Disaster Impact on Households in Tuvalu*

Tauisi Taupo & Ilan Noy †

June 6, 2016

Abstract

This paper empirically examines the relationship between disaster risk and hazard, exposure, vulnerability, and the responsiveness of households to cyclones. This reveals policy implications for future adaptive capacity, lessening exposure, vulnerability reduction, and resilience enhancement. This study used primary data obtained from a detailed household survey (Pam module) that was carried out in the affected islands of Tuvalu by the Tropical Cyclone Pam (TC Pam). Disasters such as cyclones, droughts, and floods were ranked the top three stressors affecting households in Tuvalu. The study confirmed that a significantly large proportion of households, particularly the poor, were badly affected and suffered monetary losses from damages from the TC Pam. Moreover, the ability of households to respond to cyclones is limited by insufficient financial resources, the absence of proper early warning mechanisms, and the lack of administrative support for training and capacity building. This resulted in further hardship on the poor who are already struggling financially. Future climate risks are likely to drive the poor deeper into poverty unless we concentrate our policies to alleviate poverty and minimize the effects on them. We employed a disaster risk model using 321 household data from the affected islands of Tuvalu. Since most of our results conform to prior literature, we further strengthened the notion that low-income and poor households in small island developing states are more vulnerable and exposed to cyclones with less ability to respond.

Keywords: Disaster risk, hazard, exposure, vulnerability, responsiveness.
JEL codes: I3, Q54, Q56

*The authors thank all interviewers Fafetai Talesi, Kolopa Kaulua, Savali Niulasi, Teagi Ielemia, Kaafia Pulusi, Mona Lagitupu, Tina Paka, and Peleseti Folitau, and interviewees who contributed and helped to make the Pam module survey a success. The authors also acknowledge the support of the NZAID.

†Address: School of Economics & Finance, Victoria Business School, Victoria University of Wellington, Wellington, New Zealand. Corresponding Author's Email address: ilan.noy@vuw.ac.nz

1 Introduction

Among the Pacific Island Countries (PICs), a Polynesian island nation of Tuvalu which consists of low-lying stretches of atoll islands is one of the most vulnerable countries to natural disasters in per capita terms, particularly to destructive cyclones with associated storm surges.[1] The changes in weather patterns and the threat of rising sea levels further aggravate these threats. Given the increasing frequency and magnitude of extreme weather events in association with climate change, Tuvalu has faced challenges beyond its capacity to deal with, independently.

Tuvalu is extremely vulnerable to disasters due to its small geographical size, insularity and remoteness, the concentration of economic activities and settlements along low-lying coastal areas, the narrow width of islands, narrow natural resource base, heavy reliance on agriculture and limited disaster mitigation capabilities. Climate change has compromised existing conditions, thus presenting unprecedented challenges to development and the survival of both the people and the nation. Foreign aid plays a pivotal role in both its development and disaster response and recovery processes. In general, hardly anyone is safe when a major tropical cyclone path runs directly close to Tuvalu. Therefore, preparation for building better resilience and coping mechanisms in advance is vital for both human and economic security.

This empirical paper examines the risks in relation to hazard, exposure, vulnerability and the responsiveness or the ability of households in Tuvalu to face cyclones, particularly its experience with the Tropical Cyclone Pam (TC Pam) in March 2015. Since most of the poorest and marginalized populations reside in high-risk areas with the minimal capacity to prepare and respond to climate disasters, special attention will be given to these households.

Section 2 discusses the background of Tuvalu. Section 3 is the survey of the literature. Section 4 discusses the empirical methodology. Section 5 describes the data and the survey design. Section 6 discusses the survey analysis results. Section 7 explains the empirical results. Section 8 discusses the conclusions and policy implications in Section 9.

[1] In terms of lowest maximum elevation, Tuvalu is the second lowest country in the world after the Maldives.

2 Background

Limitations to development and resilience to disasters is a continuing issue for Tuvalu given its economic, environmental, resources, and geographical characteristics. Its remoteness, the narrowness of the islands, low elevation of not more than four meters, lack of resources, dependence on aid, the absence of insurance, inactive building codes, lack of preparedness and drills for disasters, lack of micro-finance mechanisms and dependence on rainwater makes them highly vulnerable to cyclones.

Christenson et al. (2014) found out that in their estimations of population exposure rankings toward cyclones, 65% of the top 20 countries world-wide are from the Small Island Developing States (SIDS). The EMDAT shows only three storms that affected Tuvalu since 1900 to 2016.[2] The 1972 Tropical Cyclone Bebe was the worst among the above mentioned which struck down 90% of the houses and trees and killed five people (or 0.07% of the overall population). Recently, the unrecorded 2015 TC Pam badly hit Tuvalu, thus sending a message about the vulnerability of SIDS to cyclones. Tuvalu was again hit by gale winds later that year which also affected most of the islands especially the capital Funafuti.

The 2010 Household Income & Expenditure Survey (HIES) shows that a significantly large proportion of poor households residing near prone areas to cyclones. Some of these households live in informal and weak structured houses.[3] Although the TC Pam was over 1400 kilometers (km) from Tuvalu, the people were affected by the strong winds and storm surges and suffered huge monetary loss amounting to almost 20% of the GDP due to damage to properties, appliances, assets and loss to plantations and livestock. Poor households often lack the financial resources and access to information to respond effectively to cyclones. They often face a slow recovery due to financial constraints. Efforts to reduce future cyclone risks to the poor is crucial. Otherwise, they will be forced deeper into poverty, and the vulnerable people will likely fall under the poverty threshold.

Some of the questions that we intend to answer are; Who and what is exposed to cyclones? What are the extent and spread of poor and non-poor households around cyclone prone spots? What are the impacts of the 2015 TC Pam on households? Are the impacts heterogeneous? How resilient are poor households to cyclones? What is the role of the

[2]Storms recorded in 1972, 1990 and 1993. The EMDAT purely underestimate disaster damages for Tuvalu. Other strong winds in the 90s that affected the islands were not recorded, possibly because they do not fit the criteria to be counted as one in EMDAT.

[3]In fact, building codes are not being enforced, therefore houses are not up to expected structure that fully withstand cyclones.

government in facilitating private adaptation? To what extent can households respond effectively to cyclones and what are the barriers to adaptation? What are policy options for reducing vulnerability and exposure? What are policy options for increasing ability to respond to disasters? Can financial inclusion help the poor cope with impacts?

3 Literature Survey

The literature and different organizations have their own definitions for disaster resilience. However, IPCC (2012) defined resilience as "the ability of a system and its component parts to anticipate, absorb, accommodate or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration or improvement of its essential basic structures and functions". With the increasing global threats of climate change and disasters, measuring resilience has become very popular with efforts attempting to build climate change and disaster resilience. Moreover, integrating of climate change and disaster resilience has also gained popularity in the aim to reduce risks from disasters (Disaster Risk Management (DRM) and Climate and Disaster Resilient Development). Recently, many literature emerged with definitions and indicators for measuring resilience. However, there is much to contribute to this field, particularly small island states.

For a tiny country with geographical characteristics as Tuvalu, disaster resilience is a complex question to deal with at all levels of national, community, household and individual. Resilience is an important concept as it shows the capacity of the population to face and cope with disasters, thus preventing peoples lives and their livelihoods. Measuring resilience comes in many forms depending on assumptions about resilience and empirical characteristics. Bene et al. (2012) explained the "3D Resilience Framework" with different components of resilience capacity in terms of absorptive, adaptive, and transformative capacities. They built these analytical and measurement frameworks with intentions of understanding resilience in different levels.

Moreover, existing measurements of resilience based on theoretical frameworks of disaster resilience have built up the work on resilience. However, there is much to contribute to this rising field. Winderl (2014) discusses measurements of resilience like the World Risk Index, Hyogo Framework for Action (HFA), Global Focus Model, the Prevalent Vulnerability Index, and Baseline Resilience Indicators for Communities (BRIC). Nevertheless, there

are more emerging studies and discussions on resilience as a system, process, network, and security (Frankenberger and Nelson, 2013; Gall, 2013; Mitchell et al., 2013; UNDP, 2013).

Measures that protect individuals, households and assets from disasters depend on how people and governments react and cope with it (World Bank and United Nations, 2010). Climate change and disasters inflict pressures on food security, water resources, agriculture, health, education, income, and employment. These problems will crumble the very foundations of development and poverty alleviation efforts, thus threatening the livelihoods of the poor. The World Bank (2014) pointed out the idea of an active risk management for natural disasters as a crucial one which encourages national governments, NGOs (Non-Governmental Organizations) and development partners to have the incentive to reduce vulnerability and the impact of natural shocks on the people of the Pacific islands. According to the World Bank (2013), risk management in the case of Bangladesh have reduced the loss of life from cyclones through building more safe shelters along with improved forecasting capacity with relatively simple but effective warning systems.

Mitchell et al. (2013) identified economic indicators of resilience based on impact, outcome, output, and input. The IPCC (2012) also express the crucial role of natural hazards, exposure, and vulnerability in measuring disaster risk. This interaction will be useful in identifying areas needed to build resilience into its development. Moreover, they outline the importance of planning in terms of development, poverty, environmental degradation and climate change as their interaction can magnify the effects of disasters.

Clark et al. (1998) stressed that the two functions of vulnerability are exposure and coping ability. This coping ability is partitioned into resistance and resilience. It is identical to social vulnerability. According to Briguglio et al. (2009), risk is determined by two elements of exposure and coping ability that are associated with vulnerability and resilience, respectively. Cutter et al. (2008) discusses a framework called the Disaster Resilience of Place (DROP) model. They also explained that there is more to articulate about the relationship between vulnerability, resilience and adaptive capacity. However, they defined vulnerability and resilience as the inherent characteristics that create the potential for harm, and the ability to respond and recover from disasters, respectively.

Since the poor are facing rising costs and relatively higher losses and damages, there is a need to integrate disaster preparedness, mitigation, and prevention into development strategies (De Haen and Hemrich, 2007). They believe that the extent of disaster risk

depends on natural hazard and vulnerability. Vulnerability in the urban areas is high due to the higher population density. Normally, the poor are affected more than others due to economic and social factors (Wisner et al., 2003). Small Island Developing States (SIDS) are mostly prone to disaster risks due to increasing intensity of cyclones and sea-level rise. They illustrate the "inverted U" relationship between economic development and disaster vulnerability, indicating that middle-income countries are specifically vulnerable to natural disasters.

Gunasekera et al. (2015) developed an exposure model for hazard risk assessment from a Country Disaster Risk Profile (CDRP) which complements vulnerability and hazard models. Hosseini and Barker (2016) modelled infrastructure resilience by quantifying resilience as a function of absorbtive, adaptive, and restorative capacities using Bayesian networks. Sri Lanka achieved a good practice of disaster resilience that is displayed through Early Warning System (EWS) components of infrastructure, risk knowledge (i.e. hazard, vulnerability, and risk assessment), preparedness and early warning dissemination, disaster response and coordination (Hettiarachchi and Weeresinghe, 2014).

Briguglio (1997) recognized the vulnerability of SIDS to disasters and the lack of economic resilience arising from the relative inability of these countries to face forces of these magnitudes which are out of their control. Ebi and Bowen (2016) outline the key drivers of health vulnerability to extreme weather and climate events. The level of impacts on environmental services, social and economic factors and health depend on the extent of exposure, susceptibility and capacity to cope.

Wind velocities of more than 100km/hr lasting several hours in intervals for 5 days were experienced by the islands of Tuvalu during TC Pam. This causes considerable damage to houses, roads, power and communication lines. To mitigate these losses, it is essential to estimate vulnerability of existing house structures and strengthen them to appropriate standards to reduce future losses. Murlindharan et al. (1997) refer to damage as to "any deficiency and/or deterioration of strength as caused by external loading and environmental conditions as well as human errors in design and construction".

Christenson et al. (2014) estimated population exposure to climate-related hazards like cyclones, droughts and floods. Using gridded datasets, they calculated the population exposure by the relative hazard frequency in a particular area weighted by the population density frequency. They ranked countries by population exposure to these extreme events.

Christenson et al. (2014) conceptualized exposure as the "likelihood that an individual in a given location is exposed to a given type of climate-related hazard event over a certain period of time". Nadiruzzaman and Wrathall (2015) strengthened the link between poverty and disaster for Bangladesh saying that the poor are not only more vulnerable to natural events but have less ability to access resources due to factors such as social and political identity, kinship, social networks, financial capacity, political connections and rivalry. They believed that the dynamics of livelihoods, local power, resilience and cyclones are all connected.

Smith and Rhiney (2015) examined climate justice for the SIDS like the Caribbean and arguing that factors driving vulnerability points to centuries of economic neglect and political marginalization that are strongly related to communities' socio-economic characteristics, geographical locations, heavy reliance on land-based resources, and the capacity to adapt to climate change. Smith and Rhiney (2015) and Lopez-Marrero and Wisner (2012) stressed that vulnerability to negative impacts of climate change is partly a function of the differential coping and adapting capabilities of various groups of people in developing countries. Smith and Rhiney (2015) pointed out that vulnerability to climatic impacts is inherently developmental as the differentiated levels of exposure and sensitivity to natural hazards are partly created by basic social and economic inequalities, and accessibility to land-based resources, assets and government support. Lopez-Marrero and Wisner (2012) further strengthened that the vulnerability and capacities to cope with natural hazards differ due to differential accessibility to resources such as natural, physical, economic, human, social, and political.

The different terms of disaster risk, vulnerability, exposure and hazard are illustrated in Table 1. Wisner et al. (2003, 2011) elaborate the framework of the 'dual-faced' character of nature that presents a set of possible opportunities and possible hazards. They emphasize that disasters are not solely natural or driven by our natural environment itself, but also influenced by human activities, i.e. the product of political, social and economic environments. Wisner et al. (2003, 2011) introduce a framework that defines and explains the relationship between risks, hazard and vulnerability. The "Pressure and Release" (PAR) framework illustrate that the intersection of hazard, vulnerability, and coping and recovering capacities correspond to disaster risk. Wisner et al. (2011) reveal in Appendix A the framework of "progression of vulnerability" that comprise of root causes, dynamic pressures, and fragile livelihoods and unsafe locations. "Root causes" centers around existing social, economic (distribution of resources, wealth and power) and political structures. "Dynamic pressures" concerns with societal deficiencies (in terms of economic

opportunities), lack of macro forces. Unsafe conditions specifically express the situation facing vulnerable people in a given time and place. This reflects the limited access to various resources, which allow for risk reduction and coping and recovering mechanisms from hazards.

