RURAL ISLAND COMMUNITIES:

A CASE STUDY FROM THE SAMOAN ISLANDS

（島嶼国における沿岸地域コミュニティの海面上昇適応:

サモア諸島の事例から）

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DEDICATION

To my wife Rachel, and sons Issei, and Niko. You inspire me to be more.

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List of Abbreviations

CBA Community-base Adaptation

CCA Climate Change Adaptation

CH4 Methane

CO2 Carbon Dioxide

DEM Digital Elevation Maps

DRR Disaster Risk Reduction

ENSO El Nino Southern Oscillation

FDGs Focus Group Discussion

GCF Green Climate Fund

GHG Greenhouse Gases

GoS Government of Samoa

IPCC Intergovernmental Panel for Climate Change

IOM International Organization for Migration

LDC Least Developing Countries

PIC Pacific Island Countries

MWCSD Ministry of Women, Community and Social Development of Samoa

N2O Nitrogen dioxide

Samoa Independent State of Samoa

SDS Strategy for the Development of Samoa

SFDRR Sendai Framework for Disaster Risk Reduction

SIDS Small Island Developing States

SLR Sea-level rise

SRTM Shutter Radar Topography Mission

RCP Representative Concentration Pathway

UNDP United Nations Development Program

UNFCCC United Nations Framework Convention on Climate Change

WPWP West Pacific Warm Pool

List of Traditional Terms

Ali'i chief titles are the highest titles in a family. Ali'i are considered to be 'sitting chiefs', in that they rarely speak, but they have much of power in the final decisions on matters of discussion.

Ali'i ma Faipule chiefs and orators that form the village council

Aualuma is the village organization for unmarried women

Aumaga is the village organization for untitled men.

Fa'asamoa is an all-encompassing term for the Samoan customs, traditions and language, as well as a system of behavior, duties and responsibilities towards each other and to those in positions of authority.

Fa'alavelavea has multiple meanings in the Samoan language. It incompasses a general reference to the following: 1. sudden unforeseen crisis (involving danger) or unfortunate mishap (a death), 2. a planned celebratory event of large magnitude (such as a wedding), 3. Sudden or by chance events without an apparent cause. 4. An inconvenience 5. Disruption or intrusion

Fono a matai is the village governing authority, which has both an executive and judicial role in village affairs.

Itumalo district or political division

Komiti o tina ma tamaitai Committee of women that are organized in each village.

Lapita is used to reference a people and culture that have settled the Pacific Islands. The term originates from a place in New Caledonia island where pottery was discovered and have since been found across many parts of Melanesia and west Polynesia.

Matai A chief of Samoa. There are two types, a Tulafale and Ali'i

Nu'u A village or community in the Samoan islands.

Pulenu'u The pulenu'u is the village mayor, a matai chief elected by the village council to represent the village in political affairs.

Tafa'i'fa are the four highest paramount (royal) titles of Samoa.

Tulafale are chiefs also with ranks lower than that of Ali'i. They are also known as 'oratory chiefs', as they are expected to be very skilled in the art of speaking. They are considered the mouthpiece who speak on behalf of the Alii, to convey any positions of the Ali'i chief of the family.

Abstract

The inevitability of sea-level rise has created much scientific discussion about the possibility of climate-induced migration or displacement of coastal settlements. Adaptation will be essential, as rising seas will continue into the foreseeable future even if the emission of greenhouse gases can be halted, and temperatures stabilized. Sea-level rise will largely affect communities in low-lying areas around the globe, from mega-cities to Small Islands Developing States (SIDS), and even rural settlers. Despite numerous studies suggesting migration away from coastal areas will become an adaptation mechanism, there is little actual evidence of relocation taking place. Many communities, including low lying atolls such as Kiribati and Tuvalu that are well studied, are reluctant to move, even though they are already experiencing tidal flooding during annual king tides. Additionally, there are limited empirical studies that focus on mountainous SIDS and their coastal communities, such as Samoa.

Samoa is one of the SIDS in the Pacific Ocean, consisting of two islands (Upolu and Savaii) and eight smaller islands, three of which are inhabited. It has a total landmass of approximately 2,944 km^2 with a total current population estimated at 201,098. The two main islands are where the majority of the population can be found, with more than 70% living within a 1 km zone of the coastline. This fact makes Samoa highly vulnerable to the pernicious effects of climate change, and the knock-on effects of sea-level rise. Furthermore, Samoa, and especially its rural communities, are deeply rooted in its traditional systems and culture. The existence of these traditional decision-making bodies and indigenous traditional knowledge means that, coupled with climate data deficiencies

and localized understanding of climate risks, adaptation options, and potential migration pathways, designing appropriate adaptation strategies represents a difficult task.

A myriad of adaptation projects have been undertaken in Samoa, employing a top-down approach on the assumption that this would increase effectiveness, but with little to no long-term success. However, given that local decision-making structures are impervious to national policies, a degree of mismatch between national policy and grassroots decision-making exists. Localized adaptation and understanding of adaptation pathways could lead to dependency reduction and autonomous adaptation that are more sustainable.

Addressing these gaps requires a place-based understanding of climate change that involves local impacts and vulnerabilities, strengths, and adaptive capacity to demonstrate effective adaptation. This study uses a case study approach, examining rural island communities in Samoa. The study sites are three coastal communities in Gagaemauga III district, on Savaii, the biggest island in the Samoan archipelago. These three communities are projected to be extensively flooded by rising seas by the end of the century under multiple Representative Concentration Pathways (RCP), except the lower RCP 2.6.

The Alliance of Small Island States (AOSIS), which includes Samoa, fought hard for a 1.5°C temperature limit agreement at the Paris Accord. However, despite this global milestone achievement, global dilatory intervention since the agreement will like result in surpassing this temperature cap goal. This fact coupled with the inevitability of sea-level rise even if we achieve zero-emission today would make adaptation an important step to addressing the climate impacts, especially that of sea-level rise.

The key questions that the candidate's thesis will aim to answer are: How will rural island communities address a slow-onset disaster such as sea-level rise? How would traditional communities plan towards a distant future if they were presented with scientific data on sea-level rise?

To investigate this, a multimethod research approach was undertaken. The study included a field visit, coastal surveys (including the use of remote sensing equipment), household surveys, and a Participatory Approach with the incorporation of Focus Group Discussion (FGDs).

The study shows that these communities have had a history of experiences with disasters, and despite them continue to rebuild in low-lying areas, undeterred by climatic-risks. To address future risks, the communities are willing to use multiple adaptation methods of protection and accommodating, before resorting to retreating from their current settlements. Thus, contrary to the popular idea of mass migration and community abandonment, rural island communities are reluctant to abandon their village settings and leave the idea of a full-scale relocation as a last resort strategy. Furthermore, the communities are opting for an 'extensive settlement' (involving the construction of secondary homes inland, which are marked as disaster evacuation homes), which can address concerns of climate-risks from both sudden-onset and slow-onset disasters. By reducing the investments they make in the coastal area of their settlement, communities will be able to divert resources to inland regions. Environmental factors, even severe sea-level rise, will most likely not cause the collapse or abandonment of these communities into the near future.

Other findings regarding traditional decision-making bodies, such as the Council of Chiefs (Fono a Matai), show that these can facilitate a community-lead relocation process. However, traditional practices and designs were not considered as adaptation mechanisms by the communities, probably due to the loss of indigenous traditional knowledge on risk management infrastructure. In addition, the study found a predisposed linkage between gender, age, and particular adaptation pathways. For example, one of the findings shows that women (including youth in both sexes) prefer ecosystem-based adaptation while men, who have decision-making roles, favor hard solutions such as coastal walls. Differences in adaption preferences between women, youth, and untitled men, and that of *matai* are not represented in the decision-making body, the *fono,* in which the matai only have the privilege to speak. There are notable differences in adaptation preferences between women, youth, and untitled men, which has, in many cases, led to these groups being marginalized during decision-making processes.

Overall, the main illation of this study is that holistic localized understanding is necessary for identifying climate change adaptation pathways and that community-led discussion will facilitate a more sustainable response to addressing climate change.

(Word count 953)

Keywords Climate Change; Adaptation; Sea Level Rise; Natural Disasters, Indigenous culture; Samoa; Gender; Youth

Chapter 1: Introduction

It is expected that future climate change impacts will be felt in different ways across the globe, as they will all be heavily influenced by local factors. Nevertheless, what is clear is that climate change will disproportionately affect the poorer countries and communities, and particularly small island developing states (SIDS). Furthermore, an additional layer within SIDS that is expected to be particularly vulnerable includes different groups, including women, people with disabilities, and youth.

Essentially, since the beginning of the industrial revolution human activities have greatly contributed to the increase in greenhouse gases (GHGs) concentration in the atmosphere, which is behind the ongoing increase in global temperatures. The Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC AR5., 2013) stresses the contribution of these gases to anthropogenic changes in the world's climate (see Figure 1.1). Higher temperatures are causing polar ice, glaciers, and ice sheets, to melt, increasing the volume of the ocean as a knock-on effect. Furthermore, the increasing temperatures are causing a warming of the ocean, contributing to further sea-level rise (SLR) due to phenomenon such as thermal expansion, and fueling stronger tropical cyclones for the Pacific (Australian Bureau of Meteorology & CSIRO., 2014.). In addition, the oceans are experiencing increases in acidity, as they absorb much of the excess carbon dioxide in the Earth's atmosphere, which contribute to coral mortality. The present thesis will thus focus on the contribution of future sea-level rise and its local impacts on rural communities in the Samoan islands.

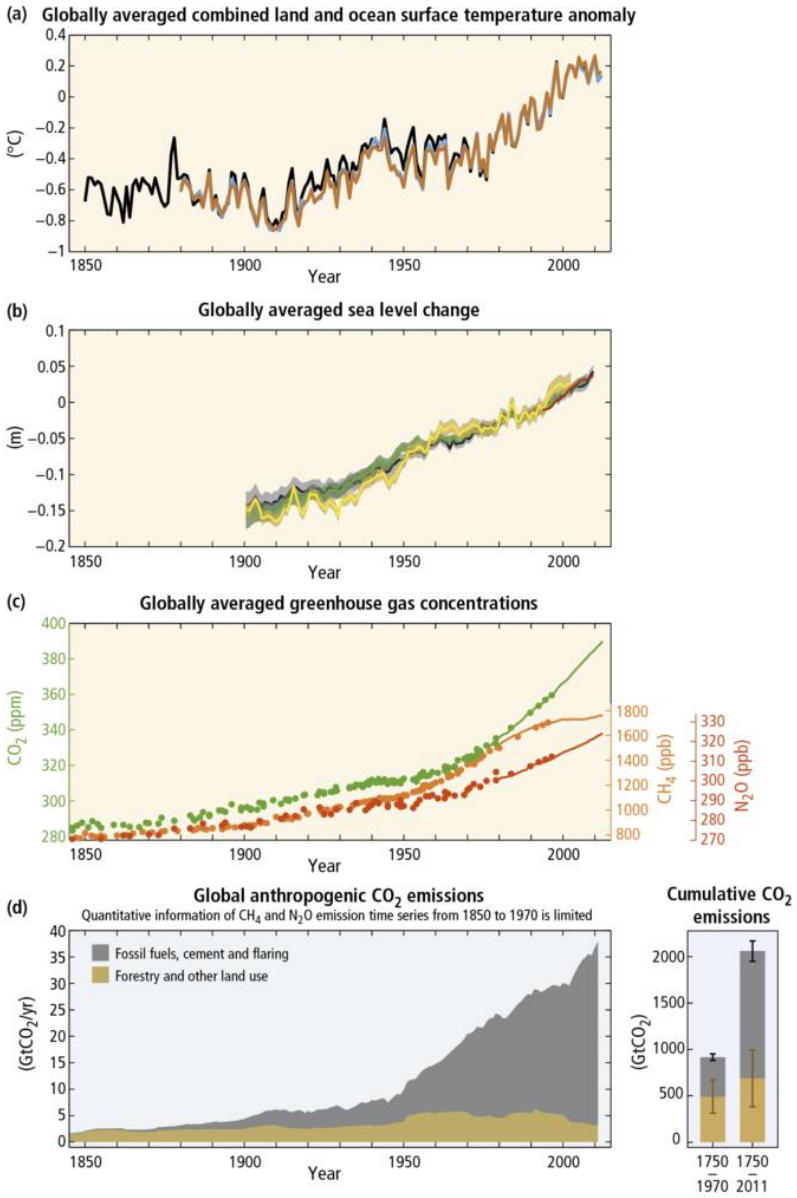

Figure 1.1 (Obtained from IPCC AR5) Observations and other indicators of a changing global climate system. Observations: (a) Annually and globally averaged combined land and ocean surface temperature anomalies relative to the average over the period 1986 to 2005. (b) Annually and globally averaged sea level change relative to the average over the period 1986 to 2005 in the longest-running dataset. (c) Atmospheric concentrations of the greenhouse gases carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) determined from ice core data (dots) and from direct atmospheric measurements (lines). Indicators: (d) Global anthropogenic CO_2 emissions from forestry and other land use as well as from burning of fossil fuel, cement production, and flaring. Cumulative emissions of CO_2 from these sources and their uncertainties are shown as bars and whiskers, respectively, on the right-hand side.

1.8 Impacts of sea-level rise on islands

Climate risk profiles are not homogeneous for island nations due to their diverse political, cultural, socio-economic backgrounds, location, and physical attributes (Nurse et al., 2014). The impact that climate change and SLR will have vary from island to island, the most noticeable changes will likely regard air and sea-surface temperatures, length and intensity of the wet and dry seasons, annual mean rainfall, extreme rainfall events, droughts, days with extreme heat, ocean acidification, tropical cyclone, and mean sea-level (Australian Bureau of Meteorology & CSIRO., 2014). Sea-level rise is an irrefutable climate change impact that poses a significant threat to low-lying coastal areas on islands, and especially atolls (Oppenheimer et al., 2019; Church et al., 2013). According to the Fifth Assessment Report of the IPCC, we should expect a global mean sea level rise of 0.26-0.98 meters by the end of the century (in line with Representation Concentration Pathways (RCP) 2.6 and 8.5, respectively) (Church et al, 2013). However, more recent probabilistic modeling that takes into consideration the Antarctic ice sheet melt has found these figures to be very conservative (Kulp and Strauss., 2019; Kopp et al., 2017; 2014; Le Bars et al., 2017). Future projections suggest that the global mean sea level will continue to rise for the foreseeable future, reaching perhaps 1.65m (above the 1987-2005 baseline) by the year 2100; possibly over 5 m by 2300 (Horton et al., 2020). This process of deglaciation has been the central focus of sea-level-rise, though for some time the impact of a warming climate on Antarctica was not well known. The contribution of the Antarctic region, and particularly the west Antarctic region, to sea-level-rise mostly is in the form of oceanic erosion (Depoorter et al., 2013), which is likely to be significant in the future (Hallegate et al., 2013; Kulp and Strauss., 2019).

The expansion of the Western Pacific Warm Pool (WPWP) and inter-annual climate drivers (like ENSO) could also impact daily weather on Pacific Islands, as well as intensifying or lessening the rates of sea-level rise in the region. (IPCC, 2013; Merrifield, 2011; Becker et al., 2012). Many island countries are located in the tropical western Pacific, where SLR exceeds the global average of 3.2mm ± 0.4mm/yr (IPCC, 2014), as high as by three times in some areas (Becker et al., 2012). In Samoa, the rate of SLR between 1993-2009 was about 4mm/yr (Australian Bureau of Meteorology & CSIRO., 2011), slightly higher than the global average, and is expected to increase to 40–87 cm by 2090 (Australian Bureau of Meteorology & CSIRO., 2014).

The impacts of SLR on coastal zones will be especially high for islands in the Pacific where most people reside along the coast, which is where most infrastructure is also located (Kumar and Taylor, 2015). Yet, the impact of SLR will differ from one island to another depending on the island type, topography, and available resources, and these challenges should be addressed at a localized level rather than follow a top-down approach (Nurse et al., 2014; Asugeni et al., 2019; McMichael and Katonivualiko, 2020). SLR may disproportionately impact many of the small rural settlements situated in peripheral/marginal contexts (Korovulavula et al., 2019; Nunn and Kumar, 2019) especially in archipelagoes like Samoa, as these communities are generally less globally aware and lack the resources to adequately address their vulnerability to climate change (Lata and Nunn, 2012). In many cases, rural communities appear to be almost powerless to make decisions regarding adaptation, as national or international assistance are earmarked for specific sectors. Nevertheless, it is also worth noting that the appearance of vulnerability may be misleading, as many Pacific island communities, and especially

those in the more peripheral locations, may have a considerable culturally-grounded autonomous community coping ability that should be privileged in any future adaptive climate change strategies (McNamara et al., 2020).

Natural or man-made disasters, coupled with sea-level rise, will cause major disruptions to the lives of people living along the coast. Such a combination can affect coastal communities by means of storm surges, and impact farmland, freshwater aquafers, and economic structures such as tourism operators and hotels. Furthermore, natural cycles such as El Nino/Southern Oscillation (ENSO), the Southern Annular Mode (SAM), increases the exposure of coastal communities to extreme coastal erosion and flooding, independent of sea-level-rise (Barnard et al, 2015), the impacts that climate change will have on El Nino Southern Oscillation are yet to be fully ascertained (Collins et al, 2010). Natural cycles such as ENSO, combined with climate change and natural hazards such as tropical cyclones, will likely result in an increase in the frequency of extreme sea-level rise events in Samoa (Walsh et al, 2012).

1.2 Climate, climate variability and change in Samoa

Climate records in Samoa date back as far as 1890. These data show an annual mean temperature warming trend of 0.12C° per decade since 1930 (Australian Bureau of Meteorology & CSIRO, 2011), with more pronounced changes in daily maximum temperatures also being indicated. Climate drivers of these climatic changes are greatly influenced by El Niño-Southern Oscillation (ENSO), bringing dry weather during El Niño and wetter conditions causing flooding in low lying areas during La Niña. Another main

driver of the climate is the South Pacific Convergence Zone (SPCZ) and the dominant south-east trade winds, which bring rain to the windward side of mountainous islands. However, due to the position of the island archipelago (lying parallel with the direction of the trade winds) there is comparably little variability in the actual rainfall patterns across the Samoa islands, in contrast to the extreme conditions of the leeward and windward sides of islands such as Hawaii.

Ocean water temperatures have also been warming of about 0.08C°per decade since 1970. Aragonite saturation has observed a decline from about 4.5 since the 18th century to 4.1 ±0.1 by 2000. A decrease in aragonite saturation brought by ocean acidification will cause stress on marine organisms such as corals, shells and other aragonite structures (Quin and Seller, 2004; Nathaniel et al., 2018), and high acidity and extreme low aragonite saturation will cause shellfish to dissolve. Less saturation leads to a decrease in calcification rates and productivity in marine organisms that small islands and its rural communities depend on. This will have significant impacts on the food sources of rural islands. Sea-level have risen by 4mm per year since 1993, slightly higher than the global average or 3.2 ±0.4mm per year. Furthermore, relative SLR increase escalated due to viscoelastic relaxation following the 2009 Samoa-Tonga earthquake, causing rates five times faster than the global average SLR (Shin-Chan et al. 2019). With more than 70% of its 200,000 national population living along the coastline, even the low-end estimate of 1 meter of SLR would represent a huge socio-economic cost to the Samoans, though the current global trend will most likely surpass that threshold.

Regarding sudden-onset disasters, tropical cyclones frequently affect Samoa. Between 1969 to 2010, a total of 52 tropical cyclones traversed within 400km of the capital of Apia, averaging 10 tropical cyclones per decade (Australian Bureau of Meteorology & CSIRO, 2014). Climate forecast predicts that these tropical cyclones might in the future decrease in frequency but become more intense (Australian Bureau of Meteorology and CSIRO, 2014; IPCC AR5, 2013), likely leading to more severe damage. The effect of these events was further compounded by that of the 2009 the Samoan tsunami, which lead to widespread destruction along the country's southern coastline (National Disaster Management Office, 2009; Dominey-Howes and Thaman, 2009; Mikami and Shibayama, 2015). As a result of the 2009 tsunami many communities in other unaffected parts of the island started to relocate inland, as many people could observe the destruction caused by this event on national TV channels. Though tropical cyclones have contributed to a slow relocation in the past, the 2009 tsunami event exacerbated an inland settlement in the last decade. In December 2020, a Cat 5 typhoon destroyed parts of the Fiji island, and contributed to heavy flooding in the Samoan islands, and such disaster events can influence the behaviour of people in Samoa to address climate related risks. SLR combined with disasters such as tropical cyclones will slowly represent a higher threat and increase the vulnerability of coastal communities. These conditions are projected to worsen and will significantly impact communities living along the coast of these islands, as well as the Pacific in general.

Climate change adaptation are more beneficial when coupled with other development activities such as disaster risk reduction and community-based led development. Some studies analyze of decision-making process that results in relocation

(Choi and Honda, 2014; Song et al., 2018). This includes communicating future risks to local communities (Nurse et al, 2014). The Pacific region has created an integrated approach between climate change adaptation and disaster risk reduction due to many of its overlapping priorities, which has been developed under the Pacific-regional Framework for Resilient Development in the Pacific 2017-2030 (which combines the global frameworks of the Sendai Framework for Disaster Risk Reduction and UN Framework Convention on Climate Change, or UNFCC). However, performing this task is proving to be difficult as the costs of protection work to address sea-level rise is extremely high for small island nations (Tsyban et al., 1990; Yamamoto and Esteban, 2014), while the damage costs will also be enormous with respect to their economies (Anthoff et al., 2010; Yamamoto and Esteban, 2014). The Samoan government does incorporate a sector-wide approach to address the environmental challenges of climate change and disasters into its national framework for development, Strategy for the Development of Samoa (SDS) 2016/17–2019/20.

1.3 Mass migration theory and climate refugee

Approximately more than 630 million people are at risk of suffering the effects of sea-level rise by the end of the century (Kulp and Strauss., 2019). This high volume of population exposed to rising seas that could face possible displacement has led to scientific discussion of mass migration as an adaptive measure to SLR, and the idea that eventually the ocean could claim low-lying small island nations has led to the coining of the new concept of “climate refugees”.

Essentially, due to rising seas, many in the scientific community have painted a future where people without lands move to other countries in search of safer grounds to resettle. This has been met with criticism from researchers conducting work in SIDS, not only because this concept of "climate refugees" is not yet a recognized term under international laws such as the UN Convention on the Status of Refugees (Yamamoto and Esteban 2014), but also because it paints a picture of SIDS and its communities as hopeless victims, rather than empowered individuals and communities with significant adaptive capacity (Farbotko and McMichael, 2019; McNamara et al. 2018; Nalau et al, 2018).

Needless to say, there is no global consensus on the definition of what constitutes migration. However, for reasons of legitimacy, migration is defined under the United Nations Migration Agency (IOM) as:

> *Any person who is moving or has moved across an international border or within a State away from his/her habitual place of residence, regardless of 1. the person's legal status; 2. whether the movement is voluntary or involuntary; 3. what the causes for the movement are; or 4. what the length of the stay is.*

Local and regional perspectives of what consists of migration and that of relocation can be very different. Such an attempt to highlight a distinction between these two terms will be undertaken in this study from the context of Samoan rural island communities, and possibly the Pacific region.

Migration as a solution to sea-level rise has been a commonly highlighted as an option among studies relating to Small Island Developing States (Perch-Neilsen et al, 2008), though the decision to migrate is not as simplistic as it may seem (McNamara & Gibson, 2009; Black et al, 2011; Zickgraf, 2019, Yamamoto and Esteban, 2017; Farbotko 2019). However, there is currently a lack of empirical studies on the effect of SLR on island migration (Barnett and McMichael 2018; Oakes 2019), and evidence of climate change induced relocation as a response is very limited, with only a few cases of successful relocation of small numbers of people, such as for example in Vunidogoloa, Fiji (McNamara and Des Combes, 2015; Charan et al, 2018).

Some authors question whether mass migration will actually take place as a result of SLR (given its slow onset nature), given that adaptation measures can be taken to address the rising water level (Jamero et al, 2019, Narayan et al., 2020). In fact, there is some evidence that even when flooded communities in small islands adapt in-situ rather than relocate, until they reach their limits (Jamero et al., 2017, Esteban et al., 2019). Nevertheless, it is important to note that episodes of significant migration can take place following sudden societal shocks that arise from natural disasters, such as for example storm surges or tsunamis (Campbell et al. 2005).

Needless to say, while mass migration could be inevitable as the sea level continues to rise, it could also take place as a slow onset relocation (as communities seek short-term solutions to address the rising water levels). The classification of people under terms such as “climate refugees” is unhelpful as it fails to consider their adaptation capacity and intentions” (Farboroko and McMichael, 2017; McNamara et al., 2020).

While significant research has been carried out on mass migration theory regarding SIDS, especially atoll island states or low-lying islands, much is yet to be known about potential migration on mountainous or volcanic high island nations. More attention, therefore, needs to be given to understanding the socio-cultural factors that enable adaptation within the mountainous SIDS. To address this knowledge gap, in the present thesis the author will examine the adaptive capacity of Samoan communities and the important role that cultural values and social structures play in enabling actions in response to climate change.

1.4 Literature and Research Gaps

There is no shortage of studies regarding the vulnerability of coastal communities, and over time such assessments have continued to advance in terms of the methodological processes used. One such improvement includes the spatial-temporal exposure assessment methodology produced by Kulp and Strauss, 2019. The unique features of such methodologies include spatial-temporal population modeling (Kulp and Strauss, 2019; Kopp et al. 2017; Hauer et al., 2016) and diurnal differences in flood risk exposure (Smith et al., 2014). However, one clear limitation of these global studies is the limited localized data, as SLR inundation maps were produced with the use of big world datasets, often with a coarse resolution, and inevitably contain some errors. While the use of Shuttle Radar Topography Mission (SRTM), which has an absolute vertical height accuracy of less than 16m, is a big improvement from the 30m vertical accuracy before 2014, could still be improved further as the likely magnitude of SLR by the year 2100 is one order or magnitude lower. Any errors in elevation were only adjusted for coastal

inundation maps for places including that of the United States of America, and Australia (Kulp and Strauss, 2019). Therefore, while these SLR inundation maps are useful, there are high possibilities of errors in them, and local assessments should be made. This is the first gap the present thesis will attempt to address.

As previously mentioned, limited studies exist on how different climate scenarios will contribute to migration or relocation, with only a few successful examples from the Republic of Fiji being documented in literature (e.g. McNamara and Des Combes, 2015). There is a need for local studies that examine the specific circumstances that enable or prevent migration, given that each case has unique differences in physical attributes, location, cultural, political, and socio-economic differences (Nurse et al, 2014; IPCC-SR1.5°C, 2018) that affects their adaptation. The fact that there are no studies on the Samoan island communities and how they plan for future events such as rising sea levels, as well as any linkage towards possible human migration, is indicative of an under-researched area.

There are limited studies on climate change and risk perception in the Pacific (Lazrus, 2015; Elrick-Barr et al. 2017; Walshe et al. 2018,) covering Tuvalu, Australia, and Samoa, Fiji, and Vanuatu, respectively. For the case of Samoa these studies focus on school teachers' perception and on two local communities in the country, of which one is located inland far from the ocean and the other being a coastal community. Thus, there is a lack of empirical studies on risk perception of climate change risks and a need for more localized studies of climate change implication on rural communities' indigenous groups, and marginalized people. (IPCC, SR1.5C, 2018)

Samoa has unique traditions and customs (more details will be provided Chapter 2) that are likely to play a significant role in adaptation. McNamara et al, 2018 and Nalau et al, 2018 highlighted some of the traditional and customary roles of Pacific indigenous communities in adaptation and climate change. While the work of McNamara has focused on some pacific islands, and especially Australia, Nalau et al., 2019 highlight some of the concerns in Samoa regarding the role of traditional indigenous knowledge and traditional systems such as decision-making bodies. These factors will influence each community's approach to addressing climate change (Jamero et al, 2017), and there is a mismatch between national adaptation and community-based adaptation (CBA) in how climate risks should be addressed. Another key contribution is to provide research tools for informing local and regional decision-making (IPCC, SR1.5C, 2018).

1.5 Research Contribution / Originality

While there are many concepts and theories regarding how the inhabitants of SIDS will migrate and relocate (which has led to the coining of the term "climate refugee", which is still dubious from a legal point of view), there is a dearth of actual studies that analyse how adaptation will take place. The present thesis will seek to provide some evidence of how adaptation is likely to take place, focusing on the case of rural island communities in the Pacific, and more specifically the case of Samoa. This research will unearth a new concept that has not yet been used in academic discussions and narratives, which the author will refer to as 'extended settlement.'

The rural island communities, through their disaster risk reduction processes, have also addressed some of the concerns associated with sea-level rise. Essentially, some of the members of the community and their family units have already established secondary homes inland on higher grounds as a means to retreat temporarily during emergencies, though they still continue to maintain their main residences next to the coastline. This is a new concept that rural island communities will likely be adopting to address future slow onset problems such as SLR (see Figure 1.2).

Samoa, unlike low-lying, atoll island states such as Tuvalu, Kiribati or Marshall Islands, consist of high tropical island with elevation more than 30 m. This sets Samoa aside from atolls, due to the availability of underdeveloped, and sometimes even virgin landmasses, which are available to villagers due to the traditional customary culture. This allows population of these islands an option to relocate further inland within their own village if they choose to. Thus, the present research will highlight how the understanding of traditional systems and the socio-geographical reality of settlement will play a crucial role on how to find sustainable ways to adapt to SLR.

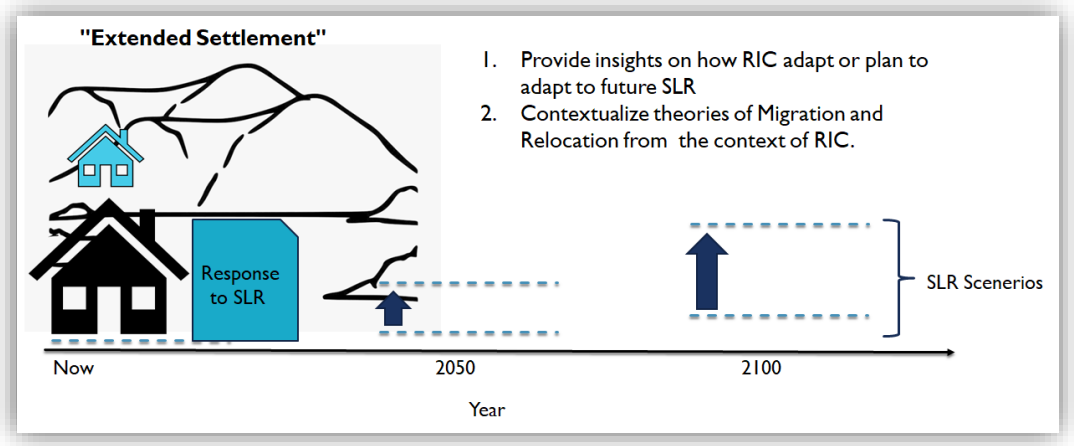

Figure 1.2 Concept of 'extended settlement' to address future disasters and sea-level rise.

1.6 Research Questions and Objectives

This research explores three research questions and their respective objectives, as summarized in Figure 1.3 below. These questions should help to answer the question of how do the Samoan communities plan to adapt to sea-level rise? How would that be differ from other communities who will also experience this problem?

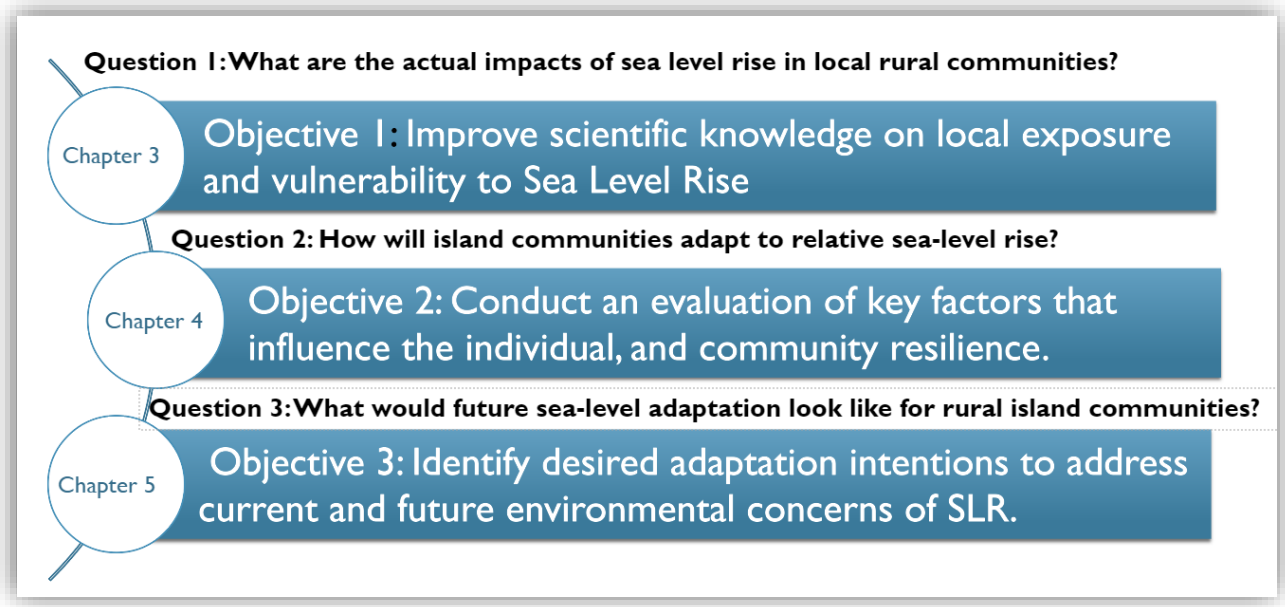

Figure 1.3 Research Objectives and Research Questions, in relation to the chapter structure of this thesis.

1.7 Structure of this dissertation

This concludes Chapter 1 of this theses. Chapter two will cover the framework and methodology taken to answer the research questions and objectives of this research.

Furthermore, it includes a section on the study site, explaining the logic behind the focus on rural island communities. Chapters three to five will discuss the results and findings of the different methods used. Each chapter focuses on a specific method which are, the Digital Elevation Mappings and SLR inundation maps using remote sensing technologies, household surveys, and a participatory approach, respectively. Chapter six will discuss the findings and limits to adaptation. Finally, Chapter seven will outline the conclusions and areas of possible future research.

Chapter 2: Background, Framework and Methodology

2.1 Background

2.1.1 Samoa

The western part of the Samoan island archipelago is known as the Independent State of Samoa, comprising two larger and two smaller inhabited islands (namely, Upolu, Savaii, Manono, and Apolima) that are surrounded by several uninhabited islands. These island masses account for a combined total landmass of 2,831 km^2. The national Gross Domestic Product (GDP) per capita is USD$4,316 (2019), with an unemployment rate of 14.47% (2017) according to World Bank data (World Bank, 2020).

The Samoa national average household size is 6.9 members, with the poorest households having a larger average at 9.3 members (Moustafa, 2016). Life expectancy based on 2018 figures was 73.2 (World Bank, 2020). According to the Samoa Bureau of Statistics (SBS) projections, the population will reach 202,506 by 2020 based on the 2017 national population census (which registered 197,611 inhabitants) and its growth trajectory. Of this total 164,590 (81.3%) are said to live in rural areas, with an annual population growth of 0.99%, in contrast to the urban dwellers on the capital city of Apia growing at 0.36% (despite a slow pace of urban migration, (Samoa Bureau of Statistics, 2017). The higher growth in the rural population, coupled with the limited urban migration, will mean that population is likely to continue to be concentrated in rural areas.

The protection of a population that is largely spread along the coast outside the central business areas could prove costly, requiring complex solutions, but offering little economic return due to high unemployment and low capital generating activities in these areas. Many residents in rural settings depend heavily on natural resources for daily sustenance, but these resources are already over exploited and are increasingly being affected by a changing climate (Ziegler, et al., 2018; Morrison and Addison, 2008). The combination of these factors could place future generations of Samoa's rural communities at higher risks to potential future negative impacts of climate change.

Furthermore, more than 70% of the country's population has settled along the coast (Daly, 2012) of the four major islands. This also explains why many important social infrastructure is located along the coastline. This is quite common across the Pacific region, with an estimated 57% of built infrastructure located in risk-prone coastal areas (Kumar and Taylor, 2015).

While these facts contribute to the risks associated with natural hazards and climate change, other socio-economic factors contribute to exacerbating the potential problems. Communities have little financial capital for projects and often require governmental and overseas developmental assistance (ODA) to fund community needs (Nunn and Campbell, 2020). Most financial revenues are concentrated in the main business district of Apia, leaving the rural areas largely under-developed, with small windows of opportunities created by local tourism operators.

2.1.2 Geology of the Samoan Islands.

The Samoan islands are mountainous, fertile land surrounded by coral reefs. These high islands were formed from multiple volcanic eruptions that have given rise to a continuous mountain chain, which originated from a hotspot in the east of the island chain. The most recent volcanic eruption was between 1905-11 on the island of Savaii. Its highest mountain is also on Savaii island, Mt. Silisili, with an elevation of 1,859 m (6,096 ft) above sea level. The mountains gradually slope towards the sea, with abundant rivers and freshwater springs originating from them.

2.1.3 Historical evolution of Samoan communities

Samoan islands were first settled by *lapita* people more than 3500 year ago. Samoan people are part of the Polynesian settlement that expands from the Hawaiian Islands in the north, Rapa Nui (Easter Island) to the east, Aotearoa (New Zealand) to the South and some remote islands scattered across the Melanesian countries of the Pacific, such as the Solomon and Vanuatu islands. Over many centuries they developed their Samoan language and cultural identity. This is known as the *Fa'asamoa*, meaning the Samoan way, which encompasses the language, culture, and way of life.

European visitors who arrived in the late 18th and early 19th centuries described a society with a high standard of living, equal economic standing, where food was abundant (Meleisea et al. 1987). The Samoan island were first called "The Navigator Islands" by the Dutch due to their skillful knowledge exploring the ocean. The Samoans, like many

Polynesians, were very migratory explorers crossing vast bodies of water in the Pacific Ocean. There were three categories of land:

1. settlement land which consisted of residential area and community shard grounds.
2. Plantation land for the cultivation of crops divided by chiefs known locally as *Matai* and distributed among families, and
3. Uncultivated village lands from the mountains to the reef.

This system of land still exists today and is protected under national laws (Meleisea et al. 1987), and belong to a *nu'u*, an equivalent of village in modern context. However, a *nu'u* is more than simply a settlement; rather, it is a community with a deeply shared history and socio-political ranks. Lands and their use are governed and directed by the matai. There are two categories of matai, known as the *ali'i* and *tulafale* within a family unit. Although both are classified as *matai*, they differ in status and role. Ali'i are the highest ranks within a family unit, and often seen presiding over meetings as the family representative. They have the final say in all discussion even though they do not speak often in such meetings. The role of the Tulafale, which are often referred to as the "talking chiefs", is to speak on behalf of the Ali'i. Their role is to negotiate and speak on behalf of the Ali'i with other Tulafale from the village or elsewhere. A given family decides who is bestowed these matai titles, who become part of the *fono,* or the council of chiefs. Men who are not title holders belong to the *aumaga* group (meaning "the strength of the village"), while women below to the *aualuma* group (meaning "those in the front", see Figure 2.1).

Unlike the Samoan women of today, historically women had much more political and social influence. Although gender division existed, authority was not specific to men. Women had authority to dictate affairs, with the sisters of *ali'i* and *tulafale* having the highest authority in the village (Meleisea et al. 1987). A *nu'u* was politically autonomous, and belonged to a higher division of a group of *nu'u*, making up a 'itumalo' or districts. Districts are grouped under a territorial division under the *ao ma papa* titles, or royal titles, in which there are four, called '*Tafa'i'fa*'. Over time and through intermarriage and warfare, these royal titles eventually were held by one, Queen 'Salamasina,' a woman during the 14th century. Today all high-ranking titles are traced back to her, according to Meleisea et al (1987). The role of women has changed with the introduction of western/colonial culture and Christianity. Some current gender studies highlight the poor representation of women in current Samoa political affairs (Fiti-Sinclari et al, 2017; Meleisea et al, 2015). Prior to European arrival, Samoans were polytheists, but were often referred to as a godless society by the Rarotongans (Meleisea et al. 1987). These customary districts and divisions have become the electoral districts in the present-day Government of Samoa (GoS).

Furthermore, colonialism, and the spreading of Christianity in the Pacific, may have been the deciding factor that created today's coastal communities (Nunn 2003). New research using LiDAR technology have unearthed sights of previous Samoan settlement and ancient ruins several kilometers inland (Jackmond et al., 2019; Wallin et al., 2007; Wallin and Martinsson-Wallin, 2007). It is thought that these inland settlements were the result of adaptation measures to past sea level change during the Medieval Warm Period and the Little Ice Age (Nunn and Campbell, 2020)

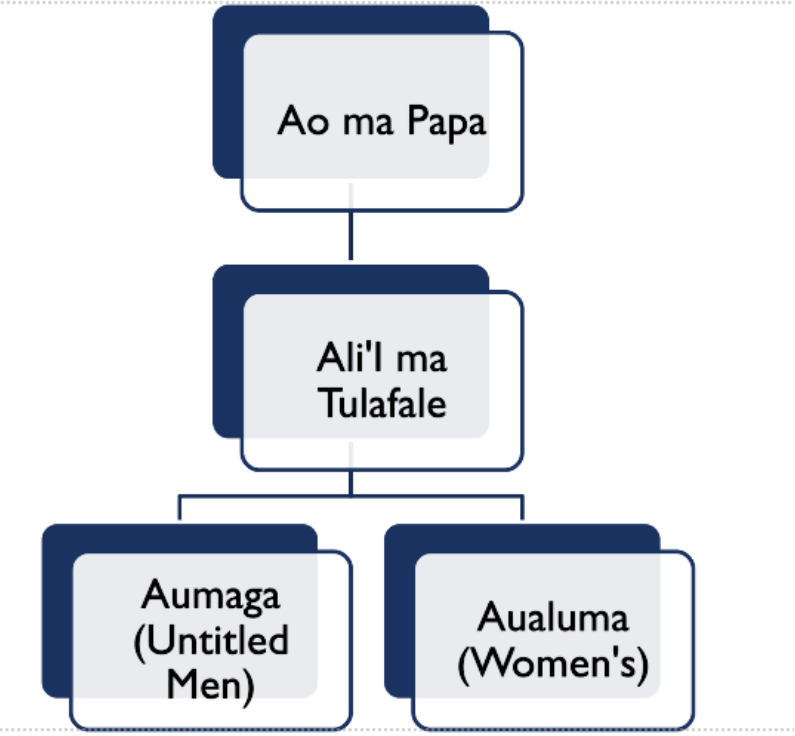

Figure 2.1 Simple illustration of the historical (pre-colonial to pre-independence time) Samoan community hierarchy

2.1.4 Study site

A large proportion of the population that resides in coastal communities would not have a homogenous exposure to the impacts of climate change, due to differences in ground elevation, relative proximity to the coastline, and the uneven distribution of coastal defense infrastructures (such as breakwaters and sea-walls). The author identified the island of Savaii as the primary target for this research, particularly the northern district of Gagaemauga III where the villages of Satoalepai, Fagamalo, and Lelepa are located (see

Figure 2.2). These sites were specifically selected because they are low-lying and are likely to be heavily affected by sea-level rise, as will be discussed in chapter 3.

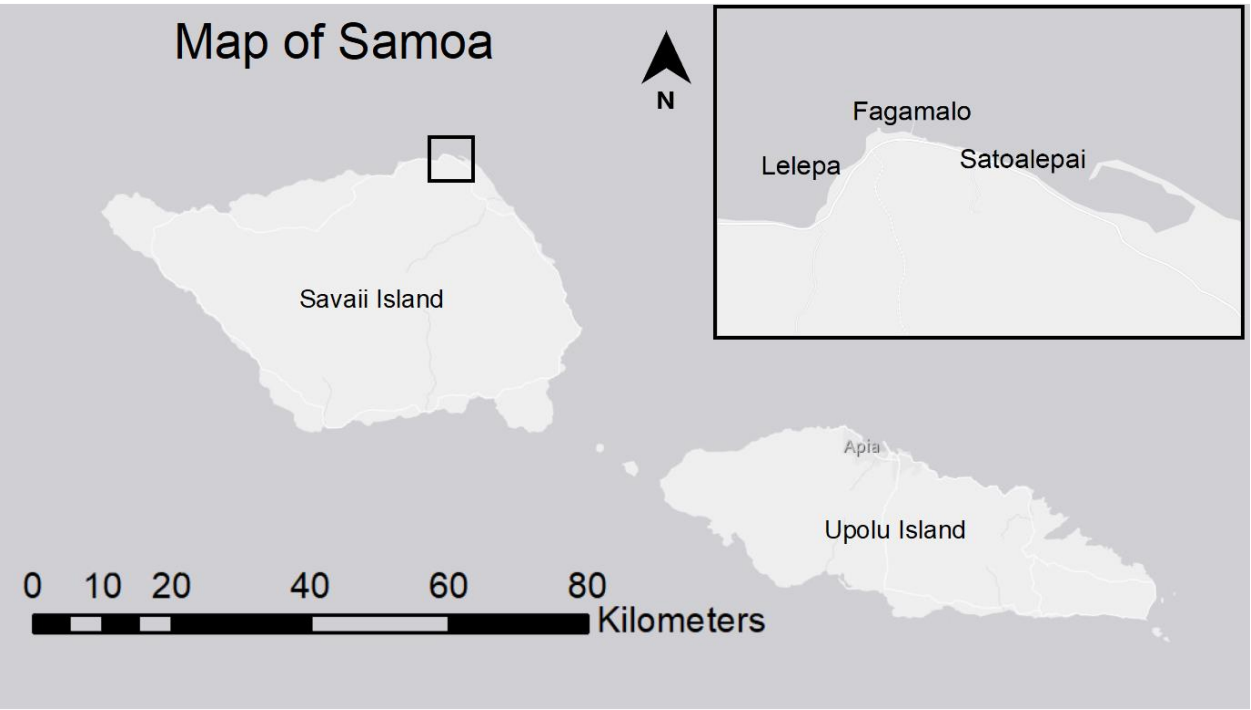

Figure 2.2. Study site on the northern section of the island of Savaii, in the Independent State of Samoa, showing the location of the communities of Satoalepai, Fagamalo, and Lelepa.

All three communities have seen steady growth in their population, with Lelepa having the greatest growth rate of the two (see Figure 2.3) according to the MWCSD Village Profiles. Few people have pensions, and out of 901 total residents only 40 have pensions (Ministry of Women, Community and Social Development, 2013). The majority of these 901 are in the younger demographic (Samoa Bureau of Statistic, 2017), which is common among many developing countries, and some members of the family may have

moved to urban areas for employment to support their family in the communities. It is also possible that some members of the family are living overseas, and sending remittance to support them. This has been the case in previous disaster encounters (Le De et al, 2014). Samoa has a heavy reliance on remittance from overseas, which in 2019 accounted for 17.2% of the national GDP (World Bank, 2020).

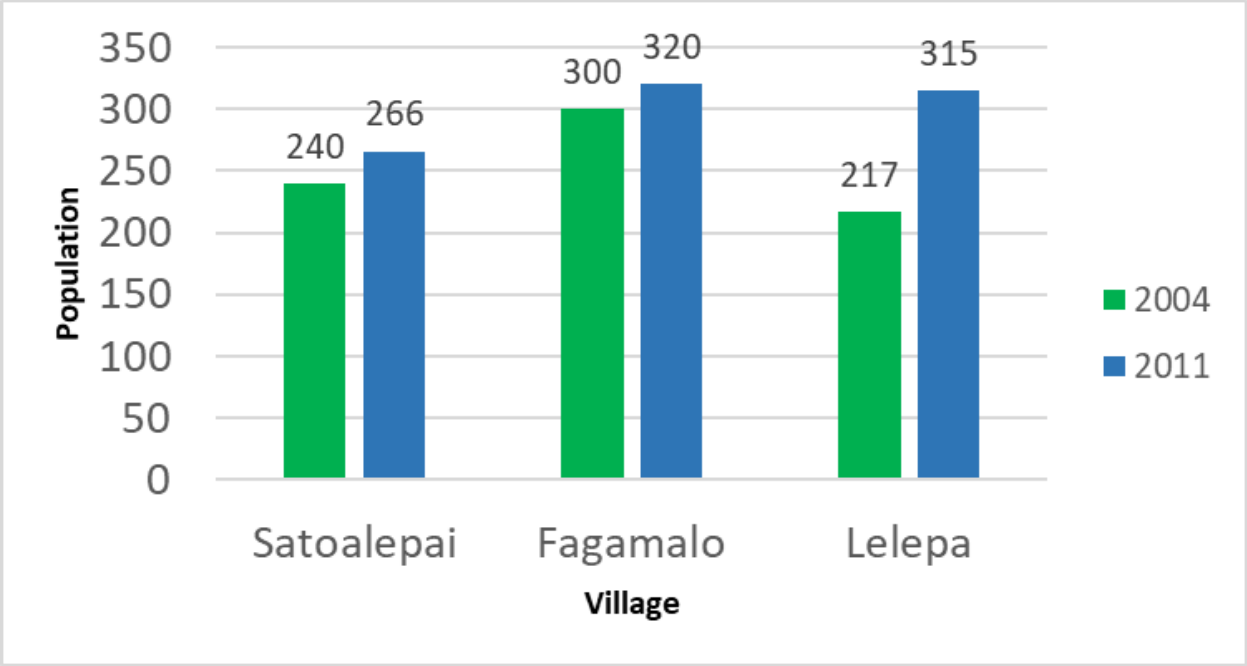

Figure 2.3. Population grown per village between 2004 and 2011 (source: Ministry of Women, Community, and Social Development: 2013 Village Profile)

2.1.5 Rural Island Communities

Rural island communities have a great level of autonomy within Samoa, as the national government has little authority to dictate what development and projects to

implement at the community level, due to strong customary traditions Communities are able to direct how to develop their resources, whether on land, air, or sea, as long as they are within the village boundaries. A representative of the community called a *Pulenuu* (village mayor) and a representative of the *Komiti o Tina ma Tamaitai* (Women's Committee) attend governmental meeting to discuss national development and government plans, and disseminate that information to their respective councils/committees. These two positions receive some remuneration for their services, though the village *Alii ma Faipule* (Village Council) do not have to comply with any of the government's requests or plans (see Figure 2.4).

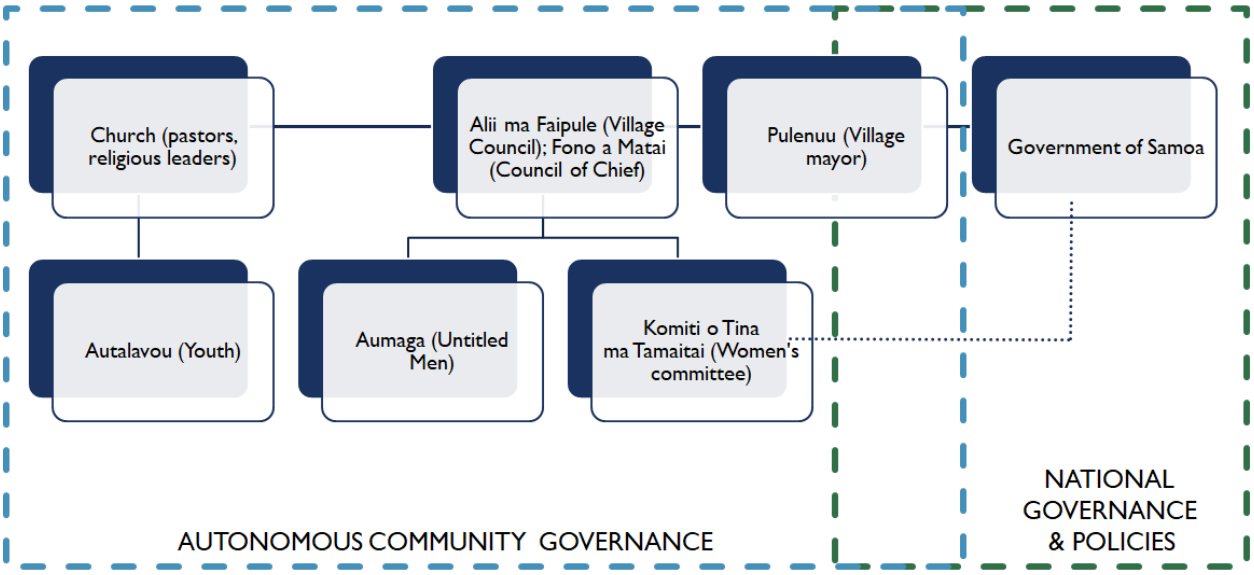

Figure 2.4 The Samoan community hierarchy in relation to the National Government

2.1.6 National Government of Samoa

The national Government of Samoa (GoS) is built on the model of the British Parliamentary democracy, altered to take into account Samoan customs and traditional governing system. This has been the model of government since gaining independence from the New Zealand (and British) rule on January 1, 1962. GoS is supported by the traditional system of *Matai*, though as mentioned earlier individuals without titles are disqualified from holding government seats. While there is a strong linkage with the traditional matai structure, the national government does not have the power to dictate how land and other resources within the village boundaries are to be utilized. Even elected officials who may attempt to utilize village resources without the approval or acceptance of the communities may face re-election problems, and even physical eviction. In such situations, the national government's only solution is to support and entice the support of these communities through training and workshops that should improve the understanding of the residents to support any national projects. Often it is the communities themselves who have to ask government for support on community priorities and project which sometimes are not in line with national priorities.

2.1.7 Adaptation Projects against environmental issues and climate change

To address climatic risks villages have been the recipient of multiple climate change adaptation projects, funded entirely or in part through partnerships with either the

Government of Samoa, international donors, civil societies, and religious organizations. Whether community members are aware of these community projects was a subject of curiosity for this research and was included in the household questionnaire surveys. Projects that directly or indirectly address some of the concerns of climate change from early 2000 to the present include:

Table 2.1.: Community projects addressing environmental and climate change concerns. Source: Government of Samoa 2013 Village Profile, researcher during the site visit.

Village	Project	Stakeholders/ Agency	Funding Source	Year	Project Status
Satoalepai	Second Infrastructure Asset Management (SIAM 2)- C6 Risk Adaptation Measures Small Grant Scheme (RAMSGS)	Ministry of Natural Resources and Environment (MNRE); Satoaleapi Village Council	World Bank	2004-2008	Complete
	Cyclone Emergency Response Project (CERP)	Ministry of Natural Resources and Environment (MNRE)	World Bank; Government of Samoa	2006	One-off
	Community-based Adaptation (CBA) protection and conservation of mangroves ecosystems and coral reefs	United Nations Development Program (UNDP); Ministry of Natural Resources and Environment (MNRE)	UNDP-GEF Small Grants Program; AusAid; Government of Samoa	2006-2012	One-off
	Mangrove replanting	Ministry of Natural Resources and Environment (MNRE)	World Bank	2006	One-off
	CERP Small Scale Resilience Strengthening Small Grants Scheme	Ministry of Natural Resources and Environment (MNRE)	World Bank; Government of Samoa	2009	One-off
	Tilapia fish stocking and management plan	Ministry of Agriculture and Fisheries (MAF)	Government of Samoa	2001	Completed
	Community-based Fisheries Management Program	Ministry of Agriculture and Fisheries (MAF)	Government of Samoa	2007	One-off
	Independent water scheme	Water and Sanitation Sector Policy Program. Ministry of Natural Resources and Environment (MNRE)	European Union (EU); Asian Development Bank (ADB);	2010	Completed
	Water Tank distribution	Civil Society Support Program	AusWSCCA	2012	Completed
	Seawall Construction	Ministry of Works, Transportation, and Infrastructure (MWTI)	UNDP		One-off
Fagamalo	Community-based Adaptation (CBA)-protection and conservation of mangroves ecosystems and coral reefs	United Nations Development Program (UNDP); Ministry of Natural Resources and Environment (MNRE)	UNDP-GEF Small Grants Program; AusAid; Government of Samoa	2006-2012	One-off
	CERP Small Scale Resilience Strengthening Small Grants Scheme	Ministry of Natural Resources and Environment (MNRE)	World Bank; Government of Samoa	2009	One-off
	Tree Replanting project	Ministry of Natural Resources and Environment (MNRE)	World Bank		One-off
	Stocking of substrates (palolo)	Ministry of Natural Resources and Environment (MNRE)	Government of Samoa	2003-2004	One-off
	Tilapia restocking	Ministry of Agriculture and Fisheries (MAF)	Government of Samoa	2001	completed
	Community fish reserves	Village members	Village	2007	completed
	Giant Clams marine reserves	Ministry of Agriculture and Fisheries (MAF)	Government of Samoa	2011	Ongoing
	Water tanks	Civil Society Support Program	AusWSCCA	2012	
	Community Water tanks, inland water system	The Church of Jesus Christ of Latter-Day Saints	LDS Charities		completed
	Independent water scheme	Water and Sanitation Sector Policy Program (WASSP). Ministry of Natural Resources and Environment (MNRE)	European Union (EU); Asian Development Bank (ADB); Government of Samoa	2010	
	Reconstruction (tar seal) of new access roads inland	Ministry of Works, Transportation, and Infrastructure (MWTI)			
	Extension of electricity supplies inland	Electric Power Corporation; Government of Samoa	Japan International Corporation Agency (JICA)		One-off
Lelepa	Community-based Adaptation (CBA)-Protection and conservation of mangroves ecosystems and coral reefs	United Nations Development Program (UNDP); Ministry of Natural Resources and Environment (MNRE)	UNDP-GEF Small Grants Program; AusAid; Government of Samoa	2006-2012	One-off
	CERP Small Scale Resilience Strengthening Small Grant Scheme	Ministry of Natural Resources and Environment (MNRE)	World Bank; Government of Samoa	2009	One-off
	Replanting scheme: 250m 'talie' and 'fetau' trees, 500 coconut trees	Ministry of Natural Resources and Environment (MNRE)	Small Grant Program PEF; AusAid	2010	One-off
	Giant Clam restocking	Ministry of Agriculture and Fisheries (MAF)	United Nations Development Program (UNDP)	1999	completed
	Independent water scheme	Water and Sanitation Sector Policy Program (WASSP). Ministry of Natural Resources and Environment (MNRE)	European Union (EU); Asian Development Bank (ADB); Government of Samoa	2010	Ongoing

2.2 Framework

2.2.1 Conceptual Framework

The conceptual framework employed in the present thesis incorporates the Climate Risk Conceptual Framework (IPCC AR5, 2013) and Sustainability Science's three pillars of Economic, Social and Environmental assessments to the context of the Samoan rural island communities (Figure 2.5).

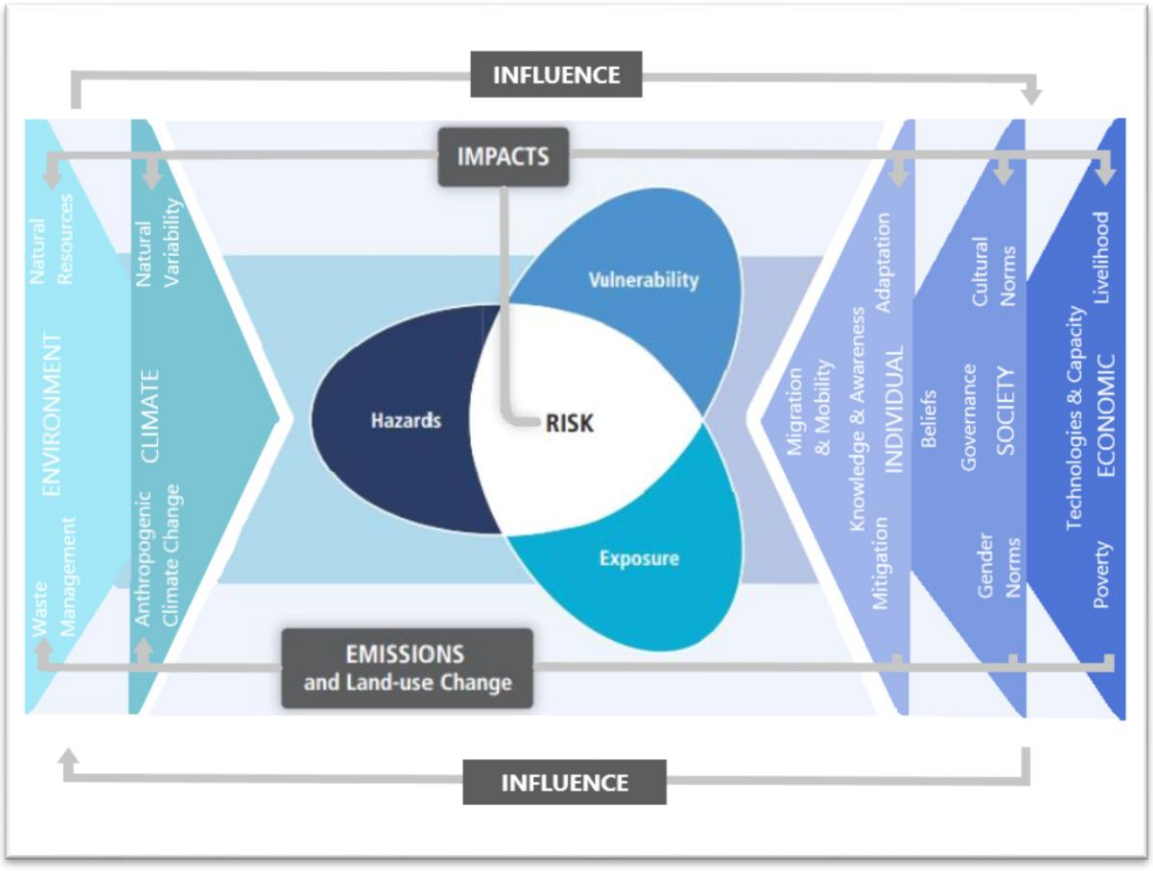

Figure 2.5 Conceptual framework

The economies of most SIDS are small in scale (compared to larger industrialized countries), but their rural communities face a particularly acute limitation in terms of the revenue they have available for community development. Their livelihoods, poverty rate and access to technologies and social capital influences to their ability to address the risk associated with sea-level rise and disasters. Furthermore, their social beliefs, cultural and gender norms influence individuals and their ability to adapt and address climate risk. Lastly, there are also environmental factors to be considered, that is, the availability of natural resources such as land and environmental-friendly waste management, which can reduce the impacts of the population on the environment and climate in general. Environmental, societal and economic pressures thus impact on the global climate, contributing to the climate risk of these rural communities (although, obviously, the contribution of such small nations is far less than other major polluting countries).

In this research the author will evaluate the climate risk and the adaptation preference based on the assessments on environment, economic and social norms of the Samoan islands and how that shapes the individual and community response to address climate change in the current situation, and in future scenarios for the year 2050 and 2100.

2.2.2 Research Framework

To investigate the research objectives, the research utilized multiple methods to understand Exposure & Vulnerability, Individual and Community resilience, and understand their current and future adaptation preference (see Figure 2.6).

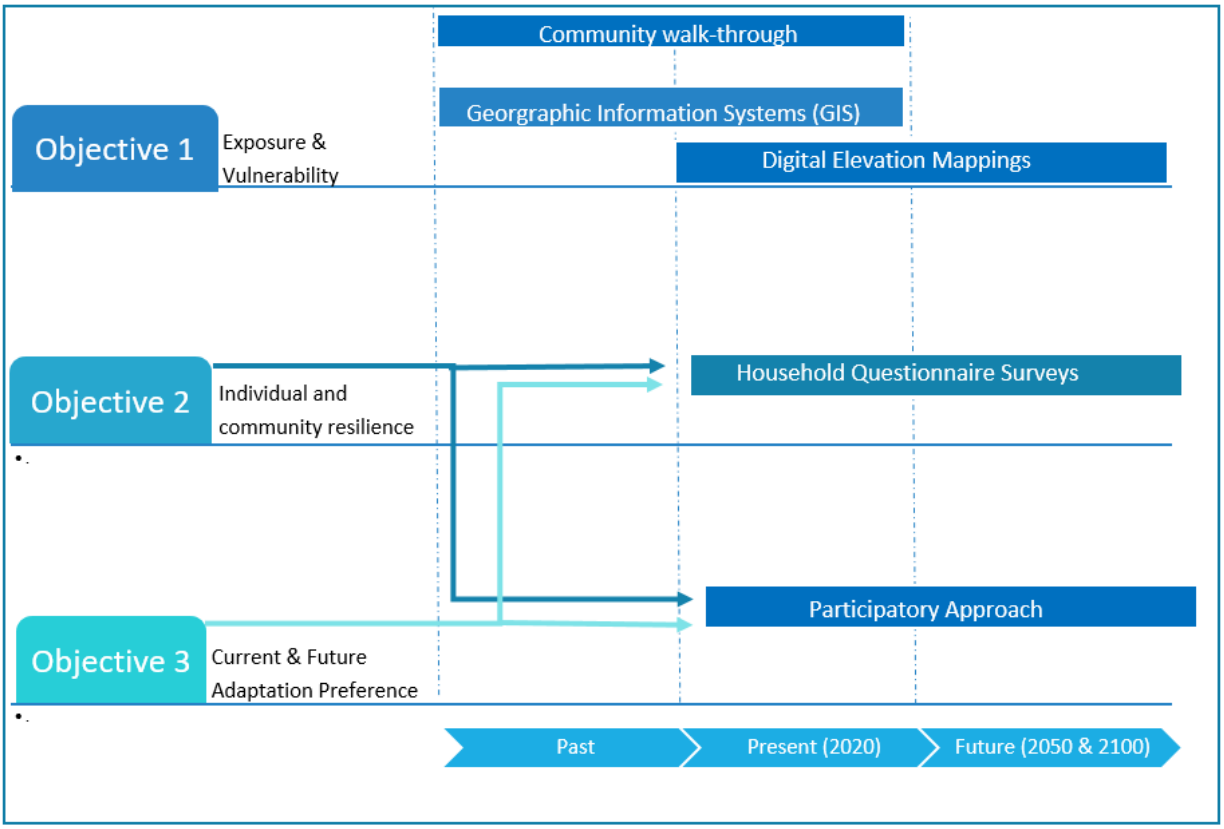

Figure 2.6 Research Methodological Framework

2.3 Multimethod Research

The following are the methods used in the present research: aerial drone video and still photography, ArcGIS, household survey questionnaire, and participatory action approach community workshop. Details of these various methodologies are explained below.

2.3.1 Drone Mappings and Geographic Information Systems (GIS)

This part of the research that was conducted used a variety of remote sensing technique that employed GIS, aerial drones, and mapping software, as will be detailed below.

2.3.1.1 Aerial Drone Photography

A lightweight unmanned aircraft (drone) was used to conduct this survey. The author used a quadcopter operating with four propellers known as Phantom 4 Pro by DJI Technologies. This drone is equipped with altitude sensors, vision system sensors (forward, rearward, and downward) for detection of obstacles, and GPS. The aircraft has a GPS with positioning accuracy of ±0.1m (visioning position) and ±0.5m (GPS positioning) vertical; and ±0.3m (visioning position) and 1.5m (GPS positioning) horizontal respectively. It is equipped with a high-resolution Go-Pro camera and with infrared detection, a wind resistance of up to 10m/s, as well as gimbal for automatic horizontal correction, making it possible to conduct orthorectified imagery. This allows it to be used for taking high-resolution vertical aerial photographs to obtain up-to-date and realistic data of a coastal area.

The drone was flown manually due to time limitations and uncertainties in power supply source in the location (i.e. given the drone high consumption of battery life and isolation of the study site, the researcher thought it best not to use a waypoint system.) The drone was flown along the coastline for each village community using a zig zag

pattern, at a height of 100 ft (30.48m) with a speed between 2-10 m/s; continuous still photography was taken at 2 second intervals. This is so that an overlap per photo can be greater than 60-80%to maximize accuracy (see Figure 2.7).

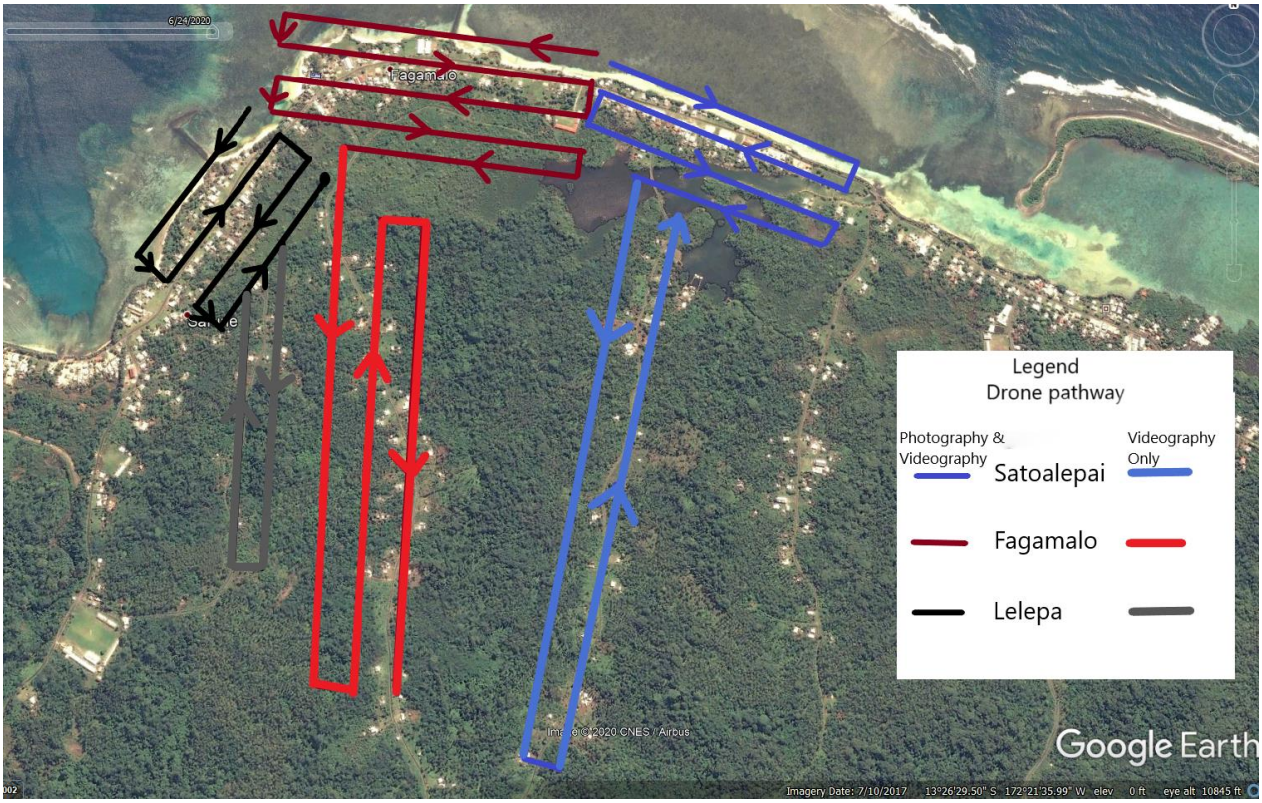

Figure 2.7: Drone pathways in the case study area.

The photos were stitched using Agrisoft Photoscan software, which includes the ability to perform Survey and Mappings, Digital Elevation Model, and adjusting those using a Dense Point Cloud for structural precision. The results were then overlaid in ArcGIS over the study site to visualize the extent of inundation according to different sea-level rise scenarios, following the findings of Kopp et al, 2017 and Kulp and Strauss 2019.

2.3.1.2 Aerial Drone Videography

Video imagery was also taken of each study site for the construction of a 3D model of the terrain. The drone was flown at 80 ft (24.83 m) and video footage was taken with the camera at a 45-degree angle. In this manner a high-resolution dataset can be obtained for the construction of a 3D topographic model of the coastal areas of the target communities. The stitched imagery obtained from the still photography was overlaid with the video to achieve this effect.

2.3.1.3 Geographic Information Systems

ArcGIS was used for two purposes, as discussed earlier. First, the images were stitched in Agrisoft Photoscan to produce a Digital Elevation Model with Dense Point Cloud. Then, it was also used to compare inland migration and changes in the settlement between 2003 and the time when the surveys were carried out,

2.3.2 Household Surveys

The author conducted a household survey questionnaire in the villages of Satoalepai, Fagamalo, and Lelepa. A total of 150 surveys were printed so that they could

be distributed to the 145 households identified in the 2013 Village Profile of the Government of Samoa (MWCSD 2013). The household distribution per village for Satoalepai, Fagamalo, and Lelepa was 41, 56, and 48, respectively (MWCSD 2013), with extra surveys being printed in case there were newly created households not identified in the 2013 national report. A total of 88 responses were received, 13 (32% of households) for Satoalepai, 39 (70%) for Fagamalo, and 36 (75%) for Lelepa. These questionnaire surveys were distributed to each household through the use of six surveyors (including the author). In some cases, when requested by a household, these surveyors also acted as enumerators, reading the questions on it and recording answers. However, for the case of most respondents, the survey was self-administered, with the surveyors leaving it and returning several hours later to collect it. Each village was assigned two surveyors for the distribution, transcribing (where required or requested), and collection of completed surveys. Answers were also received in both languages, although the majority of responses were in the Samoan language. These were all translated into the English language for this research.

2.3.2.1 Questionnaires

The questionnaire contained 33 questions, which would require between 30 – 60 minutes to complete. The survey was made available in the two national languages of Samoa: English, and Samoan. Instructions were disseminated to each household so that any member of its members (not specifically the head-of-household) was able to complete

the survey, including a disclaimer for the protection of their identity, personal information, and any sensitive information shared.

Each household survey required information on demographic, personal details, and contact information. The questionnaire contained a series of rankings, yes & no questions, clarification, and open-ended questions. The questions can be divided into several subsections, as shown below. The entire questionnaire survey can be found in Appendix A at the end of the thesis.

Questions 1-4 Community development priorities and environmental issues.

Questions 5-8 History and exposure to climate change awareness.

Questions 9-17 Knowledge and experience of climate change.

Questions 18-22 Governance and representation in decision-making.

Questions 23-26 Migration or relocation due to climate change and disasters.

Questions 27-32 Concerns and adaptation towards future sea-level-rise.

2.3.2.2 Coding and Reliability

All surveys were transcribed into the language used by respondents, and then those in Samoan were translated to English (when the language in them was Samoan). Each questionnaire survey was coded and assigned a number, location code, and control number. All data was then inputted into an Excel spreadsheet, which was used to perform

the data analysis and produce descriptive statistics graphs of the results. The researcher then used Statistical Product and Service Solutions (SPSS) as the analysis software tool for these questionnaires. For results see Chapter 4.

2.3.3 Participatory Approach

Rural island communities, especially those in Samoa, function almost autonomously when it comes to development and governance. Although the national government does have some influence, the decision on community priorities and the path of development are left in the hands of the traditional leaders. To examine the role of traditional systems on adaptation pathways, and any factions in the adaptation decision in community groups, this research utilized a participatory approach method, guided by the work of Chevalier and Buckles (2019), and Brock and Pettit (2007).

In that sense, the authors explored a tailored designed PAR with the incorporation of Focus Group Discussion for identified community groups. According to Chevalier and Buckles (2019), “Action research is meant to reconnect science and society” and value the participants as experts, with a wealth of experience in climate change impacts. Community members may not be familiar with the science of climate change, though they are experiencing shifts in traditional knowledge and practices brought about by a changing climate.

The main part of the workshop was organized and coordinated by the author during a one-month-long field visit in November 2019. Three coastal communities in the northern

part of Savaii island, the villages of Satoaleapai, Fagamalo, and Lelepa (see Figure 2.1), which are located next to each other, were invited to participate. Lelepa offered to host the workshop, which took place between 19 and 22 November 2019. 53 participants attended the workshop, although the majority were from Lelepa, with only a few participants from Satoaleapai and Fagamalo (due to some internal political discussions, and village interment that prevented Satoaleapai and Fagamalo from having the desired number of participants). The original working materials for the workshop were written in English and were translated into Samoan by the author. The entire workshop was conducted in Samoan.

The participants were grouped into their respective villages, and further into specific focus groups, such as *matais* (chiefs), women, youth, and others (including any persons with disability). A total of 20 individuals were identified as persons with disabilities in the national census in these 3 communities (Ministry of Women, Community, and Social Development, 2013). The conceptual framework intended to include such persons and specific instruction was delivered to include an invitation for persons with disabilities, though none attended the workshop. In total there were 8 groups, though one group did not wish to participate and one village decided to combine both youth and chiefs' groups into one during the first 2 sessions, yet chose to participate in the discussions. Council of chiefs that participated were all men, something which is typical in Samoa, as these individuals are predominantly, if not almost always, men. The workshop was divided into 8 sessions, with each one lasting between 15-30 minutes.

The activity, purpose, and outputs of each of the sessions are detailed in Table 2.2. The lead author explained each of the sessions and then moved between the groups,

answering questions where and when needed, and facilitating the overall process. Essentially, the participants were first asked to perform a community map-drawing exercise (Figure 2.8, Figure 2.9) on which they were then asked to identify any relocation within the communities that had already taken place.

Figure 2.8. Group mapping activities. Left: Group of chiefs from Lelepa village. Right: Lelepa youth and woman groups.

Figure 2.9: Presentation by groups. Left: Fagamalo men. Center: Lelepa Women. Right: Lelepa Youth

The author then gave a presentation explaining the purpose of the research (which had not been disclosed at the beginning to all participants, to avoid influencing their mapping output or having expectations for project monetary funding regarding adaptation projects), and provided some background information about the science of SLR and how it could affect the communities. This background information concerned scientific findings that contribute to SLR and its impact on small island states, according to the consensus in the IPCC AR5 and 1.5C reports. The coordinator also emphasized the uncertainty in these climate models when it comes to predicting future events. Therefore, best- and worst-case scenarios of SLR were presented, based on scientific models, and emphasis was placed that the actual outcome could be anywhere in between these two scenarios. These scenarios were essentially either a +0.26 and +0.93 m rise by 2050 and a + 0.98 and + 2.43 m by 2100 (following Kopp et al, 2017). The factors contributing to the best-case scenarios are SLR caused by deep and rapid emission cuts and having 'medium' luck (with luck translating to the influence of heat-trapping pollution and global warming on SLR, see Kopp et al., 2017). 'Good' luck assumes that carbon dioxide and other heat-trapping gases and global warming have little effect on SLR while 'bad' luck is the opposite, while 'medium' is in the 50th percentile range. The medium range of sea-level projection was used in these scenarios (Climate Central, 2020). Maps of the areas that could be inundated were obtained from Climate Central, using a coastal digital elevation model developed by (Kulp and Strauss, 2019). These globe inundation maps are based on elevation, tides, and coastal flood likelihoods in an area, identifying at-risk areas due to sea-level rise and annual flooding (see Figure 2.10). For more detailed maps of the community SLR inundation see Annex D. These maps are based on a global-scale

dataset for countries outside the United States, though they are lacking consideration for any local coastal defenses, current or possible future adaptations, and therefore should not place with a high degree of certainty (Climate Central, 2020).

The overall coordination was conducted through the national government body tasked with community coordination efforts, which was essential given that the author is based in Tokyo, Japan. Furthermore, translation of materials and information from English to Samoan was meticulously carried out and validated through national government manuals indicated by approved translation of scientific and climate change terms. This important consideration may have contributed to the community members showing great interest in the topic, raising several questions. The results of these community participation data will be discussed in Chapter 5.

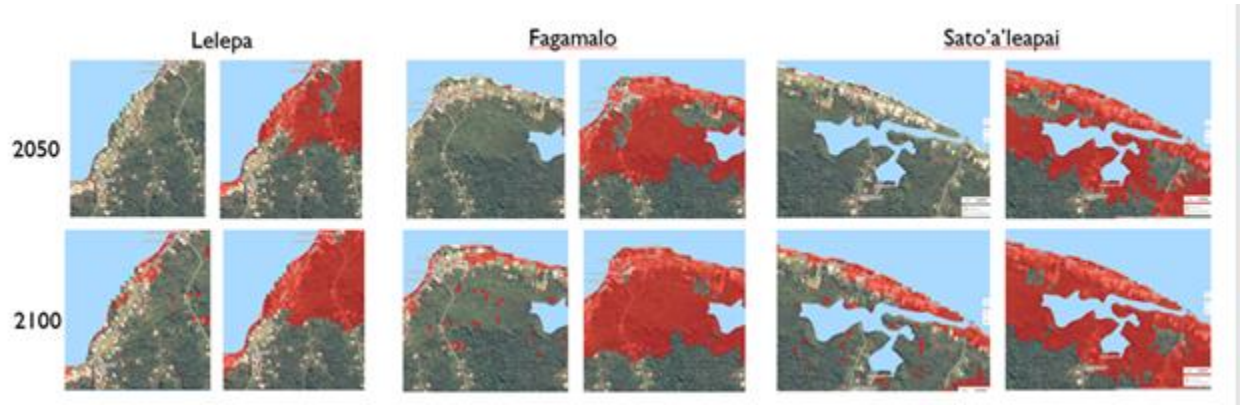

Figure 2.10. SLR inundation mappings based on Kopp et al, 2019 SLR models. Source: ClimateCentral.org

Table 2.2. Schedule of the different workshop sessions

SESSION	ACTIVITY DESCRIPTION	PURPOSE	OUTPUT/TASKS
SESSION 1	Group participants were asked to draw bird-eye-view maps of what they believe is the layout of their village, residential homes and important infrastructure.	Consider their understanding of the village layout.	Maps of each of the villages were produced by each group.
SESSION 2	Participants were asked to draw on the map from session 1 the locations of previously settlements.	Identify internal relocation within the settlement.	A group representative would present the maps to the audience for validation.
SESSION 3	Introduction of the purpose of research: SLR and the science behind what is causing it.	Increase understanding by rural community members of climate science and future SLR scenarios, using local language. Emphasis was placed on the uncertainty regarding future SLR.	Increase understanding of climate change impacts such as SLR. Introduce inundation heights of 2 scenarios (best and worst case)
SESSION 4	2050 Best case SLR inundation.	Gather adaptation preferences to address inundation scenario.	Each group would present their adaptation preference plan to the general audience.
SESSION 5	2050 Worst case SLR inundation.	Gather adaptation preferences to address inundation scenario.	Each group would present their adaptation preference plan to the general audience.
SESSION 6	2100 Best case SLR inundation scenario.	Gather adaptation preferences to address inundation scenario.	Each group would present their adaptation preference plan to the general audience.
SESSION 7	2100 Worst case SLR inundation scenario.	Gather adaptation preferences to address inundation scenario.	Each group would present their adaptation preference plan to the general audience.
SESSION 8	Wrap up session.	Open discussion and feedback.	Compare responses between groups and identify any consensus on future adaptation countermeasures.