Table 1: Related terms to disaster risk management

	Wisner et al.	**World Bank**	**United Nations**
Risk	A function of the magnitude, potential occurrence, frequency, speed of onset and spatial extent of a potentially harmful natural event or process (the hazard). It is also a function of peoples susceptibility to loss, injury or death.	The possibility of loss. It can be imposed from outside or taken on voluntarily in the pursuit of opportunities. Risk that is common to most members of an entire system is *systematic risk* while *idiosyncratic risk* is specific to some members of a system.	A function of the severity and frequency of the hazard, of the numbers of people and assets exposed to the hazard, and of their vulnerability or susceptibility to damage. *Extensive risk* is less closely associated with earthquake fault lines and cyclone tracks while *intensive risk* connects to inequality and poverty.
Vulnerability	The degree to which ones social status influences differential impact by natural hazards and the social processes which led there and maintain that status.	A high susceptibility to loss from negative shocks resulting from a systems exposure, internal conditions, and risk management.	Refer to the susceptibility of these assets to suffer damage and loss due to socially constructed factors that result in unsafe and insecure conditions in the built and human environments.
Exposure		The external environment that determines the shocks to which a system is subject.	Refer to the location of people, production, infrastructure, housing and other tangible human assets in hazard-prone areas.

Hazard	Extreme natural event or process	Potentially harmful natural event or process.	Hazardous phenomena such as floods, storms, droughts, etc.

Source: Wisner et al. (2011), World Bank (2013), and United Nations (2015).

4 Estimation Method

Analogous frameworks were displayed by the literature. However, Wisner et al. (2011) considered disaster risk to be a function of vulnerability and hazard. World Bank (2013) and United Nations (2015) extended the disaster function by adding the exposure to the right-hand side of the equation. However, we used these functions with an extension of the responsiveness (i.e. refers to the ability to respond or the ability to quickly react in a rightful, suitable and proper way) on the right-hand side. Our disaster impact framework should express as Equation 1.

$$Impact = Hazard \times Exposure \times Vulnerability \times Responsiveness \tag{1}$$

In general, we estimated a regression to determine the relationship between disaster impact and hazard, exposure, vulnerability, and responsiveness where we used a conventional cross-sectional sample of n *independent* observations Y_i where $i = 1, ..., n$ that are linearly related to explanatory variables in a matrix of X as in Equation 2.

$$Y_i = \alpha_i + X_i\beta_i + \varepsilon_i \tag{2}$$

where Y_i denotes the natural logarithm of the loss and damage over income caused by the disaster in household i, X_i represents a $1 \times k$ vector of covariates or explanatory variables of hazard, exposure, vulnerability, and responsiveness variables, with associated parameters β contained in a $1 \times k$ vector. Each observation has an underlying mean of $X_i\beta_i$ and ε_i is the error term. Since it is often intricate to quantify these explanatory variables, we deliberately select indicators in Table 2 as proxies based on specific considerations and circumstances related to the study.

$$Impact_i = \alpha_i + Hazard_i\beta_1 + Exposure_i\beta_2 + Vulnerability_i\beta_3 + Responsiveness_i\beta_4 + \varepsilon_i \quad (3)$$

Therefore, our disaster impact model is constructed in Equation 3 where $Impact_i$ is the natural logarithmic of the actual direct impacts on people in household i; $Hazard_i$ is a vector of the distant of the cyclone path that indicates the strength of the TC Pam that affected household i; $Exposure_i$ is a vector measuring the extent of household exposure to the TC Pam; $Vulnerability_i$ is a vector of household characteristics that measure household vulnerability to the TC Pam; and $Responsiveness_i$ is a vector that measures the ability of households to respond or react to the TC Pam.

5 Data and Survey Design

The study uses primary data obtained from a detail household survey (a.k.a Pam module) that I carried out from November 2015 to January 2016 in the five islands that were affected by the Tropical Cyclone Pam on March 2015.[4] The Pam module administered household interviews of a sample size of 321 or 58% of the overall households in the affected islands, which were randomly selected. To be consistent with our Central Statistics Division, we used a systematic random sampling approach where we calculated a skip interval (i.e. household population size divided by the household sample size) before randomly selecting a starting point from our list of households, then we count down and skip by the number of the skip interval until you have your sample size.[5]

For convenience, the questionnaire was further translated to the Tuvaluan language. We administered and monitored the survey, which was conducted by using trained interviewers. We conducted workshops for interviewers and guide them throughout the process. We fully met the cost of the survey, but partly funded under my scholarship research grant from the New Zealand Agency for International Development (NZAID). Detailed information was obtained on losses and damages to households. Alongside, we also use secondary data of

[4]The "Pam module" questionnaire is attached in Appendix C.

[5]The survey questionnaire was approved by the Victoria University of Wellington's Ethics Committee before conducting it in Tuvalu. There were difficulties encountered during the period of the survey around December 2015 as Tuvalu was again hit by gale winds from Cyclone Ula, preventing ships from going to the outer-islands for almost a week, but luckily the survey was finally completed.

Table 2: Description of variables and their sources

No.	Variable	Description	Source
DISASTER RISK			
1	ldam	The logarithm of loss and damage.	Authors' calculations based on primary data from the "Pam Module" survey.
VULNERABILITY			
2	lincr_cap	The logarithm of income per person (in AUD dollars).	Authors' calculations based on primary data from the "Pam Module" survey.
3	hholdsize	Number of persons in the household.	
4	strhouse	Strong house structure, 1 if cement otherwise 0.	
EXPOSURE			
5	coastdist	Distant to the nearest coastline in kilometers.	Authors' calculations based on GPS locations of households using reference system UTM Zone S60 with ellipsoid WGS 84.
6	elevat	Elevation of household in meters.	
HAZARD			
7	cycpdist	Distant from household to the cyclone path in kilometers.	Authors' calculations based on GPS locations of households using reference system UTM Zone S60 with ellipsoid WGS 84 and the Digital Elevation Model (DEM).
RESPONSIVENESS			
8	strhou	Strengthen the house in preparation for the cyclone. Dummy, takes the value of 1 if the house was strengthened, otherwise 0.	Authors' calculations based on primary data from the "Pam Module" survey.
9	capacity	Have some training and capacity building experience from cyclone respond workshops by either government, NGOs, and others. Dummy, takes the value of 1 if Yes, otherwise 0.	
10	g_warn	Received cyclone warning at least 12 hrs in advance before it hit. Dummy, takes the value of 1 if Yes, otherwise 0.	

Source: Authors' calculations from the Pam module.

Censuses and Household Income & Expenditure Survey (HIES) data collected by the Central Statistics Division (CSD) of the Tuvalu government, Rapid Assessment Reports from the offices of the World Health Organization (WHO) and the United Nations Development Programme (UNDP) that provided relevant information at both the national and household levels.

The survey was designed purposely to meet the objective of this study to garner and understand their demographic and socio-economic characteristics, and examine the exposure of households to cyclones, vulnerability of the households to direct and indirect impacts of cyclones, and their ability to respond to cyclones. The estimates obtained not only confine to understanding the vulnerability, exposure, and the ability to respond to cyclones at the micro-level, but the possibility of relocation to other safer areas to escape recurrent cyclones. The questionnaire focused on household income and expenditure, household characteristics and assets, exposure and impact of cyclones, preparation for cyclones, relocation as an option, loss and damage from cyclones, and suggestions from households for future improvements in cyclone situations. The results presented here were weighted using methods employed by the Central Statistics Division Tuvalu to represent the population of the households.

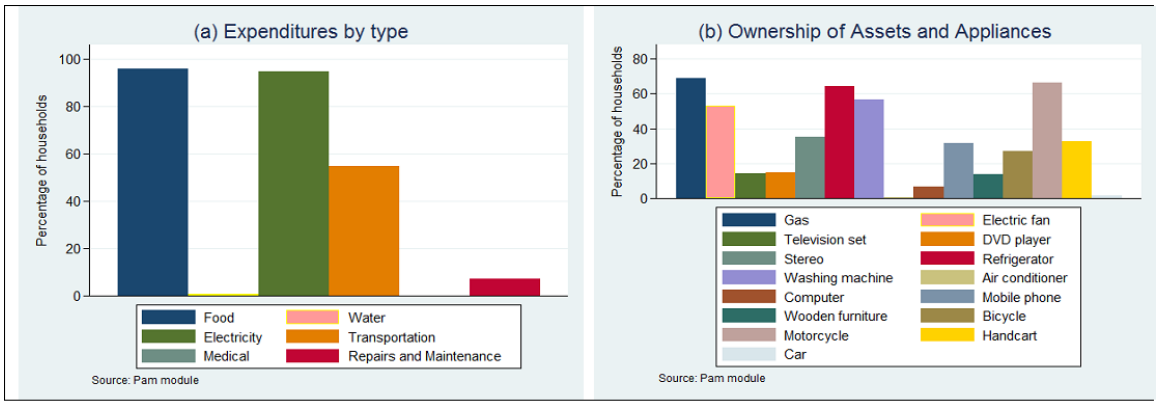
6 Survey Analysis Results and Discussions

The key focus of this paper is to analyze data, contribute and address pressing issues of development and disasters. Likewise, we encourage potential avenues to strengthen disaster risk management, and to reduce poverty and disaster risks. This section discusses the statistical results based on the primary data obtained from the Pam module survey in Appendix C.

6.1 Profile of Surveyed Households

About 60% of families have a gas stove, refrigerator, and a motorcycle. Expensive durables such as cars and air conditioners are owned by almost no one given the low monthly incomes for most households. Most families live in houses more than 20 years old on average. 61% of households are made of concrete, and 96.5% of households owned their houses while 3.5% stay in rented houses. This is imperative, as it shows how low-income households

chose the house as the most priority asset followed by other complementary assets and appliances. Houses often undergo maintenance and repair work, at least every five years. About 30% of the surveyed households have a mobile and a stereo, thus showing the level of communication. In this context, this also shows how reliable communication in reaching families by telecommunication and radio announcements to warn families of disasters.



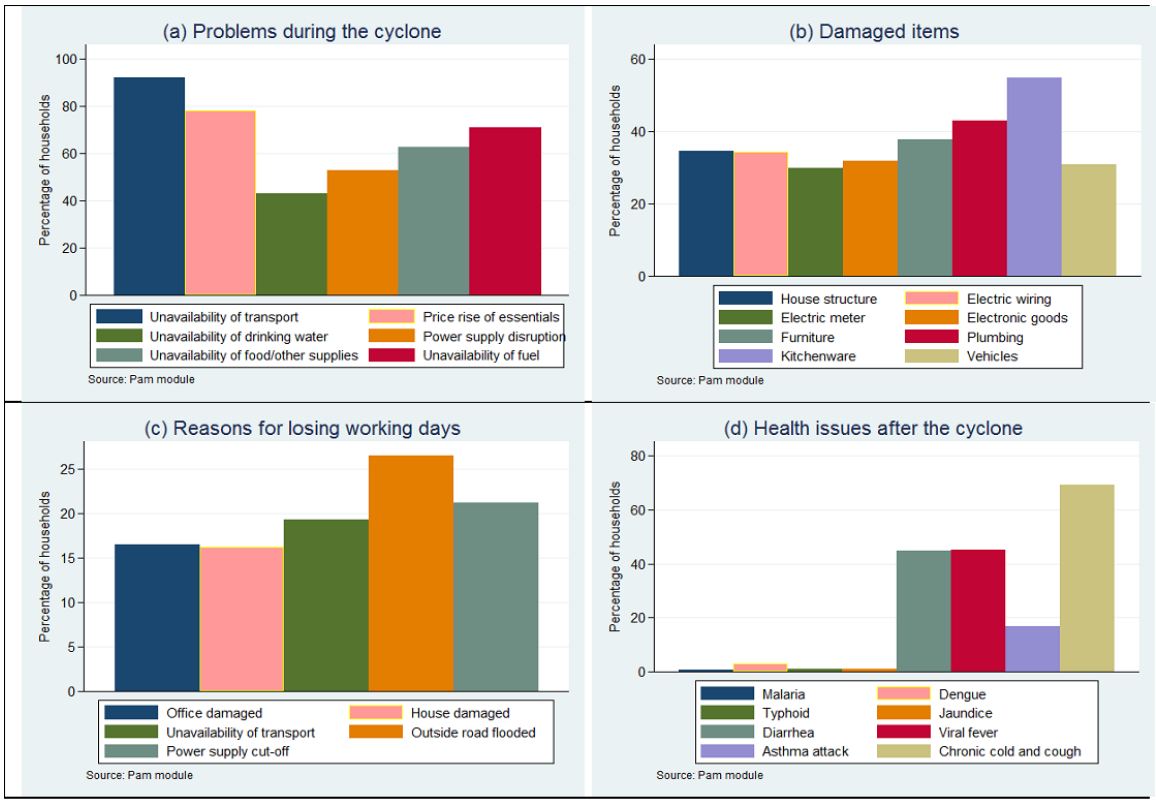
Source: Authors' calculations from the Pam module.

Figure 1: Expenditure and ownership.

Since the last Census in 2012, 13% of surveyed households moved to other houses. 37% of the surveyed households have no formal income earner, and 9% of household heads have not had any formal education at all. However, the average education years for household heads is nine years or have at least went up to secondary school level. Almost 75% of household heads working for the government are from non-poor households. Poor households dominate the business and private sectors running very small businesses.

Although Tuvalu does not face cyclones every year, strong winds unworthy of being called cyclones are still threats to the low-lying island nation. Even distant cyclones of over 1400 km away can have direct impacts on Tuvalu. This is not only evident by the vast distant of the TC Pam from Tuvalu, but from the 59% of households who reported that they usually face strong winds and storm surges every year. Furthermore, 60% of the households reported that surges associated with the TC Pam enter their homes that lasted for an average of 24 hours. Specifically, the average number of hours of flooding is 61 hours for Nui Island and less than 10 hours for the other islands.