Chapter 3: RESULTS: Remote Sensing and Field Observations

The deficiency of the recent SLR inundation maps available from climatecentral.org (as discussed in Chapter 2), which have not been corrected for areas outside of the USA and Australia to include adjustments based on localized data, digital elevation, and infrastructural development, highlights the need to perform this exercise for the target areas. The orthomosaic maps and DEM, and contour maps of Satoaleapai (see Figure 3.1 & 3.2), Fagamalo (see Figure 3.3 & 3.4), and Lelepa (see Figure 3.5 & 3.6), show that many areas are at high risk to SLR because they are very low-lying.

3.1 Digital Elevation Map

The drone imagery was used to produce high-resolution land-use maps, including local Digital Elevation Maps (DEM) which were adjusted to the sea level mark. What is strikingly interesting from the images is that the height of the evacuation route (inland road) is not much higher than the high sea level. While the communities' effort was to construct an inland road that will be used in times of sudden onset disasters such as a tsunami or other climate events, the DEM and contour maps show that all route are either the same with the sea level or slightly above. With future sea-level rise these routes will surely need to be elevated as the ocean level increases.

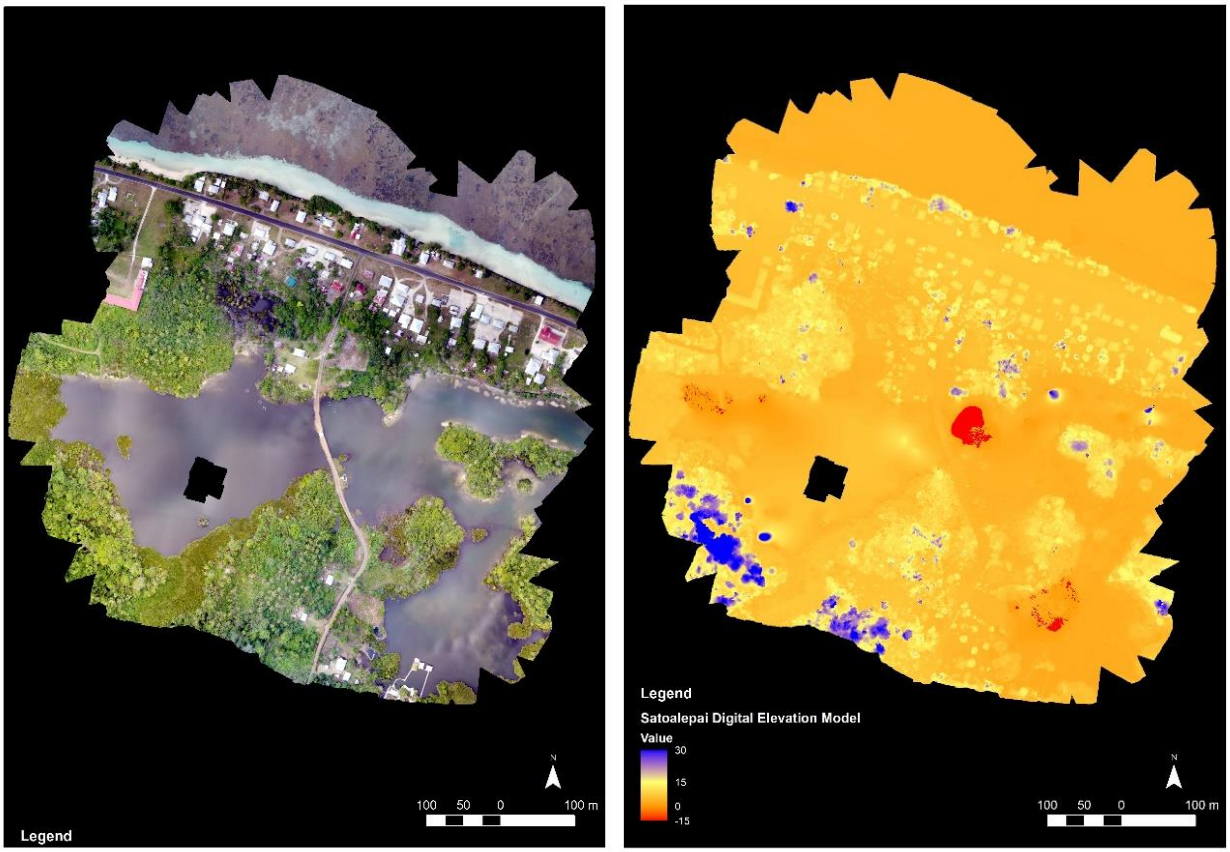

Figure 3.1 Satoalepai Orthomosaic produced from drone photography (left); Digital Elevation Maps, in metres (right)

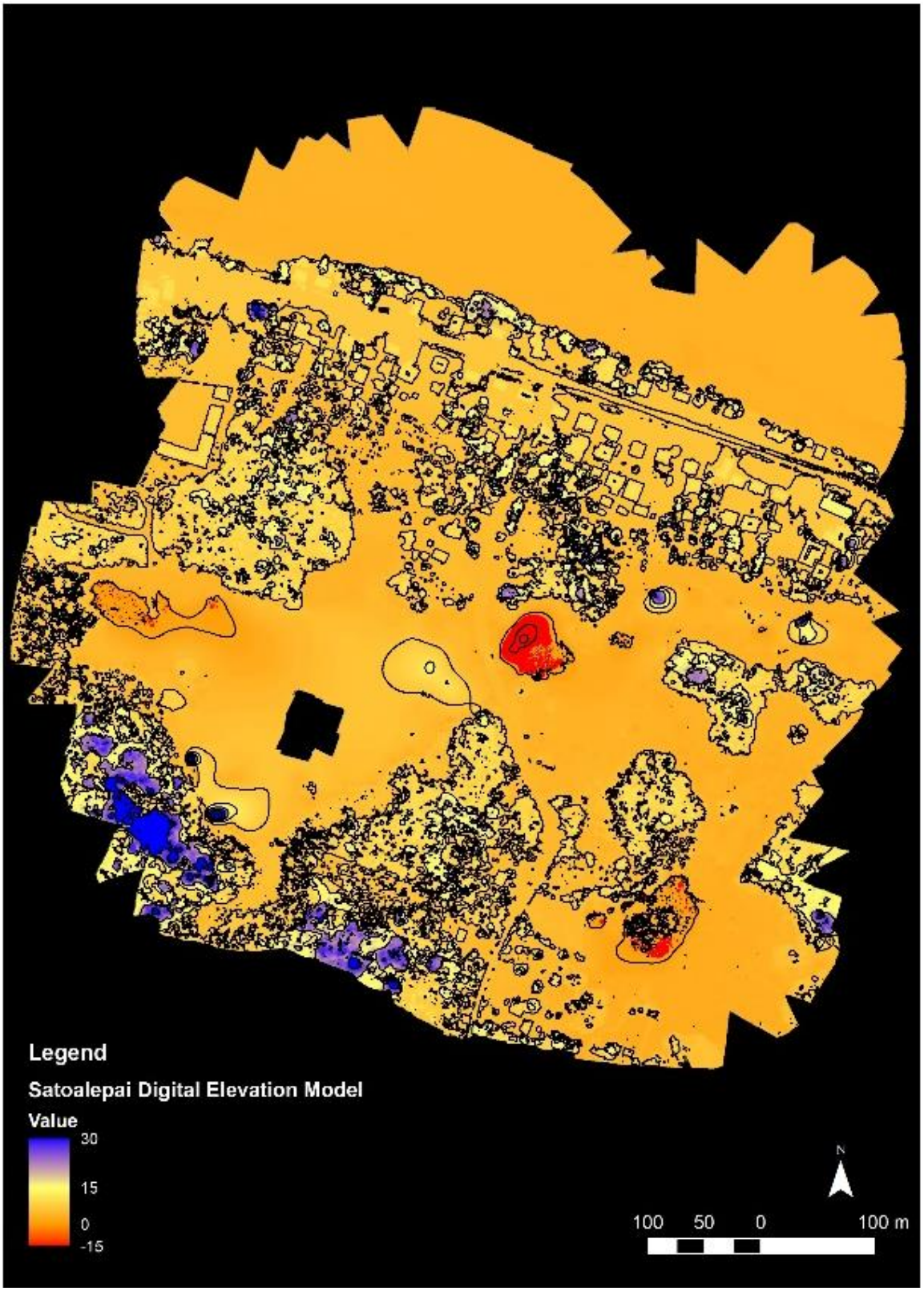

Figure 3.2 Contour map of Satoalepai village combining DEM and imagery identification (all units in metres).

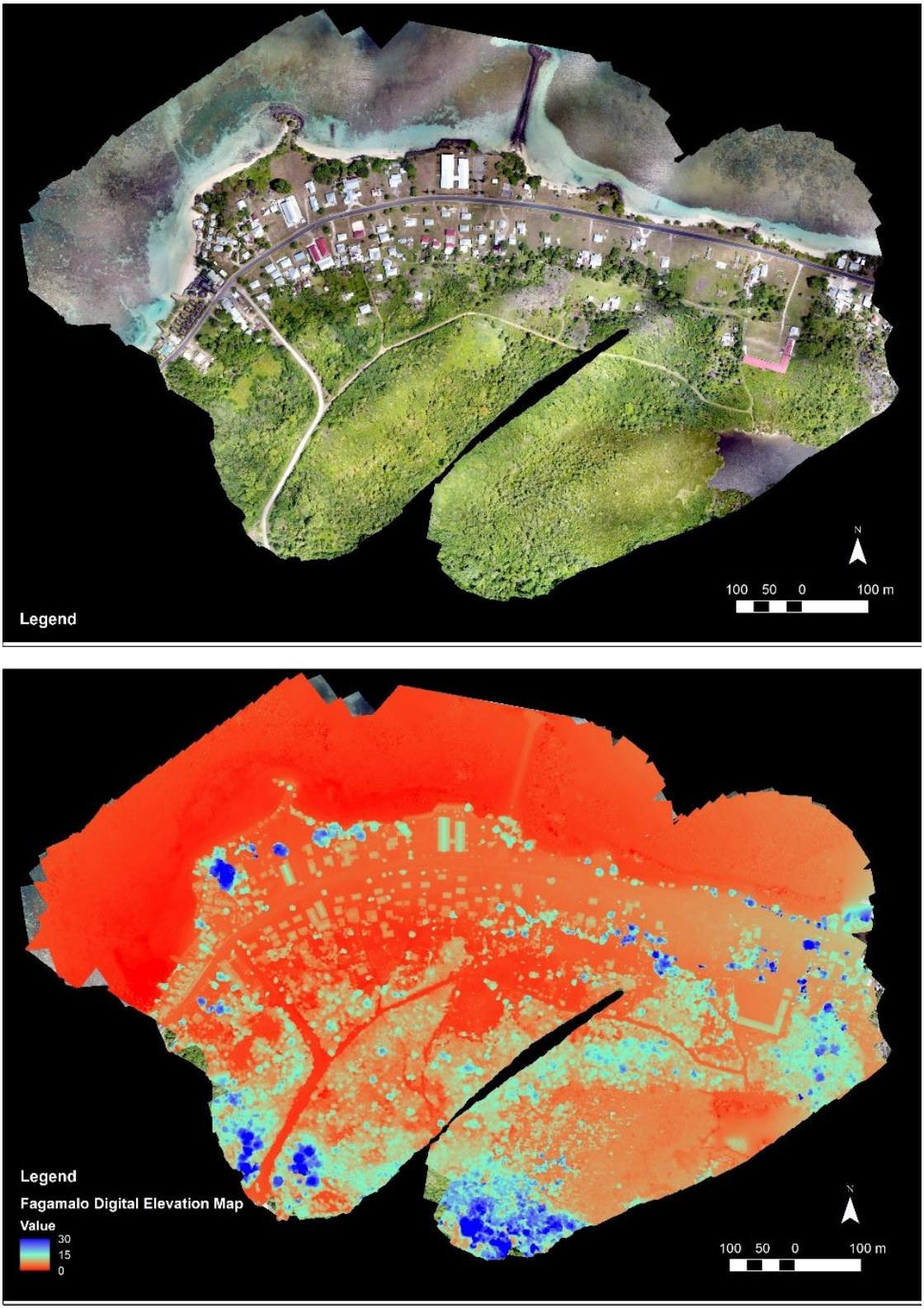

Figure 3.3 Fagamalo village Orthomosaic produced from drone photography (above); Digital Elevation Maps (below)

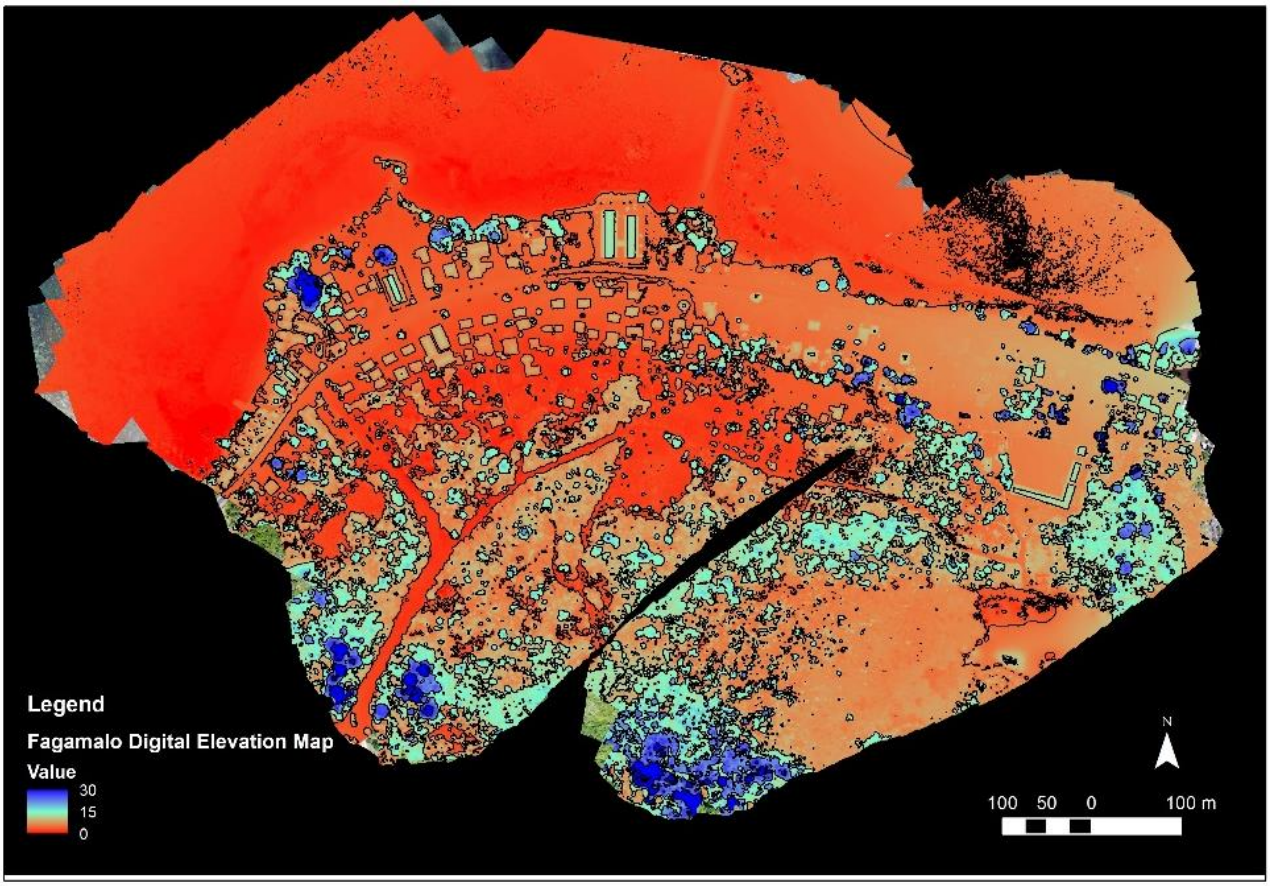

Figure 3.4 Contour map of Fagamalo village combining DEM and imagery identification

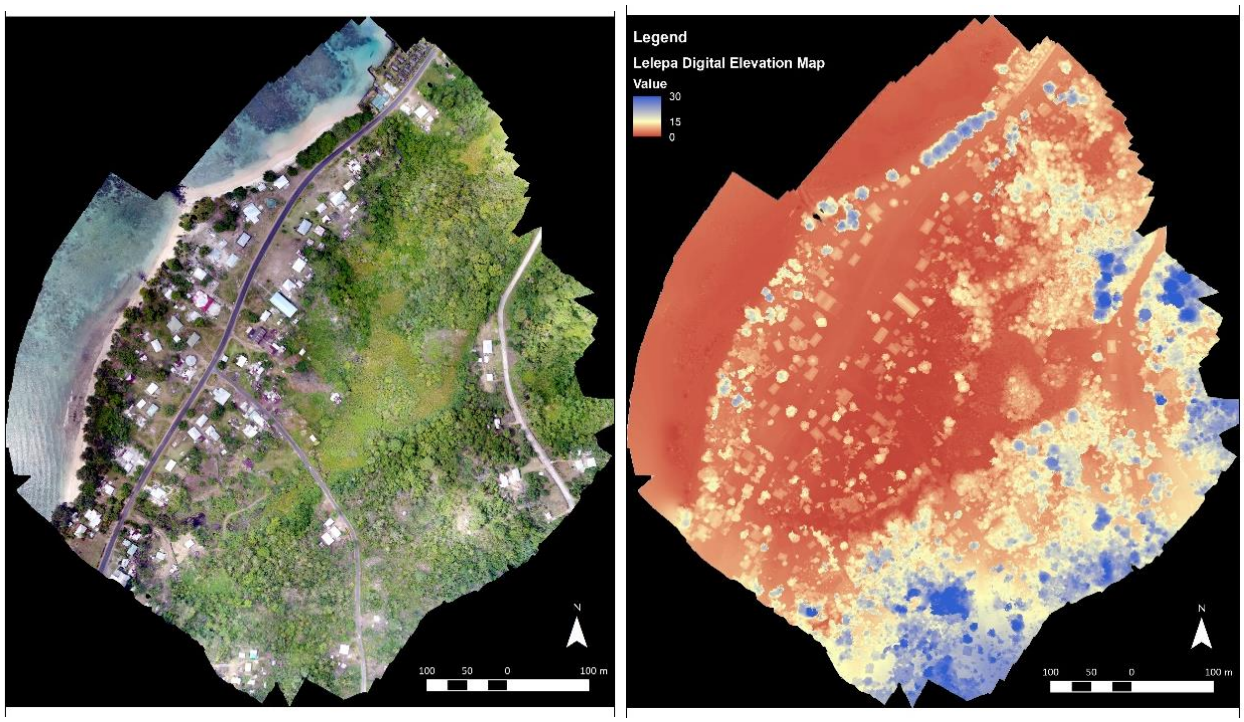

Figure 3.5 Lelepa village Orthomosaic produced from drone photography; Digital Elevation Maps based on sea (in metres)

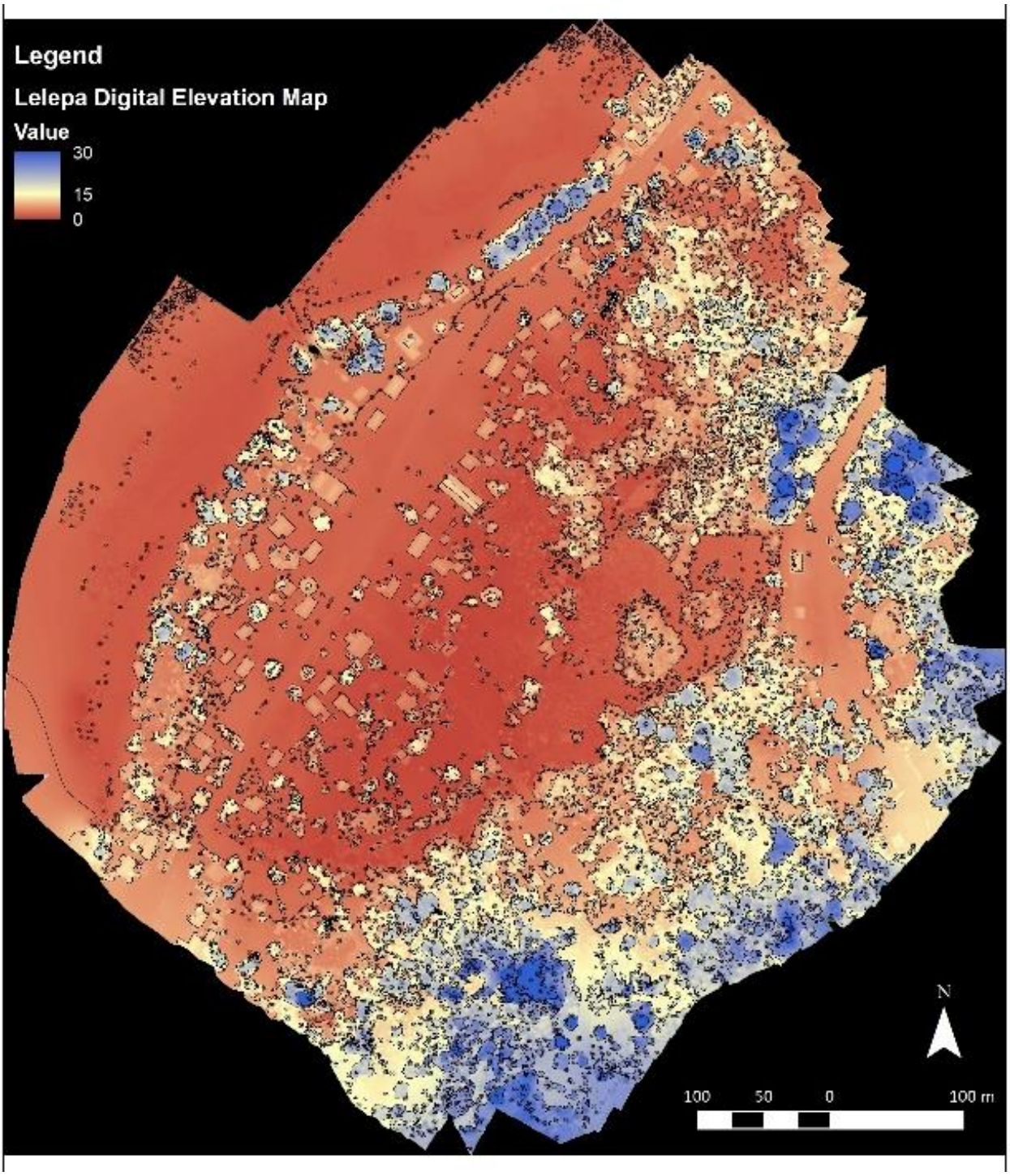

Figure 3.6 Contour map of Lelepa village combining DEM and imagery identification (unit: metres)

3.2 Satellite imagery

The results from the satellite imagery show an inland voluntary settlement in progress, as can be seen in Fig. 3.7. These inland settled areas were once village farm lands, but have since become an extension of the coastal settlement as many residents are building secondary homes in these elevated areas.

Towards the late 2000s, particularly following the 2009 Samoa-Tonga Tsunami, and to some extend other tropical cyclones, a high number of homes constructed inland (see Figure 3.7). While it is important to note that these areas were not affected directly by the tsunami of 2009, their exposure to images of the devastation e that affected the southern areas of on the main Island of Upolu caused members of these communities (and others nation-wide) to consider the move inland to reduce potential disaster risks in the future (Ministry of Finance, 2017).

The majority of the movement that can be observed is in Fagamalo village, which is coincidently the village experiencing the worse coastal erosion of the three villages, even over the period of the last decade (see Figure 3.8.) Fagamalo did not employ any coastal defense mechanism to protect its coastline. In contrast, Satoalepai requested assistance from the national government in the construction of a stone boarder sea-wall in the aftermath of Tropical Cyclones Ofa (199) and Val (1991), and Lelepa has received support for an ecosystem approach using appropriate coastal vegetation replanting (Ministry of Women, Community, and Social Development, 2013).

Figure 3.7 Satellite imagery of land-use change between 22 February 2003 (top) and 24 June 2020 (bottom)

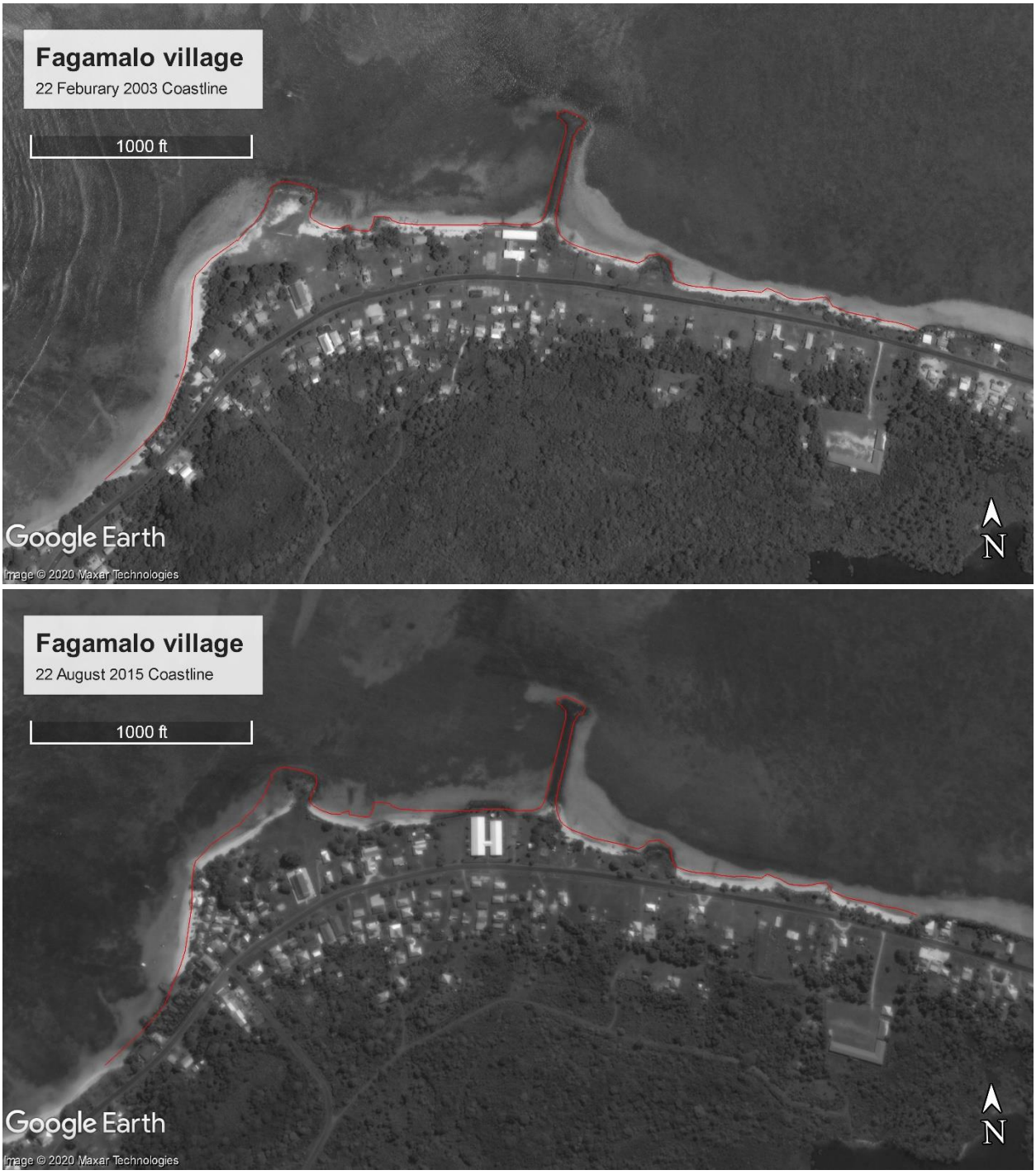

Figure 3.8 Satellite imagery of coastline change due to erosion in Fagamalo between 22 February 2003 (top) and 22 August 2015 (bottom). The red contour line indicates that the 2003 coastline that was eroded

Fagamalo also contains many evidences of abandoned infrastructures (which can be observed in Fig. 3.9 and 3.10, which show the location of foundations of buildings and ruins), unlike the other two villages that have coastal protection, due to erosion and disaster experiences of past climatic events. These images were collected during a site visit walk-through of all three villages, indicating how coastal erosion and past disaster have impacted the socio-economic conditions of those that depended on them.

Figure 3.9 More images of abandoned areas in Fagamalo village. Former National district hospital (top right), Eveni, a private retailing company (bottom right), Foundation unearthed with beach erosion (top left) and entrance to was formerly a school (bottom right)

Figure 3.10 images of abandoned areas with foundations still evident in Fagamalo village. Structures unknown.

3.3 Discussion and Summary

Following the methodologies presented in Chapter 2, the findings from the aerial mapping and analysis show that the case study area is at high risk of suffering the effects of SLR, even if only 1 m. Satellite imagery shows how the community has been expanding further inland, along roads. Many coastal residential homes have been built at some elevation, including houses with elevated foundations, a feature which is more pronounced in traditional style structures or fale, some surpassing 1.5m (see also Appendices). Damage houses and infrastructure were more noticeable in Fagamalo village, due to the lack of coastal defense (with the exception of tourism resort operators and the LDS church).

Chapter 4: RESULTS: Household Questionnaire Surveys

4.1. Household Survey Responses

According to the Ministry of Women Community and Social Development (MWCSD): Village Profiles report, the total number of households in each of the villages in 2013 was as follows: Satoalepai (n=41), Fagamalo (n=56), and Lelepa (n=48). Household Questionnaire Surveys were distributed to each household, and a total survey of 90 responses (n=90) were received from all three villages, as follows: Satoalepai (n=13), Fagamalo (n=40), and Lelepa (n=37). This represents a response ratio of 32%, 70%, and 75 %, respectively. The average household size was 7.8 members, slightly higher than the national average of 6.9 members per household.

In terms of gender, overall there was a 60% to 40% male to female ratio. The respondents' median age was 50. Given that this survey was administered during the day respondents might have been in the older age range, as this segment is more likely to be at home during that time (as opposed to younger people who might be at work). Another factor that may have contributed is the inclusion of a question of whether the respondent was the head of the household. This may have caused some unintended assumptions, as those receiving the questionnaire might have perceived that the heads of households were the target audience for this survey, as 63% of the respondents claim to be the heads of household.

4.2 Education and Occupational Background.

A majority of the respondents have either attended or completed Secondary Schooling (High School) representing 51.1%, with University association and graduates coming in at second largest at 22.2% followed by intermediate school (middle school) and no-school at 7.8% each, and primary school (elementary), and undeclared at 5.5% (see Figure 4.1).

Despite the high level of educational attainment, many of the respondents stated that they were unemployed or retired (53%), however, based on a further evaluation of the occupations listed it is highly likely that 84% of those surveyed are unemployed. As the respondents who identified themselves as students, stay-at-home wife or husband, chiefs, did not state that they were unemployed (even though they are not earning an income), this can also extend to farmers and fishers who are highly likely practicing subsistence living and not settling products for a profit (see Figure 4.2).

The average wage and salaries received per capita per week is SAT$ 103.68 (USD 41.06) for males, and SAT$97.76 (USD38.81) for females, in the Apia area (Moustafa, 2016). This average is significantly lower for the rest of the country. The national official unemployment rate is 14.47% (World Bank, 2020). Although the unemployment rate varies between different reports, with the Samoa National Employment Policy 2016-2020 reporting a national unemployment rate of 8.4%, while a 14.5% was reported by the United Nations International Labour Organization (ILO). It is not clear how unemployment was defined in these reports. A steady income within the villages studied is limited. Only

13 respondents had a job (associated with the nearby tourist resorts), highlighting the limited opportunities for full-time employment in the area. Essentially, most respondents relied on daily subsistence, farming, fishing.

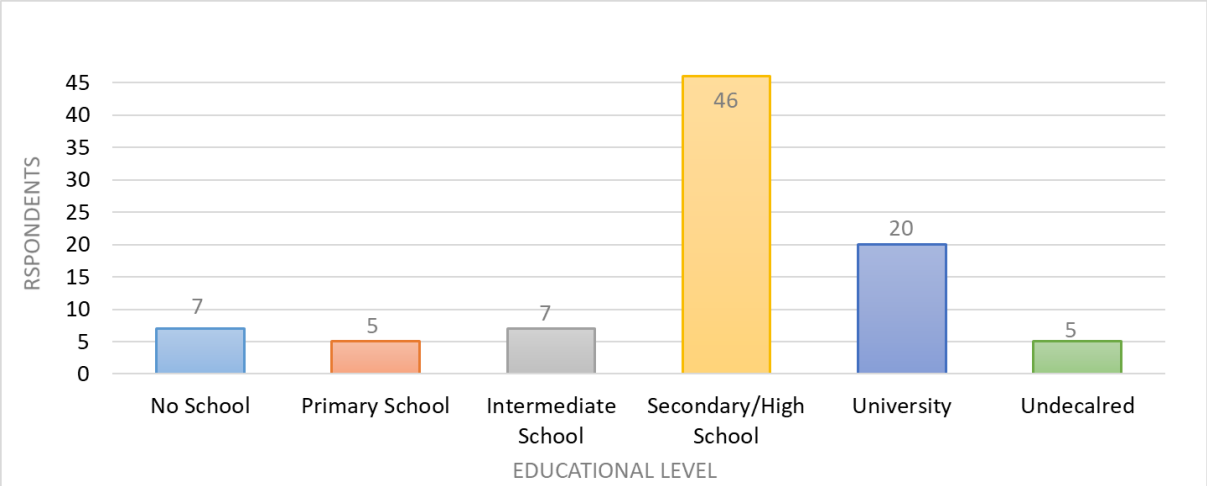

Figure 4.1 Respondents' highest educational attainment. (n=90)

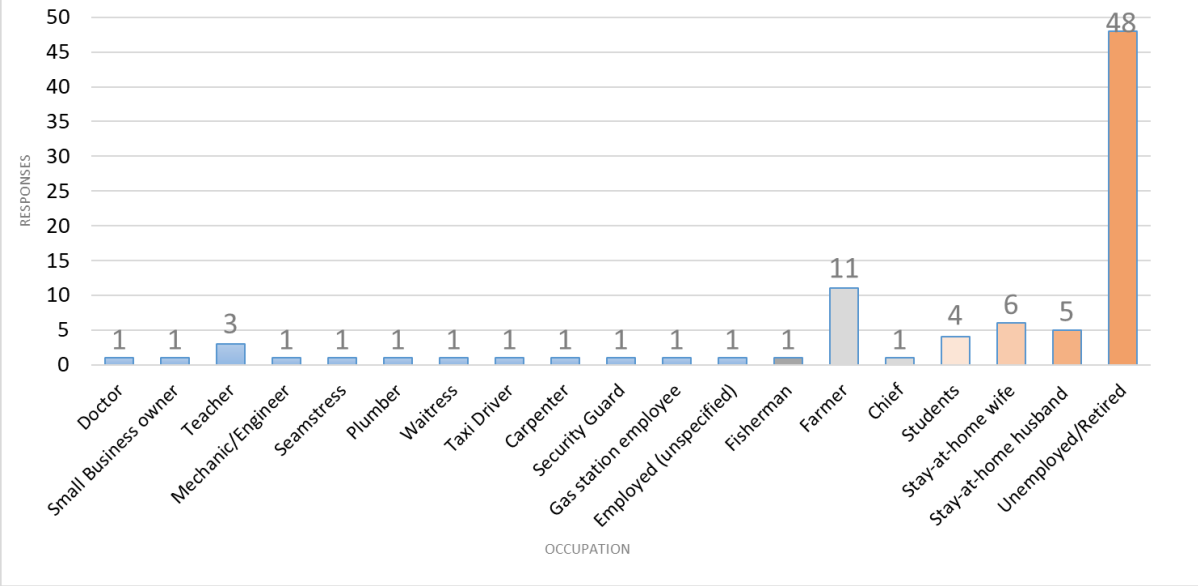

Figure 4.2 Occupation of respondents (n=90)

All respondents were asked if they are originally from the village and how long they have lived there, with the aim to determine whether the7 are familiar with community developmental issues and environmental problems. Data indicated that 85.6% of respondents were indeed from the communities, while 14.4% originated from other villages. The 13 individuals that were not from the villages included ten that moved in after marriage to a member of the community, two due to other family members that are part of the community, and one whose parents are originally from the village but were born elsewhere. Furthermore, all 13 of these respondents have spent more than 5 years living in the village, with the majority (n=8) having lived there for more than 20 years (see Table 4.1). Having spent a sufficient number of years living in these communities, it is assumed they are well aware of the challenges and issues faced by the community.

Table 4.1 Outsiders vs the number of years they have lived in the community.

Years	Number of respondents
5-9	1
10-14	1
15-19	3
>20	8

4.3 Community Development Priorities and Challenges

The participants were asked to rank the challenges faced by the community and development priorities from 1 (highest) to 10 (lowest). They were asked to rank the Environmental, Social, and Economic Issues that are most important to them, and the importance of these sectors to their community development:

- Environment – waste management
- Extreme events- Climate Change. e.g. tropical cyclones, sea-level rise, flooding
- Geological events – Earthquakes, tsunamis
- Education
- Employment, Livelihoods
- Governance
- Health
- Poverty, Money
- Food security
- Other, in which they were asked to further specify.

The results show that environmental, education, and employment and livelihoods issues are of the greatest concerns to them. This was determined using three ways. The first was obtaining a decreasing slope in the graphs, as the value of 1 should be high when an area is high priority, with the lowest priority having a score of 10. (see Figure 4.3). The second was using the mean value calculated through SPSS, where a lower mean score would indicate a higher priority (as a lower number equates to higher ranking), as described in the SPSS Descriptive Statistics (see Table 4.2). Thirdly, the frequency of values in each rank below 5 and above 6, by equating the median value between five and six to a value of zero (as shown in Figure 4.4). Thus, education has the lowest mean score, and a higher frequency indicates a greater concern for education over other important issues of environmental proportions, including climate change and disasters. This, despite having free education for the first 11 years (Ministry of Education, Sports,

and Culture, 2018), indicates some problems with the national educational development and remains a top priority for most community members. In conclusion, while Environmental issues are also ranked as important, educational development is a higher priority for them.