Major problems faced by households during the cyclone are the unavailability of transportation, price rise of essentials, unavailability of fuel, unavailability of food and



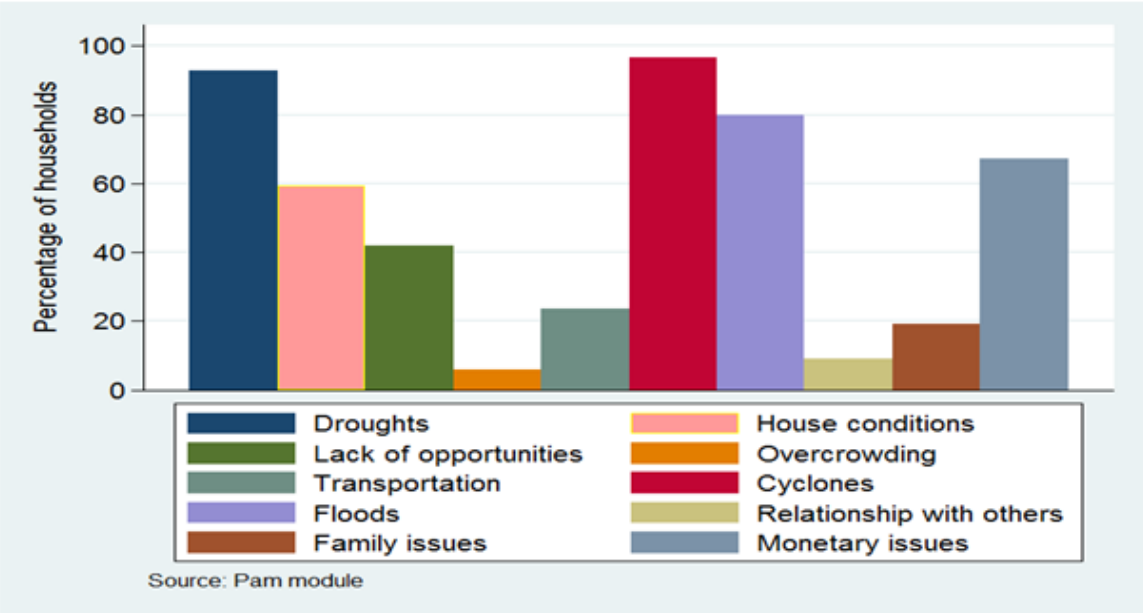
Source: Authors' calculations from the Pam module.

Figure 2: Cyclone impacts.

other supplies, power supply disruptions, and unavailability of drinking water. Most households reported damages to kitchenware, plumbing, house structure, electrical wiring, etc. Kitchenware was the most damaged item reported mainly because households in the outer-islands have local outdoor kitchens located separately from their houses. Kitchenware and plumbing were the most damaged items reported since households in the outer-islands have local outdoor kitchens located separately from their houses and outdoor plumbing from roof gutters to water storage tanks.

Flooding of the road outside and power supply cut-off are the main reasons for losing working days apart from non-availability of transportation, office damaged and house damaged. On average, families went without electricity for two days. As a consequence, households on average have reported losing about two working days and seven school days for children. More than 79% of households rated electricity as fairly reliable. Similarly, 80% of households rated the quality of drinking water and sanitation as fair. However, the average number of days without access to water is three days, and 95% of households have access to sanitation during and after the cyclone. This shows the speed of respond by

households, island community and the Disaster Coordinating Unit in mobilizing resources locally and clearing of the roads.[6] One of the important aftermath impacts of the cyclone is on health. Figure 2(d) reports chronic cold and cough as the prominent illness followed by viral fever, diarrhea, asthma attack, and dengue.



Source: Authors' calculations from the Pam module.

Figure 3: Multiple stressors affecting households.

Climate-related disasters are considered major threats to the lives and livelihood of the people of Tuvalu. Figure 3 shows various stressors that households associate with in their lives. The highly ranked stressors are disasters, i.e. cyclones, droughts and floods. The most significant stressor in this study is cyclones standing at 97% of reported households. With monetary issues as the next stressor on the ladder after disasters, it shows how development progress through modernization and monetization has become a vital part of the lives of the people. People have become more accustomed and dependent on cash for their basic needs and contributions to their various constituencies.[7] Overcrowding is the least stressor in the outer-islands compared to the high population density in the capital Funafuti. Apparently,

[6]It was evident on Funafuti when I was there during the recent 2015/2016 Cyclone Ula, early in the morning the roads were blocked and piled up with trees. But a few hours after, the heavy machinery and the people cleared out all the trees in the road and beside houses. Families left all waste on the roadsides which were later carried off by waste trucks. Then it was back to normal. The projects running on Funafuti at the moment were very instrumental as their heavy machinery were also used to clear the roads. Unlike outer-islands, it takes days to remove the boulders and heavy trees without the heavy machinery.

[7]These constituencies refer to island communities, churches, clans, families, etc.

all these factors add up to the stress felt by families in Tuvalu.

6.2 Loss and Damage

Based on calculations from the Pam module, the estimated loss and damage to households in Tuvalu is AUD6,042,874, which is 14.67% of the GDP.[8] However, the overall loss and damage at the national level is estimated to be around 20% of the GDP.[9] More than two-thirds of the disaster damage was physical, agriculture accounts for 5.3% of damages and losses, 14% for crops and 4.2% for livestock. The poor households dominate the percentage distribution of loss and damage standing at 78.3%. It is highly fortunate that the poor absorb most of the damages incurred from the cyclone at the household level. Three of the islands namely Funafuti, Nukufetau and Niulakita were affected, but with minor impact.

The geographical structure helps Nukufetau and Funafuti islands since they have lagoons and islets on the western side that shielded them from the cyclone and minimized direct impacts. If the cyclone path were to hit from the eastern side, then the impact would have been vice versa. Nukufetau Island could be one of the safest islands since most sides of the main island is surrounded and shielded by its islets and lagoon. However, some of the water storages on these islands were destroyed while others were contaminated due to the intrusion of sea water into water storage tanks. Crops on Nukufetau Island were mostly destroyed since they are located on the western islet that is directly exposed to the cyclone. Vaitupu Island was affected, but not the extent of the other five islands.

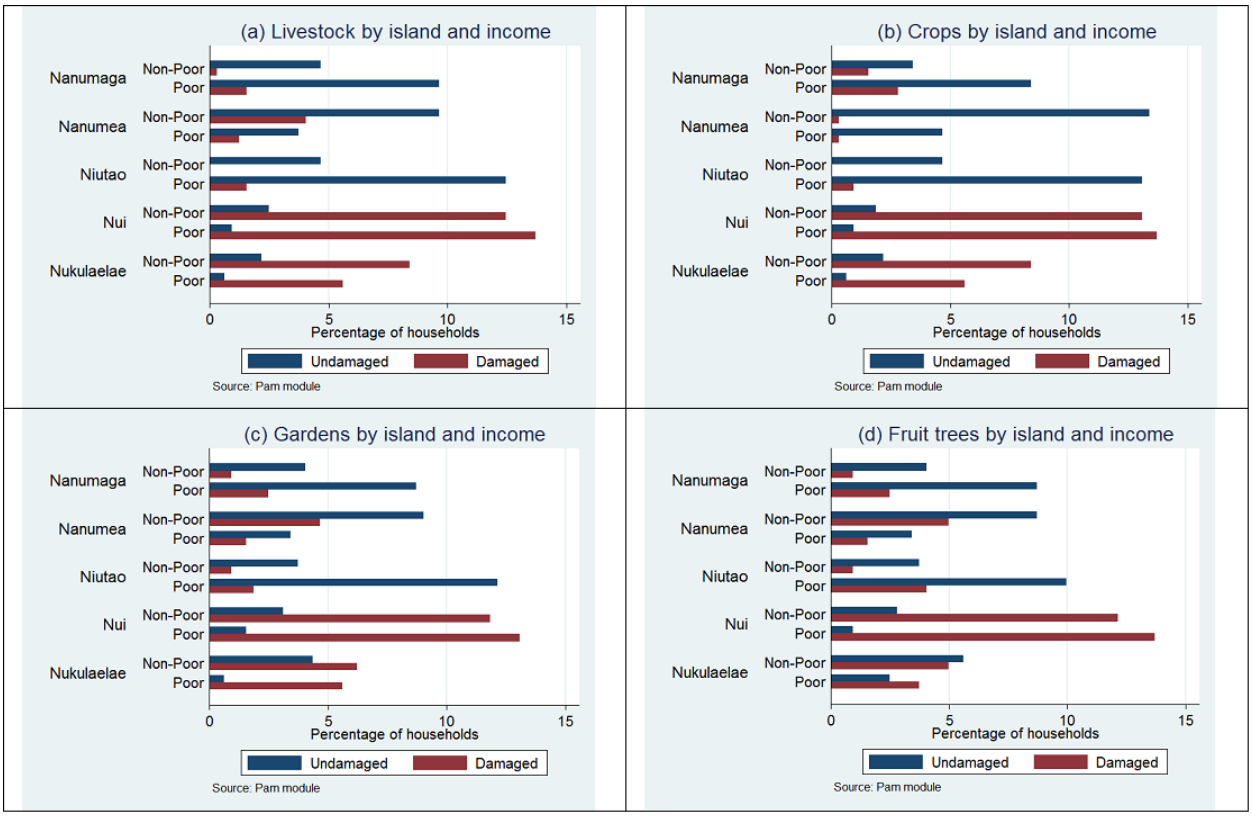
Nui and Nukulaelae islands were the most affected in terms of loss and damage to residents, local kitchens, outdoor toilets, water tanks, livestock, crop farms, vegetable gardens, fruit trees, boats, and others. The combination of low elevations and the narrowness of the island contribute to the high level of impact incurred by these households. For Nui Island, it is evident that the poor households are the most affected by the cyclone.

People in the outer-islands live on fish, crops (taro, pulaka, etc.), fruit trees (breadfruit, coconut, etc.), vegetables (cucumbers, tomatoes, etc.) and livestock (pigs).[10] The lives and livelihood of families in Tuvalu heavily depend on these essentials, hence the reason for

[8] Based on the latest GDP of AUD41.2 million in the Government of Tuvalu 2015 National Budget.

[9] This include damages to households, community halls, community water storages, seawalls, clinics, beach ramps, roads, telecommunication wiring pits, electricity meter boxes, etc.

[10] Poultry (chickens and ducks) was excluded in the calculations of losses since they are mostly left in the open. Unlike pigs, they are easily tracked as are they kept in pigsties.

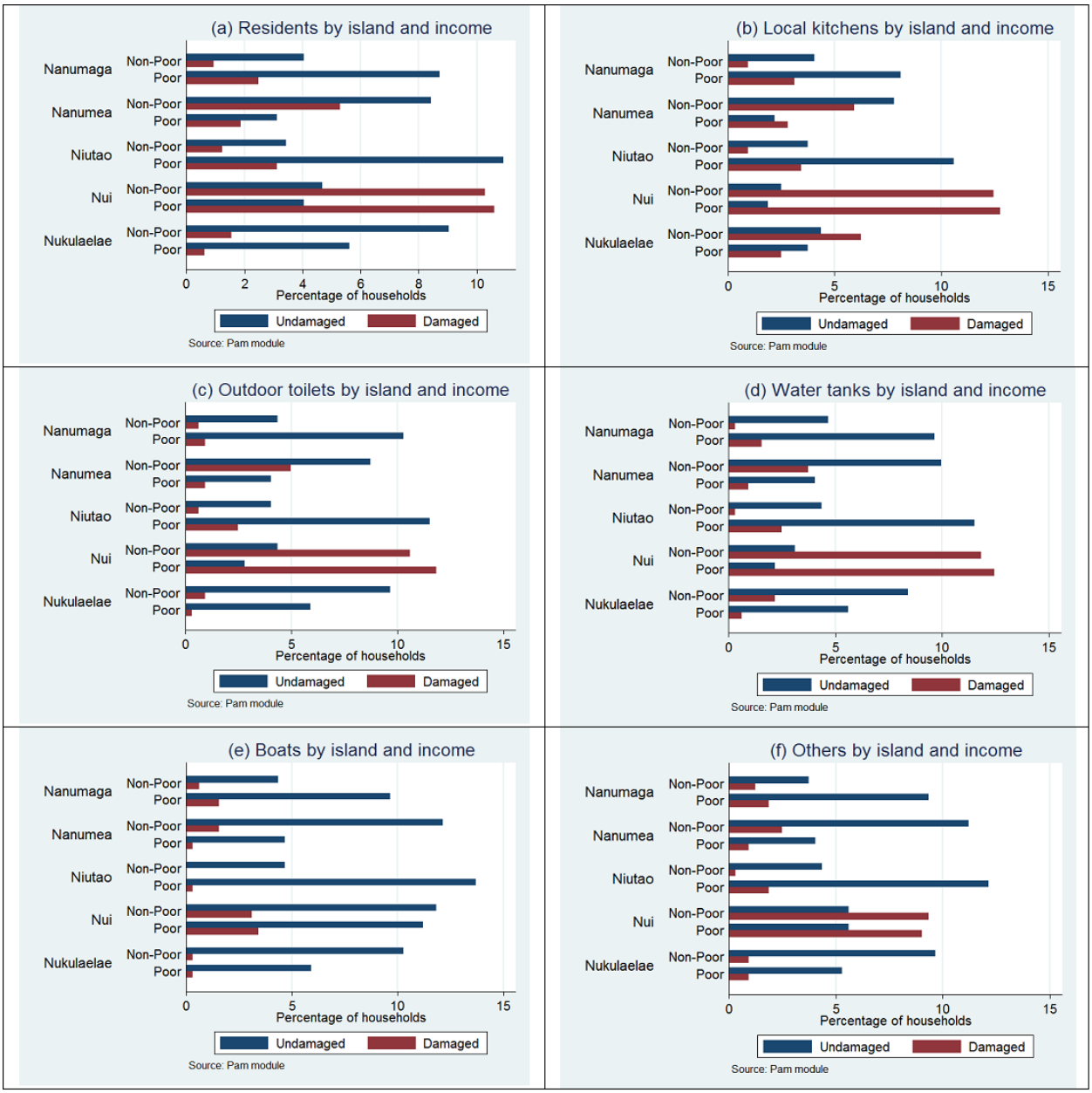


Source: Authors' calculations from the Pam module.

Figure 4: Losses incurred by households.

measuring loss and damage. In the literature, there are numerous definitions for 'loss' and 'damage' from different disciplines. In this paper, we simply interpret 'loss' as any living thing e.g. human lives, livestock and agricultural plants, crops and fruit trees that are lost in the event of a cyclone. There were no human deaths, but losses in terms of livestock, and agricultural plantations. On the other hand, we refer 'damage' to assets e.g. houses, local kitchens, outdoor toilets, water tanks, and others that were damaged and can be repaired. In overall, 95% of households reported that they incurred loss and damage. However, 63% of households reported to experience some losses, while 70% reported that they incurred damages.