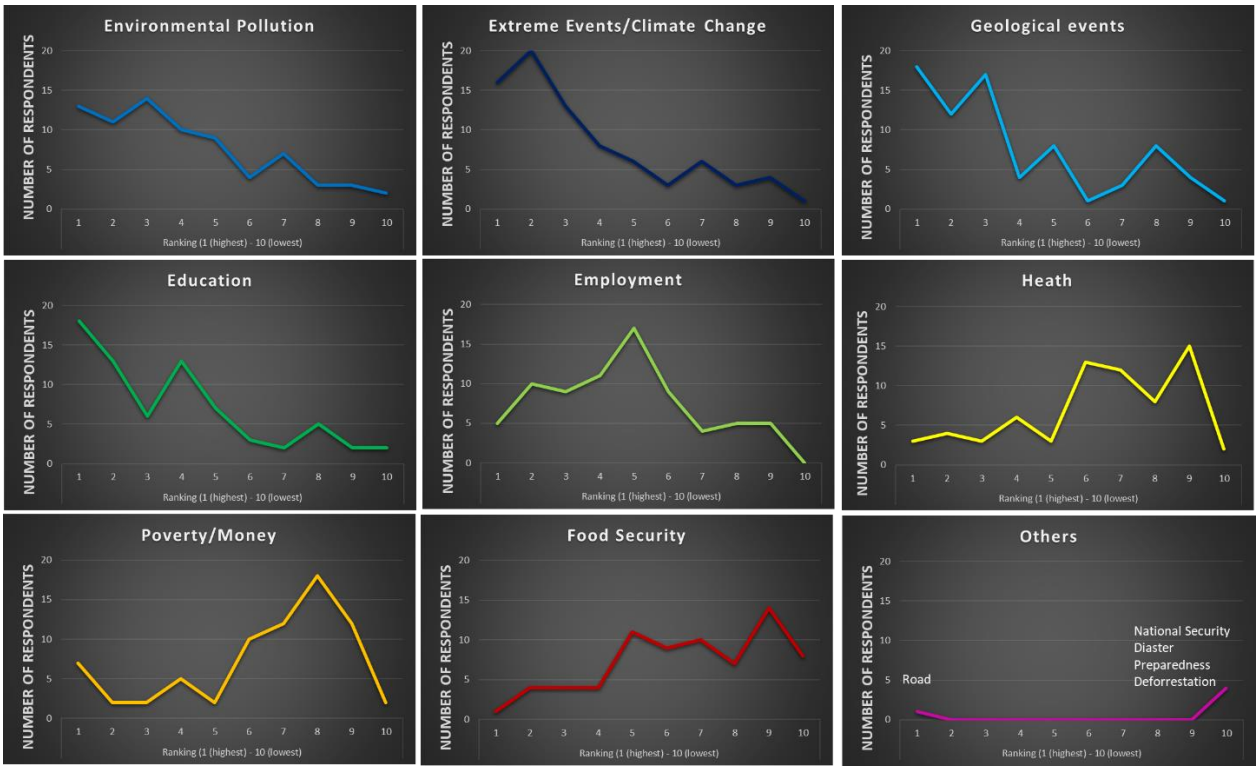

Figure 4.3 Results of current community challenges and priority rankings per sector.(n=88)

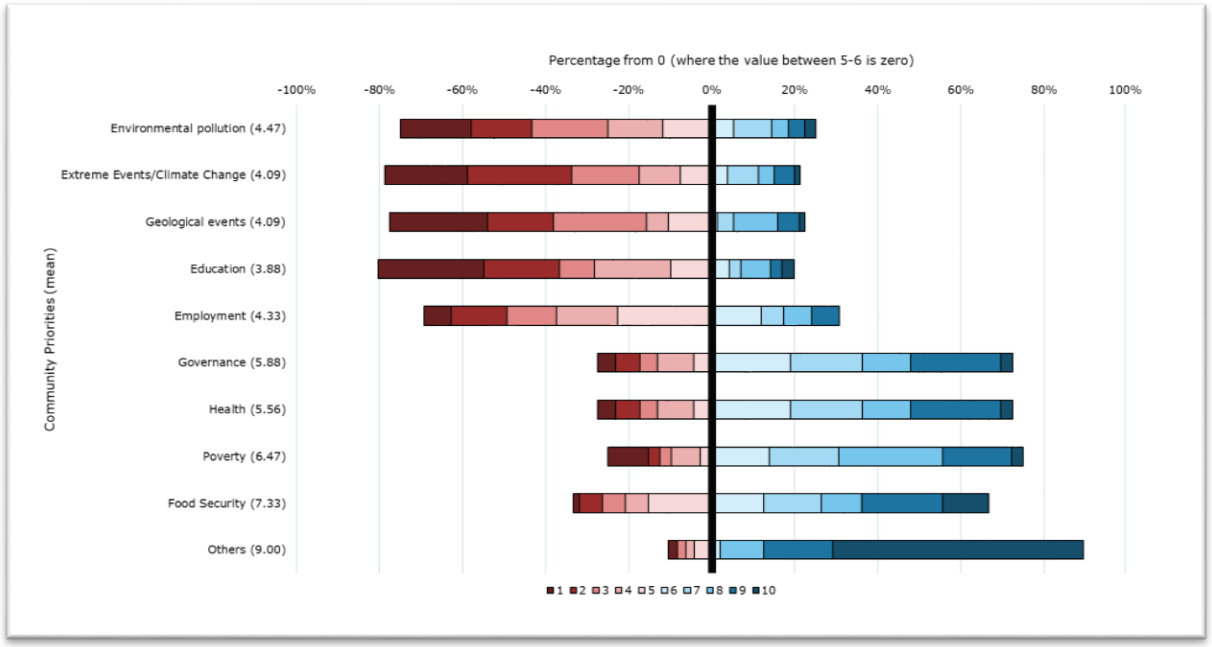

Figure 4.4 Household perceptions of current community challenges and development priorities by ranking based on the mid-value of 5. (n=88)

Table 4.2 SPSS analysis of community challenges and priority rankings

SPSS Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Environment	43	4.47	2.737	1	10
Extreme Events	43	4.09	2.698	1	10
Geological Events	43	4.09	2.671	1	10
Education	43	3.88	2.471	1	10
Employment	43	4.33	2.146	1	9
Governance	43	5.88	2.393	1	10
Health	43	5.56	1.868	1	9
Poverty	43	6.47	2.711	1	10
Food Security	43	7.33	2.286	1	10
Others	43	9.00	1.988	1	10

Friedman Test

Test Statistics[a]

N	43
Chi-Square	119.663
df	9
Asymp. Sig.	.000

However, when respondents were asked what they thought were the challenges for future generation the priorities change slightly. A drop in the mean and frequency for environmental, education, and employment, was observed, with an increase in all other sectors (see Table 4.3). Some respondents have a more optimistic view of the future, believing that environmental issues such as climate change will be better, while other sectors will see more negative impacts such as heath (see Figure 4.5). Some respondents believed that health, food security, and poverty, will be more significant in the future (see Figure 4.6).

Table 4.3 SPSS analysis of 2100 community challenges and priority rankings.

SPSS Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Environment	40	4.73	2.801	1	10
Extreme Events	40	4.30	2.757	1	9
Geological Events	40	4.75	2.968	1	10
Education	40	4.27	2.562	1	9
Employment	40	5.00	1.695	1	8
Governance	40	5.48	2.621	1	9
Health	40	4.73	2.449	1	10
Poverty	40	5.72	2.611	1	10
Food Security	40	6.30	2.604	1	9
Others	40	9.48	1.694	1	10

Test Statistics[a]

N	40
Chi-Square	93.727
df	9
Asymp. Sig.	.000

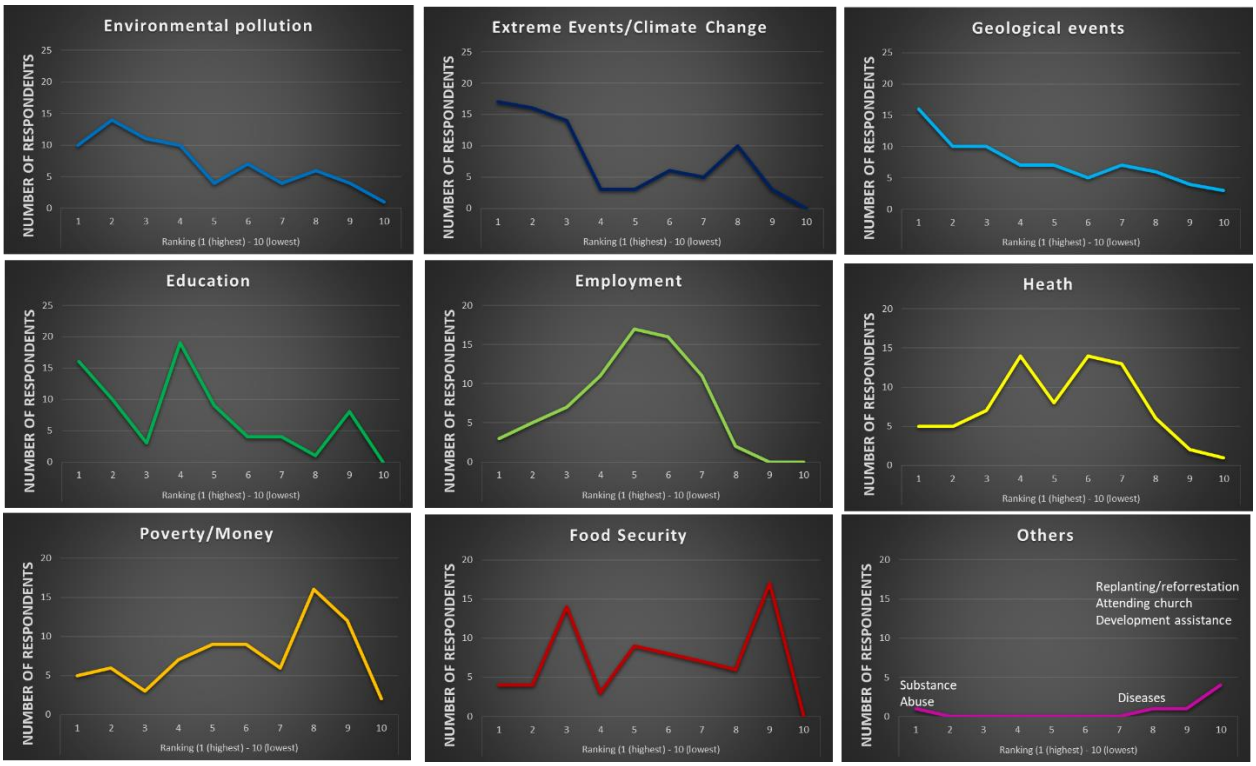

Figure 4.5 Rankings of Community development priorities and challenges (n=87)

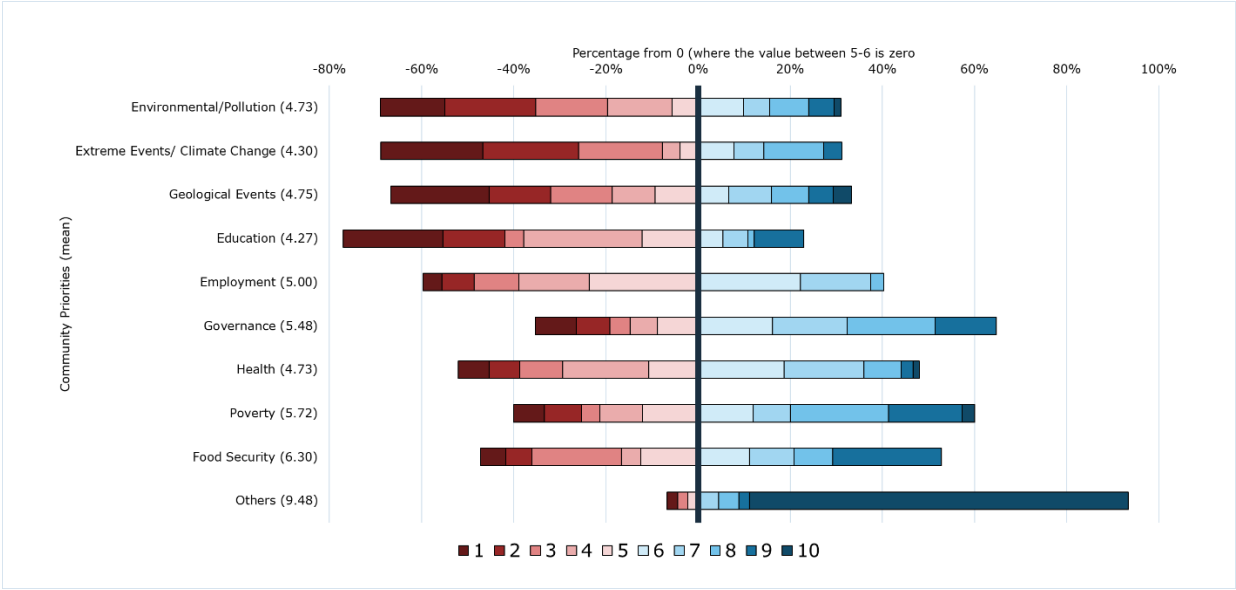

Figure 4.6 Household Perceptions of Community Challenges and Development Priorities for the year 2100 by ranking based on the mid-value of 5. (n=87)

Respondents were asked why they rate 'extreme event and climate change' on both section as they did. A large majority responded that they are already experiencing climate change impacts, with some stressing the importance of addressing climate change adaptation, and even making some efforts towards mitigation. A few thought that there were more pressing community issues, and respondent stated:

> *"Alcohol abuse is the most critical, especially now with…cheap alcohol with high alcoholic content…So disasters and climate change are low (priority) because that is God's will but this (alcohol abuse) is what we are in charge of. The village council and government should do something about it".*

Other priorities also came through:

> *"…Nowadays it's not the same, work does not earn you enough money to get what you want."*
>
> *"Today food for consumption are not protected for the people. We need to protect food".*
>
> *"A lot of infectious diseases but we don't have enough medicine and cures, and there's less recognition on the importance of Samoan medicinal practices."*

These findings suggest that although climate change impacts are supposed to get worse in the future, some community members have an understanding that climate

change will be something they only experience in the present time and that the future of climate change will not be a high priority for their community. This means that some community members may see the future with more optimism, especially in regard to environmental issues. A similar finding from rural communities in Fiji also supports the idea that climate change is a current issue with a better outlook towards the future (Nunn and Kumar, 2019), despite current negative experience amongst community members regarding present impacts of a changing climate.

A Friedman test was conducted on the data, using gender and location as the independent variable. As the author wanted to know if there were any differences in response to the questions. The chi-square test for both Table 4.2 and 4.3 were not significant. Meaning there was no influence of the independent variable to the results.

4.4 Environmental and Climate Change Awareness

A majority of respondents believe the environment and climate are changing, with 92.3% believing climate change to be a real phenomenon (Figure 4.7). While 72.4% of them believe that human activities are responsible for these climatic changes (see Figure 4.8), of the 17.2 % respondents who answered ‘no’, i.e. that climate change is not influenced by men (see Figure 4.8). Of this 17.2%, when asked why, 88% of them, attribute these changes of the climate to the ‘will of God’ which is irrespective of human desires and action, while the remaining believe climate change to be a natural phenomenon not influenced by humans.

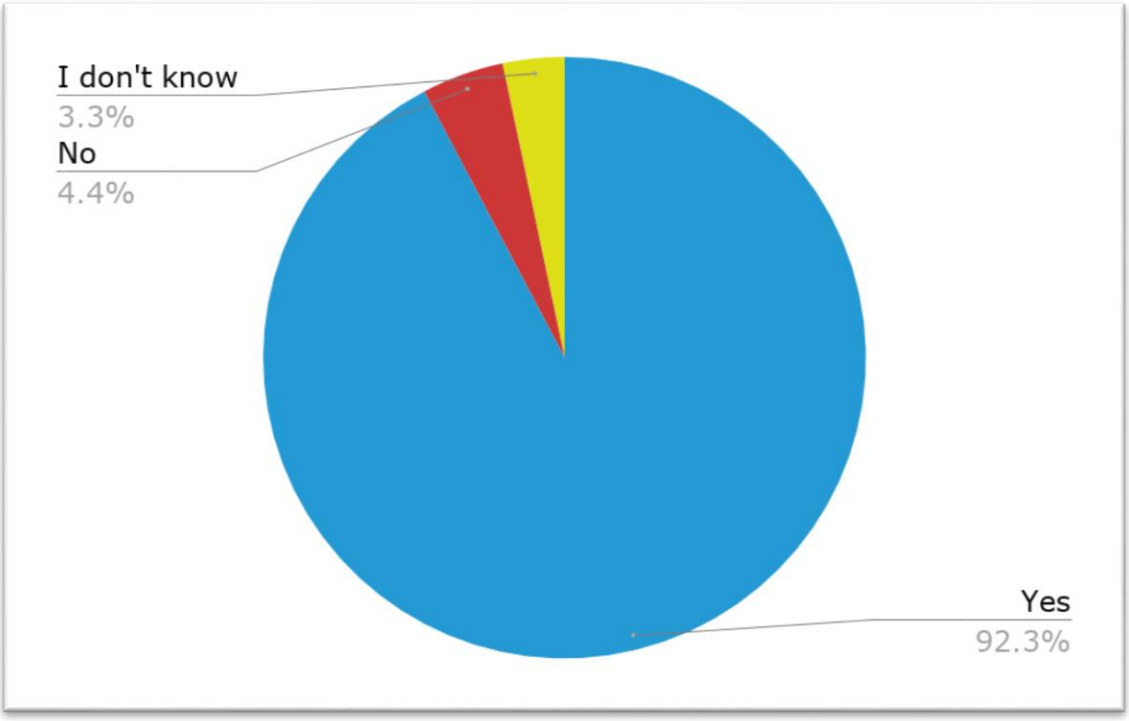

Figure 4.7 Respondents who believe in or experiencing climate change (n=90)

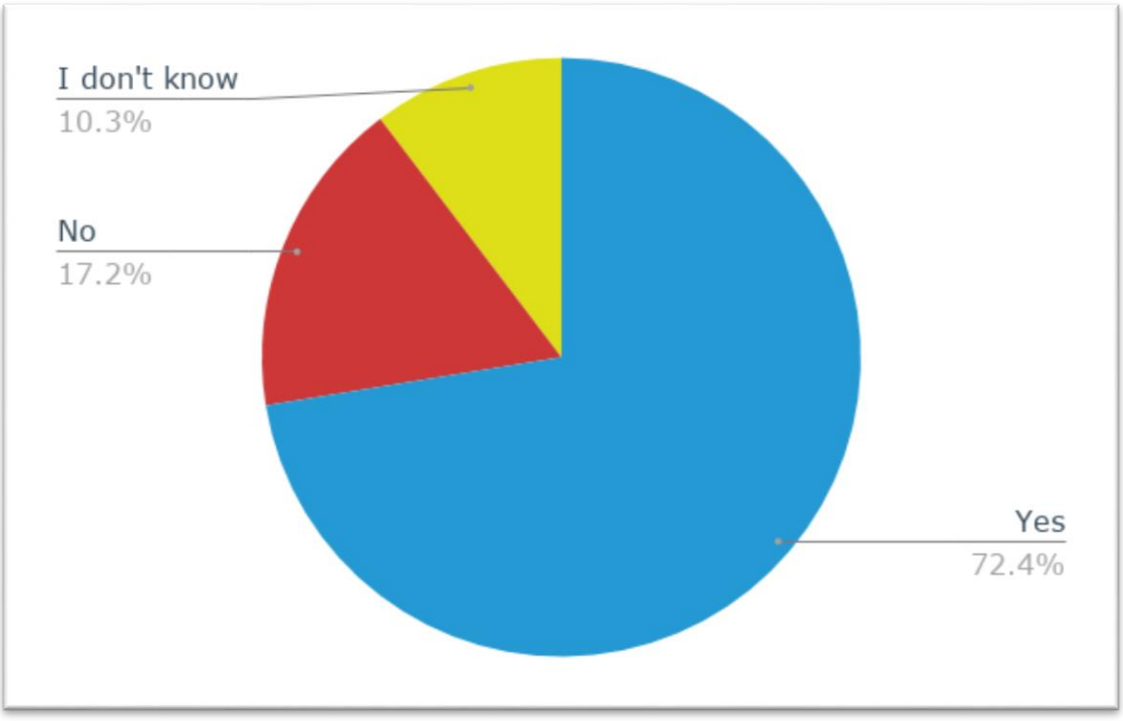

Figure 4.8 Respondents who believe in anthropogenic climate change (n=90).

This level of awareness about climate change appears to very high, compared to other studies on rural communities in the Pacific (Nunn et al, 2014; Walse et al. 2015). This high awareness might be due to national awareness seminars, community experience, or a combination of both. This was not determined in the present research.

When asked where they had observed changes in the environment, most respondents indicated the ocean and marine environment, and temperature change (see Figure 4.9). The respondents were then asked to further clarify what specific changes are they observing under each environmental category indicating changes in coral ecosystems (71.1%), sea-level rise (70.0%), coastal erosion (62.2%), tropical cyclones, and intense rainfall equally at 46.7%. Other categories some level of observed changes included more days with extreme heat, droughts, and stronger wave energy, were added by respondents and are listed in Figure 4.10 under ‘others’.

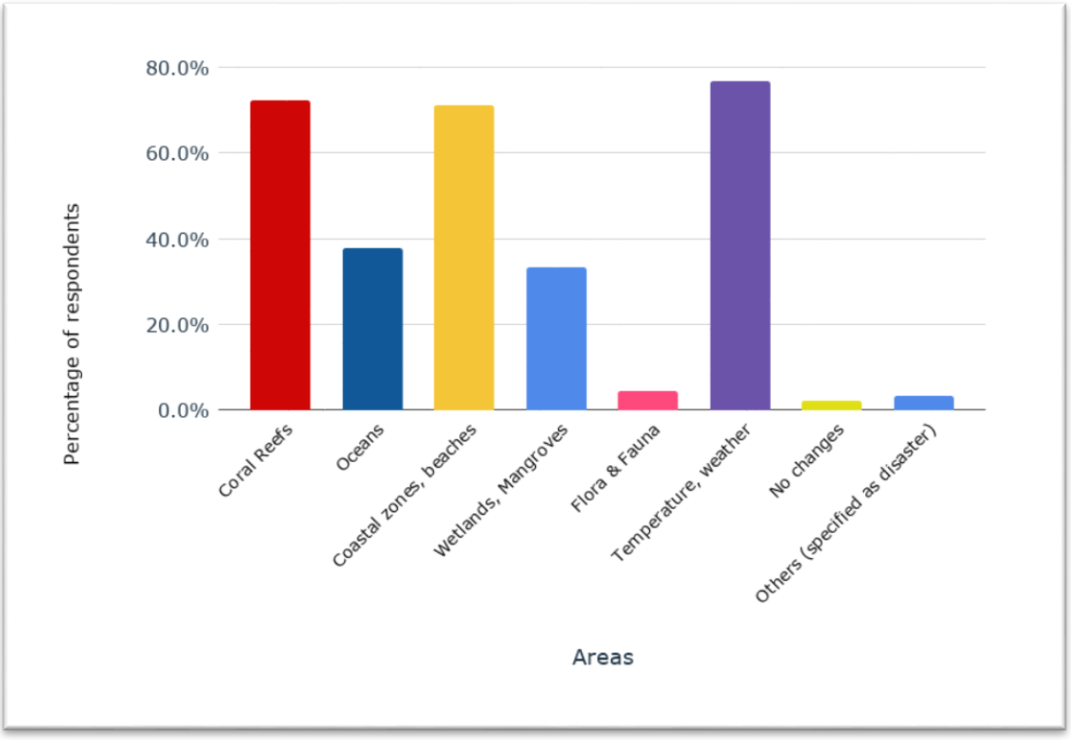

Figure 4.9 Areas where the environmental impacts of climate change have been observed by respondents (n=90)

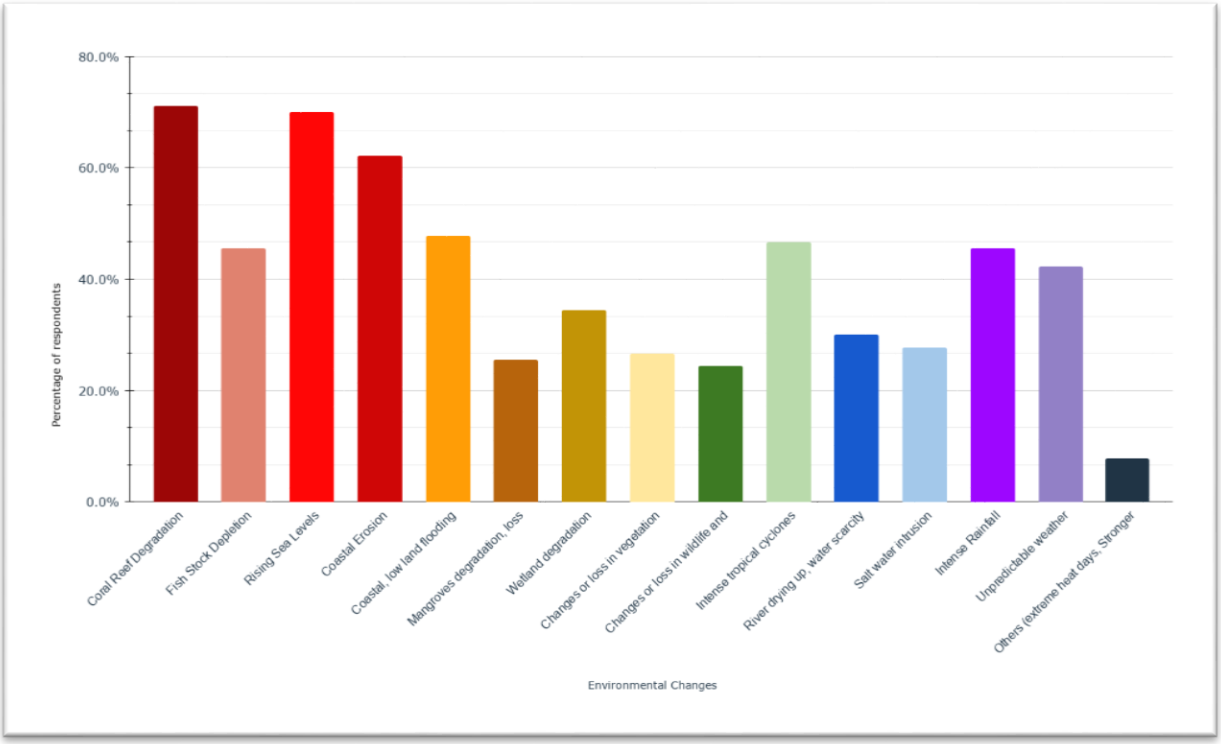

Figure 4.10 Environmental changes observed by respondents (n=89)

4.5 Community Adaptation and Governance

Respondents feel a high level of confidence regarding the adaptation measures undertaken to reduce the impacts of climate change. A majority of 68.2% believe that their adaptations are keeping them safe, while 28.4% believe they are not and 3.4% do not know, as shown in Figure 4.11. The high-level confidence and trust are attributed to a positive view on local governance, community adaptation measures, and a sense of a united community approach to risk reduction processes. Around 45% expressed satisfaction in how their village has addressed (and will continue to address) climate change and the steps taken to minimize it's impacts on the community. The following two quotes highlight some of the views of respondents

> "*I feel happy and at ease, in every way, the village has undertaken to protect and safeguard all of its people."*
>
> *"Because we are all working together to ensure everyone is safe"*

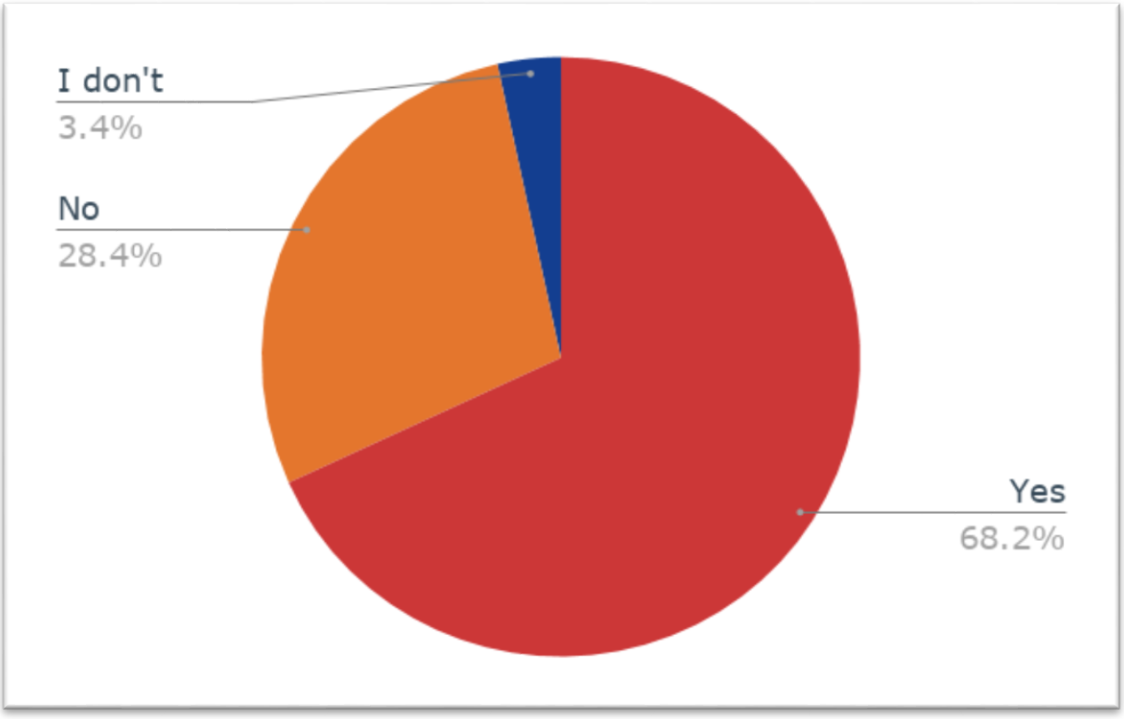

Figure 4.11. Do they feel safe with the adaptation practices the community has undertaken? (n=88)

Furthermore, respondents largely believe the local governing body, that is the *Fono a Matai*, has sufficient information and knowledge on climate change and the environment to make sound decisions (see Figure 4.12). Furthermore, 82.2% believe their concerns can be heard within their family units on any important issues, while 9.5% said 'No', giving two reasons, 1) they are not knowledgeable enough and 2) that they do not have any financial capital to make significant community contributions to be heard (untitled men might feel that having money will give them power and influence in the village). The remaining 8.3% answered 'I don't know' because they are likely not to be believed, as well as not knowledgeable enough on the subject to be taken seriously (Figure 4.13).

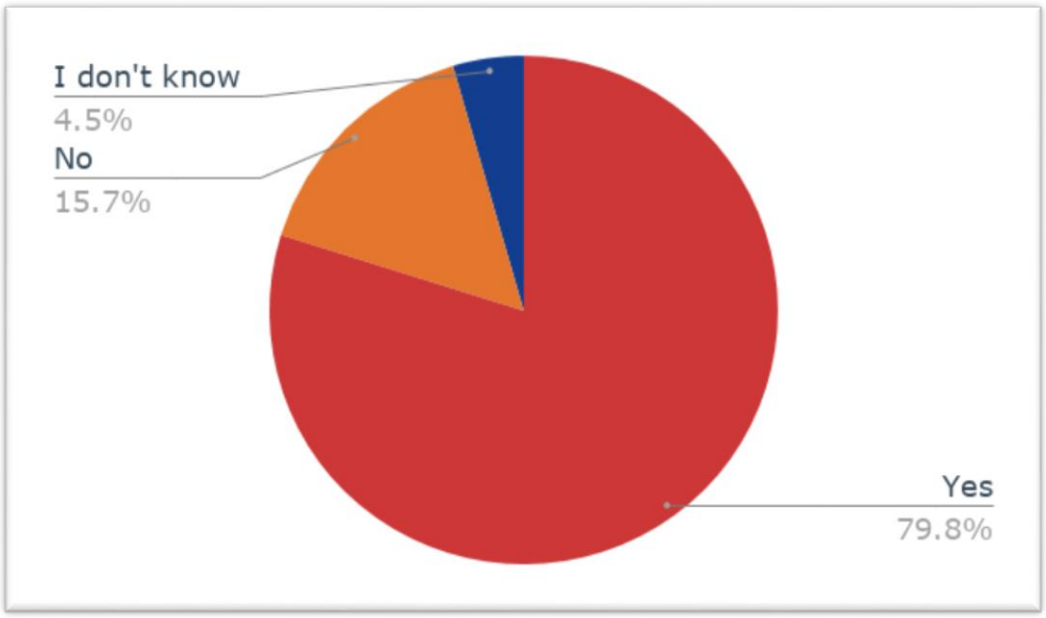

Figure 4.12 Village council knowledge and information access (n=89)

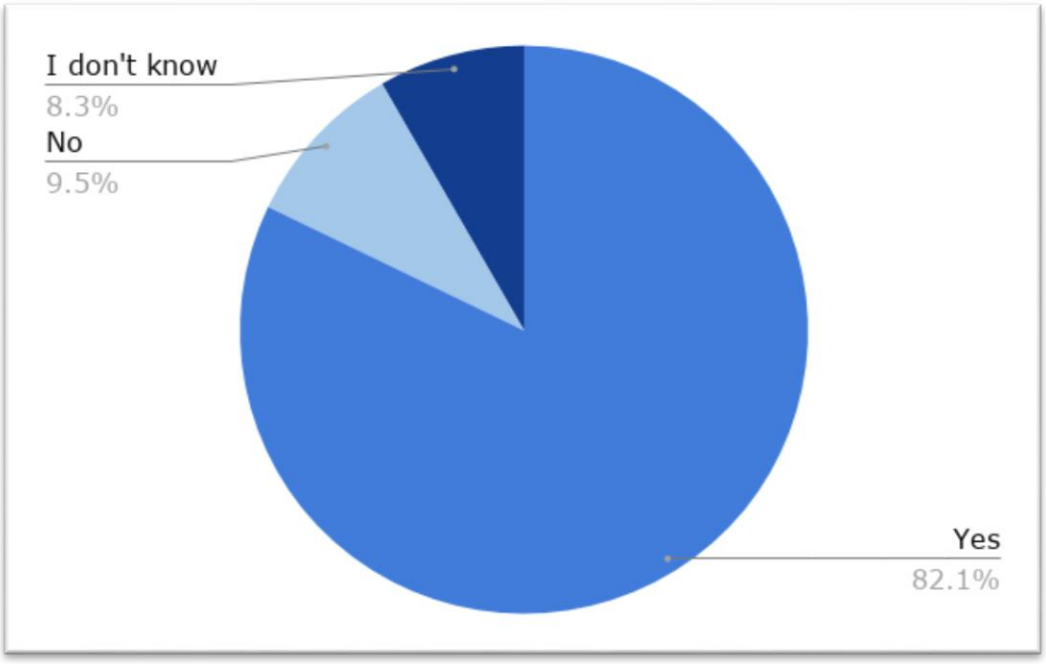

Figure 4.13 Are their concerns heard within their home. (n=84)

Similarly, when asked whether their voices are heard by the ‘Fono a Matai’, an overwhelming 85% said yes. While 8% said ‘no’, stating that the community hierarchy, not being believed, and being very disliked as reasons for this answer. 7% went with ‘I don’t know’ (see Figure 4.14), linking it to two reasons, with one individual saying they he does not know if he will be heard because he is not liked by any person within the community, and secondly having differences in opinions, either between individual and *matai* council member, or within the council ‘matai’ members themselves. However, while there are small numbers of individuals that feel their concerns will not be represented in the council’s decisions, the majority think the local systems are working well.

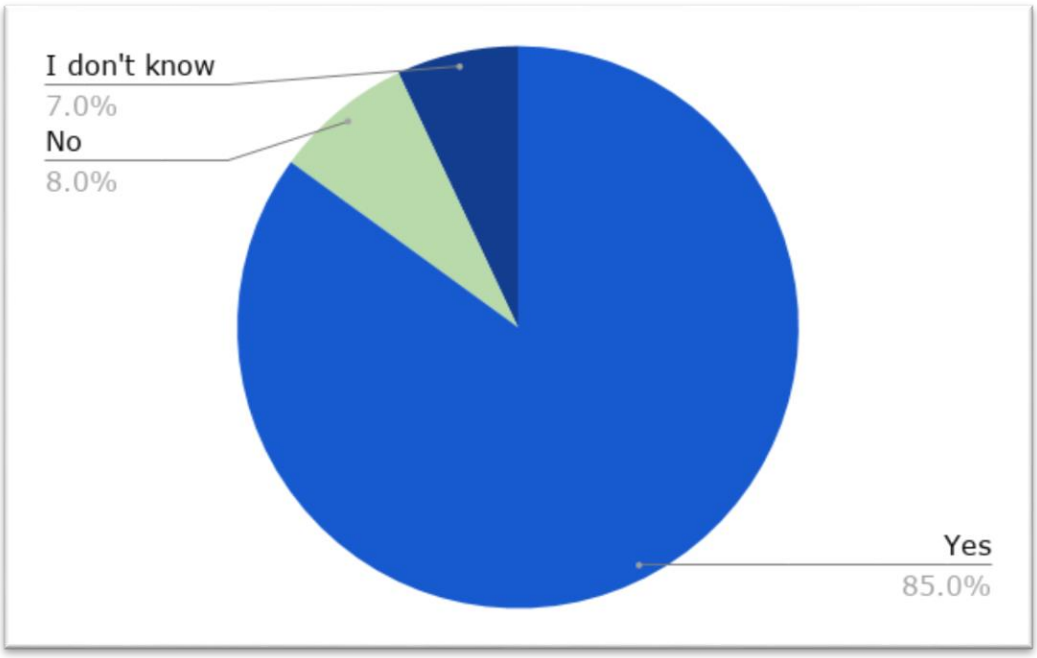

Figure 4.14 Are their concerns brought up in the ‘Fono a Matai’ (n=86)

Respondents who did not feel that climate risks were adequately addressed (see Figure 4.11) by adaptation measures provide two main reasons.

1. They are aware of the risk which SLR poses to them, and feel that current adaptation measures are insufficient.

   "...in our village, where we live, the ocean is right in front and the backyard is the wetland, meaning within the next 5 years or more it will all be inundated with ocean and freshwater."

   "Because my house is close to the ocean"

2. Skepticism on the effectiveness of the adaptation measures, and skepticism on the international community's commitment to addressing global issues.

   "Because the people of this country cannot stop other countries from destroying the atmosphere."

   "Because the American government won't help us"

Moreover, the level of confidence and trust in the local governing body may be partly a contribution of the amount of climate change information the national government delivered through adaptation projects, media programs and campaigns, community seminars, and workshops. In that sense, nearly half of respondents stating they have 'A lot of information' or 'Too much information' on climate change (in Figure 4.15). These national efforts have raised awareness of the root causes, impacts of climate change, and an understanding of the environmental changes they are observing. Increasing

awareness at the individual, household level, and local governing body, and the '*Fono a Matai'* leads to a general trust in the ability of the village systems (community members and the governing bodies (*Fono a Matai*)) to find solutions to adapt to climate change.

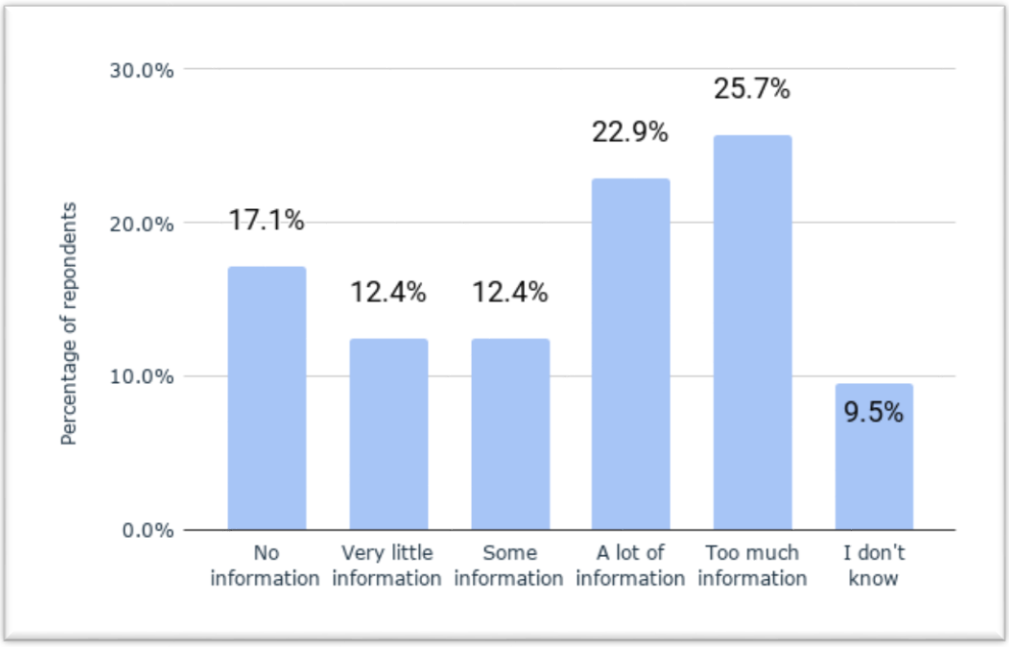

Figure 4:15 Amount of information received from the national government on environmental issues, including climate change. (n=86)

4.6 Relocation and Migration

One of the biggest questions this research set out to find is whether climate change will lead to mass migration or mass relocation of these communities. When asked if they have considered migrating the answer was universally 'No'. However, when asked what adaptation measures they would like to carry out, many referred to building a secondary

home inland, away from the ocean. So, when thinking about this willingness to have inland homes (as some form of relocation), it is important to note that the communities' do not view such solutions as either relocation or migration, as movements in their previous settlement have been a part of their historical nature. Essentially, they are building secondary homes within the boundaries of their community zones. Similarly, their current living situation shows evidence of having more than one home property, usually different houses for different or specific purposes. This is unlike the western understanding of homes. For example, many family units would have a house (usually for living and sleeping), while another structure (often an open house) is situated in front for guests and ceremonial gatherings, while the kitchen would be behind the house. It is not uncommon for one family to have many residential structures and properties. However, due to climate change and disaster risk reduction, this concept has now extended beyond the usual proximity of these buildings with each other and are now many meters or even kilometers inland well apart from the usual family residence. This leads the author of this thesis to refer to such practices as an 'extended settlement'.

Therefore, 65% of the respondent are considering relocation (see Figure 4.16), but within those who are thinking of moving 84% are considering moving within this extended settlement, and only 8% are wishing to move elsewhere within the country, and another 8% want to move overseas (see Figure 4.17). This latter group has a common denominator of searching for employment and educational opportunities as the reason for wanting to move overseas. There are many reasons provided by respondents for wanting to build a second house within their settlement, according with the challenges

and priorities they ranked previously. However, environmental issues seem to be the primary reasons for these secondary settlements (see Figure 4.18).

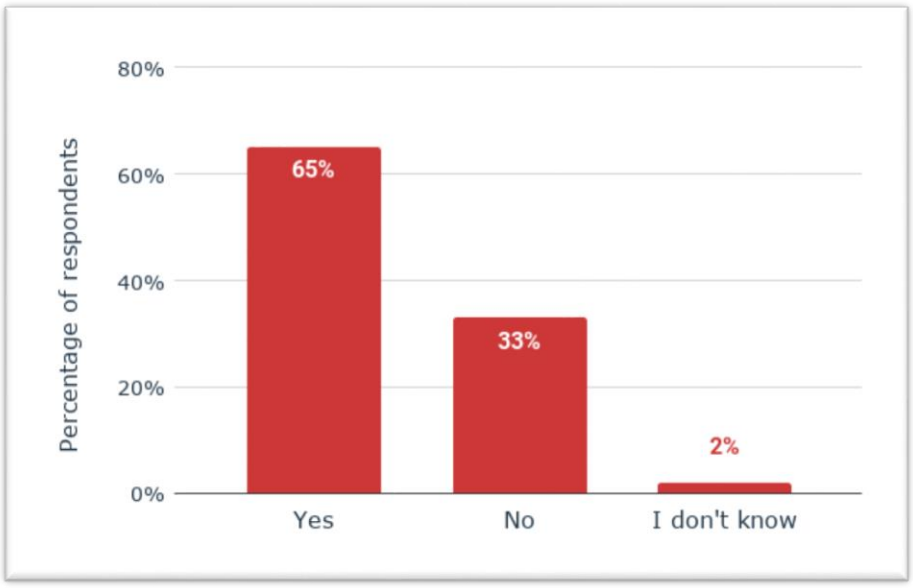

Figure 4.16 Proportion of respondents who have considered relocating (n=89)

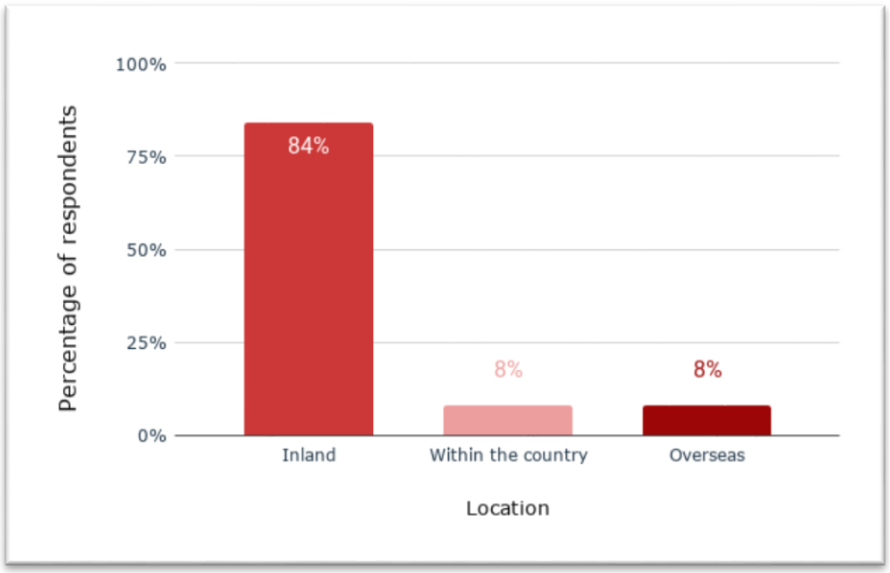

Figure 4.17 Destination where those wanting to relocate/migrate would like to go to. (n=89)

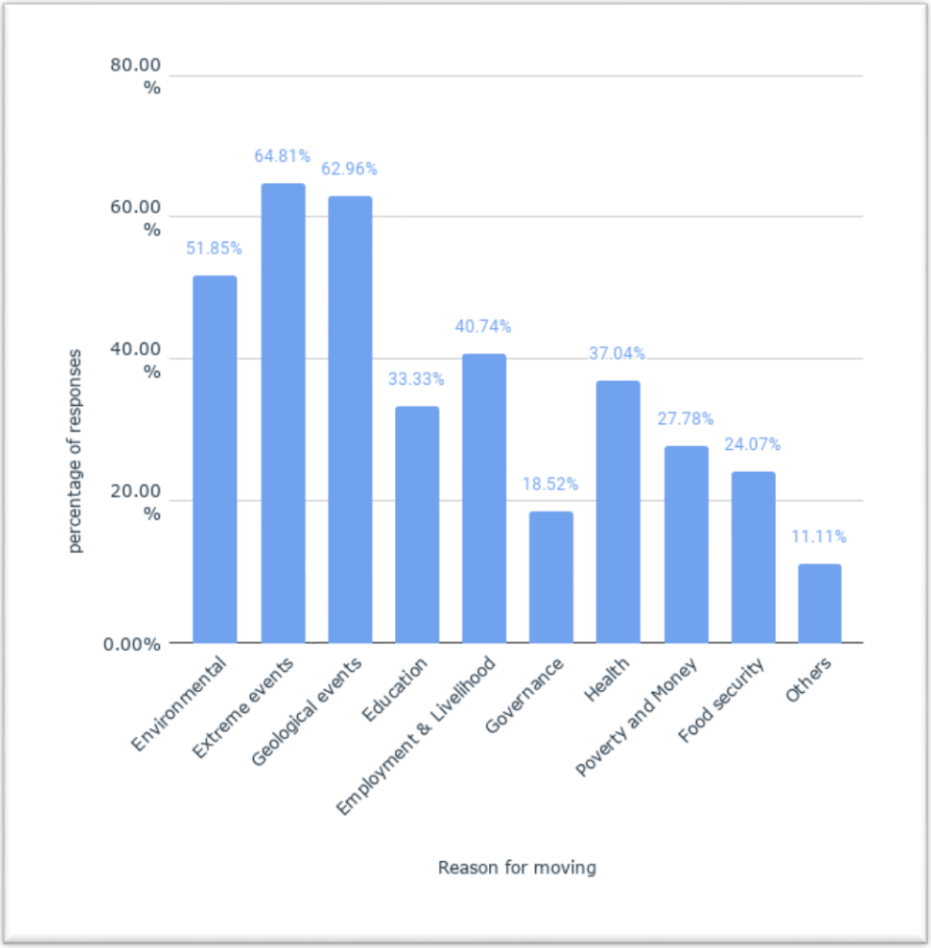

Figure 4.18 Reasons for potential future relocation (n=57). Multiple choices allowed.

While there are many reasons why the community is not willing to move or relocate, family members and properties seem to be the primary reasons why this has not taken place (see Figure 4.19). The current extended settlement movement that has taken place during the last decade has as its main objective to reduce climate risk, though many still maintain their primary residences near the coastline.

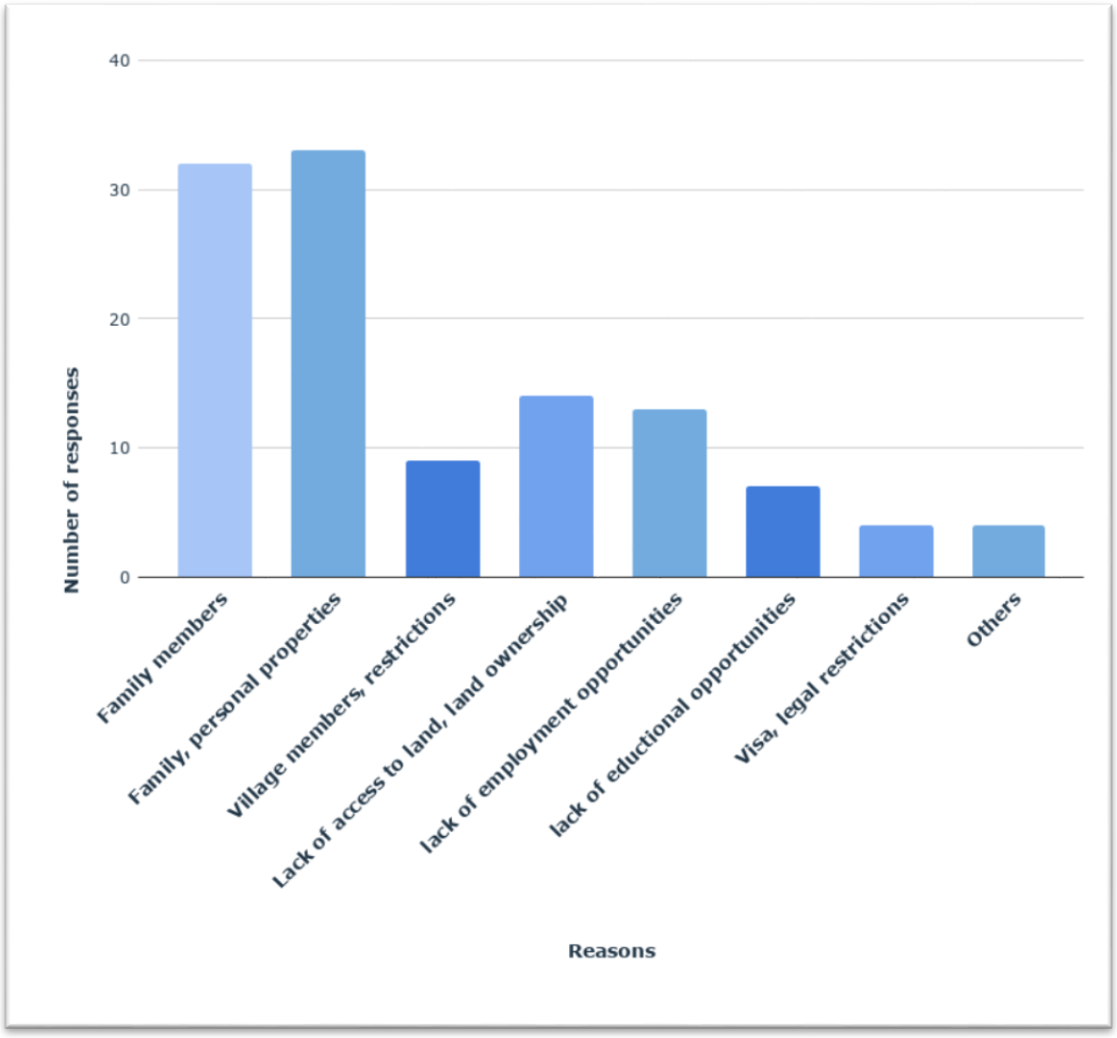

Figure 4.19 Reasons preventing respondents from moving or migrating to another location. (n=51)

4.7 Future Impacts, Climate Change, and Sea-level rise.

The respondents were asked whether they feel that they (including family and properties) are safe in 2100. An equal proportion of 38.7% both said ‘yes,’ and ‘no,’ while 22.6% were not sure. However, when asked if they are concerned about climate change

the positive response was 67.7% (see Figure 4.20). These concerns vary across many different areas (see Figure 4.21)

So, while climate change is a certain concern in the community, the risk they associated with climate change varies. Respondents who had positive views against climate change impacts thought they have adequate adaptation mechanisms, or that the impacts will not affect them personally. The most prominent reason for this view has to do with religion/faith. The assumption that having faith will yield a more promising future despite science showing negative impacts shows that religion plays a significant part in the lives of these community members, that adaptation and the magnitude of the climate risk is influence by their religious beliefs. (see Figure 4.22).

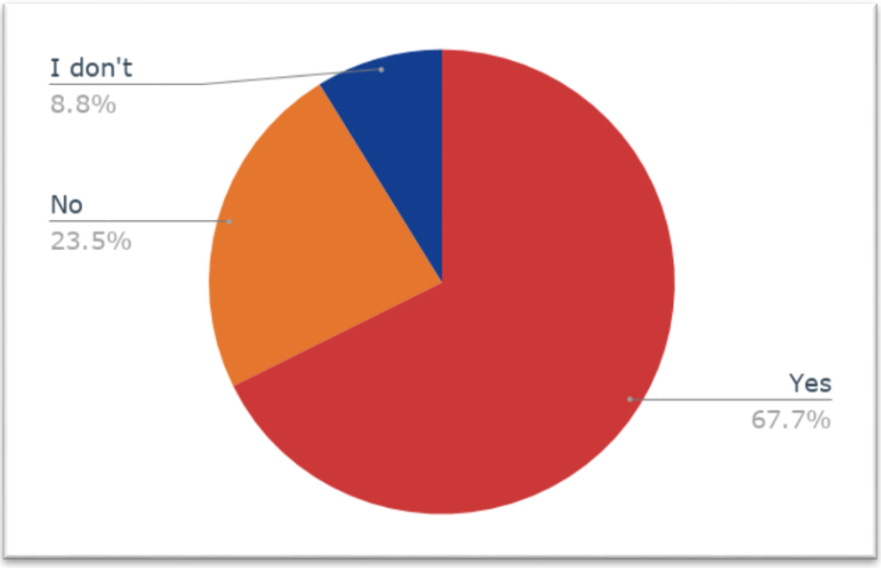

Figure 4.20 Whether they are concerned about climate change. (n=68)

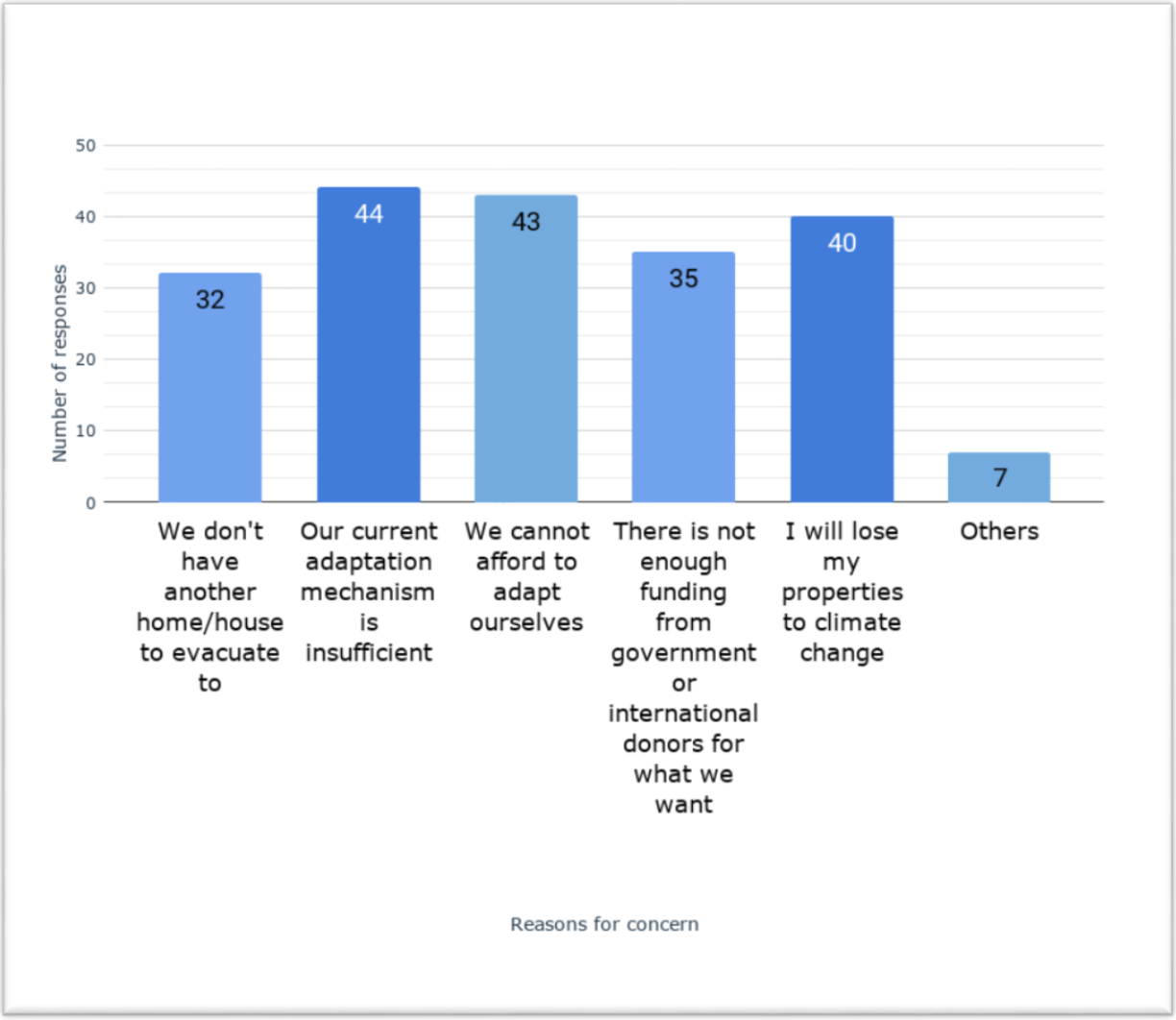

Figure 4:21 Primary reasons why they are concerned about climate change (n=69)

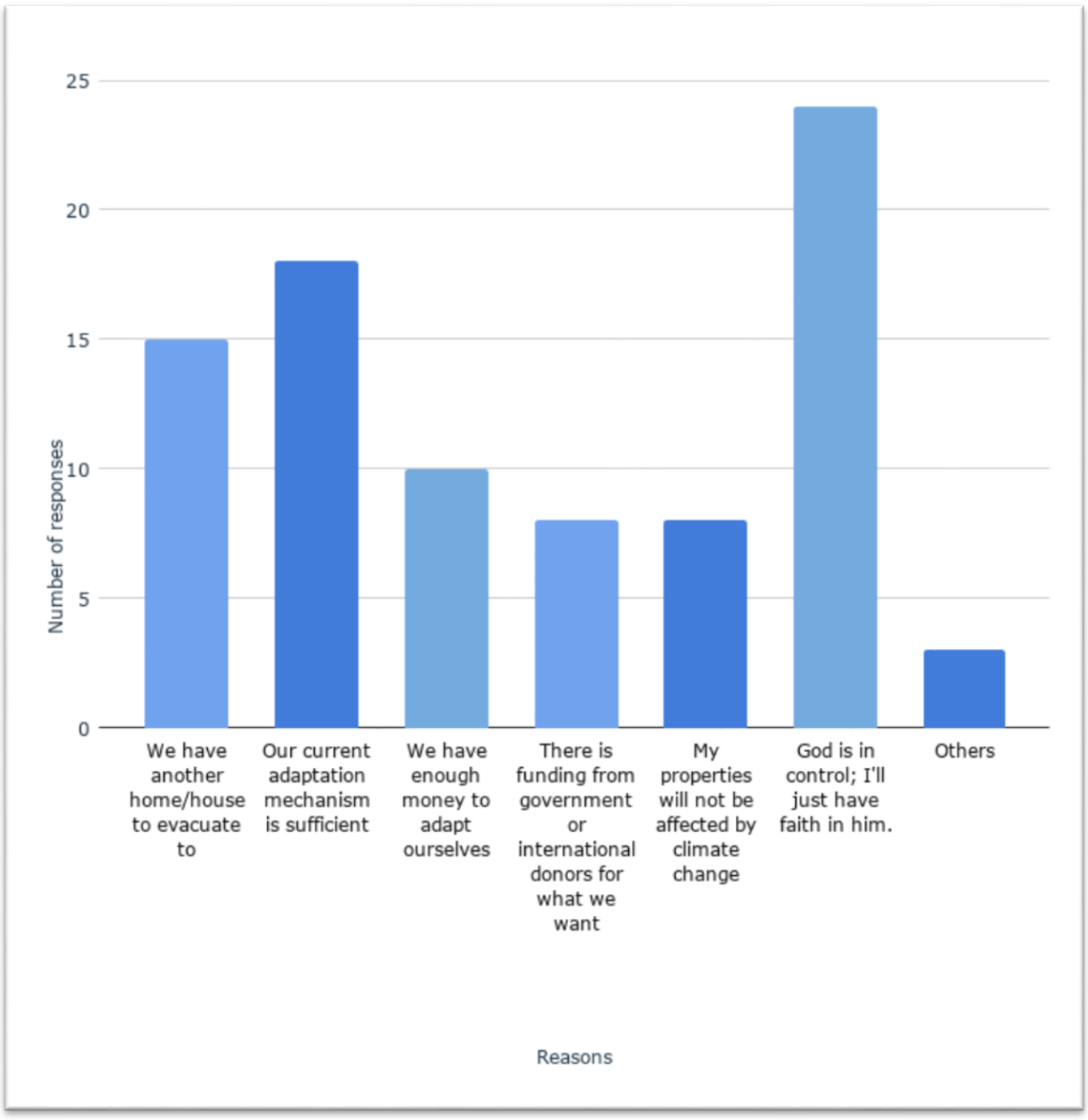

Figure 4.22 Why some members are not concerned about climate change. (n=42)

4.8 Preferred Adaptation to Sea-Level Rise.

There are six-way to respond to sea-level rise outlined in the IPCC SROCC (IPCC, 2018) (see Figure 4.23). The respondents were asked to state any adaptation measures they would like to undertake if they had the opportunity to address sea-level rise. The responses of individuals suggests that 'extended settlement' is the preferred adaptive response to sea-level rise, while protection usually in the form of seawalls is the second most preferred, and ecosystem-based approaches are the third preference. Some other interesting suggestions were gathered, including the call for mitigation by reducing greenhouse gas emissions, and discontinuing the cutting down of forests and trees. The desire for financial assistance, either from the national government or international communities, as well as relying on faith, which the author has labeled the 'do nothing' response, because it eliminate the responsibility on the individual to take any action on climate change. These were frequently shared by many respondants under their adaptation preference (see Figure 4.24).

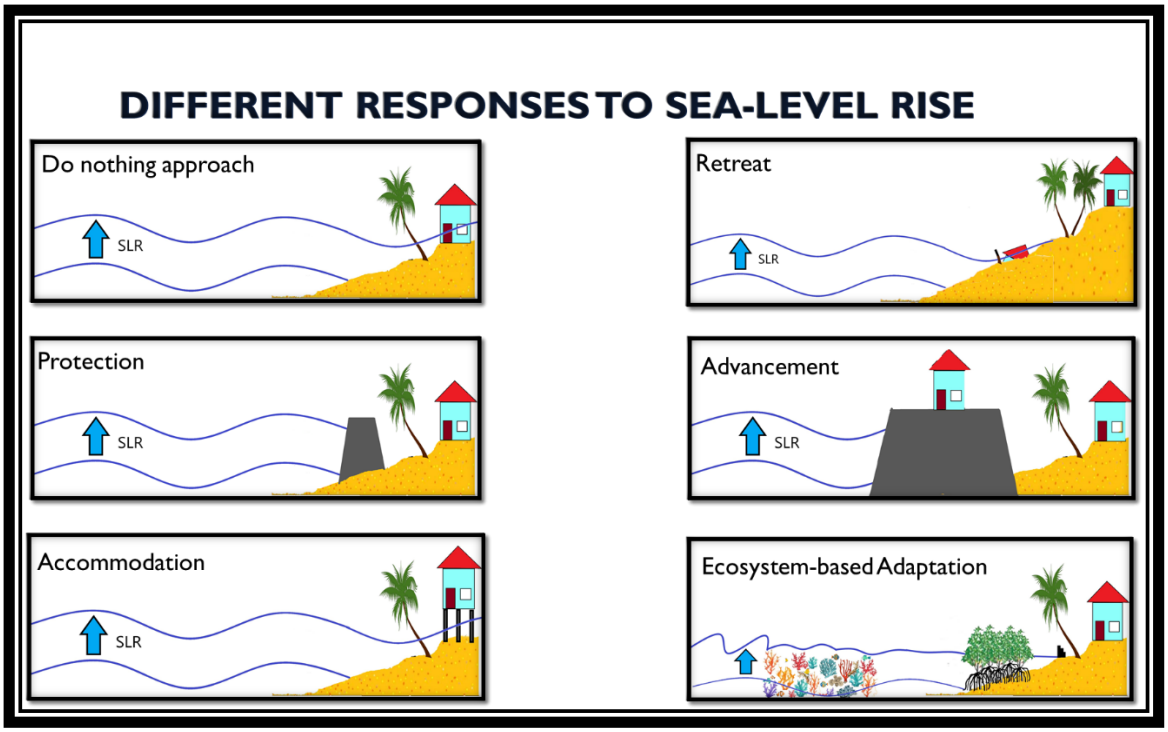

Figure 4.23 Different responses to sea-level rise.

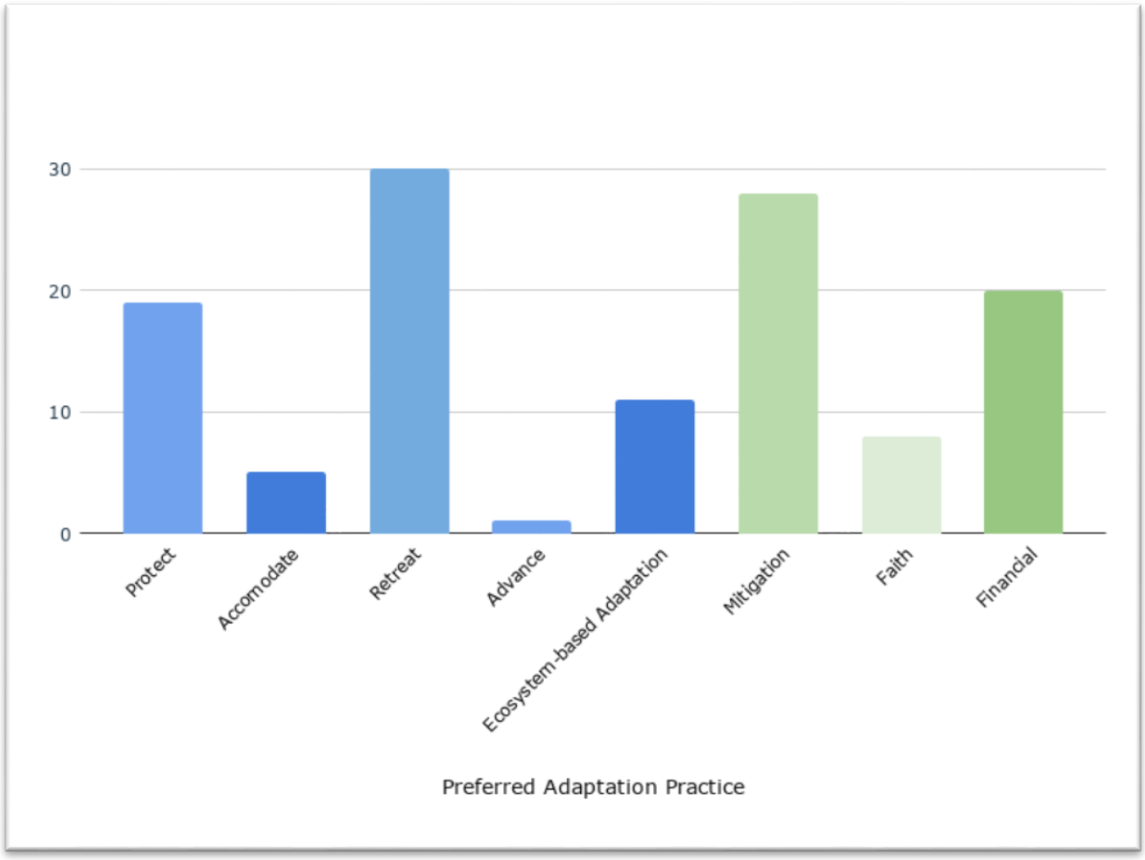

Figure 4.24 Preferred Adaptation Responses to sea-level rise. (n=64)

Inland relocation and climate change mitigation (although it is not an adaptation response), were the most common suggestions to address SLR by community members, followed by protection through hard infrastructure and financial support. Each community differed in their preferences. Satoalepai and Lelepa prefer to use ecosystem based approach and inland relocation, whereas Fagamalo seemed to prefer hard infrastructures (see Figures 4.25, 4.26, & 4.27).

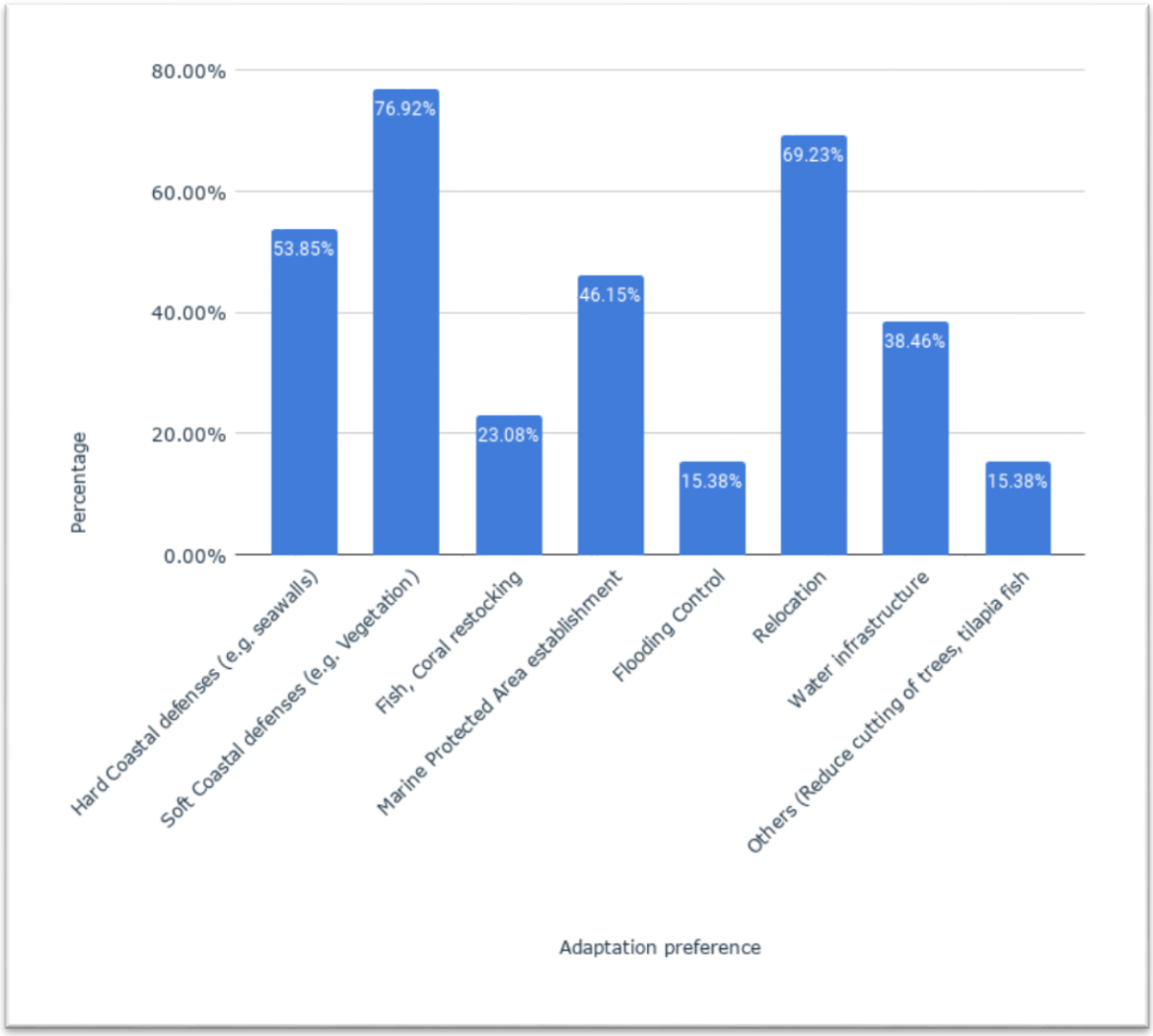

Figure 4.25 Satoalepai Village adaptation preference (n=13)

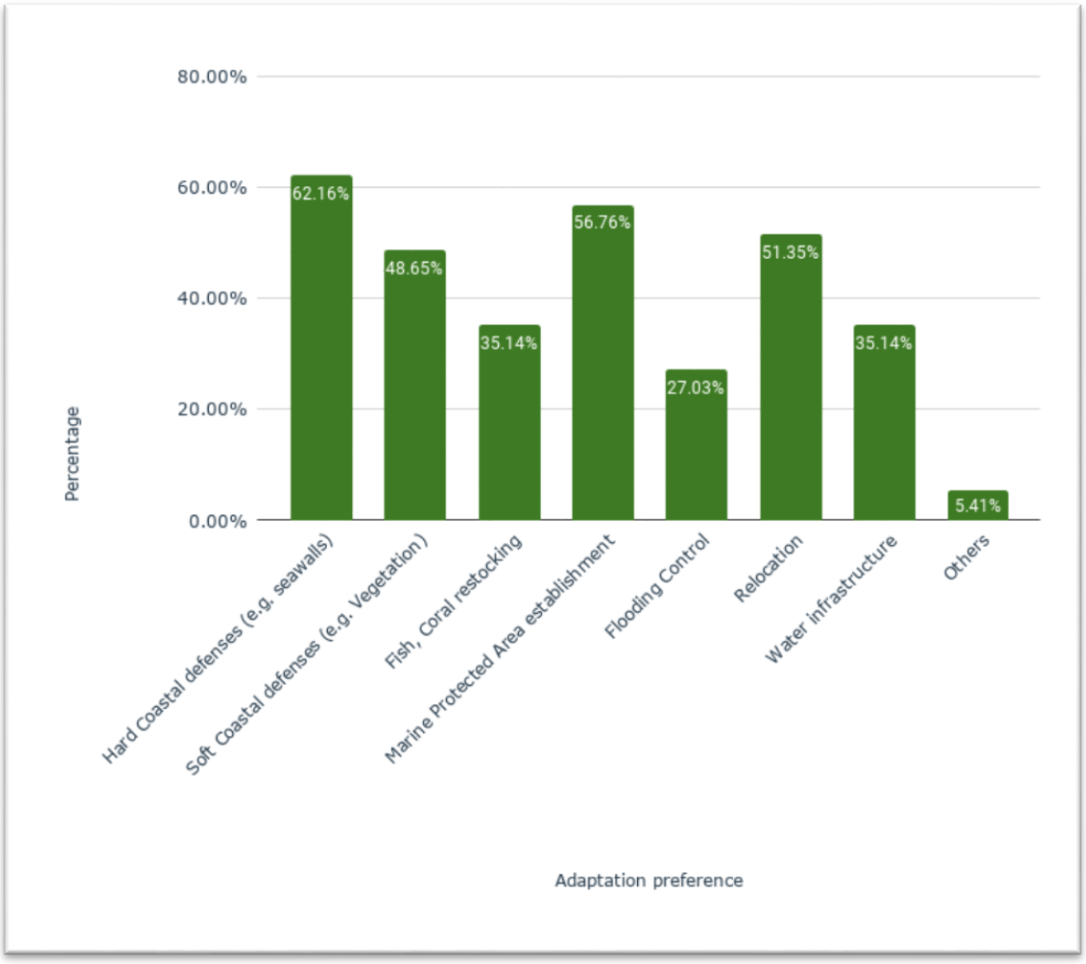

Figure 4.26 Fagamalo Village adaptation preference (n=37)

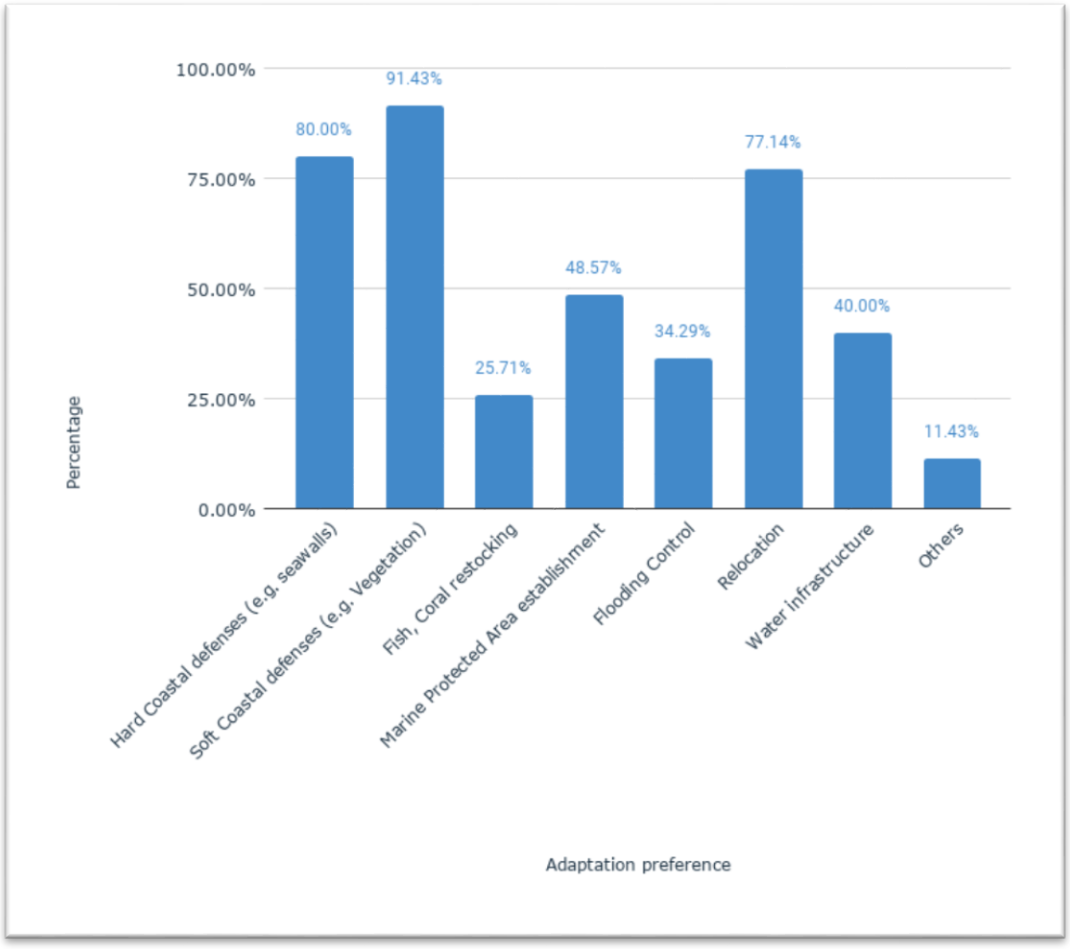

Figure 4.27 Lelepa Village adaptation preference (n=35)

4.9. Discussion and summary

In Samoa the official legal age for employment is 15, while the retirement age is 55, which may have contributed to the high unemployment rate in these household surveys, as the majority of the respondents were in the older demographics. Thus, it was not unusual that many of respondents classified themselves as unemployed/retired. Also, respondents who engage in subsistence livelihoods such as farming and fishing are

unlikely to classify themselves as having a job. As a consequence, it is likely that unemployment in rural communities in Samoa is higher than the national average, which takes into account higher employment rates in the nation's capital. Retired and unemployment were both considered as the same group in the household surveys, which contributed to the high rate of unemployment of between 53-84% (. A total of 40 individuals were receiving national pension in all three villages according to the Ministry of Women, Community, and Social Development: 2013 Village Profile. The benefit they receive includes free health and some dental care, inter-island travel and a monthly pension of SAT$135 (USD 53.70) per month for life.

The communities' view on development priorities and environmental challenges differ between generational timelines. Some respondents believe that climate change is a current problem and see the future with more optimism. Whether this influence their adaptation was not investigated further in this research. Their awareness of the impacts of climate change and SLR was significantly higher than other studies in the Pacific, including Samoa, have found. This level of awareness is not only due to their negative experience with a changing climate and disasters, but also through ongoing awareness programs with their national government, usually through capacity building workshops and seminars.

Most of the community members are happy with community governing bodies and their ability to address community concerns. There is a high level of trust on both the local and national government's ability to address concerns related to climate change and taking the necessary adaptation measures to minimize climate risks. The community, through access to customary rights and natural resources, has some power to influence

their adaptation responses, through a new type of relocation approach, referred to here as ‘extended settlement’. These factors will likely not contribute to migration or abandonment of these coastal communities for some time, as the sea rises.

Chapter 5: RESULTS: Participatory Approach

5.1 Community Group Maps.

In the mapping exercises that were conducted during the first two sessions community groups were asked to draw the current and past distributions of households and other elements of their settlement, to understand any internal community relocation that has taken place in their lifetime (see Figure 5.1). The exercise showed a small number of households did rebuild or remodel, though there was little or no major relocation from their previous settlements (i.e. their current homes were either constructed on top of their previous homes or near the periphery of them). No participant had moved a great distance, indicating that climate change has not caused any major relocation in the participants' lifetime, although there is also the possibility that those that have already relocated inland did not participate in this exercise. Groups were asked to indicate where their previous homes were located in red on their group maps (see Figure 5.1).