Regarding measuring the loss and damage, we tend to puzzle ourselves with the question of what would have been the value or the selling price of what was lost or destroyed if it was not. Murlindharan et al. (1997) defined the percentage damage of the structure as *%Damage=100×(Repair or Replacement Cost)/(Building Cost or Insured Value)*. For the damages, we computed the estimated cost needed to rebuild or repair the damages to



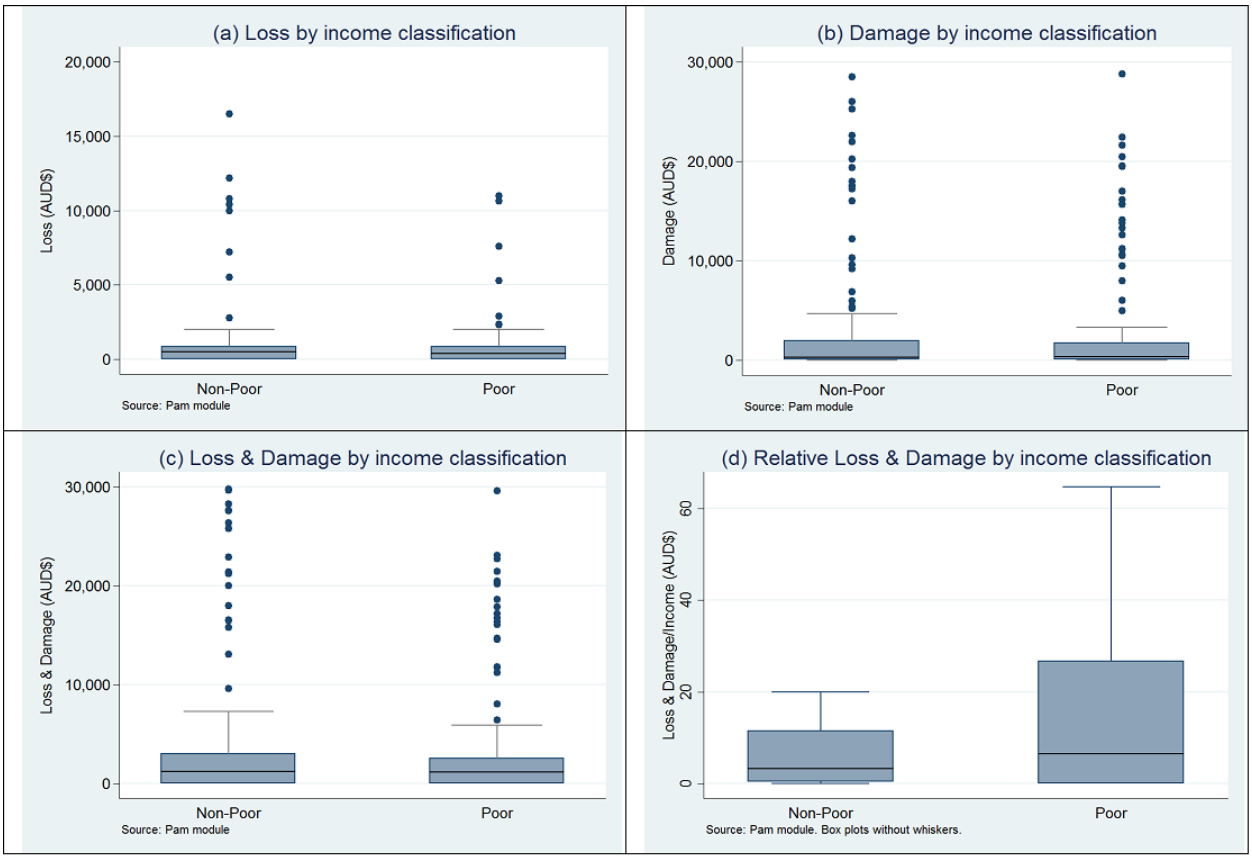
Source: Authors' calculations from the Pam module.

Figure 5: Damages incurred by households.

property and assets back to normal.[11]

Figure 7 shows that poor households spend less and save a little more in terms of saving as a percentage of income. Nevertheless, non-poor households save more in actual terms.

[11]These estimated cost of houses, local kitchens, outdoor toilets, water tanks and others were gathered from the Public Works Department (PWD), while the 2015 prices of building materials were collected from the Central Statistics Division and quotations from the 3 main hardware stores (JY Ltd, McKenzie Ltd and Messamesui Ltd) on Funafuti.



Source: Authors' calculations from the Pam module.

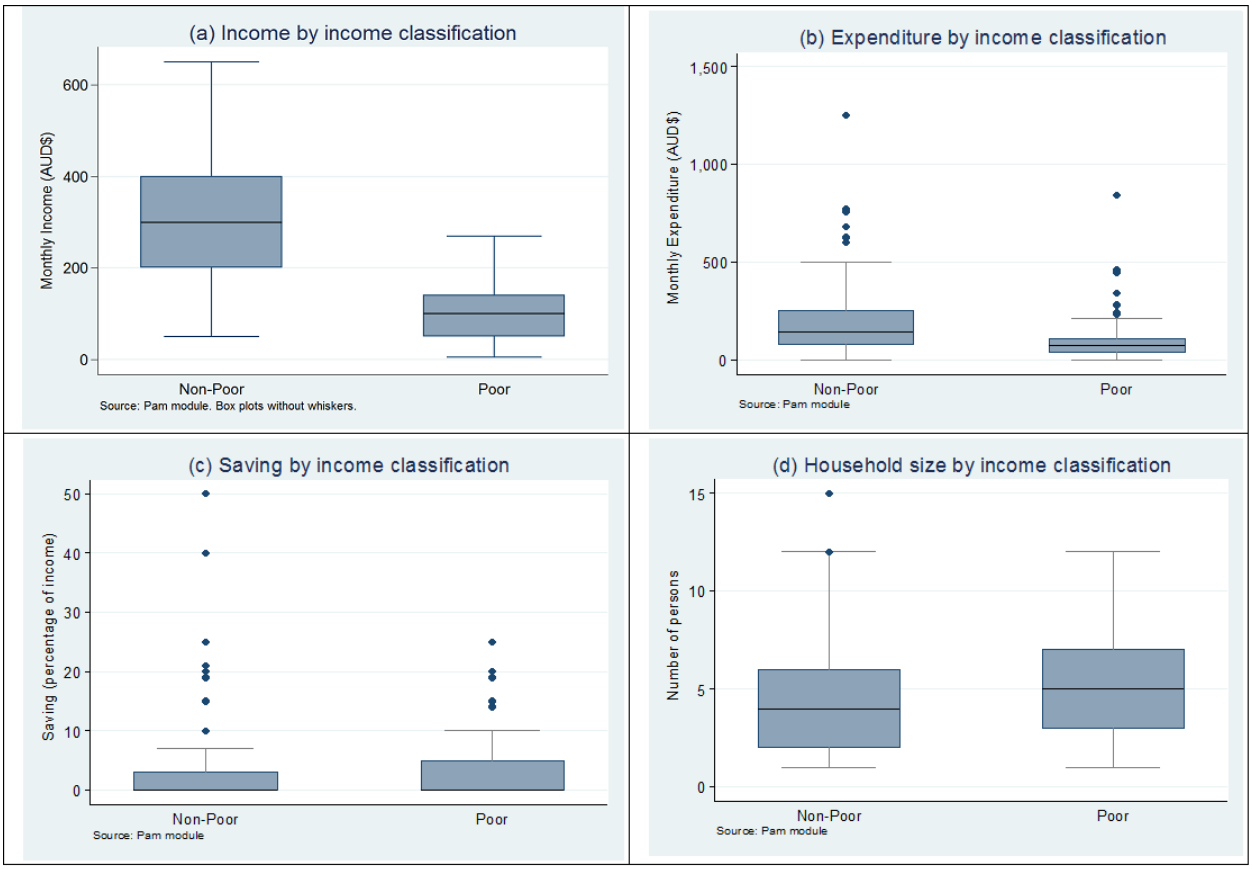
Figure 6: Loss and Damage by income classification.

It is clear that the average household size for poor households is higher than non-poor households. As per Census 2012, the average family size is 4 in the rural, and 6 in the urban. However, the average family size in the surveyed households is 5-6 persons, with only one income earning member among the 3-4 adults and two children.

Nui is the most affected island both in terms of loss and damage. Figure 8 shows that poor households incur more loss and damage costs than non-poor households.

6.3 Hazard

The cyclone started on the 9th of March and lasted for five days. In the literature, hazard for panel data often use the strength of the cyclone in terms of wind speed and the magnitude of associated factors (such as sea level, waves, rainfall, etc.) that could be compared between different events. However, since we are concentrating on a single



Source: Authors' calculations from the Pam module.

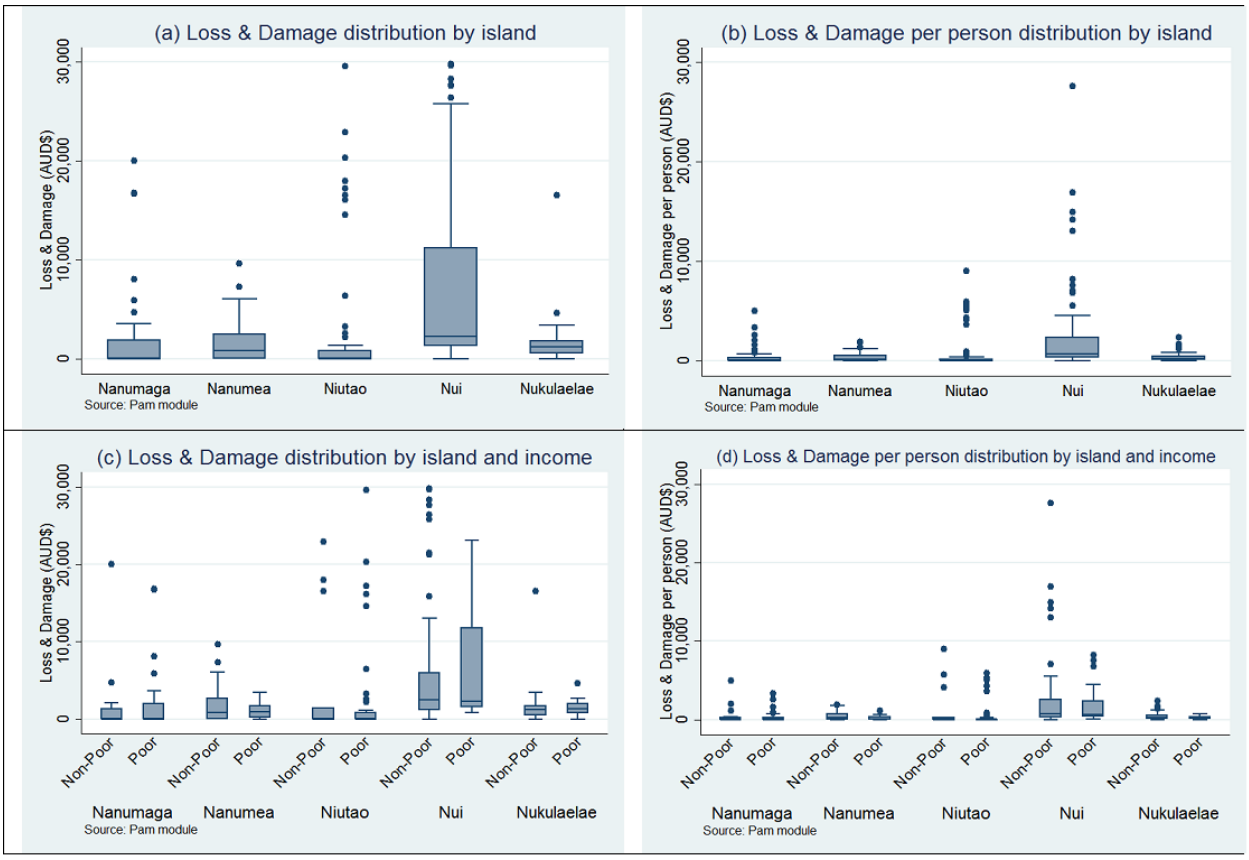
Figure 7: Income, expenditure, savings and household size by income classification.

event, it seems that the strength of the event and the magnitude of associated factors are mostly the same. Therefore, we tend to use the near distant from households to the cyclone path as our hazard indicator that captures the strength and magnitude of the cyclone. On average, the distant of the cyclone path from the households is around 1426 km. The wind speed of TC Pam rose to a Category 5 at a peak of 165 miles per hour (or 265.54 km/h).

6.4 Vulnerability

Household characteristics such as income, household size and the strength of the house were used as indicators representing the vulnerability of households. Poverty was analyzed to solidify further our uncertainty of whether the poor households in small island states are more affected by cyclones or not, with evidence from the TC Pam.

The household income distribution in Tuvalu (referring to the outer-islands that were



Source: Authors' calculations from the Pam module.

Figure 8: Loss and Damage distribution by island.

affected by the TC Pam) shows acute income inequalities with 20% of the households earning less than AUD50 per month. Around 50% of the population earns below AUD150 per month, whereas the top 10% earn more than AUD475 per month. The annual per capita income is USD414.[12] These inequalities in income distribution are signs of acute poverty in the outer-islands and also correspond with almost 40% of the population living in non-concrete houses.

Monthly average expenditure is AUD40 on groceries, AUD30 on electricity and AUD20 on transportation. Household repairs and maintenance expenses are about AUD50 per month. Food, electricity and transportation have the highest expenditure incidence. However, there is hardly any expenditure on water and medical services as households privately collect rainwater from their house roofs into water storage tanks, and the government provides free medical services to the public.

[12]The conversion rate of 1USD Dollar (United States Dollar) = 1.33AUD Dollar (Australian Dollar) used throughout this paper.

Poverty lines were determined using both income-based and consumption-based poverty methods. For the income-based poverty line, we followed the worldwide definition of living below USD1 per person per day that is used by the World Bank. For the consumption-based poverty measure, we used an estimated food consumption expenditure required for daily calorie energy intake per person that is parallel with the FAO requirement of 2100 kilocalories (Kcal). We used the consumption-based poverty measure since it is consistent with the official poverty measure used by the government of Tuvalu. Unlike relative poverty, absolute poverty does not exist in Tuvalu from the fact that no family or individual is believed to be in constant lack of food, clean water, health, and housing. Through this notion, most Tuvaluans prefer to use the term "hardship" rather than "poverty" (Abbott & Pollard). However, situational (transitional) poverty may exist as some families may fall below the poverty line due to adversities and shocks from disasters. Sometimes, effects of unfortunate events like these can be uplifted by aid and assistance.

An ongoing argument in Tuvalu is that people are seen as being poor when we measure poverty in monetary terms, but not regarding accessibility to resources for survival. Poverty statistics were brought up several times in national meetings, but they often deny these facts as there is no justification proof that hunger and living without survival necessities do exist in Tuvalu, particularly in the outer-islands. People still believe that our customs and traditional ways of subsistence living is very much viable and sustainable, but threaten by climate change and sea level rise. The sea is an open resource for fishing; people have land for agriculture and farming. Also, the common way of thinking in Tuvalu is that if people have access to these resources, then why poverty exist unless it is measured in monetary terms. This mindset of defining and measuring poverty does not fully accept the term poverty, but living in hardship is a more morally acceptable term in Tuvalu.

It is hard to believe that poverty exists in the outer-islands where people have access to resources for food consumption. They simply define poverty as those living in hunger, which is not evident in Tuvalu. If people live in hunger, then our cultural system fails in its security, safety net and provider roles to the people. The affected islands in our case were the outer-islands, but not the capital Funafuti. This food poverty line is further extended to the basic needs poverty line to capture other needed items apart from the food itself.

People currently depend on imported goods as oppose to local food, especially on the capital Funafuti mainly due to the high population density, lack of natural resources to

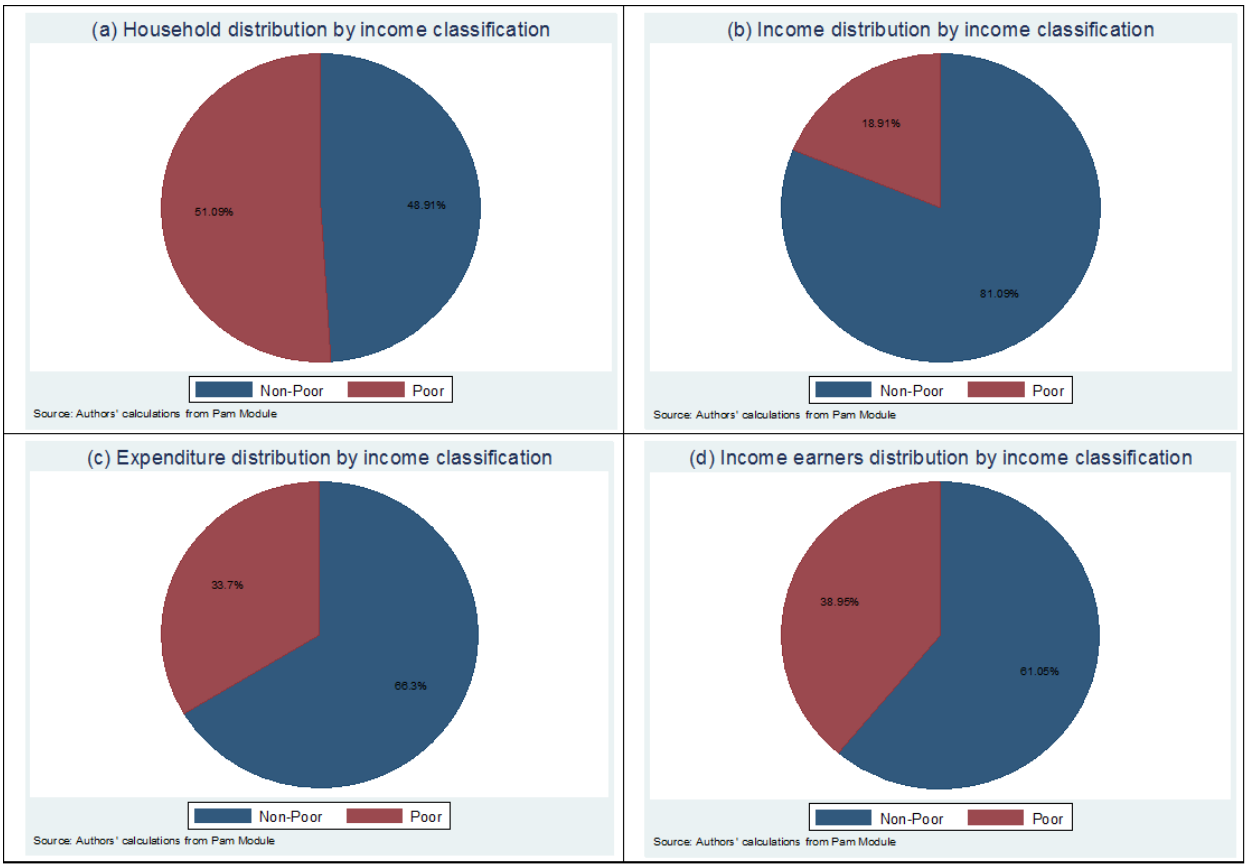
support their livelihoods, monetization of the economy and lifestyle modernization. Although people in the outer-islands are less dependent on money because they have natural resources to support their daily living consumption, the use of money is increasingly becoming part of their lifestyle, thus relying more on imported basic food items as a substitute for subsistence consumption. Practically, people in the outer-islands are often subsidized in monetary terms by their close families working in Funafuti and overseas to cover for basic food items, electricity power, and community and church monetary contributions.

Additionally, not only confine to the working people sending remittances to families in the outer-islands, but the government similarly does the same supportive mechanism by indirectly subsidizing electricity and shipping charges for outer-islands by charging below economic costs of service delivery. Subsidizing these two sectors have been a long-term concern for the government. In return, families, communities and churches serve as safety nets in times of hardship and difficulties. These support instruments are one of the reasons we hardly see people or families displaying absolute or extreme poverty symptoms. However, the government, customs, and traditions play vital roles in ensuring the good well-being of the people.

Poor household incidence is higher than non-poor households by a small margin. 81% of the income belongs to the non-poor, leaving just 19% of the income pie for the poor. Almost 34% of the expenditure pie is for the poor. Similarly, 39% income earners belong to poor households. Overall distributions of income, expenditures, and income earners are disproportionately distributed and dominated by non-poor households. This disparity in distribution is a concern in the context of poverty and inequality.

6.5 Exposure

Peoples exposure to risk is determined by their external environment, e.g. whether a house is exposed to the risk of coastal flooding depends on its location (World Bank, 2013). Part of this study is to examine the affected islands by the TC Pam to understand the nature of exposure facing households in Tuvalu. Most of the affected households reside in areas prone to storm surges and flash floods, i.e. within coastal and low-lying areas. In almost all the islands, populated areas are on the western side. One of the reasons is partly due to the prevailing easterly winds. Alternatively, it may depend on its geographical site, e.g. islands without lagoons are populated on the western side of the island, while islands with lagoons tend to reside closer to the lagoon side. Unfortunately, the TC Pam hit from the



Source: Authors' calculations from the Pam module.

Figure 9: Distributions by income classification.

western side. Even though the cyclone path stretched to over 1400 km away, its impact on Tuvalu was devastated due to its low elevation, lack of protective sea walls and the locations of the population and main centers facing the strong cyclone winds and associated huge waves.

The total population of Tuvalu has grown steadily from 9,026 in 1991 to 9,561 in 2002 to 10,782 in 2012.[13] The percentage of the population living on the capital island Funafuti was 32.6% in 1991, 46.9% in 2002 and 57% in 2012. The population density on Funafuti in 2012 is 3,476 persons per sq. km.[14] The highest point is no more than four meters, and the widest part of the island is no more than 900 meters. For a small and low-lying islands like Tuvalu, cyclones are always associated with storm surges and floods. It will be worse if it strikes during high tide seasons. We produced GIS maps linked to household surveys and using household distant to the coastline and household elevation (low elevation areas for flooding associated with storm surges) to determine the extent of exposure.

[13] Based on Censuses 1991, 2002 and 2012.

[14] Authors' calculations from Census 2012 and calculated area of Funafuti using ArcGIS.

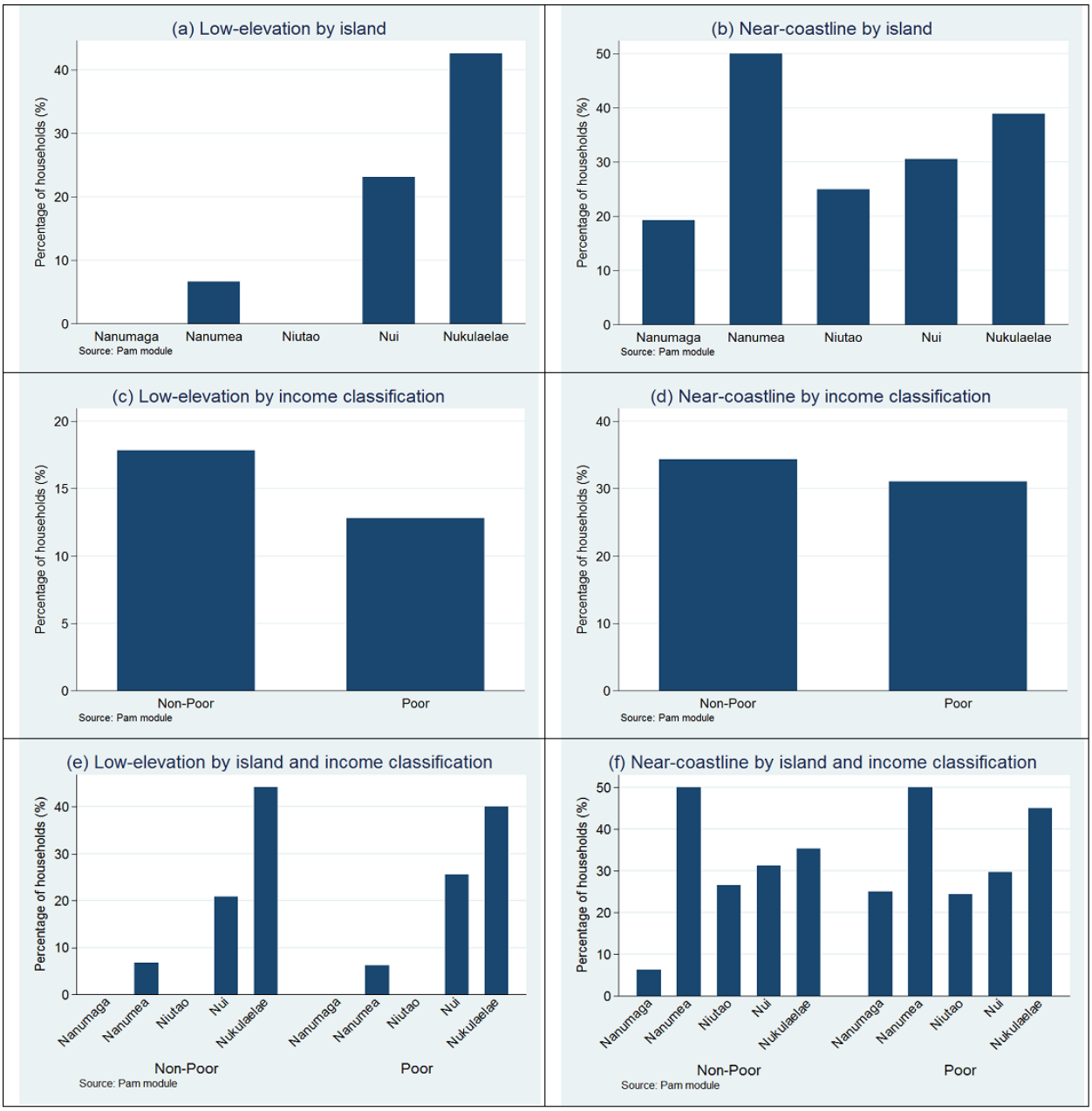
Households with elevations below 5 meters are highly exposed to flooding from high tides, rainfall and storm surges. 46% of households in Nukulaelae fall in this category, 45% for Nui island, and 8% for Nanumea. 50% of the households in Nanumea Island live less than 100 meters from the coastline, making it the most exposed in terms of distance to the coasts. However, the other islands are highly exposed as well with 30% on average of its households residing close to the coastlines.

The surveyed households from the affected islands reported surges from the TC Pam entering their homes. From the surveyed households, Nui reported the highest of 98% households experiencing surges from the TC Pam entering their homes. Similarly, Nanumaga, Nanumea, Niutao, and Nukulaelae reported 15%, 60%, 32% and 66%, respectively. Nanumea, Nui, and Nukulaelae were badly flooded following days of surges from TC Pam. This is consistent with Figure 10 which display these top three highly exposed islands to elevation and near to coastlines. Interestingly, poor households are less exposed to cyclones than non-poor households in terms of living in low-elevation and near-coastline areas.

6.6 Ability to Respond

It is crystal clear that the poor and low-income households are more vulnerable and absorb a heavier burden of the impacts of cyclones. Incomes of these poor households are far less than what is expected to cover monetary losses incurred from cyclone damages. However, indirect losses of essential services such as electricity, communication and transportation are disrupted and unavailable during and after the cyclone. The devastations of the cyclone worse hit the poor and low-income households who are less resilient to disasters and less access to any form of insurance and social protection. Only 10% of households have reported saving some money in the National Bank of Tuvalu (NBT) every month and the average amount saved is about 2% of their monthly income. Although 80% of households were reported in the 2012 Census to have access to the banks, it seems that the low-income earnings weakened households' devotion to saving in the banks.