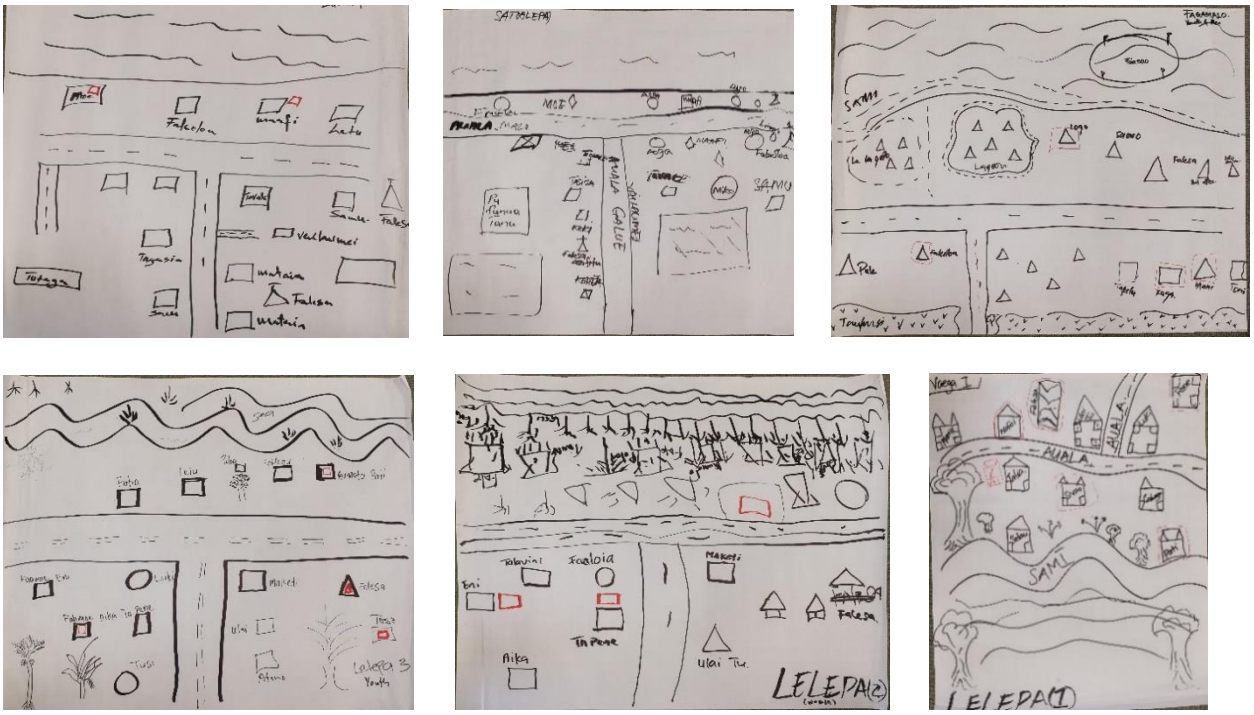

Figure 5.1: Community mapping illustration: Top (from left to right) Satoalepai women's group; Satoaleapai Chief's group; Fagamalo Youth and Men combined groups. Bottom (left to right) Lelepa Youth; Lelepa Women's Group; Chief's group.

5.2 Sea-Level Rise inundation scenarios

5.2.1 2050 SLR scenarios

For the fourth session, each group was presented with the best case SLR scenario for each of their communities, for the 2050-time horizon. Since very little inundation was shown on the map there were no major concerns expressed by any of the community groups, and no adaptation pathways were considered by them. Since it was the first time, they were presented with the actual layout of the community through a satellite map, thus most of the time was consumed with locating sites and the homes of the participants.

In the fifth session, the groups were presented with maps of the 2050 worst-case scenarios. These worst-case scenarios combined SLR based on unchecked pollution of greenhouse gas emissions and moderate luck. There was a marked difference in the responses by each of the groups with respect to best-case scenarios, as summarized in Table 5.1

When worst-case scenarios were shown to each group, the Chiefs of Lelepa opted to ask the community, without much hesitation, to relocate inland. However, the opinions from the women and youth of the same village were contrary to this, as highlighted below. The chiefs of Satoalepai also echoed the same sentiment as the Lelepa chiefs on how their village should address SLR and disasters:

> *"We feel that we can stay here and build seawalls and plant trees along the coast to protect us all, and our lands, and homes" (Women's group).*

> *"We shouldn't give up hope and leave, we can take care of our environment. Plant trees along the coast to protect the coastline." (Youth Group)*

> *"...We have a wetland (river) running behind our village. We can see that if a natural disaster occurs, we are the first ones to go. But the first thing we should prioritize is to prepare higher grounds where we can seek safety and preserve our lives there. We know that higher grounds are the only safety*

for us living here at the shorelines. We know that even if we build a wall along the seashore, the waves will break them down because they are man built. We do not interfere with our God's decisions. But we know that none of us will be around the year 2050 but we want to do something for our generations to come and our constituency." (Satoalepai Chief's)

Table 5.1 Summary of representative responses from community groups for the 2050 worst-case SLR scenarios

Groups	Lelepa	Fagamalo	Satoaleapai
Chiefs (Matai)	"It seems the only thing and best option is to relocate inland"	"This workshop and information is very useful."	"We should prepare secondary homes inland, because even if we build seawalls the ocean waves will destroy them."
Women	"We can stay and build seawalls and plant trees to protect us all".	Absent	We should relocate inland.
Youth	"We shouldn't give up hope and leave, we can take care of our environment. Plant trees along the coast to protect the coastline."	No Comment	Absent
Others	"I live inland, and I don't want people to be moving inland."	Absent	Absent

5.2.2 2100 SLR scenarios

At the start of this part of the workshop, the coordinator (i.e. the author) reiterated the uncertainty surrounding future SLR scenarios, how multiple factors will contribute to different future paths, and that the 2100 scenarios represented both the best and worst cases. As these scenarios would take place 80 years later, it was emphasized that participants will probably not witness the consequences, but their descendants or grandchildren might.

The sixth session introduced participants to the best-case scenario for the year 2100, which showed minimal SLR inundation, with little or no major impact to the coastal zones and residential areas. The discussions and feedback from each group are summarized in Table 2.

Due to the huge contrast between the best and worst case scenarios for the year this session shifted some of the discussion from adaptation to mitigation responses. Below are some of the key discussions and voices hear:

> *"… our country compared with overseas countries where there are a lot of factories that emit gases. Compared to our Government, we do not have many factories to emit these gases, we only know a few here. But overseas countries have lots of factories emitting these gases and they are impacting our country. As we can see, by 2050 our shorelines will be badly affected. Our answer to these problems is for our country or Prime Minister need to*

plead with those countries to stop their pollutants. These have affected the sea level and greenhouse effect..."(Fagamalo Chiefs)

"…my question is, are we able to make the change...My question is can Lelepa work to salvage itself or... is it only helpful if all nations are in this? That is my question.... But what can the village do? Like what we can do is to plant trees and other developments. Would there be a change if we turn to tree planting and other developments instead of utilizing electricity, will this bring a change?" (Lelepa Chief)

Furthermore, the Lelepa chief seem to have reconsidered their stance to move the entire community inland, and have opted to stay but still have secondary homes inland for when they are needed.

"…and there is no other way but at this moment to erect sea walls and plant trees to stop coastal erosion. Our villages are the same as we are also by the seashore, I guess these are the only ways because of the situation of our village in 2100. The children now can start on these projects for the future generations to come. To work together for the betterment of our lands and villages".

So just to clarify, "what you have shared has changed somewhat as the previous thoughts were to retreat to higher grounds, but now the matai group are pledging to stay where they are? Is this true?" (author)

"Who wants to move if we see the beauty of the sea but for now, we can go both ways. Prepare higher grounds or live by the sea". (1st Matai)

"I want to add on to (that) part. We cannot ignore preparations for higher grounds and erect thereon solid brick houses. But it doesn't mean we should permanently move to high grounds and neglect here (our coastal village). Because it is here (coastal area), where we have the known (culturally significant) grounds and housings for the rest of the village. Whereas inland are the backyard of homes and backyard of our culturally (significant) area. But in the case a tsunami occurs, we can seek protection in higher grounds, where we will have solid houses and homes. But in the meantime, we live here and cater to our faalavelaves but we have our refuge places on higher grounds". (2nd Matai)

Meanwhile, the youth seem to be less hopeful for a solution:

"…if the greenhouse effect and rising sea levels continue, who are causing these things to happen? We do not know what to do. If we go to higher grounds, what if the sea level continues to rise and catch up? We feel the only thing we can do is to pray to our God for help. Those are the thoughts from the youth."

Table 5.2 Summary of representative responses from various groups for the 2100 best case SLR scenarios

Groups	Lelepa	Fagamalo	Sato'a'leapai
Chiefs (Matai)	"If this is the outcome then we want to stay here, and we can fortify our settlement with seawalls and coastal vegetation. We should also still have a secondary home inland for emergencies"	"We want major polluter countries to stop their emissions. We want the Samoan government to plead with them to do something so this map can be our reality."	"We should prepare secondary homes inland, because even if we build seawalls the ocean waves will destroy them."
Women	No comment.	Absent	"Our village is the most at risk out of these three communities, therefore we should move. We should elevate our homes near the coastal areas so we can still come back to it".
Youth	"We don't know how other countries will behave (towards mitigation), so all we can do is pray ."	We want all governments both national and international governments to act now.	Absent
Others	No comment	Absent	Absent

The seventh session discussed the 2100 worst-case scenario, as summarized in Table 3. At the conclusion of this session, the Chiefs encouraged heads of households to start building secondary homes inland for future relocation. No opposing views or comments were made from other groups following this final statement.

The conversation moved from adaptation measures to mitigation action, with the youth seeming to have lost hope for the future. At the end of this session, it was not clear how each village would address the issue of sea-level rise. What was clear is that all

villages have different desires on how to adapt to climate change, and different groups have also different desires for the future. All villages seemed to be having a desire to mitigate, and to ensure they will see best case scenarios for SLR:

> *"As I can see, we are living by the sea and it is a big risk. I have been to many seminars on climate change and natural disasters. My answer is, we have to move to higher grounds. But if you still want to remain in your house here, then be prepared to take a swim in the sea". (Satoalepai women)*

Table 5.3 Summary of representative responses from groups for the 2100 worst-case SLR scenarios

Groups	Lelepa	Fagamalo	Sato'a'leapai
Chiefs (Matai)	"We need help. We encourage families to move inland" "What can we do ourselves to mitigate the effects of a changing climate?"	"We will act to stop our own emissions. We stop cutting down trees and burning any trash"	"We should try to protect our homes but we should not neglect to rebuild inland where it is safer"
Women	No comment	Absent	"We definitely need a better escape route so we can easily move inland".
Youth	"We feel like there is no point but to move".	No Comment	Absent
Others	"The Samoan government and scientists should urge other countries to stop their emissions. I still think the people living here in the coastal areas should not relocate inland to where we live". "We need to work together with all other communities to minimize our emissions because we cannot do it alone. We have to work together".	Absent	Absent

The eighth session discussion started with expressions of gratitude from participants towards the workshop, as it was a first of its kind (allowing community members to participate in such an exercise). Participants from all groups came to the conclusion (despite opposition from individuals already living inland) that future relocation is inevitable and preparation for it should start, with secondary homes built inland (as some members of the communities have already done as a countermeasure against natural hazards). This suggestion was mainly promoted and vocalized by the members of the Chiefs' group.

5.3. Discussion and summary

In the early discussions, the Matai of Lelepa were in favour of relocating the community inland. This was met with some resistance from the women and youth, who were wishing to stay. In the final discussion the Matai of Lelepa seems to have toned down their views and incorporate the opinion of the women and youth, promoting a combination of all views. The views from each village also differed from each other. Hence, the answers provided were clearly location-dependent. Attachment to land, society, and willingness to remain are all factors that can be found in many other studies (Murakami et al. 2020; Tanaka et al, 2012). However, one of the limitations of the present study was that, due to an outbreak of measles that killed nearly a hundred people on the island, followed by the covid-19 situation, no further fieldwork was possible, and thus it

was not possible to ascertain if the results could be replicated in other communities. Also, it would be interesting in the future to see if communities in other countries in the region had similar views.

Furthermore, although there might be some disparity between the community participatory approach and the household surveys, it appears that most in the community think that they should establish secondary homes inland, while maintaining their current settlement along the coast as long as they are able to. Some of the slight differences in opinion might be down to the fact ethat during the workshop scientific evidence and data were presented, while the household surveys did not provide such information.

The methodology employed had several limitations, which are common to similar workshops and map-making exercises conducted elsewhere (Cubelos et al, 2019). Known problems include some members of the group taking a leading role, and others becoming passive, making it unclear to what extent the group outcomes represent the real views of all participants. Essentially, the ideas and maps were always presented as a group, and they might in that sense represent either a consensus, or the view of the "leaders" who were presenting on behalf of each group. Conducting the research with more groups, and a wider inclusion of the community members would have helped to see whether indeed different groups arrived at a similar consensus.

The decision-making body of *Ali'i ma Faipule* currently do not have any direct mechanisms for feedback from marginalized groups or village groups to be heard, who may have differences of opinion in how adaptation to climate change should be conducted. Furthermore, adaptation responses were limited to what the communities were exposed to, with high preferences towards external settlement, hard infrastructure (engineering)

and eco-system based adaptation (soft measures). This means that the adaptation responses they opted for are what they saw other communities carrying out. Thus, it is possible that the idea of an external settlement may have been originated from one village as a response to climate hazards, and has since expanded to other communities. Nevertheless, whatever the origin, the establishment of this ideas has reduced vulnerability, and likely will lead to lower future losses in these communities.

Lastly, uncertainty in future SLR (i.e. how high it will be in the future) prevented any concrete solutions towards SLR adaptation. The community were also not aware of future risks and how these may evolve, further highlighting some lack of knowledge regarding such issues.

Chapter 6: Discussion

6.1 Limits to adaptation

The push for adaptation has become more prominent due to global torpidity on mitigating the effects of climate change. Adaptation strategies, however, have limitations. These limitations put in question the effectiveness and efficiency of these adaptation mechanisms. Adaptation can also lead to maladaptation; such was the case of the village of Salei'a (a few hundred meters from Lelepa) where the elevation of the coastal road built to address rising seas has led to fluvial and pluvial flooding for the residents, as the path for the water to flow towards the ocean is now obstructed by the elevated road (Crichton and Esteban, 2019). Similarly, the construction of seawalls as a coastal defense may negatively affect the retention of sandy beaches, which can lead to impacts to tourism and revenue. Hard infrastructure often has a negative impact on revenue generating activities, especially those in tourism, as they offer less viewer satisfaction than nature. Furthermore, these structures often require upgrades or modification over time (Crichton and Esteban, 2018), which are often costly.

The question of whether hard infrastructure is an effective way to address such problems is still being debated. Following the *Tohoku 2011 Earthquake and Tsunami*, the recovery process included the construction of high walls, some measuring 14 meters in height. However, the construction has raised questions on whether these have increased the vulnerability of the community, who are not able to participate as easily as before in

activities related to the ocean, and the tall walls prevent residents to see any approaching tsunamis (Valenzuela et al, 2019).

In Samoa, some coastal revetments running on the side of the road have required elevation (see Figure 6.1 and 6.2). Over time these adaptation practices will become progressively more expensive and eventually may lead to a point where the expenses exceed the benefits, though detailed cost-benefit calculations would be required to understand this. As the ocean continues to rise in the future the height of the revetment will also have to rise. The effectiveness of adaptation methods could change drastically when sudden on-set and extreme events are considered, such as tropical cyclones or tsunamis.

Figure 6.1 Newly elevated national road along the coastline of Upolu Island, and elevated coastal rock revetment.

Figure 6.2 Height of the revetment crown.

Ecosystem-based adaptation practices also have their own limitations. Some communities who have attempted to use tree-planting activities find it hard to maintain the growth of these plants as the ocean encroaches inland, often at a pace faster than the trees can grow, and especially following a sudden onset disaster like tropical cyclones. Marine Protected Areas, which are also common adaptation practices in the Samoan communities, have seen little success, and often require long period of time to provide positive benefits, unless fish stocking intervention is included in such projects. Coral garden and coral replanting are susceptible to bleaching events and other oceanic impacts from climate change, such as ocean acidification and increase sea-surface temperatures (Crichton and Esteban, 2018).

Thus, while adaptation efforts are important to reduce the climate risk for rural communities, it is important to note that there are many limitations of such approaches, and it is clearly important to consider these from the start.

6.2 Evidence from the past

Evidence of building ruins, especially around the shores of Fagamalo village, suggest that the various communities studied in this thesis have a long history dealing with the problem of an encroaching sea. These remains of past settlement and important social infrastructures highlight the socio-economic implications or their loss, and the future consequences of climate change and SLR. Fagamalo has the most pronounced evidence of loses, compared to the other two villages (who attempted some types of coastal adaptation mechanism), with the disappearance of building and structures and evidence of erosion being significant even within a decadal period. Villages of Lelepa and Satoalepai both sought for coastal adaptation through replanting along the coast and a coastal revetment, respectively. Some of the participants in the workshop, suggested that Fagamalo attempted a coastal replanting but due to poor plant choice (intolerance to saltwater environment), many plants did not survive. This can explain why Fagamalo has the most significant coastal erosion problem compared to the other two.

The Digital Elevation Mappings (DEM) performed as part of the present research show a community far more exposed to SLR than the previously available mappings. These new maps show more areas at risk of sea-level rise, even for 1-meter rise scenarios or less. The evacuation route (inland road) is not much higher than the current

sea level at high tide. As this road is what they use during disaster evacuation, this presents a threat as it could easily be inundated during a major flooding event. However, the constructions of these roads and the provision of basic necessities such as access to water and electricity have contributed to an increase in inland settlement in all three communities. This would not have been possible without the intervention of national government, and international partners and donors. As multiple stakeholders (national government, private and international donors) provide the basic needs of the community, such as access to electricity, water and access road, these actions have led to a voluntary settlement or extended settlement further inland. Synergies between government and international partners' assistance to community level are essential for community especially when it involves community relocation (Choi and Honda, 2014; Ong et al., 2016)

6.3 Traditional homes and adaptation to SLR

Traditional homes and structures offer some remedy to risk associated with sea-level rise, due to these traditional structures often having a high elevated foundation, of a meter or more off the ground (see Figures 6.3 and 6.4). Whether these structures will have an impact on the relocation process over time as sea-level rises is yet to be fully understood.

Figure 6.3 Modern traditional structure with an elevated cement foundation of about 165 cm

Figure 6.4 Modern traditional structure with a stone foundation elevation of about 150cm

6.4 Rural Island Communities, Climate Change and Sea-level Rise.

The understanding of rural community member about intergenerational development priorities and challenges shows they are more optimistic about the future than what they are experiencing. Some have the impression that the negative impacts of climate change will be reduced in the future, though their current exposure and experience with ongoing climate change helps them imagine a world that is centered around these exposures. Meaning, while they believe the negative impacts of climate change will be reduced, their current experience with the difficulty in growing crops and food production due to experiencing more days with extreme-heat and droughts has led to the impression that food security will be worse in the future, and financial hardship will increase, irrespective of the role of climate change on those sectors.

The community understanding of the root causes and impacts of climate change seems to be higher than in other previous studies, such as in Walse et al. 2015 and Nunn et al, 2014. These communities have higher proportions of individuals who believe climate change to be real, and that it is caused by human activities and their greenhouse gas emissions. This could be attributed to the fact that these communities have experienced losses due to climatic events, and their proximity to the ocean (Brody et al. 2008), and possibly due to government awareness interventions, through community workshops and seminars.

6.5 Governance

Governing bodies, both at the national and local levels, have largely been deemed by rural community residents as effective in addressing climate change, despite the latter having little formal educational exposure to information on climate change. The role of religious leaders also carries significant weight on influencing community perspectives on climate change. In Samoa, religiosity plays a significant role in the acceptance of climate change, and the action required to address its impacts, similar to findings from other PICs (Luetz and Nunn, 2020). These trust hierarchies are non-avoidable, but very essential in addressing climate change in the rural communities of Samoa and the Pacific Islands.

6.6 Relocation as an adaptation response.

While relocation is still the least desirable option, it seems that a retreat response is the most preferred adaptation mechanism for sea-level rise, but in the form of extended settlement. Families and family properties are two of the main reasons why people are reluctant to relocate away from a settlement which has existed for hundreds of years. The reason why family is hindering their relocation is not fully understood. Possibilities that there is pressure from other family members to stay, primary care for elderly members and members with disabilities whose care might be difficult when moved to elevated areas, or their close proximity with extended families who might be neighbours or live in nearby communities, something that might change with moving inland. In addition, the concept

of relocation in the context of the Samoan islands is different from the understanding of western world. In this sense, the meaning of relocation in Samoa involves having to move outside of the boundaries of community customary borders, whereas movement withing the village boundaries is not seen as relocation.

The voluntary relocation encouraged by the matai as a remedy for disaster risk reduction brought about by past disaster experiences is causing a slow relocation inland (as evidenced by satellite photographs of different years), which could suffice to address the rate of SLR and future inundation. Thus, by addressing disaster risk, these communities are also tackling the risks associated with SLR. Traditional systems of decision-making bodies can play a critical role in addressing environmental risks (Rumbach and Foley, 2014). This could prove to be a significant factor to improve the adaptive capacity of these communities, which should be effectively utilized by policy-makers to ensure successful future adaptation pathways (Petheram et al. 2015; Petheram et al. 2010 and Parsons et al., 2017).

The participants of the workshop concluding that they have a strong desire to remain in their current settlement and maintain the status quo, similarly to the findings from the household questionnaire surveys. However, the dissemination of climate change information and potential future scenarios presented to them caused a revisit of the idea of inland relocation. Lelepa village chiefs were in favor of abandoning the current settlement when presented with the 2050 worst case scenario, but opted to stay when the best case one for 2100 was explained. For the 2100 worst case they decided that it could be possible to stay (if coastal adaptation measures were implemented), though the option to be able to relocate remained a last resort strategy. Fagamalo village looked

towards mitigation against climate change, thus suggesting a reluctance to relocate from their current settlement. Satoalepai village choose to leave for all the scenarios that were proposed to them, as they were the most exposed of the three settlements

6.7 Future adaptation (2050 & 2100)

The participatory approach was designed to understand the participants' opinion regarding two different sets of SLR scenarios, for two different time horizons. The severity of future SLR and the ideal scenario presented in the best case shifted conversations between adaptation and mitigation action during the course of these two sessions. For the case of the 2100 scenarios, participants were asked to consider the future of the following generations, which is something similar to the concept of futurability (Hara et al. 2019). There was little to no differences between planning for the 2050 and 2100 worst case scenarios, with the exception of women and especially the youth group of Lelepa. These groups expressed a strong consensus for the establishment of protective measures (a combination of infrastructural and ecosystem adaption) in 2050, while choosing to relocate in the 2100 scenarios. There was a strong sense of optimism when dealing with the SLR affecting them, in contrast to feelings of hopelessness when addressing the needs of future generations. This situation is similar to gender and age attitudes towards climate change risk in other Pacific Island contexts (Weir et al. 2017; Clarke et al. 2019), although in especially vulnerable coastal locations, such as the Solomon Islands, pessimism is widespread (Asugeni et al. 2015).

The original idea to build new roads further inland came from the communities, though the source of funding for this comes from the government and other international organisations. The availability of international agreements and funding such as the Green Climate Fund (GCF), in which the government can tap into for adaptation projects, is very important. If SLR continues much of the infrastructure will be lost, and thus the government can negotiate with communities whether to start building more roads and infrastructure further inland. Since national infrastructures and road are mostly located along the coast and the cost of adaptation will be high to protect them, it is in the national interest to build access roads further inland.

The building of the homes takes place at an individual basis, with each household making a decision whether to build a secondary structure or home based on their own needs and financial situation. Despite the decision being individual, there is some negotiation between community members, as all lands in the village are held as customary land belongs to the community and their chiefs. Thus, there is negotiation between the customary caregiver, the matai, and the individuals, on how to allocate the land. The role of the government currently is to facilitate and provide basic services that will promote and encourage the establishment of these secondary settlement. In order to improve adaptation mechanisms, it would thus be helpful for the government to work closely with communities in developing a holistic plan, bringing together inter-governmental ministries and agency, especially Ministry of Finance (MoF), Ministry of Natural Resources and Environment (MNRE), Ministry of Women, Communities, and Social-Development (MWCSD) and Ministry of Works, Transportation and Infrastructure (MWTI) to devise a plan for community adaptation towards disasters and SLR.

The range of adaptation strategies that were considered by participants was somewhat limited, probably restricted to exposure to adaptation mechanisms seen in other neighboring communities or from national government earmarked projects. The adaptive measures discussed in the exercise were restricted to the following four: coastal seawalls, coastal replanting, river dykes, and inland relocation. It is important to note that if the author had provided more pre-defined adaptation options there could have been more comprehensive outcomes. Different types of adaptation categories included under protection, accommodation, retreat, and acceptance options are outlined in Hay & Mimura, (2006) and Mimura et al. (2007). Nevertheless, the author also wanted to understand what types of adaptation options came to the mind of participants, without any being suggested. Interestingly, traditional practices and designs that can reduce their vulnerability to SLR were not mentioned or discussed by participants. For example, a common feature of traditional fales or housing structures are high elevated foundations, shown previously in Figure 6.3 and 6.4. These are common features in these communities, though they were not considered in the inundation sea-level-rise scenarios maps presented.

Rural community have a high dependency on overseas remittance, mostly from family members who ventured overseas in search for educational and more economic opportunities. An increase in remittance due to disasters have been documented (Le De et al, 2014). In that same study it was found expenditures for *fa'alavelave*, food and building/upgrading houses, and church were the main use of overseas remittance. While after the 2009 tsunami the priorities shifted to prioritize, rebuilding/repairing home, food, and heath care took precedence. Thus it is likely that overseas remittances might provide

much of this capacity to adapt. It is highly likely these adaptation measures (and those they will undertake in the future) depended largely on remittance from family members living overseas.

6.8 Community awareness of climate risks.

The communities' awareness of the risks associated with disasters and climate change was very high. Similar conclusions were also yielded from the household questionnaire surveys, as discussed previously. This could be explained by their experiences and their physical position and proximity (Brody et al. 2008) to the ocean. They see this as highly important, unlike in the findings from more developed countries such as the United States of America and Europe (Lorenzoni and Pidgeon, 2006; Lorenzoni et al. 2007), although climate change is one of the multiple community developmental priorities.

6.9 Climate Change, Gender, and Age

Significant age and gender differences regarding adaptation preferences could be seen between the various groups. These differences appeared to depend on the severity of the potential future flooding scenarios. Furthermore, some groups were hesitant to provide their opinion in some of the sessions, marked as 'no comment' in Tables 5.1- 5.3.

Whether this was due to a hesitance to express their views (i.e. due to community hierarchy issues), or due to other reasons, is uncertain. A similar gendered preference for particular adaptation options has been found in other Pacific Island contexts, which has been attributed to gendered knowledge of the environment or length of residence in a particular community (du Bray et al. 2019)

Uncertainty regarding the extent of future SLR, that is, how much higher sea levels might actually be by the year 2100, caused ambiguities within the different groups regarding what would be the best adaptation plan. Finally, all three communities decided to maintain their current settlements with the assistance of ecosystem and infrastructural countermeasures (such as seawalls), as these would suffice to protect their homes for a time. This is in line with the preferences for 'voluntary immobility' when it comes to addressing a changing climate that have been reported by other authors (Farbotko and McMichael, 2019). However, residents also recommended that they should start looking towards building secondary homes inland, as a disaster evacuation plan for the present, and to be able to relocate inland during disasters, returning when it is safe, and perhaps fully relocating at some future date when necessary. The idea of building inland in areas within the community customary boundaries may not be considered by the people as relocation, but rather something of an 'extended settlement.'

6.10 Role of traditional knowledge and systems

The introduction of western ideologies (and especially Christianity) eroded many of the traditional practices and indigenous knowledge within these communities (Nalau et al, 2018). Indigenous knowledge regarding traditional resilience, food preservation, navigation, and more, and even expertise in traditional structural construction known as 'Tufuga-fau-fale' have become rare. This may account for the lack of association of traditional resilience with addressing modern problems such as climate change. Nevertheless, traditional knowledge is important in climate adaptation strategies (Lafale, 2010; Korovulavula et al, 2019; Granderson, 2017; Nalau et al, 2018).

Traditional cultural systems play a significant role in the adaptation strategy, and the availability of customary land makes relocation feasible. Village council and customary land stewardship through chiefly titles can provide the land resources that encourage future relocation. As customary land is designated under a stewardship rather than ownership type lands, the division of land can be done internally within the community, without the financial burden of each family/household having to purchase new land. Such cultural practices clearly represent a strength within the community, which can help its members adapt to future SLR. These contributions from traditional cultural systems, including indigenous traditional knowledge (ITK), to assist community adaptation practices are not uncommon throughout the Pacific. Traditional cultural systems that govern local communities are unavoidable and essential in the successful implementation and sustainability of adaptation practices, as found in places like Vanuatu and Samoa (Nalau et al, 2018; Granderson, 2017; Crichton et al., 2020.)

6.11 Limitations of the study

The research outlined in the present thesis presents a number of limitations, particularly given the fact that it is highly culturally specific to the case of Samoa. Within the context of Samoa, it should also be noted that the communities studied represent only a fraction of the total number of coastal settlements in the country, and that were all located in one area of one of the islands. While there is no reason to think that other settlements would have differed significantly (given the small size of the country and the relative high socio-ethnical composition of the island), the results should nevertheless be treated with caution when extrapolating to the wider national context.

Thus, while the results obtained may provide some insights into the thoughts of other communities in the Asia-Pacific region, they should be treated with caution when generalizing to a wider regional context. Given such limitations, future work should focus on generalizing the results by investigating other communities, and hopefully in that process translate climate change science into more local traditional languages and communities. Nevertheless, the author hopes that the methodology outlined and experience from this workshop can provide some insights for future researchers and educators in the region, and help guide government policy.

Another limitation was the number of surveys collected. Obviously, a better representation of community views would have been obtained if more community members took the survey. Expanding the surveys out to other villages may also help to

ensure that the views of these communities truly represent those of the entire nation, and that these are more applicable to other contexts.

The focus of this study was to investigate the impacts of SLR and how communities should adapt. While tropical cyclones are a common disaster experience, they were considered out of the scope of this study. Although the findings provide some degree of insights on how the communities might adapt to tropical cyclones and tsunamis in the future, they were ultimately only designed to understand how communities might respond to slow onset disasters such as SLR.

The gap between scientific knowledge (including terms), which are ever expanding and evolving, with indigenous traditional knowledge and languages exist, though attempts to bridge this gap are growing, with more recognition of indigenous cultures and knowledge. Differences in understanding between science and indigenous culture present challenges for researchers. Although this is more of a linguistic problem, having to find the best available translation, sometimes results in the true essence of the information divulged can be missed. An example of this can be found in this study, regarding the all-encompassing Samoan term ‘tau’, which in its deeper sense means: temperature, weather, and climate. This term makes it sometimes difficult to distinguish the exact meaning that is being translated into the English language and vice-versa.

Chapter 7: Conclusion

7.1 Summary of findings

The impacts of climate change -and specifically SLR- will be inevitably felt even more in the Samoan islands in the future, affecting the environment and various socio-economic aspects, at the national, local, and individual level. Rural communities enjoy a wide level of autonomy in decision-making, which influence the climate change adaptation strategies that they will choose. Understanding how these traditions and culture, and their role of determining adaptation practices can help national and regional policy-makers to find the best ways to deal with the problems of climate change. In that sense, understanding the stance of rural communities on how to deal with climate change will reduce unnecessary adaptation practices (including maladaptation).

Samoa, as a pacific island, has a history of migration due to environmental issues, and relocating inland through the extended settlement concept identified in the present thesis can be considered to be part of their traditional practice of adapting to environmental issues. This has been their way of live for millenniums. By addressing and preparing for sudden-onset disasters, the inhabitants of Samoa are also adapting to slow-onset disasters such as SLR. In that sense, it is worth noting that the decision to move inland was not mandated by the national government, and is instead made at the household level. By simply building a new secondary house further inland, the households are reducing their risks towards SLR and disasters, though such activities also face the

challenge of finding the necessary costs for building and moving to the new locations. These also present challenges such as financial cost of building, and moving, although as previously discussed it is likely remittance, national government assistance, and donor funding will fill these financial gaps. That is the government and donor will continue to fund essential infrastructural development such as roads, water, and electricity supply, while residential homes as part of this extended settlement will be an individual family cost.

However, such “extended settlements” are not without their problems. Most of the transportation in Samoa is along the coastal road, and moving inland means that villagers have to walk a long disaster to have access to transportation. Thus, they somehow lose some of the benefits of living along the coast. Nevertheless, there is considerable flexibility in the community, and people can also move backwards and forwards between their different family homes

Adaptation of coastal areas in mountainous islands may vary from place to place. While SIDS countries differ from developed mountainous island countries like that of New Zealand, Japan, or the United Kingdom, which are comparatively larger than countries like Samoa, and have strong economies. Another additional difference between mountainous island of SIDS is the acknowledgement and existence of their traditional systems, something that is found in Samoa and other Pacific Island Countries, that is different from western cultures, including island countries like New Zealand, the United Kingdom, and Japan (who has adopted the western system). These local traditional aspects are playing a role in adaptation practice for PIC and islands like Samoa.

The results of the present research indicate that many groups in the village have differences in opinion about their adaptation preferences. More importantly, it is the youth who will be facing the increasingly negative impacts of climate change as time progresses, though they do not have any seat to take part in the political discussions taking part in the village. There are clearly difficult power dynamics between the participants of the workshop, and that of the households surveyed. For example, when the matai spoke other villages group members were hesitant to voice their opinions. It is also possible that economic situation of participants had some effect on the results, and this was not clear as the participants were not asked about their economic standing. Differences in the relocation results from the household surveys and the community workshop could be explained in that the explanation about climate change data was only given at the only given at the workshop (i.e. respondents of the household questionnaire survey received no such explanation) In the conclusion of the workshop there was a general consensus to build secondary homes inland, while also attempting to adapt to the rising seas by protecting the shoreline.

The national government, as a funder of community projects, could use such differences between the influence of the different groups as a reason to negotiate the inclusion of all groups in the village, so as to have a more inclusive, equitable community development plan that benefits all. While often the practice of national government is to work with the *Alii ma Faipule*, bringing in members of the other groups would facilitate a meaningful adaptation plan that is more inclusive and representative of the entire community.This can be implemented in the form of national policy, similar to the inclusion

of community women representatives in the national government led community meetings and briefings, this could be applied to all community adaptation projects to mandate the inclusion of representatives from all community groups.

Other stakeholders such as international and donor agencies, Non-Governmental Organizations (NGOs), private and religious organizations who are also actively participating in community development projects can also demand the inclusion of various members of community groups in their community programs and projects, for equity and inclusion. Each of these organization have specific visions and organization mandates, together with the GoS they could use a holistic approach to address these community development priorities and facilitate a multi-stakeholder community adaptation plan.

In order to overcome the challenges brought about by SLR it is necessary for the government, funding agencies, and the communities to work together. The national government has the power to dictate how its funding should be implemented, even given the autonomy of the communities. Thus, one of the key roles of the government could be to formulate certain guidelines that villages should follow in their adaptation process, and then help to connect villages that comply with them to international and domestic funding. In that sense it is worth noting that while the national government has adaptation projects, they still face financial restraints, as they do not have the resources available to developed countries (or even other richer countries in the region such as Fiji, where the government can support the relocation of the communities). Potential funding organisations in the region include United Nations, World Bank, Asia-Development Bank, Secretariat of the Pacific Regional Environmental Program, bilateral partnerships with developed countries

such as Australia, New Zealand, Japan, China and USA, and religious organizations such as Later-Day Saints Charities, Catholic Charites, and Adventist Development and Relief Agency.

Rural coastal communities are seen as lacking in adaptive capacity to address climate change, but they are able to tap into existing resources, such as land availability and traditional governing systems that can encourage relocation as an adaptation mechanism to address climate change. Such voluntary secondary homes can facilitate a slow onset relocation, which reduces the risk of both immediate shocks from natural disasters as well as future climate change. This allows for relocation to occur over a period of time, while reducing the financial burden of buying land for relocation. While possible internal conflicts may arise between current inland communities and future people willing to relocate, traditional governing systems could facilitate a successful negotiation that eases community tensions. In addition, while the variety of adaptation mechanisms shared during the exercise was very low, exposure to other adaptation countermeasures (including the recognition of traditional knowledge and practices) may diversify how rural communities can address future SLR

Science-based research, translated to the needs of rural coastal communities, can facilitate meaningful discussions for future planning by community members, even if many of these have comparative small degrees of higher educational achievement. It was difficult for the villages to decide how to adapt, as it is difficult to know what will the final SLR they will be facing in the future. This makes it difficult to decide when the limit will exceed their capacity to adapt, or when the cost of adaptation will too high for the

community to bear, and eventually this is something that each village will have to decide by themselves (or to ask for the national government to fund part of the costs).

The gratitude expressed by community members for the holding of such a workshop (the first of its kind in the community) indicated the lack of attention that is often paid by researchers to the real adaptation intentions of communities on the ground, and how they plan to reduce the possible risks brought about by climate change. The science regarding future climate change impacts should not be withheld from rural communities which are probably already experiencing it without knowledge of how bad the situation can get.

7.2 Recommendation for Future Studies.

While adaptation, especially involving the relocation of coastal communities can be costly, collaboration between national government and communities can facilitate a smoother transition that is both community-led and sustainable. In that sense, the government and international partners can assist with the planning or building of secondary homes or an extended settlement through the provision of basic services to the new location that the communities can identify, and provide access to roads, electric power, and water supply. If this can be achieved, then the movement and the expenses of relocation can be borne by the individuals at a household level. Creating adaptation plans, coupled with local job creation, could accelerate the rate of inland relocation, providing financial resources for rural communities to direct their own adaptation plans. This might represent an interesting path for future research.

These three communities have histories associated with disaster losses and are also experiencing rising seas. These impacts may require socio-economic assessments to understand what has been lost and what they stand to lose in the future when sea-levels will fully inundate these communities. These socio-economic assessments will help to more holistically understand the national costs associated with sea-level rise.

Variations in adaptation preference were evident from the discussion between men, women, and youths during the workshop. Gender and age do play a vital role in desired rural community adaptation pathways, though even villages that are in close proximity may also show variations in their preferences. It would appear that the traditional hierarchy does not necessarily represent the views of all groups. Climate change impacts will severely affect future generations, though these generations are often left out of the decision-making process that determines their future. Furthermore, the inclusion of women and youth in future adaptation discussions (which are absent from traditional systems) may also increase the inclusion of other adaptive mechanisms, especially that of eco-system adaptation to address immediate or future impacts. While this study found conclusive difference in gender adaptation preferences, it is difficult to associate this at the national level, as it is case specific. This will require more community case studies from around the Samoan islands to have a full understanding of gender adaptation preferance at the national level.

Hazard mappings for sea-level rise (and potentially other hazards), Digital Elevation Maps, should be produced for all coastal communities in Samoa. These types of maps are very scares, but their important for development work. More than 300 other communities around Samoa do not have such maps.

The inland settlement experienced in these study areas (as well as across the country) will have significant environmental impacts, however, no Environmental Impact Assessments or similar assessments have been conducted on these newly established settlement, as the number of inland settlements may increase in the future, understanding the impacts, and trying to mitigate negative impacts of these movement will be important.

In the future it would be advisable to apply this research to other coastal communities within Samoa, and elsewhere in other island nations where similar cultural dynamics exist. While such research is likely to be relevant to other Polynesian islands countries and territories, similarities between this case study and rural communities such as Otsuchi town in Japan (where there is also a strong cultural identity, Murakami et al. 2020; Tanaka et al, 2012), suggest that there could be the possibility of replicability in a non-Pacific island context.

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APPENDICES

Appendix A. Community Surveys

Title of the study: *Rural Island Communities Adaptation to Rising-seas and Disasters*

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PhD candidate
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Invitation to Participate: You are invited to participate in the abovementioned research study conducted by Richard Crichton, who is being supervised by Dr. Onuki Motoharu and Dr. Miguel Esteban.

Participation: If you wish to participate in this study, please complete the attached survey. Your decision to complete this survey will be interpreted as an indication of your consent to participate. The survey should take you approximately 25 minutes to complete. You do not have to answer any questions that you do not want to answer. Once you have completed the survey, please return it.

Purpose of the Study: From this research we wish to learn *adaptation preference of rural communities*
Benefits: *Increased understanding of rural community future adaptation preference, and*

Risks: Information shared might be sensitive as it involves future anticipated climate impacts.

Confidentiality and Anonymity: The information that you will share will remain strictly confidential and will be used solely for the purposes of this research. The only people who will have access to the research data are those mentioned above and surveyors. Your answers to open-ended questions may be used verbatim in presentations and publications but neither you (nor your village) will be identified. Results will be published in pooled (aggregate) format. Anonymity is guaranteed.