In anticipation of the cyclone, 51% of households moved to safe shelters, and 42% shielded house windows. This is an indication that there are many exposed houses to cyclones. As expected, food and water were the most stock-up items just before the cyclone. On average, families went without food for 1 to 2 days. High-value durables and vehicles were the top priority assets to be protected during the cyclone. 45% of households shifted

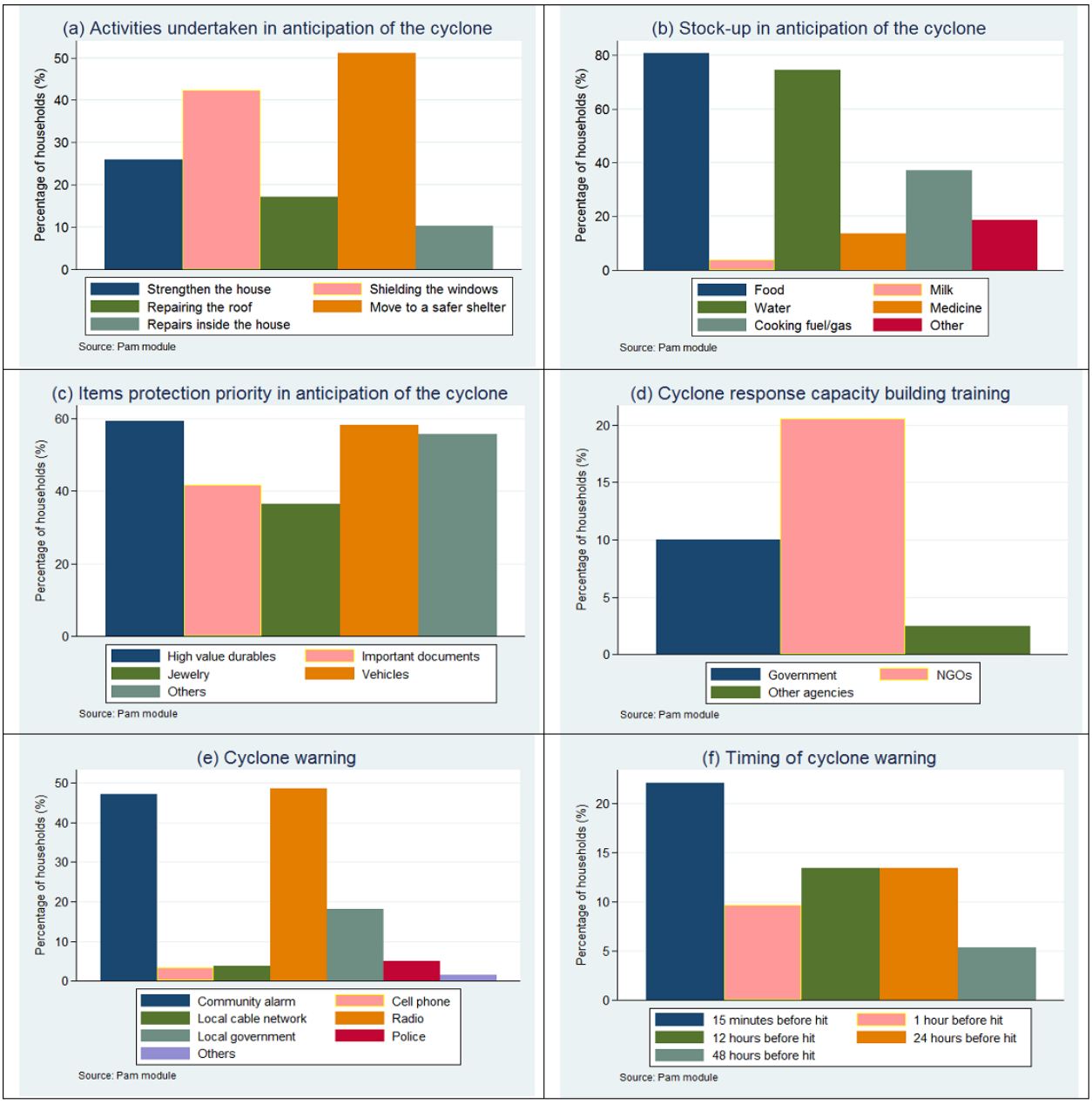


Source: Authors' calculations from the Pam module.

Figure 10: Household exposure

their assets and valuables elsewhere in anticipation of the cyclone, of which 24% shifted their assets to other houses and 21% elevated them within their houses in anticipation of the associated surge that causes flooding.

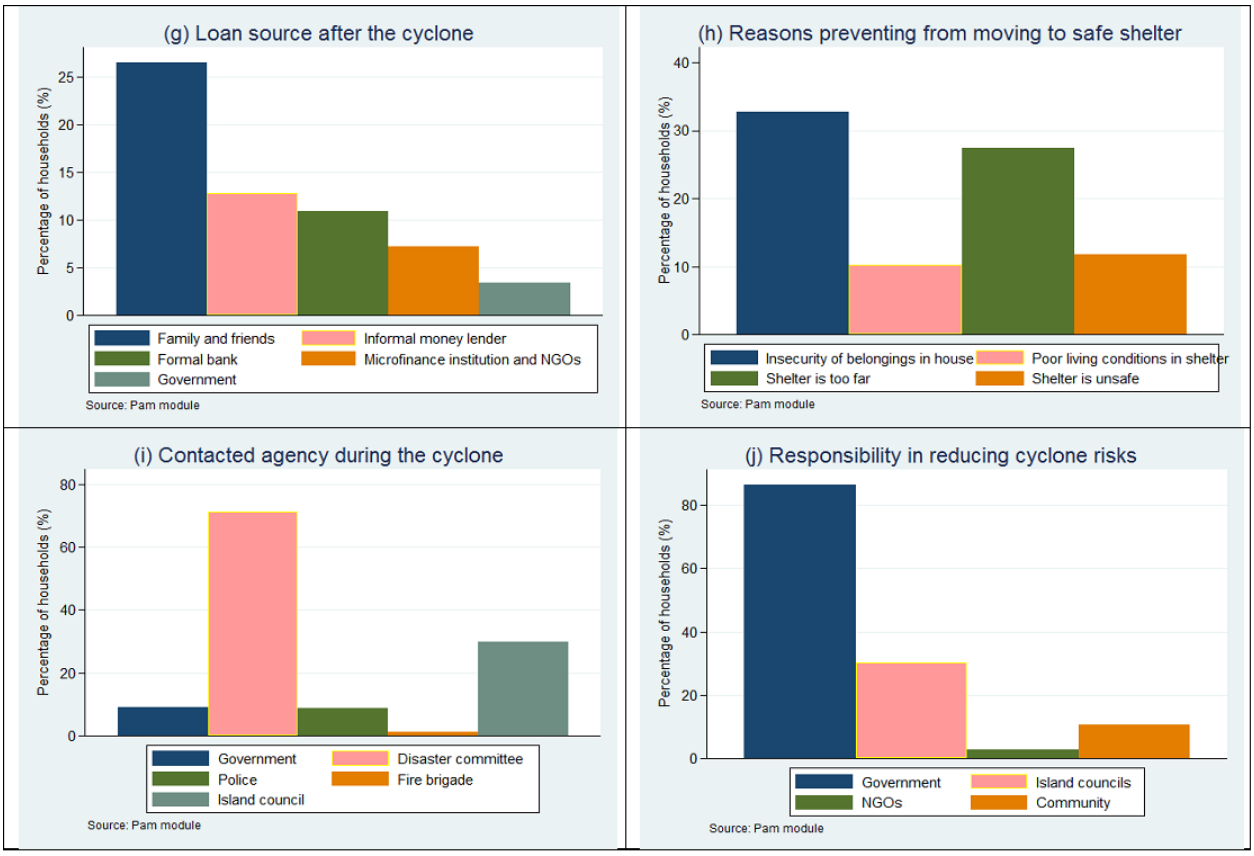
Around 26% of responses received some cyclone response training. Since Non-Governmental Organizations (NGOs) conducted more than twice of cyclone response



Source: Authors' calculations from the Pam module.

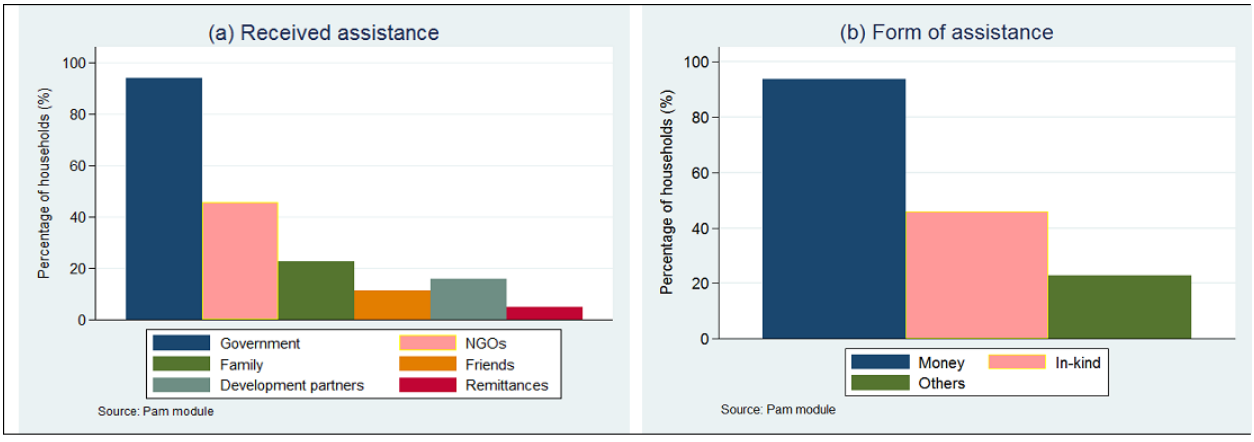
Figure 11: Responding to the cyclone.

capacity training and workshops than the government, it shows how they play an important role in cyclone response training. Most of the people received cyclone warnings from the radio broadcast and island community alarms. 15% of households were not aware of any safe shelters during the cyclone, and 39% did not receive warnings of the cyclone. The average time to travel to the safe shelter is 13 minutes, which is very timely. 57% of households have never shifted to these safe shelters for some reasons.



Source: Authors' calculations from the Pam module.

Figure 12: Responding to the cyclone.



Source: Authors' calculations from the Pam module.

Figure 13: Form of assistance.

97% of households received some assistance from the government, NGOs, family, friends, development partners, and remittances. 13% of households received money assistance, 67%

received in-kind assistance, and 23% received other kinds of assistance. No household is reported to have insurance on properties damaged by the TC Pam nor even insurance of any type. There is no role played by insurance in Tuvalu at the personal, household and national levels when it comes to disasters. Alternatively, at the national level, there are responses regarding aid (cash and in-kind) from development partners, foreign friends, organizations, families and friends from overseas that goes through the government for its dissemination and distribution to the affected islands, communities, and households. Moreover, based on assessments the government offer monetary assistance to affected households to rebuild back damages to their properties, particularly destroyed houses.

In general, non-poor households are more resilient to weather-related natural disasters than the poor. On average, non-poor incur more actual damages than the poor by a very small margin. However, poor households suffer six times more than non-poor households in terms of loss and damages in relative terms to income. Intuitively, assuming based on relative loss and damages on monthly income from Table 3 that, if households were to use all their income to rebuild back the damages, it will take up to at least 15 months for a non-poor household to rebuild the damages or recover back to normal, while a poor household takes at least 93 months. This is a huge disparity in potential for recovery amongst the poor and non-poor households.

Table 3: Risk, Vulnerability and Resilience indicators

	Indicators	Poor	Non-poor
Risk	Loss (mean)	680	942
	Damage (mean)	2518	2680
	Loss and Damage (mean)	3186	3612
	Loss and Damage over income (mean)	93	15
Vulnerability	Monthly income (mean)	97	436
	Households (%)	51.09	48.91
	Number of persons in the household (mean)	5	4
	Number of dependents i.e children and elderly (mean)	3	3
	Household lived in concrete and wood house (%)	85	81
	Distance from the cyclone shelter in minutes (mean)	14	12
Exposure	Households within 100 meters distance from the coast (%)	31	34
	Residing in low elevation (%)	13	18

Hazard	Distant from the cyclone path in kilometers (mean)	8923.07	8929.52
Respond ability	Strengthen house in preparation for the cyclone (%)	55	45
	Shift valuable assets to safe place (%)	47	43
	Households attended cyclone respond workshops (%)	74	75
	Households received a cyclone warning (%)	63	60
	Percentage of income usually saved (%)	2.85	2.90
	Household evacuated to the cyclone shelter (%)	44.5	41.1
	Social safety net (%)	29.9	29.9
	Access to credit (%)	32.9	33.1
	Households received some form of assistance (%)	94.5	100.0
Relocation	Prefer to relocate to a safer place (%)	44	37

Source: Authors' calculations from the Pam module.

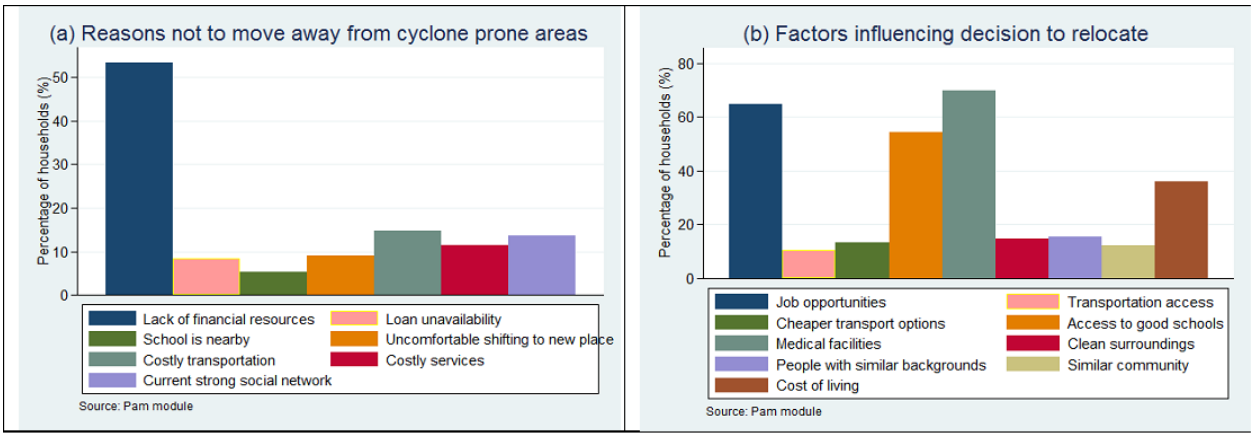
Apart from poor households having less income, they have more household members and further away from cyclone shelters. Poor households also tend to live closer to the cyclone path. They are more responsive to cyclones in terms of preparation, strengthening their houses and shifting valuable assets to safety. More of them received warnings, less cyclone respond workshops, save less money, and more of them were evacuated to cyclone shelters. There are more poor households receiving assistance from families and friends, but have less access to credit and received less assistance overall. They prefer to relocate to safer places.

6.7 Relocation as an Option

The impacts of recurrent cyclones portray how surveyed households react to relocation as an option. 41% of households have considered moving away from their current homes to safer places. 86% of households will consider moving if given an option of relocation by the government. Given the threats of climatic disasters, people look at options like building stronger sea walls, move away from disaster prone areas, etc.

6.8 Recommendations from respondents

When the interviewees were asked "if they have any suggestions for the authorities or the people to improve cyclone situations in the future?", 75% responded with either a suggestion or suggestions of their choosing while 25% have no comments to the question.



Source: Authors' calculations from the Pam module.

Figure 14: Relocation decision.

The suggestions from the respondents were tabulated and summarized in Table B1. Their comments broadly covered areas of cyclone preparedness, safe shelters, assistance and aid, protection, relocation and migration, early warning systems, strengthening of responsible agents, machinery and equipment for preparedness and recovery, assessment reports of the impacts, establishment and sustaining of a disaster fund, support and cooperation amongst the people and various stakeholders in times of disasters.

Although the suggestions pinpoint responsibilities of the government and other responsible economic agents in reducing cyclone risks, they also acknowledge their own responsibilities. However, individuals and households mainly rely on the government and island councils to take steps in reducing cyclone risks. It is highly evident that the respondents to suggestions is highly dominated by poor households, hence revealing that they are the most affected and demanding for assistance, aid, support, protection, cyclone preparedness, capacity training, cooperation, etc.

7 Empirical Results

Table 4 presents the estimation results explaining the log of damages. We used three regressions with the same dependent variable and explanatory variables, but with different sample groups. Regression (1) includes all households surveyed, while regressions (2) and (3) use separate samples for poor and non-poor households, respectively. The estimation results from regression (1) are all highly significant with expected negative signs. The negative signs indicate negative correlation between damages and income per person, household size,

having a cement house, having some cyclone respond training, receiving cyclone warning at least 12 hours in advance, distant to coast in kilometers, household elevation in meters, distant to the cyclone path in kilometers, and strengthening household in response to the cyclone. The high values of R^2 indicate the goodness of fit of the model.

For robustness check of results, we present regressions results in Appendix B with several different specifications where we used control variables in Table 4 with additional variables namely *savings* (household savings), *assist* (household received assistance), *i_earners* (number of income earners in the household), *totdist* (land-width where the house is located), *a_shift* (shifted assets to a safe place), *elevate* (elevate assets to higher elevation in anticipation of a flood), *shelter* (household knows the safe shelter location). The estimate of some parameter is not sensitive to the exact specification used and robust in a sense that it is consistent and there are no changes in the signs and significance of the coefficients when we alter the covariates and the sample.

Higher exposure imposes higher cyclone effects on households. As expected, the effect of the cyclone tends to be lower for households with longer distance from the coast and higher elevation. This implies that households on higher elevations and further away from the coast are more resilient to cyclones. Proximity to hazard imposes higher cyclone effects on households. The effect of the cyclone tends to be lower for households with higher distance from the cyclone path. This implies that households who are further away from the coast are more resilient to cyclones.

Higher vulnerability imposes higher cyclone effects on households. As expected, higher income per capita and having a strong house reduces the effect of the cyclone. However, the effect of the cyclone tends to be lower for households with a larger household size. This implies that households with a higher number of members are more resilient to cyclones since they tend to have more capacity to better strengthen and prepare their households before the cyclone hits. Surprisingly, prior literature does not fully support these findings in terms of resilience as larger household size tend to have lower per capita income and expenditure leading to high vulnerability.

Higher responsive to cyclones imposes lower cyclone effects on households. The effect of the cyclone tends to be lower for households who received cyclone warnings, cyclone respond capacity training, and strengthened their houses in preparation for the cyclone. This implies that households with the abilities to respond to cyclones are more resilient to cyclones.

Table 4: Model estimation results explaining the log of loss and damages

	(1)	(2)	(3)
	ldam	ldam	ldam
lincr_cap	-0.0375	-0.552**	0.198
	(0.114)	(0.271)	(0.223)
hsize	0.0679	0.0539	0.0669
	(0.0446)	(0.0648)	(0.0626)
strhouse	-0.587**	-0.547	-0.536
	(0.289)	(0.436)	(0.385)
capacity	-0.679**	-0.450	-0.733*
	(0.270)	(0.376)	(0.404)
g_warn	-0.913***	-1.043***	-0.733*
	(0.255)	(0.366)	(0.380)
coastdist	-0.00532***	-0.00301**	-0.00783***
	(0.00102)	(0.00146)	(0.00146)
elevat	-0.160***	-0.211***	-0.106**
	(0.0332)	(0.0456)	(0.0503)
cycpdist	-0.000616***	-0.000358	-0.000658**
	(0.000211)	(0.000306)	(0.000303)
strhou	-0.438*	-0.0997	-0.694**
	(0.237)	(0.366)	(0.321)
_cons	11.08***	11.99***	10.15***
	(0.824)	(1.148)	(1.523)
N	305	148	157
R^2	0.257	0.304	0.277

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' estimations from the Pam module.

8 Summary and Conclusions

The study of Tuvalu is crucial and relevant to understand the vulnerability and impacts of cyclones to small low-lying islands and the fact that 70 percent of households in Tuvalu live less than 200 meters from the coastline with elevation of no more than 4 meters above sea-level. Households are acutely vulnerable to cyclone impacts and being at the fore-front facing the threats of sea-level rise, climate change and related climate disasters is a grave concern to its population. Future climate risks is forecast to worsen in the coming years. It is also critical to understand the extent of exposure of poor households to these risks, the degree of impacts on them and the ability to respond and cope to these risks.

A clear-cut picture is that the poor obtained 3/4 of the total losses and damages and suffered far more losses and damages relative to income than the non-poor households. Although poor households are more vulnerable in terms of loss and damages incurred, there is no solid evidence that they are more exposed to cyclones. It seem rational since lands in the outer-islands that were passed down through generations were well distributed amongst the local families without any influences on land allocation decisions. In contrast, this contradict conclusions for the capital island Funafuti as most people residing there are not local Funafuti people but are there for work, therefore renting houses from the locals. This is where house rental preferences for families to either reside in more exposed areas to cyclones or not depend on income. Poor households on Funafuti are most likely to live in exposed areas to disasters such as near-coastal areas and narrow parts of the island. For the surveyed islands, one thing is for sure is that the islands of Nanumea, Nui and Nukulaelae are the most exposed and vulnerable islands which is also reflected in the huge losses and damages they incurred, and the fact that they were heavily hit by surges and flood during TC Pam.

Apart from household exposure to cyclones, many other activities and services were exposed too, e.g. offices, medical services, infrastructure, retail shops, educational institutions, public utilities and social amenities. Furthermore, there is indirect exposure associated to disruptions in services and amenities.

Households identify cyclone, flooding, droughts as the top three most important stressors followed by monetary issues. In relative terms, monetary burden was unevenly distributed

between the poor and non-poor households. The losses and damages of poor households is 93 times their monthly income where as the non-poor households are 15 times their monthly income. The losses and damages suffered by households are uninsured. Besides low income for poor households, they have low savings potential and less access capacity to acquire loans as well. Since the poor invest their earnings in their assets such as the house, durable goods and furnitures, their asset base was threatened by storm surges and associated floods in low-lying areas.

In the absence of insurance and formal social security, the cost of repairs and replacements are borne by families regardless of their income. Under these circumstances, government intervention is paramount. Innumerable discourses by the government over assisting in meeting rebuilding costs of damages to houses that were destroyed by the TC Pam have yet to materialize, but believed to be in progress. The questions on what percentage of losses to be covered, does every affected household receive this assistance, when will they receive this assistance, whether it is a continuous assistance for future disaster events, what criteria and how will they determine assistance, are some of the questions in mind. This initiative seem justifiable to households that were badly affected by the TC Pam especially the poor, marginalized and low-income households.

Households have reported problems associated with the TC Pam like disruption of power supply, and non-availability of food, water, transportation, fuel and other supplies. Working days and school days were lost. These problems are associated with indirect losses which are difficult to measure in monetary values. However, there were also health effects experienced as a consequence of the TC Pam.

Financial resources, training and capacity building, responsive administration, early warning system, and preparation for cyclones are key factors that ability to respond depends upon. It is clear that the poor are the victims as they tend to have limited financial resources and access to financial facilities, thus resorting to families, friends and informal loans to cope with the impacts. These mechanisms are not fully available and has the potential to add burden to these low-income households.

9 Policy Implications

Analyzing and understanding disaster impacts on households provide fruitful avenues to building policies that can help to reduce disasters and mitigate hazards, while at the same time improving living standards and opportunities.

It is evident that the poor bears the brunt of cyclones as they have a far greater share of the loss and damage. However, on average terms, the non-poor households have higher values of loss and damage. Nevertheless, loss and damage in relation to income is far worse for the poor households. Therefore, coping and adaptation planning and programs should be well directed by planners and policy makers.

Interestingly, the non-poor households are more exposed to cyclones than poor households in terms of elevation and near-coastline. Although it is the reality for the outer-islands, this does not actually hold for the capital island Funafuti where poor households are more likely to reside in not only low elevation and near-coastline but in narrow parts of the island as well. Therefore, there is a need for pro-poor planning on Funafuti Island and efforts to achieve economic growth and poverty alleviation. The involvement of the poor in pro-poor processes is crucial.

The average number of persons in a household is higher for poor households. The overcrowded with a high population density in the capital Funafuti due to urbanization is becoming an issue. Therefore, the government may require installing or revising current policies on population, urbanization, decentralization, rural development and efficient internal management of islands.

Strengthen responsible stakeholders to cooperate and strife for an integrated approach that encourage well coordinated attempts for dealing with cyclones. Since there are no insurance mechanisms in place in Tuvalu, policy makers should consider exploring alternative options to provide protection and finance against climate change and climatic disasters such as cyclones.

Poor households face more damages to houses simply because their houses are constructed not up to quality as non-poor households, therefore they are less capable to withstand strong winds and cyclones. We should assess the vulnerability of urban areas and introduce appropriate building codes. Additionally, the government should encourage participatory

approaches for community risk assessments for "build back better" and for sustainable development.

We may require to rethink current strategies and management practices if there is a need for a change taking into account lessons learned in reducing vulnerability, building resilience, and enhancing risk management capacities. Capacity training for responding to cyclones seem very effective in preparing for cyclones.

The threats of climate change, sea-level rise, and climatic disasters may require relocation to safer places for households residing very close to the coast, in narrow parts of the island and in low-lying areas. Planners and policy makers should devise policies to enable movement options for these vulnerable and exposed households.

Strengthening determinants of adaptive and coping capacities for effective disaster preparation and response is crucial. The implementation of strategies such as vulnerability assessments, adaptation strategies, capacity development, improving disaster risk management, disaster risk reduction, and "building back better" principles are imperative.

Bibliography

Bene, C., Wood, R., Newsham, A., and Davies, M. (2012). Resilience: New Utopia or New Tyranny? Reflection about the Potentials and Limits of the Concept of Resilience in Relation to Vulnerability Reduction Programmes.

Briguglio, L. (1997). Small island developing states and their economic vulnerabilities. *Scope-Scientific Committee on Problems of the Environment International Council of Scientific Unions*, 58:210–215.

Briguglio, L., Cordina, G., Farrugia, N., and Vella, S. (2009). Economic Vulnerability and Resilience: Concepts and Measurements. *Oxford Development Studies*, 37(3):229–247.

Christenson, E., Elliott, M., Banerjee, O., Hamrick, L., and Bartram, J. (2014). Climate-Related Hazards: A Method for Global Assessment of Urban and Rural Population Exposure to Cyclones, Droughts, and Floods. *International Journal of Environmental Research and Public Health*, 11(2):2169–2192.

Clark, G. E., Moser, S. C., Ratick, S. J., Dow, K., Meyer, W. B., Emani, S., Jin, W., Kasperson, J. X., Kasperson, R. E., and Schwarz, H. E. (1998). Assessing the vulnerability of coastal communities to extreme storms: the case of Revere, MA., USA. *Mitigation and adaptation strategies for global change*, 3(1):59–82.

Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., and Webb, J. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change*, 18(4):598–606.

De Haen, H. and Hemrich, G. (2007). The economics of natural disasters: implications and challenges for food security. *Agricultural economics*, 37(s1):31–45.

Ebi, K. L. and Bowen, K. (2016). Extreme events as sources of health vulnerability: Drought as an example. *Weather and Climate Extremes*, 11:95–102.

Frankenberger, T. and Nelson, S. (2013). Background Paper for the Expert Consultation on Resilience Measurement for Food Security.

Gall, M. (2013). *From social vulnerability to resilience measuring progress toward disaster risk reduction*. UNU-EHS, Bonn.

Gunasekera, R., Ishizawa, O., Aubrecht, C., Blankespoor, B., Murray, S., Pomonis, A., and Daniell, J. (2015). Developing an adaptive global exposure model to support the generation of country disaster risk profiles. *Earth-Science Reviews*, 150:594–608.

Hettiarachchi, S. and Weeresinghe, S. (2014). Achieving Disaster Resilience through the Sri Lankan Early Warning System: Good practises of Disaster Risk Reduction and Management. *Procedia Economics and Finance*, 18:789–794.

Hosseini, S. and Barker, K. (2016). Modeling infrastructure resilience using Bayesian networks: A case study of inland waterway ports. *Computers & Industrial Engineering*, 93:252–266.

IPCC (2012). *Managing the risks of extreme events and disasters to advance climate change adaption: special report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, New York, NY.

Lopez-Marrero, T. and Wisner, B. (2012). Not in the same boat: Disasters and differential vulnerability in the insular Caribbean. *Caribbean Studies*, 40(2):129–168.

Mitchell, T., Jones, L., Lovell, E., and Comba, E. (2013). *Disaster Risk Management in Post-2015 Development Goals*. Overseas Development Institute, London.

Murlindharan, T., Durgaprasad, J., and Rao, T. A. (1997). Knowledge-based expert system for damage assessment and vulnerability analysis of structures subjected to cyclones.

Nadiruzzaman, M. and Wrathall, D. (2015). Participatory exclusion Cyclone Sidr and its aftermath. *Geoforum*, 64:196–204.

Smith, R.-A. J. and Rhiney, K. (2015). Climate (in)justice, vulnerability and livelihoods in the Caribbean: The case of the indigenous Caribs in northeastern St. Vincent. *Geoforum*.

UNDP (2013). Community Based Resilience Assessment (CoBRA) Conceptual Framework and Methodology.

United Nations (2015). *2015 Global Assessment Report on Disaster Risk Reduction*. United Nations Office for Disaster Risk Reduction, New York.

Winderl, T. (2014). Disaster Resilience Measurements.

Wisner, B., Blaikie, P., Cannon, T., and Davis, I. (2003). *At Risk: natural hazards, peoples vulnerability and disasters*. Routledge, New York, 2nd edition edition.