Conservation of data: The surveys will be kept in a locked filing cabinet in the office of the supervisor/investigator at The University of Tokyo for a period of *5* years at which time they will be destroyed.

Voluntary Participation: You are under no obligation to participate and if you choose to participate, you may refuse to answer questions that you do not want to answer. Completion and return of the questionnaire by you implies consent.

Information about the Study Results: If you have any questions or require more information about the study itself, you may contact the researcher or his/her supervisor at the numbers mentioned herein.

Please keep this form for your records.

Thank you for your time and consideration.

Richard CRICHTON _____(date)

Enumerator	Location code	Control #

COMMUNITY SURVEYS

Igoa muamua / First Name	Fa'ai'u / Last Name	Nu'u / Village
Tausaga / Age	**Sex / Alii po'o le Tama'ita'i**	**Numera telefoni / Contact information**
Galuega / Occupation	**O oe o le ulu o le aiga? / Are you the Head of household?**	**How many people live with you?**
	☐ Yes ☐ No	

Highest educational level attained

☐ No school	☐ Secondary School (Year 9-13)
☐ Primary school (Year 1-6)	☐ University Graduate
☐ Intermediate School (Year 7 & 8)	

QUESTIONS

1. **What are your biggest challenge living in this community? (rank in terms of priority; 1 being high to 7-10 being low)**

☐ **Siosiomaga- faatamaiga (pollution), otaota lafoai/ Environment – waste management**

☐ **Tulaga ogaoga o le tau- suiga o le tau, e pei o, afa malolosi, si'isi'I o fogatai, lologa / Extreme events- Climate Change. e.g tropical cyclones, sea level rise, flooding**

☐ **Mea tutupu I laufanua, pei o mafu'ie, galu afi /Geological events – Earthquakes, tsunamis**

☐ **Ao'ao'ga/ Education**

☐ **Galuega, Alagatupe /Employment, Livelihoods**

☐ **Pulega, e lavea ai faigamatai, faigamalo /Governance**

☐ **Soifua maloloina / Health**

☐ **Le tagolima, mea tau tupe / Poverty, money**

☐ **puipuiga o meaai taumafa mo le lumanai, po'o aso leaga / Food security**

☐ **Isi (faamatala mai) /Other (Please specify) _____**

2. **O le a le mafua'aga ua e lisiina ai fa'alavelave ogaoga- suiga o le tau I lea tulaga?**
Why did you rank Extreme events-Climate change this way?

3. **O lea sou taofi e iuga I ni lu'I o le a feagai ma le nu'u I le isi 80 tausaga o I le lumanai?**
(Fa'ailo le pito sili amata mai le 1 seia oo I le 10 le maualalo)
What do you think will be the future challenges living in this community in 80 years (2100)?
(rank in terms of priority)

☐ **Siosiomaga- faatamaiga (pollution), otaota lafoai/ Environment – waste management**

☐ **Tulaga ogaoga o le tau- suiga o le tau, e pei o, afa malolosi, si'isi'I o fogatai, lologa / Extreme events- Climate Change. e.g tropical cyclones, sea level rise, flooding**

☐ **Mea tutupu I laufanua, pei o mafu'ie, galu afi /Geological events – Earthquakes, tsunamis**

☐ **Ao'ao'ga/ Education**

☐ **Galuega, Alagatupe /Employment, Livelihoods**

☐ **Pulega, e lavea ai faigamatai, faigamalo /Governance**

☐ **Soifua maloloina / Health**

☐ **Le tagolima, mea tau tupe / Poverty, money**

☐ **puipuiga o meaai taumafa mo le lumanai, po'o aso leaga / Food security**

☐ **Isi (faamatala auiliili mai) /Other (Please specify) _____**

4. **O le a le mafua'aga ua e lisiina ai fa'alavelave ogaoga- suiga o le tau I lea tulaga?**
Why did you rank Extreme Events-Climate Change this way?

5. **Sa e fanau i totonu o le nu'u nei?**
Were you born in this village?

☐ **Ioe / Yes (go to Question 9)**
☐ **Leai / No**
☐ **Ou te leiloa / I don't know**

6. **Afai e leai, o fea le nu'u ma le afioaga e te sau ai? (Nu'u ma le Itumalo)**
If no, where are you originally from? (Village and District)

7. **O lea le mafuaaga na e sui nu'u ai?**
What made you move here?

☐ **Fa'aipoipoga/Marriage**
☐ **Isi tagata o le aiga/Other family members**
☐ **Siosiomaga- faatamaiga (pollution), otaota lafoai /Environment – pollution, waste management**
☐ **Tulaga ogaoga o le tau- suiga o le tau, e pei o, afa malolosi, si'isi'I o fogatai, lologa / Extreme events- Climate Change. e.g tropical cyclones, sea level rise, flooding**
☐ **Mea tutupu I laufanua, pei o mafu'ie, galu afi /Geological events – Earthquakes, tsunamis**
☐ **Ao'ao'ga/ Education**
☐ **Galuega, Alagatupe /Employment, Livelihoods**
☐ **Pulega, e lavea ai faigamatai, faigamalo /Governance**
☐ **Soifua maloloina / Health**
☐ **Le tagolima, mea tau tupe / Poverty, Money**
☐ **puipuiga o meaai taumafa mo le lumanai, po'o aso leaga / Food security**
☐ **Isi (faamatala auiliili mai) / Other (Please specify) _____**

8. O lea le umi o e nofo ai I lenei nu'u? /
How long have you lived in this village?

☐ **lalo ifo o le 1 tausaga / less than 1 year**

☐ **1-4 tausaga / 1-4 years**

☐ **5-9 tausaga / 5-9 years**

☐ **10-14 tausaga / 10-14 years**

☐ **15-19 tausaga / 15-19 years**

☐ **sili atu ma le 20 tausaga / more than 20 years**

9. E iai se manatu ia te oe, o suisui pea le tau ma le sio'sio'maga?
Do you think that the climate and the environment are changing?

☐ **Sao lelei / Agree**

☐ **E sese (Alu I le fesili 12) / Disagree (go to Question 12)**

☐ **Ou te leiloa / I don't know**

10. O fea o lo'o e vaai ai I ia suiga? (maka uma mea e talafeagai)
Which of these are the changes you observed? (mark all that applies)

☐ **Amu o le sami / Coral Reefs**

☐ **Moana / Oceans**

☐ **Tai, Matafaga / Coastal zones, beaches**

☐ **Fanua o iai vai, togatogo / Wetlands, Mangroves**

☐ **Laau ma Manu / Flora & Fauna**

☐ **Tau / Temperature, weather**

☐ **Leai se suiga / No changes**

☐ **Isi (fa'amatala mai) / Others (please specify) _____**

11. O a suiga ua e va'ai I totonu o lou siosiomaga? /
What are changes you are observing in your environment?

☐ Fa'aleagaina o amu / Coral Reef Degradation
☐ Fa'aititia o i'a / Fish Stock Depletion
☐ Si'itia o le sami / Rising Sea Levels
☐ Aia o eleele lalata I le sami / Coastal Erosion
☐ Gataifale, lologa o fanua maulalalo / coastal, low land Flooding
☐ Fa'aleagaina ma le aveseinga o togatogo / Mangroves degradation, loss
☐ Fa'aleagaina o fanua tu vai (fanua pala) / Wetland degradation
☐ Suiga ma le fa'aitiitia o lautoto / Changes, loss in vegetation
☐ Suiga ma le fa'aitiitia o manu vao ma manu lautele/ Changes, loss in wildlife and animals
☐ Matagi ma afa malolosi / Intense tropical cyclones
☐ vaitafe ua mago, utiuti o vai / River drying up, water scarcity
☐ Sao mai o le sami i vai ma laueleele / salt water intrusion
☐ Timuga mamafa / Intense Rainfall
☐ Tau femoumouai pe le tumau /unpredictable weather
☐ Isi (faamaoti mai) / Others (please specify) _____

12. O a tuaiga gaioiga po'o suiga foi ua faia e le nu'u i le taumafai ai e puipui mai aafiaga o le suiga o le tau? (maka mea uma e talafeagai)
What are your current adaptation strategy taken by your village? (tick all that applies)

☐ Auala fausia e tagata mo le puipuiga o gataifale (pei o Taligalu) / Hard Coastal defenses (seawalls)
☐ Auala mai le siosiomaga mo le puipuiga o fataifale (pei o la'au) / Soft Coastal defenses (vegetation)
☐ Faatumu ia o le sami, ma le toe toto o amu / Fish, Coral restocking
☐ Fa'asao I le sami / Marine Protected Area establishment
☐ O auala e foia ai lologa / Flooding control
☐ Si'itia ese mai nofoaga le saogalemu / Relocation
☐ Auala e fa'asao atu ai pe puipui ai le suavai / Water infrastructure
☐ isi (fa'amatala mai) / Others (please specify) _____

13. O e lagoa e saogalemu ona o auala o puipuiga mai suiga o le tau ua fa'ataunu'u I totonu o lou nu'u?
Do you feel safe with current climate change adaptation strategy within your village?

☐ Ioe / Yes (go to Question 9)
☐ Leai / No
☐ Ou te leiloa / I don't know

14. Aisea ua e lagona ai faapea? / Why do you feel this way?

15. O lea sou silafia I taumafaiga a le Malo o Samoa e faaupegaina o nu'u taitasi I ao'ao'ga e uiga I le suiga o le tau ina ia latou faia ni filifiliga lelei ma le aoga?
How much information on climate change do you think the Government of Samoa is sharing with the village council to make effective governing decisions?

☐ Leai ni faamatalaga tuu mai / No information
☐ Laititi faamatalaga tuu mai / Very little information
☐ Feololo faamatala tuu mai / Some information
☐ E tele faamatalaga tuu mai / A lot of information
☐ Ua tele nau'ua faamatalaga tuu mai / Too much information
☐ Ou te leiloa / I don't know

16. E te talitonu o suiga o le tau na mafua mai ona o tagata ola?
Do you believe climate change to be man-made?

☐ Sao lelei (alu I le fesili 18) / Agree (go to Question 18)
☐ Sese / Disagree
☐ Ou te leiloa / I don't know

17. Afai e leai, Aisea?
If no, why?

18. Faamata o lava tapena le pulega a le nuu (fono a matai) I mataupu tau le siosiomaga ina ia faia ai so latou filifiliga lelei?
Do you think that the village council have enough information about the environment to make sound decisions?

☐ Sao lelei / Agree
☐ Sese / Disagree
☐ Ou te leiloa / I don't know

19. Afai e iai se mea ogaoga o lo'o e fia faailoaina, faamata e tali lelei ni ou lagona e tagata o lou aiga?
When you have an important concern/issue, are your thoughts taken seriously by members of your family?

☐ Ioe (alu i le fesili 21) / Yes (go to Question 21)
☐ Ieai / No
☐ Isi taimi / Sometimes

20. A fai e tali "leai" po'o "isi taimi," Aisea?
If "no" or "sometimes," why?

21. Afai e iai se mea ogaoga o lo'o e fia faailoaina, faamata e talia lelei ni ou lagona e mati o le nu'u (nofo a matai)?
When you have an important concern/issue, are your thoughts taken seriously by the village council?

☐ Ioe (alu i le fesili 23) / Yes (go to Question 23)
☐ Ieai / No
☐ Isi taimi / Sometimes

22. A fai e tali e leai po'o isi taimi, aisea?
If no or sometimes, why?

23. E iai sou manaoga e te alu ese atu I se isi laueleele?
Have you consider migrating to another location?

☐ Ioe / Yes
☐ Leai (alu I le Fesili 30) / No (go to Question 30)
☐ Ou te leiloa / I don't know

24. O fea e te fia siitia agai iai? /
Where have you thought about migrating to?

☐ I uta i laufanua a le nu'u / Further inland
☐ Se isi nu'u / Another village
☐ Isi motu / Other islands
☐ Taulaga o Apia / City of Apia
☐ Atunu'u I fafo / Overseas

25. O a ni faapogai o lou fia siitia ese atu? (maka uma mea e talafeagai)
What reasons are behind your desire to migrate? (tick all that may apply)

☐Sio'siomaga – Faatamaiga (pollution, otaota lafoai / Environment –waste management
☐Tulaga ogaoga o le tau – suiga o le tau, e pei o , afa malolosi, si'isi'I o le fogatai, lologa / Extreme events- Climate Change. e.g tropical cyclones, sea level rise, flooding
☐ Mea tutupu I laufanua, pei o mafu'ie, galu afi / Geological events – Earthquakes, tsunamis
☐ Ao'ao'ga /Education
☐ Galuega, Alagatupe / Employment, Livelihoods
☐Pulega, e lavea ai faigamatai, Faigamalo / Governance
☐ Soifua Maloloina / Health
☐ Le tagolima, mea tau tupe / Poverty, Money
☐puipuiga o meaai taumaga mo le lumanai, po'o aso leaga / Food security
☐ Isi (faamatala mai) / Other (Please specify) _____

26. O a ni faapogai ua le mafai ai ona e siitia ese atu ai? (maka mea uma e talafeagai)
What reasons is preventing you from moving? (tick all that may apply)

☐ Tagata o lou aiga / Family members
☐ Aiga, Mea fale ma fanua / Family, personal properties
☐ Tagata o le nu'u, tapu pe fa'asaina / Village members, restrictions
☐ Leai ni fanua, o e pulea fanua / lack of access to land, land ownership
☐ Leai ni avanoa faigaluega / lack of employment opportunities
☐ Leai ni avanoa mo aoaoga / lack of educational opportunities
☐Visa ma mea faasaina faaletulafono / Visa and legal restrictions
☐ Isi (faamatala mai) / Other (please specify) _____

27. I le tausaga 2100, faamata e te lagona e puipuia lelei lou aiga ma lau fanua mai le siitia o le suasami?
In 2100, do you feel you, your family, and properties are protected against rising sea level?

☐ Ioe / Yes
☐ Leai / No
☐ Ou te leiloa / I don't know

28. Aisea ua e lagona ai faapea? Why do you feel this way?

29. O iai sou lagona popole i le lumanai ma le suiga o le tau ma le siitiaga o le sami?
Are you worried about the future of climate change, sea level rise?

☐ **Ioe / Yes**
☐ **Leai (Alu i le fesili 31) / No (Go to Question 31)**
☐ **Ou te leiloa / I don't know**

30. O lea se mea e pito sili ona faapopoleina ai oe? (maka uma mea e talafeagai)
What are you most worried about? (mark all that may apply)

☐ **E leai se isi fale matou te sulufai iai / We don't have another home, house to evacuate to**
☐ **E le atoaatoa le matou tapenaga mo ia suiga / Our current adaptation mechanism is insufficient**
☐ **E le lava mea tau tupe e sauna ai mo ia suiga / We cannot afford to adapt ourselves**
☐ **E le lava se tupe mai le Malo po'o tupe mai fafo e saunia ai I auala matou te mananao ai / There is not enough funding from government or international donors for what we want**
☐ **O le aveese atu matou fanua ma fale ona o le suiga o le tau / I will lose my properties to climate change**
☐ **Isi (faamatala auiliili mai) / Other (please specify) _____**

(Alu loa I le fesili 32 / go to Question 32)

31. Aisea e te le popole ai i suiga o le tau ma le siitia o suasami? (maka uma tali e talafeagai)
Why are you not worried about the future of climate change, sea level rise? (mark all that may apply)

☐ **E iai seisi fale matou te sulufai ai / We have another home we can evacuate to**
☐ **Ua lava tapena matou mo ia suiga / Our current adaptation mechanisms are sufficient**
☐ **O lo'o lava se matou seleni mo ia suiga / We have enough money to adapt ourselves**
☐ **O lo'o iai se vaega tupe mai le Malo po'o tupe mai fafo mo matou manaoga / There is funding support from the government or international donors for what we want**
☐ **E le aafia matou fanua ma fale I suiga o le tau / My properties will not be affected by climate change**
☐ **O le Atua e pule; ua lava lou fa'atuatua ia te ia. / God is in control; I'll just have faith in him.**
☐ **Isi (fa'amatala mai) / Other (please specify) _____**

32. Afai e te mafia ona filifilia auala (metotia) e puipui ai lou fale po’o le nu’u, o le a le auala (metotia) e te filifilia? If you could select any adaptation practice to protect your home or village, what would it be?

Appendix B. Participatory Approach Workshop Video (transcription & translation)

Handwritten notes
Lelepa Matai (2050 worse case)

Ia I le vaai atu I le ata lea, e fai a se tele o le eseesega mai I le ata muamua, ou te iloa pau a le mea ma se tulaga lelei o le o I uta e nonofo ai. Talosaga mo se taligalu

Translation: When we look at these print-out photo, there is a big difference between the first one shown and this one. It seems the only thing and best option is to relocate inland" "We will probably need to request for a seawall"

Lelepa Women (2050 worse case)

E le mafai oga tatou taofia le sami, ma e iu lava ga tatau oga oo I uta. O le matou a ia lagona e mafia lava ona tatou nonofo pea i nei, ae fai taligalu ma toto laau i gataifale e puipui ai tatou laufanua ma o tatou fale.

Translation: We cannot block sea level and maybe we might need to move inland. We feel that we can stay here and build seawalls and plant trees along the coast to protect us all, and our land and homes".

Lelepa Youth (2050 worse case)

Se matou faasoa atu, e le tatau ona tatou give up ma o ese atu ma I gei. E mafai oga toto laua I gataifale e taofia ai le tafea ese o le ogeoge.

Translation: In our opinion, we shouldn't give up hope and leave, we can take care of our environment. Plant trees along the coast to protect the coastline."

Lelepa (inland resident) (2050 worse case)

Ia ma le fa'aloalo lava o au ou te nofo i uta, na o se talosaga, aua aua lava nei o'o atu seisi i uta. <jokingly>

"With all due respect, I live inland, and I don't want to see anyone moving inland."

Fagamalo Matai and Youth (2050 worse case)

Faafetai mo le avanoa, manaia tele le tatou polokalama, faasoa mai ai foi ni manatu. Ae se matou tali e magaomia taligalu aua e le mafai e seisi oga taofia le siisiii o le sami.

Translation: Thank you for the opportunity. This program workshop and information is very nice, to share with us some new ideas. But our short answer is we need coastal defenses because no one can stop the sea from rising."

Beginning of audio-video recording
Transcription/Translation of Video MVI_8140
[Satoaleapai Matai and Untitled men] (2050 worse case)

"Sa saunoa le alii saienitisi i lenei taeao, e tele lava le aafiaga o si matou pito nuu. O le alagavai atoa lava lea e i tua o le matou nuu. E maitau atu a tupu se mala faanatura, e feoti lava e lei te'a ese ma le vai. Ae o le faagaioiga muamua e kakau oga fai e kakau oga kapega uka, sosola i le mauga e feola ai. Makou ke iloa o uka lava o le sulufaiga lea mo kakou ae maise lava le kalafakai lea o kakou i lo kakou iku malo. Ia makou ke iloa, pe fai foi se kaligalu e kalepe lava e le sami ga fai e lima o kakou. Ae leai foi se isi e pule i fuafuaga a le Atua. Ia ae makou ke iloa i le 2050 e pei o ga kaua, e le aulia e se isi o kakou. Makou ke magagao e fai uma gaioiga e fua i gai alo ma fagau o le kakou iku malo. Maguia legei aso."

Translation
"The scientist has spoken this morning regarding the many adverse impacts of our shore lines. We have a wetland (river) running behind our village. We can see that if a natural disaster occurs, we are the first ones to go. But the first thing we should prioritize is to prepare higher grounds that we can seek safety and preserve our lives there. We know that higher grounds are the only safety for us living here at the shore lines. We know that even if we build a wall along the sea shore, the waves will break them down because they are man built. We do not interfere with our God's decisions. But we know that none of us will be around the year 2050 but we want to do something for our generations to come and our constituency. Blessed day."

Transcription/Translation of Video MVI 8143
[Lelepa inland resident] (2050 worse case)

"….e tafe mai mauga le manuia. Aua, aua lava nei ou vaai i seisi o alu atu i le mauga (laughter). Nonofo pea iinei. Fai mai le isi upu ana silafia e le Atua, e leai se mea tatou nonofo ai …..(inaudible)…afai tatou te malelemo iinei, malelemo faatasi ua uma foi la outou taimi. Ma le faaaloalo."

Translation

"…from the mountains flows the blessing. I don't ever, ever want to see anyone come to the mountains (laughter). Stay here. There is a saying "if God knew there was nothing for us to live at…….(inaudible)…. if we drown here, so be it, because your time has come. With due respect."

Transcription/Translation of Video MVI 8144
[Lelepa Matai] (2100 best case)

"….ma e leai lava se isi auala, pau o le mea i le kaimi gei, fai kaligalu, koko laau ia aua le aia i le sami. E kukusa makou afioaga aua e kalafakai i le sami. Ia ga oga pau ga o auala aua a oo aku i le kaimi lea ua makua magaia lava o le kaakiaga o le makou fagua lea ua aumai I le 2100 pe a aulia. O isi foi alo ma fagau e pei oga e kaua, e galulue i le kaimi gei aua fagau lalovaoa mo le lakou lumagai. E galulue mo le lelei akili o fagua ma afioaga."

Tanslation:
"…and there is no other way but at this moment, erect sea walls and plant trees to stop coastal erosion.
Our villages are the same as we are also by the sea shore. I guess these are the only ways because of the situation of our village in 2100. The children now can start on these projects for the future generations to come. To work together for the betterment of our lands and villages."

Coordinator: Richard
"Ia masalo o le malamalama ua faasoa mai, ua sui manatu, aua o le manatu muamua faapea e o i uta, ae o le taimi nei, ua tonu i le fonotaga a matai, o le a nonofo pea iinei. O le sa'o lea?"

Translation
"I guess the knowledge (you) have shared has changed somewhat as the previous thoughts were to retreat to higher grounds, but now the matai group are pledging to stay where they are? Is this true?"

1st Matai
"Ia, o ai e fia alu pe a vaai aku i le magaia o kai gei e vaai aku i le sami…pe a oo aku i lega kaimi o le kulaga lea o loo iai. Ia ae kausia pea mea e lua, poo le o I uka poo le gogofo iigei."

Translation:
"Who wants to move if we see the beauty of the sea but for now we can go both ways. Prepare higher grounds or live by the sea."

2nd matai
"O se faaopopoga lega o le makou vaega. E le mafai lava oga kuuua le o e kapega uka, ia fai fale piliki. Ae le faapea la a o i uka oga kiai ai lea o iigei. Leaga o iigei lea e iai kulaga maoka ma kulaga laoa o le nuu. Ae pei o uka o kua laoa ma kua maoka. Ae a kupu loa gi mea pei o sugami, kaufekuli loa i kua. E o aku o loo mauku gofoaga e gogofo ai. Ae a kukupu lava mea iigei pei o faalavelave, o mai e faakigo ae pei o uka lava e gogofo mau ai ae o iigei o mea e kukupu aua le sami. O se faaopoopoga lega o le makou vaega lea.

Translation:
"I want to add on to (that) part. We cannot ignore preparations for higher grounds and erect thereon solid brick houses. But it doesn't mean we should permanently move to high grounds and neglect here (our coastal village). Because it is here (coastal area), where we have the known (culturally significant) grounds and housings for the rest of the village. Whereas inland are the backyard of homes and backyard of our culturally (significant) area. But in the case a tsunami occurs, we can seek protection in higher grounds, where we will have solid houses and homes. But in the meantime, we live here and cater to our faalavelaves but we have our refuge places on higher grounds."

Coordinator: Richard
Faafetai lava. O Lelepa 2, le autalavou ma tina.

Translation
"Thank you. Next group Lelepa 2, the youth and women."

Transcription/Translation of Video MVI 8145
[Fagamalo Matai and Youth] (2100 best case)

"….o se kulaga ua oo iai le makou pepa. O lea ua ou vaai aku i le 2100 ua kaakia mai foi fagua ma kulaga e pei oga iai. O se magaku lava ia e pei o ga makou kalagoa iai ma gai uso ia ae maise si o kakou akuguu ma faakusakusa lea i akuguu mamao e pei oga iai le kele o fale e gaosi ai kasa ma fua i le kakou Malo. E moi a ae o lo kakou Malo, e le kele gi fale gaosi kasa ma e laiki lava gai mea makou ke iloa. Ae pei o aku guu mamao ia e kele agai iai ia kasa ma ua aafia ai si o kakou akuguu lea ua iai ai suiga ia. O le 2050 lea ua makou kilokilo aku ua makua faalekogu le gakaifale ae le gaka i lea…o le kali la a matou ia o le mafaufau akili ae maise le Malo ua gofo uka ma ia kaulogologo i malo o akuguu mamao e ave iai se kuualalo a kakou e ala i se palemia i fale ia e gaosi ai kasa. Ae o kakou ia, e laiki gi fale gaosi kasa ua mafua ai le faakupulaia o le sami ma le ea. Ae o kakou lima lava e iai le soifua ma le ola."

Translation:
"…regarding our paper. We can see that by 2100, the results of our lands from the current circumstances. Our thoughts as discussed with our brothers and others and compared our country with overseas countries where there are a lot of factories that emit gases. Compared to our Government, we do not have many factories to emit these gases, we only know a few here. But overseas countries have lots of factories emitting these gases and they have affected even our country. As we can see, by 2050 our shorelines are badly affected. Our answer to these problems is for our country or Prime Minister to plead with these countries to stop these pollutants. These have affected in rise of the sea level and greenhouse effect. But our hands have the answers to our lives."

Transcription/Translation of Video MVI 8146
[Satoalepai Matai and Women] (2100 best case)

"… o le vaega o le aso e tusa ai ma le polokalama. E manaia tele le polokalama. E tapenapena ma sauniuni. Ae pei ona vaai atu i le ata muamua i le 2050, e fai sina afaina tele o le matou afioaga. Ae o lea ua ou vaai atu i le 2100, pei la ua kau magaia mai. E pei la e magaia foi i le kasi o finagalo, e le mafai ona tuua mea o lo matou nonofo ai, mea o loo iai tulaga maota ma laoa foi i tai, e pei la o se talosaga foi e avatu i le paia o tou ofisa, i ni nai puipuiaga mo si o matou nuu i le taimi nei, aua o le mea sa'o lava o lea e nonofo matou i luga o le sami. E vai tua ae luma le sami. O loo faapena o na ati pea le nofoaga o loo matou nonofo ai, e manaomia la le puipuiga i gi kali vai aua le puipuiaga, ae o lea o le a fai gi kapegapega o le makou guu i uka mo gi fale e kua iai i kua aua le kapegapega mo faalavelave faafuasei pei o se sunami… ae pei o le lelei o kali galu mo le lelei pea o gi makou afioaga. la o se kala lega ma le faaaloalo."

Translation:
"…at this time of the day according to our programme. It is a very good programme. To prepare and be prepared. But as we can see from the first picture of 2050, our village suffers a big devastation. But we can see in 2100, it is not so bad. We kind of support another view that was voiced, that we cannot really leave where we are now, where the chiefs' houses and untitled men's houses are here along the shoreline. But we request your respectful office for some aid in some sort of protection for our village because it is a fact that we live by the sea but a river runs in the back of our village. The sea keeps eroding our properties but we really need protection from this through the erection of a sea wall. However, our village will now start preparing to build solid houses on higher grounds for shelter from natural disasters such as tsunami…we feel that sea walls will help our village. This is all with due respect."

(Ladies group)

“Faafetai mo le avanoa. O afioaga ia ua uma ona avatu o latou manatu o le tausaga lea e iai pepa muamua agai i le lumanai, ona iai lea o lou manatu na’o a’u, e matua aafia tele lo matou nu’u ona o tulaga ia. Tulaga o le vai ae maise se tulai mai o se sunami ma isi mea faapena e tutupu i se taimi oi luma. Ou te nofo tonu lava i luma o le vai ma ou te iloa, e aafia lou fale i le sau o le vai, faatasi ma le sami. A sau le vai, fetoai ma le sami, ou te le iloa poo fea o le a ou me’i iai. O lo’u manatu la, e sili lava le o i gauta e nonofo ai. E iai foi lou manatu i ni fale tatou te o iai…(inaudible) O le lona lua o lau tala, ua iai lo matou auala laupapa. E iai le faamoemoe atonu o se taimi oi luma o le mafai ona outou fesoasoani mai i le matou auala laupapa lea, e manaomia le faamaualuga, pe a finagalo iai lau susuga. Ma le faaaloalo lava.”

Translation:
“Thank you for the opportunity. All the villages that have given their thoughts about the pictures seeing into the future of our respective villages, but my own personal opinion is that our particular village will suffer the most devastation. Regarding the water beside us and if a tsunami occurs in the future. But I live right by the river and I know that my house will not be safe from the river and from the sea. If the rivers comes and the sunami also comes, I do not know where I can be safe. So my view is, we have to move to higher grounds for safety. That we should build houses….(inaudible). My second thought is that we have a wooden bridge. I have hope that you can provide aid towards building a higher and safer bridge for our village, if it is agreeable to yourself. With

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Transcription/Translation of Video MVI 8147
[Lelepa youth] (2100 best case)

“….a faapea o lea e faakupulaia lava le kasa poo le siitia o le sami, o ai e mafua ai gei mea. E leiloa la e makou poo le a se mea laa fai gei. A o foi I uka ae alu alu gaka le 3 mika ae alu pea, leiloa loa e kakou poo le a se mea e fai, ae pau o le mea o le kakalo i le Alii. Ia o le magaku lega o le aukalavou i lenei ikula. Faafetai”

Tanslation:
“…if the greenhouse effect and rising sea levels continue, who are causing these things to happening? We do not know what to do. If we go to higher grounds, what if the sea level continues to rise and catch up? We feel the only thing we can do is to pray to our God for help. Those are the thoughts from the youth. Thanks. ”

Transcription/Translation of Video MVI 8149
[Lelepa inland resident]

"….a faapea o lea e faakupulaia lava le kasa poo le siitia o le sami, o ai e mafua ai gei mea. E leiloa la e makou poo le a se mea laa fai gei. A o foi I uka ae alu alu gaka le 3 mika ae alu pea, leiloa loa e kakou poo le a se mea e fai, ae pau o le mea o le kakalo i le Alii. Ia o le magaku lega o le aukalavou i lenei ikula. Faafetai"

Tanslation:
"…if the greenhouse effect and rising sea levels continue, why are these still happening? We do not know what to do. If we go to higher grounds, what if the sea level continues to rise and catch up? We feel the only thing we can do is to pray to our God for help. Those are the thoughts from the youth. Thanks. "

Transcription/Translation of Video MVI 8150
[Lelepa Matai] (2100 worse case)

"….e kalagoa aku i le vaega lea o le fesili oga avaku ai lea o gi magaku. O lau fesili pe mafai e lau susuga oga fesookai ma malo e auala aku ai se kalosaga o le guu o Lelepa lava ia ae kuaia isi afioaga ae pe mafaia ova avaku se kalosaga i malo mo se fesoasoani i nei mea. Pe o le mea lega e fia malamalama ai. Pe mafai foi e lau susuga oga faaulu aku se kalosaga i le Malo mo gei mea.

Tanslation:
"…to speak regarding this matter and give some thoughts on it. My question is, are you able to coordinate with governments regarding a proposal from the village of Lelepa, not including other villages, about some aid with regards to this matter. This is our question. And if this can be coordinated by yourself, a proposal to governments on this matter. "

Transcription/Translation of Video MVI 8151
[Lelepa Matai] (2100 worse case)

"….o le uiga o lau fesili, e mafai e kakou oga fai suiga? Iigei lava i Lelepa. Aua o le isi pepa lea ii, e kele ia o le malaia. Oga o le mafuaaga, ua galulue pepa, poo se faakaikai i se kala laka mai. E aumai isi pepa, o le makaga ia o le guu. Aai, aai, o le fesili aisea? Ua le galulue Lelepa i le mea e masagi ai. O le uiga la lea o le fesili e mafai e Lelepa oga galulue mo le agai i luma poo le polokalama ua e aumaia, sei vagana ua ua iai malo akoa? Pau a ga o le uiga o le fesili. Aua kakou ke o fua i le Malo, e le ago mai le Malo ia kakou. Sei vagana ua kalosaga lau susuga. A o le a lea mea a guu e fai? E pei la o le ikuaiga mea lea, makou ke o koko laau i gakai ma a gisi mea e akigae ai. E

faakumauiga le lelei le akigae. Afai faapea makou ke o e koko laau ma akigae e augoa ma le kalosaga i gei mea pei o le elekise poo a, e iai se suiga?"

Tanslation:
"…my question is, are we able to make the change? Just in Lelepa. Because looking at other papers, it is a big tragedy. The reason is, the papers are working. For e.g., some papers show how bad the village is. But the question is, why? Because Lelepa has not done work like beforetimes. My question is can Lelepa work to salvage itself or the programme you have taught is only helpful if all nations are in this? That is my question. Why go to the Government when the Government does not care about us – unless you can petition on our behalf. But what can the village do? Like what we can do is to plant trees and other developments. Would there be a change if we turn to tree planting and other developments instead of asking for electricity, will this bring a change?"

Transcription/Translation of Video MVI 8152
[Lelepa Matai] (2100 worse case)

"….lea la ua iai kasa ooga ua o ma lapisi I luga. E kakau la oga iai gi suiga o ga mea. Ave ga lapisi e faalelei ai le eleele. Ia iai se aoga o gei mea. Ae o le talosaga a le nuu ia pe talosaga I le Malo ae tatau ona galulue le nuu. O le fesili lea, pe tatau ona galulue le tatou nuu?"

Tanslation:
"…now we have the greenhouse effect plus the pile of rubbish. There should be change to solve these. Maybe the rubbish can fill the earth. Make use of these things. But for the village, even if we seek the Government's help, we should still do the work. Can the village do the work?"

Transcription/Translation of Video MVI 8153
[Lelepa Matai] (2100 worse case)

"….o au e faamaukuiga lava lau faamakalaga lea…fai fale kumau i kua. O ia foi mea faapea e galulue mo le kokoiga o laau ma isi mea, a oo lava iga sau le sugami, e aveese uma lava ae sau lava le malosi o le galu ia I le mea e gaka ai. Afai e oo mai I le fale lea, e alu uma lava le fale. Ae i lou lava kalikoguga pe a koe kilokilo lava iai i aka ia ua aumai, o e fai fale I kua. Kupu loa faalavelave, sosola loa i kua. Ia o le makou lea faamakalaga lea i lea vaega."

Tanslation:
"…for me, I reiterate what I said, go and build solid houses on higher grounds. The thing about plantings trees and other things, when the tsunami comes, everything will be wiped out from the strong waves. If the waves come to this house, it will leave nothing. But my own personal belief and looking at the sheets of pictures that have been given, go and build your solid houses on higher grounds. As soon as the tsumani comes, we can escape to high grounds. That is our thoughts on this issue."

Transcription/Translation of Video MVI 8154
[Satoalepai Youth, Women, and Matai] (2100 worse case)

"… ua saunoa le tama ia e tusa ai ma lenei itula. O lea ou te tilotilo atu, e fai lava siga kele o le faafikauli. Ae o le fesili e kulai mai, o ai e faia, o ai e puipuia? Ae o a'u lava ia e pei oga saugoa le kama o le afioaga, e leai se mea kakou ke aapa ai fua i fafo, ae o kakou lava e iai le puipuiga. Pei la oga vaai aku, o le sami lava la e gogofo ai Falevao. E makua kele lava o le afaiga. Ua kele foi semiga ua ou alu iai ma faalogo ai I mea gei o mala faanatura. Ma o lau tali la, o uka lava. Ae o se kali i le gofo i le fale, o le kaele lava i le sami ma le vai pe a oo mai. O se faamatalaga lena i lenei taimi o le aso. "

Translation:
"…our elder has spoken regarding this matter. But I can see that there remains a big problem. But the question is, who is to do the work, who is to do the protection? But for me as the elder of our village has spoken, we should not seek aid from overseas, we have to do the work for our own protection. As I can see, we are living by the sea and it is a big risk. I have been to many seminars on climate change and natural disasters. My answer is, we have to move to higher grounds. But if you still want to remain in your house here, then be prepared to take a swim in the sea. That is my saying at this time."

(Ladies group)
"Faafetai mo le avanoa. Na ona ou toe faaopopo i le saunoaga a le matai o le matou nuu. ae e iai lou talitonuga, o lea ua e faafofoga i lau tala na fai atu analeila e uiga i le matou auala laupapa. O le auala laupapa lea, na o le pau lea o le sootaga e o ai i uta le vaega lea ei tai I uta. A siliga la ma sou vaa e te alu ai I leisi itu, e leiloa poo fea e te oso ane ai. Na ona pau lava lea o le auala laupapa e o ai i uta le matou nuu I uta o le togavae, ae faapea foi i le mea matou te galulue ai. O le ala la lea o lou manatu, e te faalauiloa atu le matou auala laupapa lea, e pei ona e saunoa, e mea e te nei, e faalauiloa i fafo ina ia taofi le mea lea ma le mea lea. O lea la ua avatu lou manatu na o a'u, faamolemole, e manaomia lava se fesoasoani mo le matou nuu. o le matou nuu e matua ogaoga le leaga pe a sau mala faalenatura e pei foi ona saunoa nisi tagata I lenei aso. Pei o sau faamatalaga lea e avatu I le agaga faaaloalo. Manuia le tatou aso."

Translation:
“Thank you for the opportunity. I want to add on to what was said about our village by our matai. But I believe that you have heard what was said before about us about our bridge. This bridge, this is the only connection our village has with the higher grounds. So if you don’t have a canoe to access the higher grounds, we don’t know how else we can escape to higher grounds. This is the bridge that our village use to go to our plantations, to the forests and where we do work. So our request is, can you make known our need for the building of our bridge as you have said that you can make known our concerns to overseas countries so they can stop this and stop that. So this my personal opinion, please our village really needs this aid. Our village is the most affected in devastation if a natural disaster occurs, as already raised by others. This is my saying with due respect. Have a great day.”

“Faafetai mo le avanoa. Fia talanoa atu e uiga i le suiga o le sami ma kasa oona. Ae o le fesili, pe mafua i se a? Afai e mimiti e le la le kasa oona mai maua mai ai le suavai, ma toe timu mai ma tafe mai uta ma alu atu i le sami?”

Translation:
“Thank you for the opportunity. I want to talk more about the rising sea level and the greenhouse gases. My question is, why is this? If the sun absorbs the bad gases in the atmosphere and turns them into water that we drink, and drops them on the trees and they in turn run down to sea?”

Transcription/Translation of Video MVI 8156
*** MVI_8156 [Avao community resident walk-in] (2100 worse case)**

“Tau puepue atu tulaga uma ae faafetai ua malie i le faalogo ae o tatou uma lava… (inaudible) ae lea e faalogologo atu i le afioaga lea o Lelepa, e mafai ona sui. Aua le toe susuniina lapisi. Ae lea ou te fai atu, ae faafefea la pe afai e le susunuina lapisi a Lelepa ae susunu e Fagamalo ma Satoalepai. E faafefea la le siosiomaga lea? E afaina uma lava a? ae a tuu faatasi pulea ma malilie faatasi, sa le toe susunuina lapisi, sa le toe taina laau, ou te iloa o iina e maua ai le tali o le mataupu. Ae afai e taofi atu e matou, ae susunu pea e Satoalepai. Ia ae o le manaia ia o le tulaga o le mataupu.”

Translation:
“Trying to contribute to our matter and have been very satisfied with what was said…(inaudible) but listening to the village of Lelepa, things can change. Do not burn any more rubbish. But my concern is, what if Lelepa decides to ban the burning of rubbish but the other villages of Fagamalo and Satoalepai don’t concur? What is they still go ahead and burn their rubbish? What kind of environment are we creating? We

will all be affected. But my suggestion is, how about our villages enter into some sort of agreement and ban burning of rubbish, the cutting down of forest? I know this is the only answer to this problem. But if we don't stand together, then nothing good will come to us. But I am satisfied with our discussions on this matter."

Transcription/Translation of Video MVI 8157
[Fagamalo Matai] (2100 worse case)

"….faalogologo aku lava I gisi o failauga ae maise le aukalavou ua kakou faakasi ai I legei polokalama makagofie. Malie foi i saugoaga a isi failauga, e mafai lava oga foia faafikauli, pe a loto kasi e kaofi le kaiga o laau, ae le gaka I lea le suiga o le lapisi, ae o si ou magaku o kakou lava e mafai oga kakou kaofia gisi o gei kulaga, faakasi ai ma se kuualalo mo akunuu mamao e ala aku I le kakou Malo, ia faaikikia fale gaosi oloa mo le saogalemu mo le agai i luma ."

Tanslation:
"…listening to some comments from the orators, youth and others involved in this informative workshop, some of the comments are well said. That we can do some work to solve these problems if we all work together like saving the trees and not cut them down, how to deal with our growing rubbish. This is what we can do as individuals. We submit our plea to overseas countries to please reduce the factories that emit gasses so that we can have a safe place and all of us and generations to come."

Appendix C. Some of the elevated houses and structures typical of rural villages.

Appendix D. Community workshop and Field work schedule.

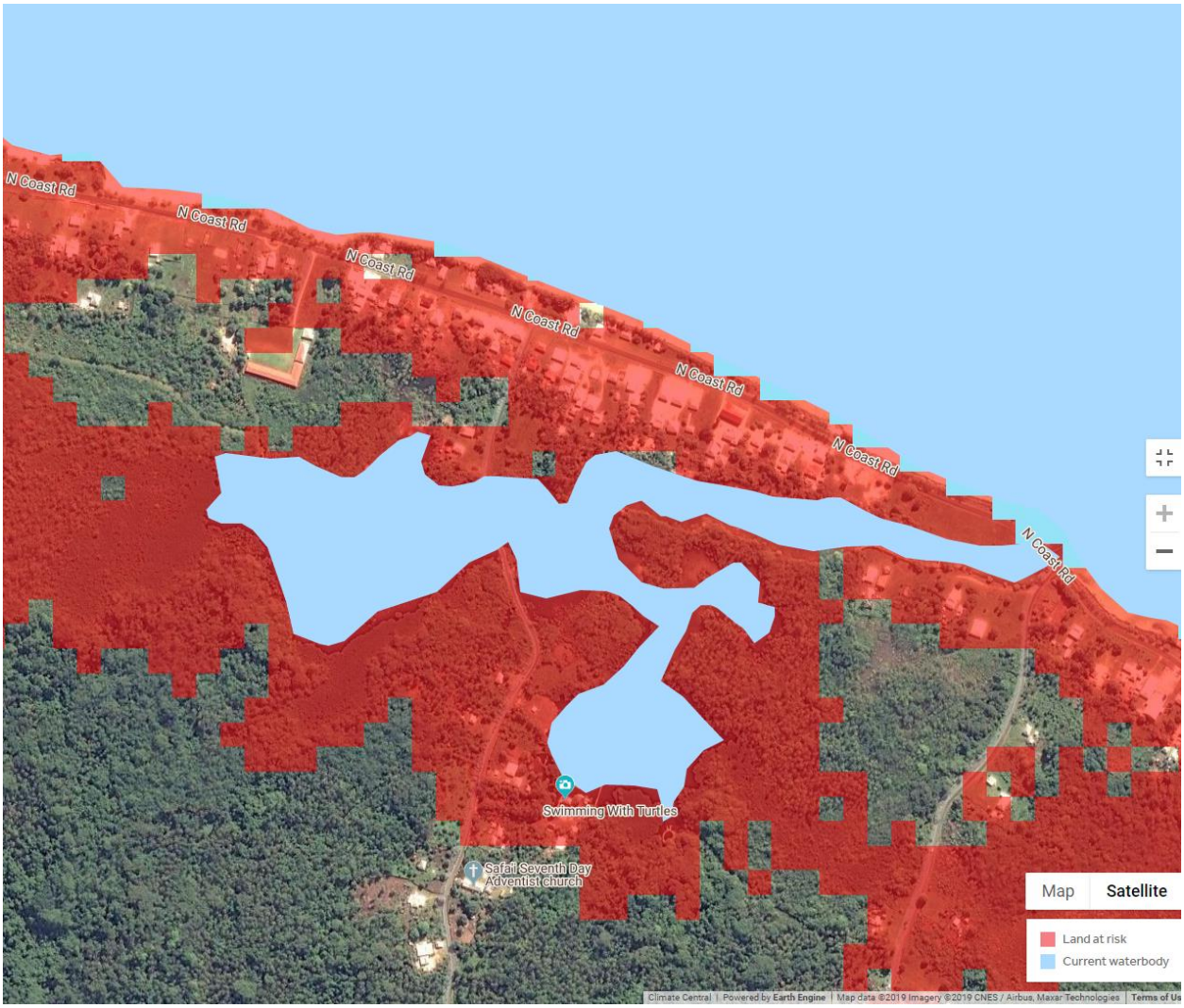
Samoa Field Work (November 14-25, 2019)

Date	Activities	Notes
Thursday 14	Depart Tokyo, Narita International Airport, via Auckland @ 18:30	6 hour layover in Auckland
Friday 15	Arrive at Faleolo International Airport @ 20:40	Depart Auckland International @ 15:30
Saturday 16	Assemble of underwater surveyor with Go-Pro camera. Lunch meeting with team (Researchers)	Buy materials at local hardware store Location TBC
Sunday 17	Preparation for early morning ferry from Upolu to Savaii	Arrange drop off to Mulifanua
Monday 18	Travel to Savaii Island on 6am Ferry ETA at Fagamalo District 11am Lunch at 12pm Briefing on methodology Meeting with Village Council at 1pm - Traditional Welcoming Ava ceremony Aerial Drone surveys 3:00-6:00 - Depending on the weather	Take equipment Rent a car from Jetz Rental Check in @ Tanu Beach Fales Overnight stay at Tanu Beach: Accommodation and Lunch ($100/day/person)
Tuesday 19	Workshop days (Lelepa) First Session 9:30 – 11:30 Lunch 11:30 – 12:30 Second Session 12:30 – 2:30 Tea break 2:30-3:00 Final Session 3:00-5:00pm Return to Tanu Beach Fale: Debriefing	Overnight stay at Tanu Beach Accommodation and Lunch ($100/day/person)
Wednesday 20	Community Surveys Marine Ecosystem surveys Aerial Drone surveys 3:00-6:00	Overnight stay at Tanu Beach Accommodation and Lunch ($100/day/person)

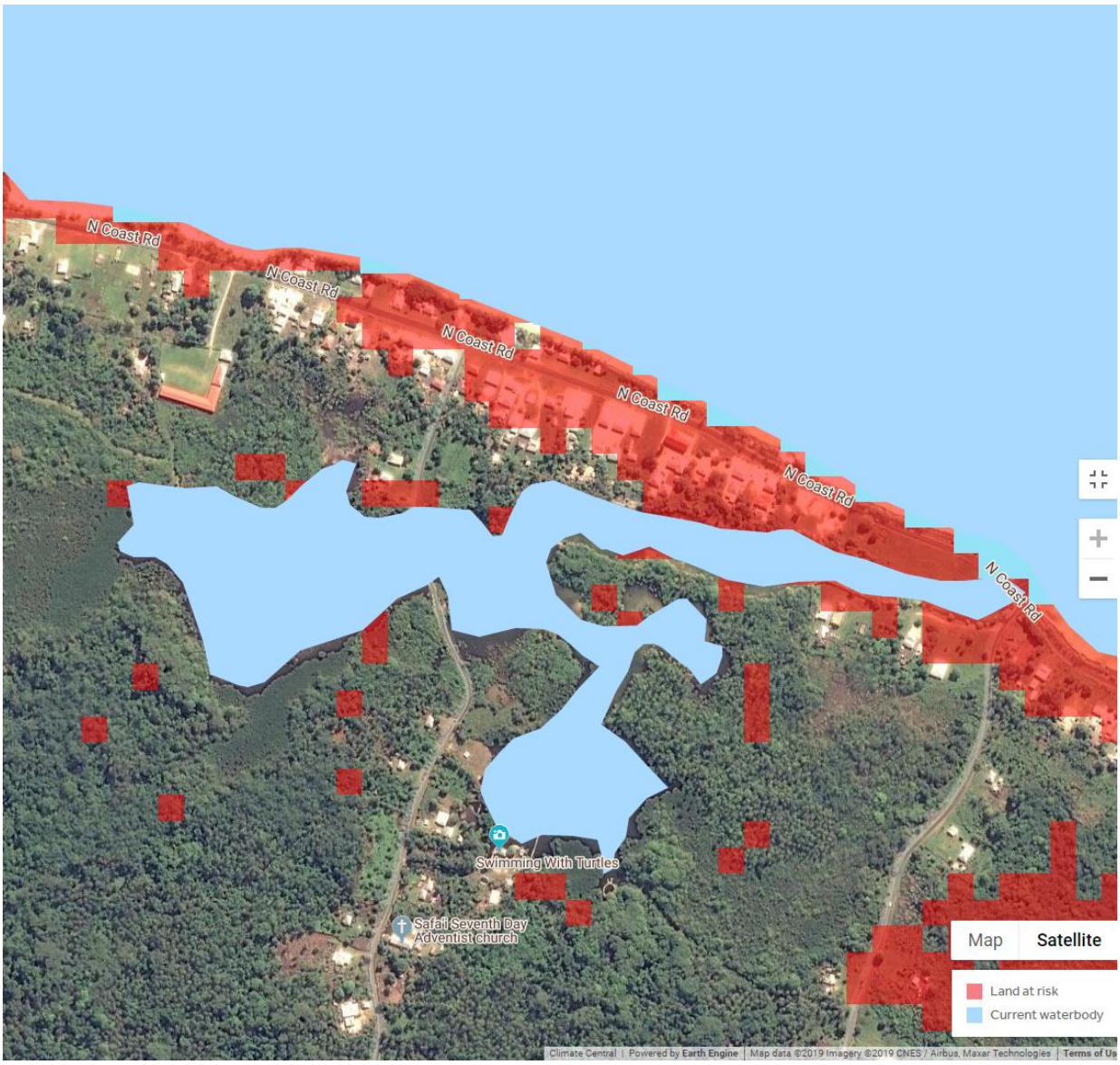
	-Depending on the weather (and Monday)	
Thursday 21	Workshop days (Fagamalo, Satoaleapai) First Session 9:30 – 11:30 Lunch 11:30 – 12:30 Second Session 12:30 – 2:30 Tea break 2:30-3:00 Final Session 3:00-5:00pm Return to Tanu Beach Fale: Debriefing	Overnight stay at Tanu Beach Accommodation and Lunch ($100/day/person)
Friday 22	Community Surveys Lunch 12:00 Marine Ecosystem surveys (back-up) Team Debriefing	Check out of Tanu Beach Catch 16:00 Ferry to Upolu Arrange pick up from Mulifanua
Saturday 23	Down time Free day for any issue arising. Preparation for departure	
Sunday 24	Depart Apia for Auckland @ 21:40	Stay overnight in Auckland, depart @ 9:50
Monday 25	Arrive in Tokyo	Narita international @ 16:50

Appendix E. Detailed maps for each community – SLR inundation in 2050 & 2100.

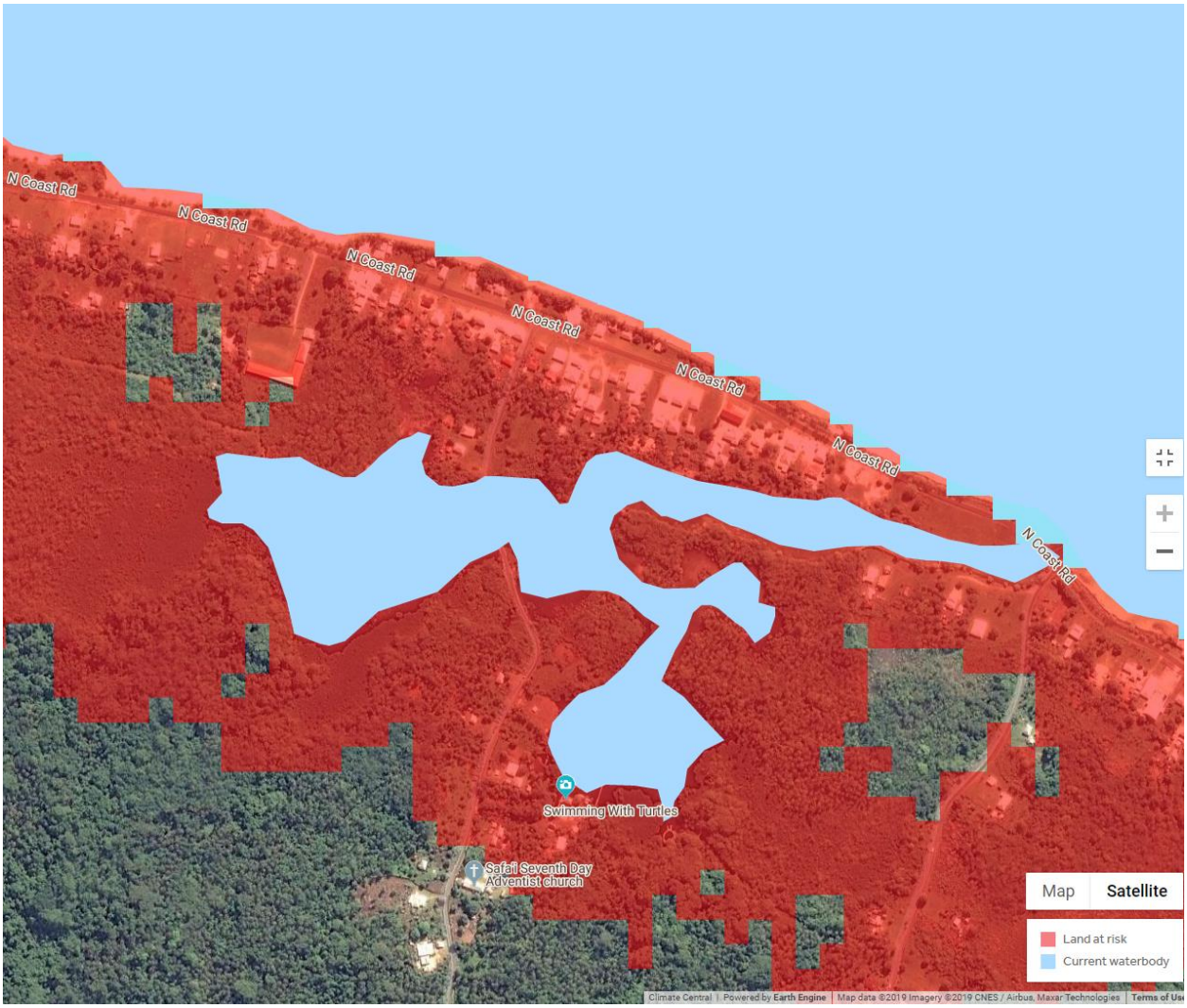
Satoalepai: 2050 Best case scenario (deep emission cuts)



Satoalepai: 2050 Worse case scenario (unchecked, flooding with medium luck)

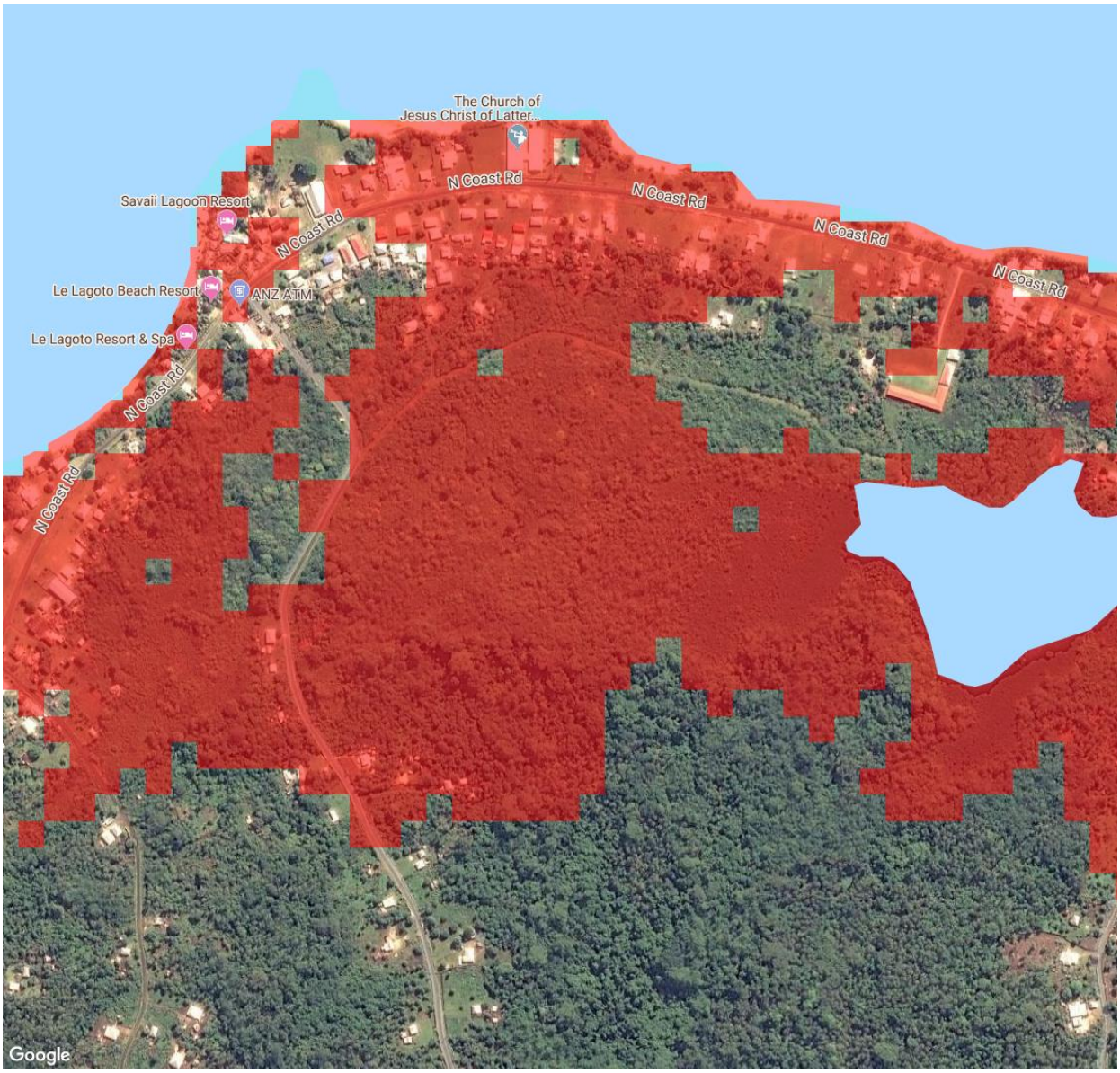


Satoalepai: 2100 Best case scenario (deep emission cuts)

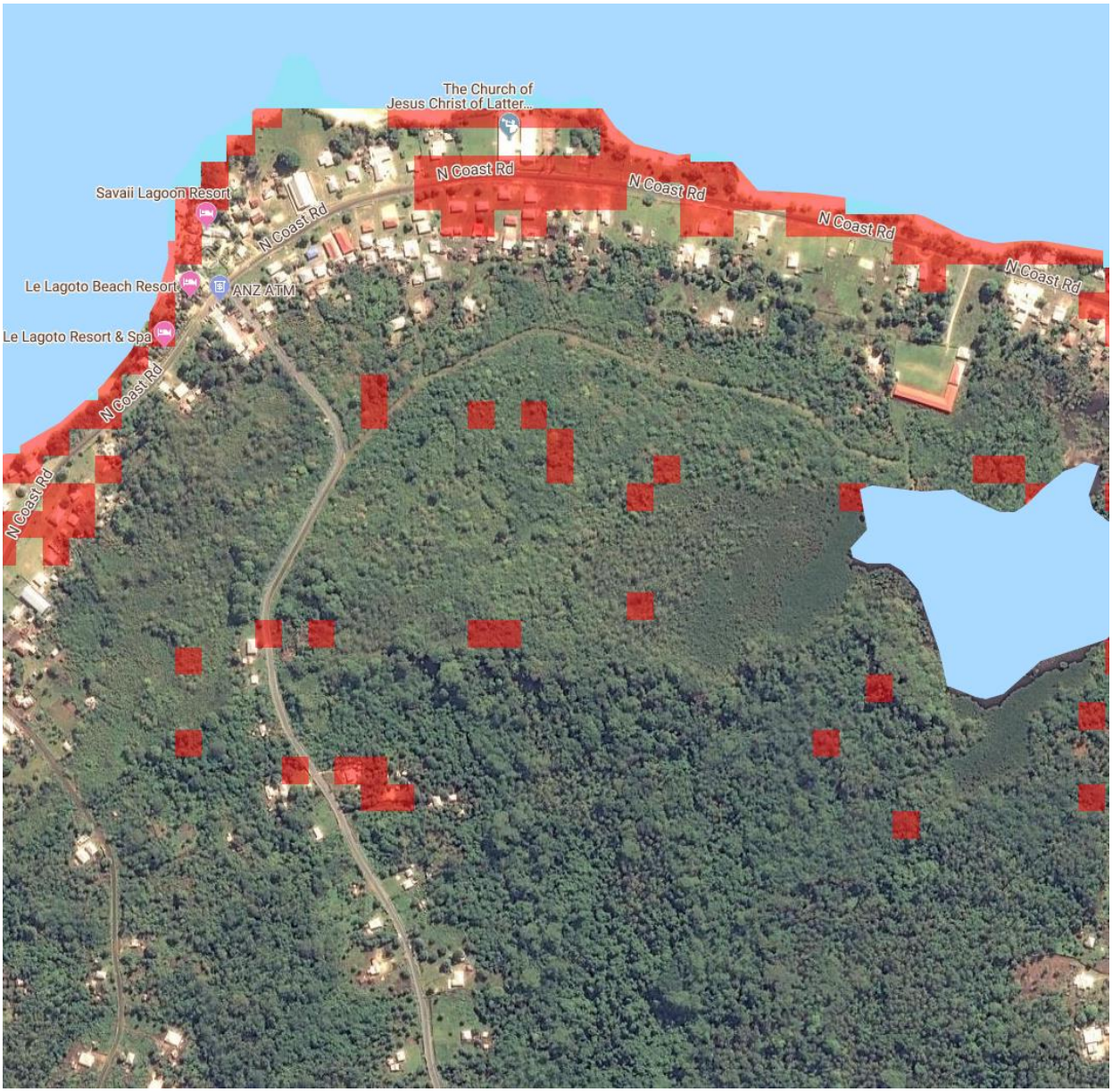


Satoalepai: 2100 Worse case scenario (unchecked, flooding with medium luck)

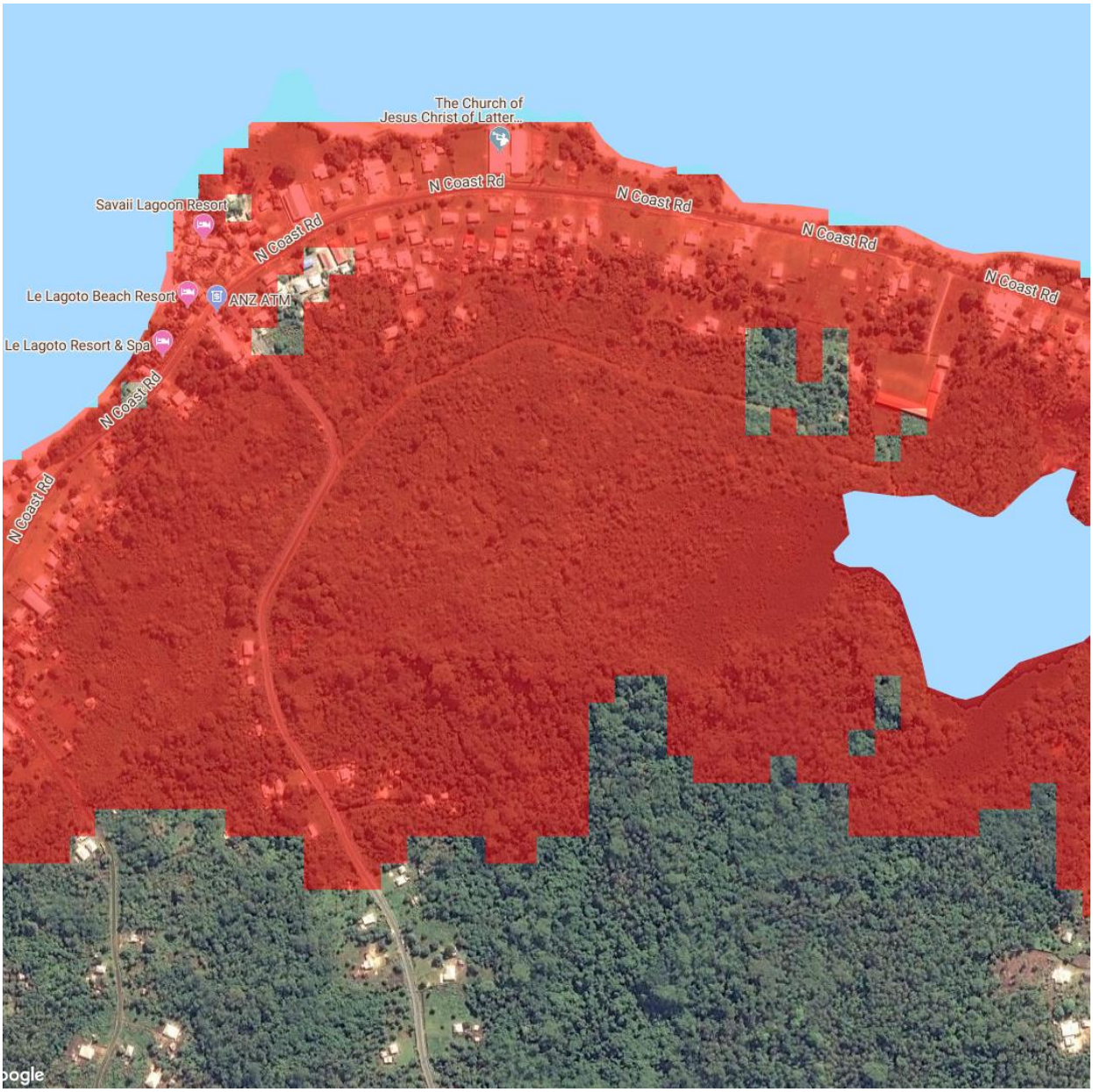
Fagamalo: 2050 Best case scenario (deep emission cuts)



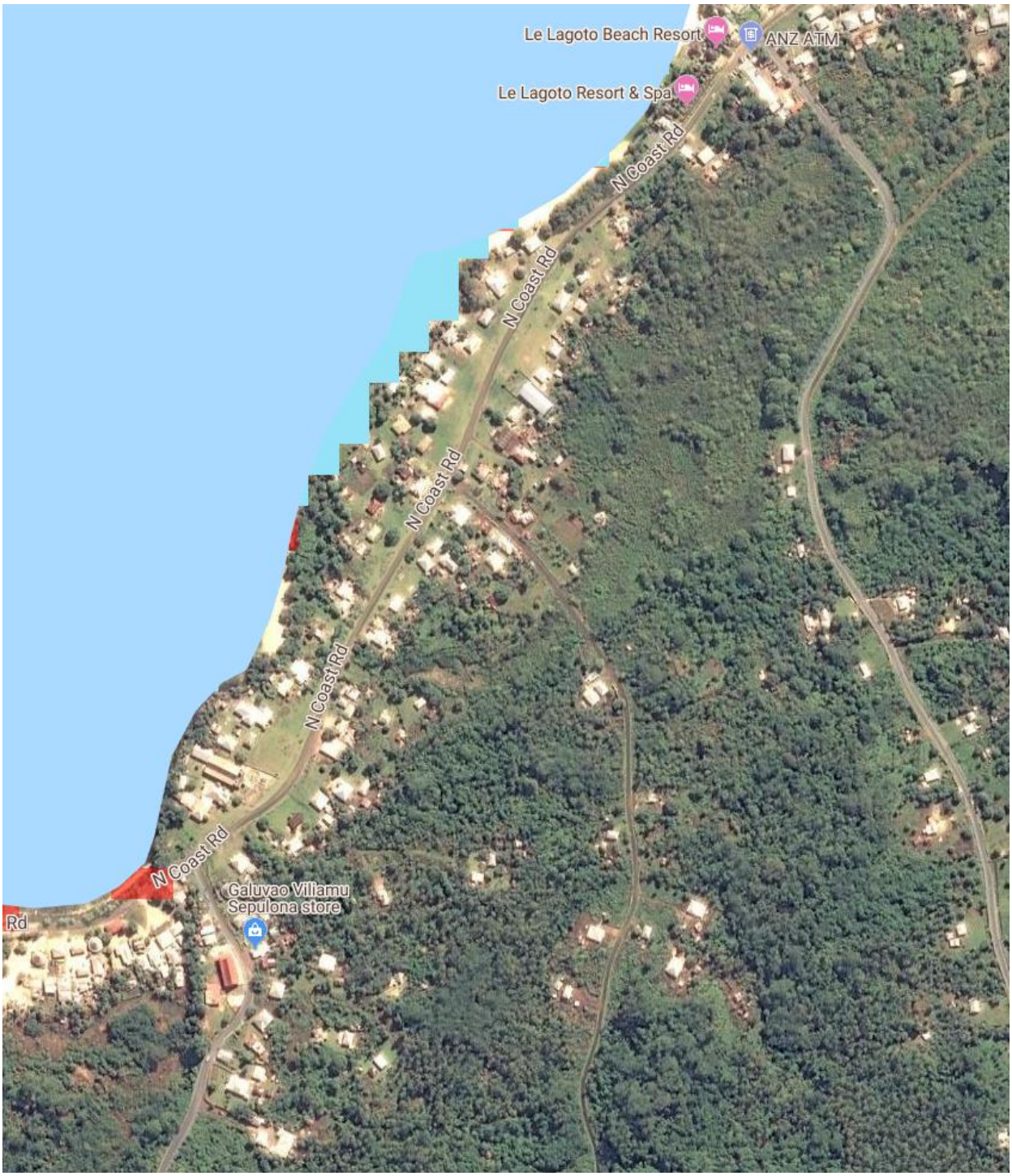
Fagamalo: 2050 Worse case scenario (unchecked, flooding with medium luck)



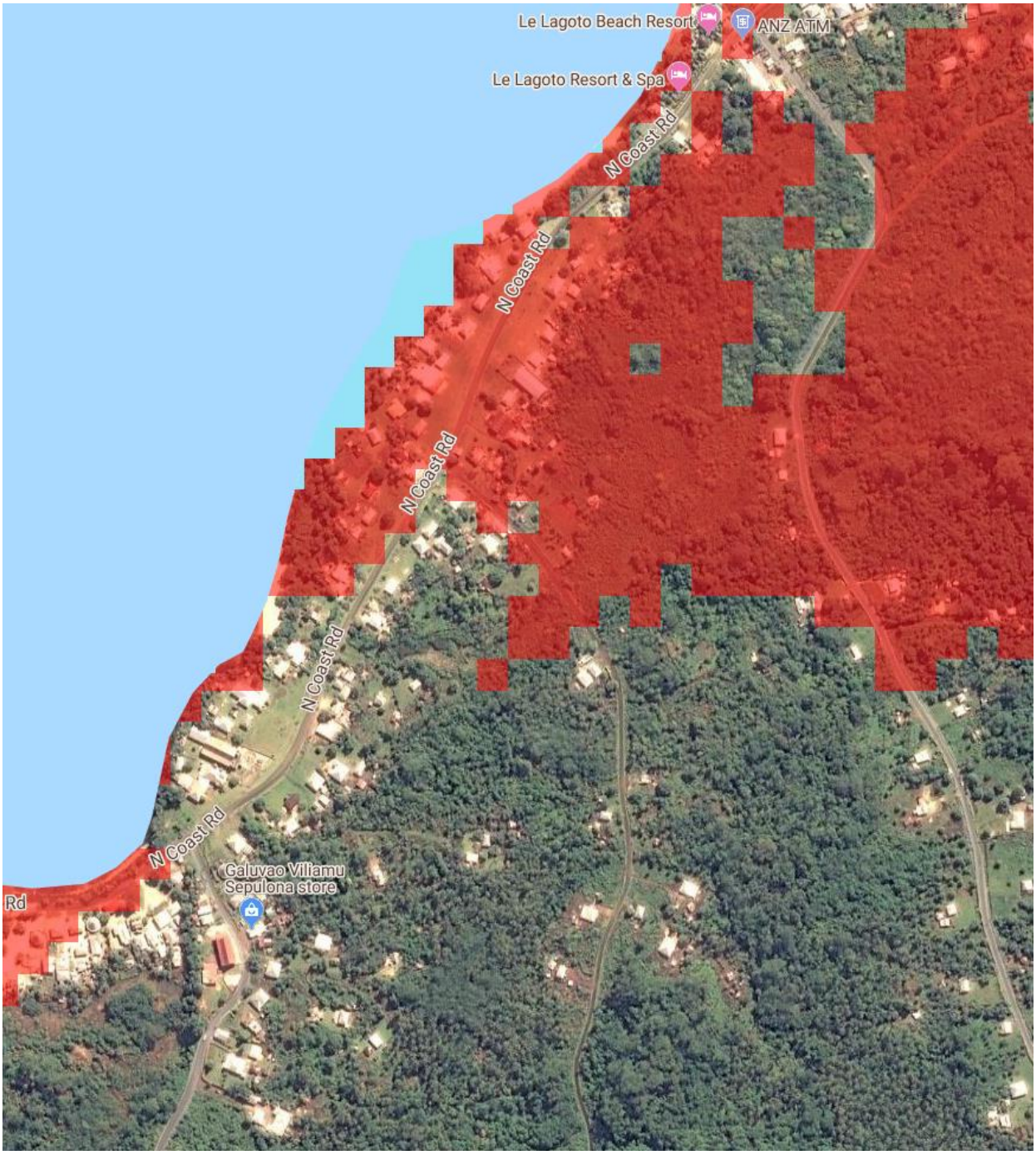
Fagamalo: 2100 Best case scenario (deep emission cuts)



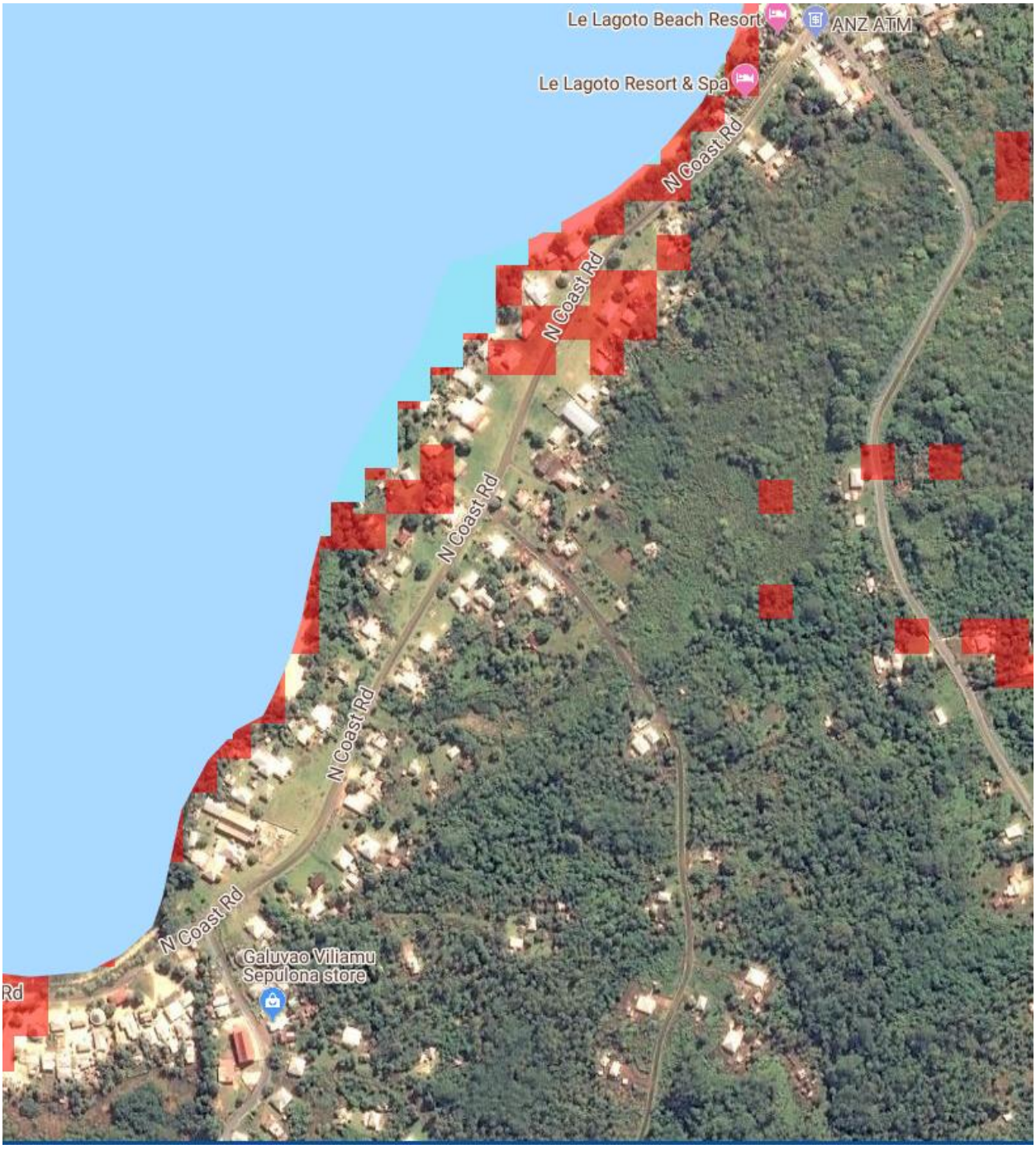
Fagamalo: 2100 Worse case scenario (unchecked, flooding with medium luck)



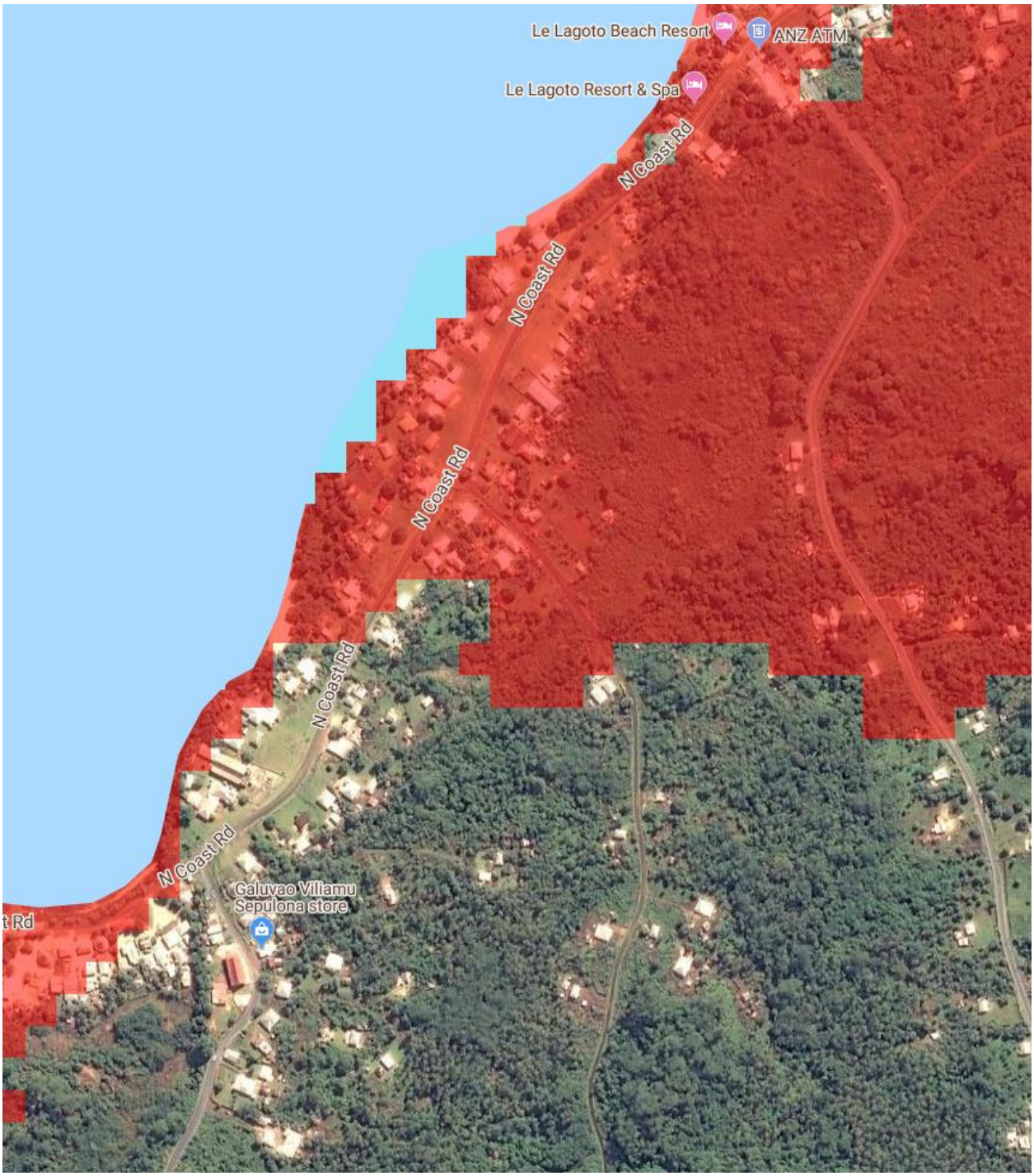
Lelepa: 2050 Best case scenario (deep emission cuts)



Lelepa: 2050 Worse case scenario (unchecked, flooding, with medium luck)



Lelepa: 2100 Best case scenario (deep emission cuts)



Lelepa: 2100 Worse case scenario (unchecked, flooding, with medium luck)