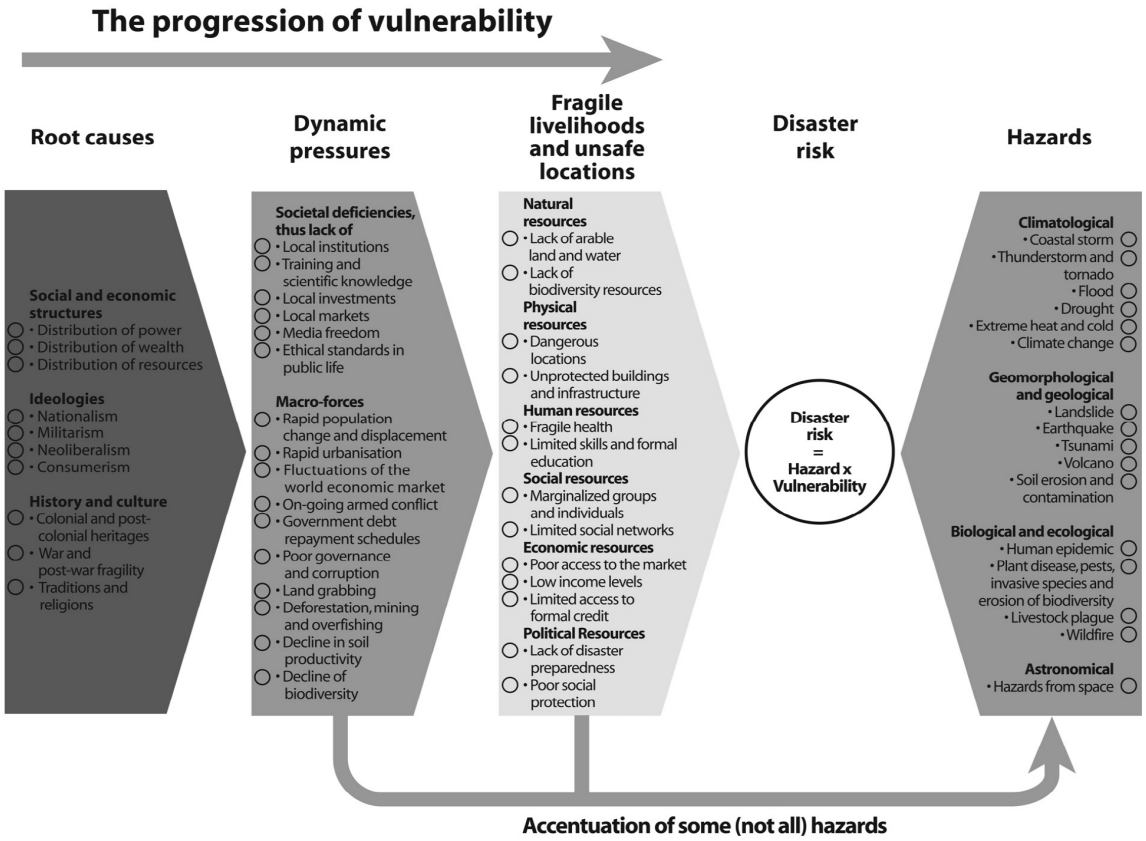
Wisner, B., Gaillard, J. C., and Kelman, I. (2011). Framing disaster.

World Bank (2013). *World Development Report 2014: Risk and Opportunity - Managing Risk for Development*. The World Bank, Washington D.C.

World Bank (2014). *Hardship and Vulnerability in the Pacific Island Countries*. The World Bank, Washington D.C.

World Bank and United Nations (2010). *Natural Hazards, UnNatural Disasters: The Economics of Effective Prevention*. The World Bank, Washington D.C.

Appendix A Progression of Vulnerability Framework



Source: Wisner et al. (2011)

Figure A1: Framework for the progression of vulnerability

Appendix B Robustness Check

Table B1: Model estimation results explaining the log of loss and damages

	(1)	(2)	(3)	(4)	(5)	(6)
lincr_cap	-1.022***	-1.040***	-1.052***	-1.015***	-0.993***	-1.029***
	(0.109)	(0.112)	(0.122)	(0.109)	(0.107)	(0.111)
hsize	-0.166***	-0.170***	-0.186***	-0.162***	-0.185***	-0.165***
	(0.0429)	(0.0431)	(0.0523)	(0.0426)	(0.0419)	(0.0429)
strhouse	-0.567**	-0.574**	-0.585**	-0.518*	-0.341	-0.600**
	(0.279)	(0.278)	(0.278)	(0.278)	(0.277)	(0.278)
capacity	-0.720***	-0.691***	-0.710***	-0.711***	-0.717***	-0.728***
	(0.260)	(0.261)	(0.260)	(0.258)	(0.253)	(0.261)
g_warn	-0.901***	-0.912***	-0.896***	-0.916***	-0.866***	-0.899***
	(0.245)	(0.245)	(0.247)	(0.244)	(0.238)	(0.246)
coastdist	-0.00521***	-0.00530***	-0.00519***	-0.00561***	-0.00442***	-0.00522***
	(0.000984)	(0.000989)	(0.000985)	(0.000995)	(0.000978)	(0.000985)
elevat	-0.128***	-0.138***	-0.137***	-0.115***	-0.155***	-0.136***
	(0.0334)	(0.0320)	(0.0321)	(0.0335)	(0.0314)	(0.0323)
cycpathdist	-0.000476**	-0.000472**	-0.000481**	-0.000576***	-0.000522***	-0.000471**
	(0.000203)	(0.000204)	(0.000204)	(0.000206)	(0.000198)	(0.000204)
strhou	-0.461**	-0.440*	-0.446*	-0.436*	-0.369	-0.464**
	(0.229)	(0.229)	(0.229)	(0.227)	(0.225)	(0.229)
savings	-0.246					
	(0.220)					
assist		0.622				
		(0.624)				

i_earners			0.113			
			(0.160)			
totdist				0.000330**		
				(0.000149)		
a_shift					0.834***	
					(0.260)	
elevate					0.194	
					(0.306)	
shel						-0.254
						(0.307)
_cons	14.00***	13.43***	14.14***	14.15***	13.76***	14.21***
	(2.000)	(2.093)	(2.007)	(1.988)	(1.954)	(2.012)
N	305	305	305	305	305	305
R^2	0.378	0.377	0.376	0.385	0.415	0.376

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' estimations from the Pam module.

Table B1: Suggestions from Respondents

Classification	**Suggestions**	**Response Rate (%)**	
		Suggested	**Poor**
Cyclone preparedness	Responsible agents to conduct more cyclone preparedness training and workshops for public awareness.	5.4	53
	Encourage people to be well prepared before cyclones.	6.6	75
	Island council with the help of the people to cut and trim down tall and dangerous trees to residents and people.	2.1	100
Safe shelter	Government to build proper safe shelters.	8.3	85
	Government to build proper large and strong double storey safe shelters.	6.2	73
Assistance	Government to provide financial assistance for households to adapt and build a more resilient environment for the people.	20.8	84
	Government to assist households financially in building back damaged houses/kitchens/outdoor toilets/etc.	15.8	87
Aid	Aids to be fairly distributed amongst families especially those who were affected.	11.2	85
	Need more food assistance since crop plantations were mostly destroyed.	3.3	75
Protection	Government to build seawalls on islands to reduce intrusion and damages from wave surges.	9.1	86
Relocation & migration	Government to look for safer lands overseas for Tuvaluans to move and stay.	5.0	83
	People living in exposed areas to move inland to safer grounds.	0.4	100
Early warning	Need for quicker early warning announcements so families have more time for preparation.	12.9	94

	Need a horns/sirens for warning particularly for those without radios and other means of communication.	0.4	100
	Need for improvement in communication during cyclones.	7.9	95
Strengthen responsible agents	Strengthen the Disaster committee and Kaupule to put more effort in helping families before/during/after cyclones.	4.2	70
Machinery & equipments	Need heavy machinery in place in the islands for clearing boulders and heavy substances.	1.2	100
	Need to have essentials like walkie-talkies, torches, food, medicines, etc.	0.8	100
Assessments	Need a thorough assessment of cyclone impact rather than just a quick one.	1.2	67
	Need for surveyors to evaluate all affected households and report true costs.	1.2	100
Disaster Fund	Need to establish some sort of disaster fund to cater for the impacts of cyclones.	0.8	100
	Need Red Cross station in the islands for cyclone training and response.	0.4	100
Cooperation	Need for everyone to cooperate before/during/after cyclones.	2.1	100
	Government to continue the fight to reduce global warming.	1.7	75
	Government to care for affected households.	0.4	100
Support	Government to support initiatives and demands from the islands on reducing disaster risks.	0.4	100

Source: Authors' calculations from the Pam module.

Appendix C Household Survey

Table C1: Pam module survey

	A: IDENTIFICATION DETAILS	
A1	Household ID number:	
A2	Name of the enumerator:	
A3	Date of the interview (DD/MM/YY):	
	B: HOUSEHOLD DETAILS	
B1	Name of respondents:	
B2	Name of the head of household (if different from respondent):	
B3	Date of birth (Day-Month-Year):	
B4	Island:	
B5	Village:	
B6	Home island:	
B7	Sex:	
B8	Marital status:	
B9	Number of elderly (65 years and above):	
B10	Contact number:	
B11	Email ID:	
B12	Did you reside in this house in 2012?:	(Yes or No):
B13	Number of family members :	Adults: Children:
B14	Number of earning members:	
B15	Education of Head of Household (HoH):	
	No formal schooling	1
	Primary school	2
	Secondary school	3
	Diploma	4
	Undergraduate degree	5
	Postgraduate degree	6
	Doctorate degree	7

	Other	8
B16	Occupation of HoH (Tick multiple options where applicable):	
	Retired	1
	Government service	2
	Private service	3
	Unskilled worker	4
	Skilled worker	5
	Business	6
	Self-employed professional	7

C: HOUSEHOLD INCOME, EXPENDITURE AND ASSETS

C1	Total monthly household income:	
C2	Average monthly expenditure:	Total expenditure: Food: Water: Electricity: Transportation: Medical: Repairs and maintenance:
C3	Approximate percentage of savings in bank account (0-100%)?: Approximate monthly savings amount:	
C4	Ownership of assets/durables (Tick all the options mentioned by the respondent)	
	1 LPG Gas	Cost:
	2 Electric fan	Cost:
	3 Television set	Cost:
	4 VCD/DVD player	Cost:
	5 Music system	Cost:
	6 Refrigerator	Cost:
	7 Washing machine	Cost:
	8 Air conditioner	Cost:

	9 Desktop/laptop	Cost:
	10 Mobile phone	Cost:
	11 Steel cupboard	Cost:
	12 Wooden furniture	Cost:
	13 Bicycle	Cost:
	14 Motorcycle/scooter	Cost:
	15 Hand cart	Cost:
	16 Car	Cost:

D: HOUSEHOLD CHARACTERISTICS

D1	For how many years have you been living in this area?	
D2	Can you identify factors that cause you stress? Rank the five most important factors causing stress.	
	Drought	Rank:
	Housing conditions not good	Rank:
	Lack of opportunities	Rank:
	Overcrowding	Rank:
	Transport related issues	Rank:
	Cyclones	Rank:
	Floods	Rank:
	Family issues	Rank:
	Monetary issues	Rank:
D3	Year of construction of the house:	
D4	How long in years are you planning on living in this house?	
D5	Type of house:	
	Concrete	1
	Timber	2
	Other	3
D6	Ownership: IF RENTED, GO TO D8	
	Own	1
	Rented	2
D7	Maintenance of the house	
	Annual	1
	Every 2-3 years	2
	5 years and beyond	3
D8	Are schools/colleges near your area?	

	Yes	1
	No	2
D9	What is the quality of water and sanitation services in your area?	
	Doesn't exist	1
	Poor	2
	Fair	3
	Good	4
	Very good	5
D10	What is the reliability of electricity in your area?	
	Doesn't exist	1
	Poor	2
	Fair	3
	Good	4
	Very good	5

E: EXPOSURE AND IMPACT OF CYCLONES

E1	Does your area get strong winds and storm surge every year?	
	Yes	1
	No	2
E2	Did the surge/flood water from Cyclone Pam 2015 enter your house? IF NO, GO TO E4	
	Yes	1
	No	2
E3	For how many hours did the house remain flooded?	
E4	Have the following items been damaged during Cyclone Pam 2015?	
	Structure of the house	1
	Electric wiring	2
	Electric meter	3
	Electronic goods	4
	Furniture	5
	Plumbing	6
	Other kitchenware	7
	Vehicles	8
E5	Did you experience these problems during Cyclone Pam 2015?	
	Non availability of transport	1
	Price rise of essentials	2

	No drinking water	3
	Disruption in power supply	4
	Non availability of food and other supplies	5
	Non availability of fuel (petrol, diesel, kerosene)	6
E6	Did you lose working days due to Cyclone Pam 2015?	
	Yes	1
	No	2
	If yes, how many working days were lost?	
	GO TO E8 IF NO DAYS ARE LOST	
E7	If you did lose working days, for what reasons? List all those that apply.	
	Office damaged	1
	House damaged	2
	Transport not available	3
	Outside road flooded	4
	Power supply cut off	5
E8	Did your children miss school/college on account of Cyclone Pam 2015?	
	Yes	1
	No	2
	If yes, how many school days were lost?	
E9	Did any of your family members face any of these health	
	Malaria	1
	Dengue	2
	Typhoid	3
	Jaundice	4
	Diarrhea	5
	Viral fever	6
	Asthma attack	7
	Chronic cold and cough	8

F: PREPARING FOR CYCLONES

F1	Did you undertake these activities in anticipation of Cyclone Pam 2015?	
	Strengthen the house	1
	Shielding the windows	2
	Repairing the roof	3
	Move to a safe shelter	4

	Repairs inside the house	5
F2	Did you stock up on the following in anticipation of Cyclone Pam 2015?	
	Food	1
	Milk	2
	Water	3
	Medicines	4
	Cooking fuel/gas	5
	Other	6
F3	During the Cyclone Pam 2015, how long, in days did you stay without access to the following?	
	Water:	
	Sanitation:	
	Electricity:	
	Your Job:	
	Food:	
	Childrens Schooling:	
F4	Did you shift assets or valuables elsewhere in anticipation of a cyclone? If so where did you shift them?	
	Yes	1
	No	2
	If yes, shift assets to others house.	1
	If yes, keep them at higher elevation within the house.	2
F5	Which assets did you protect first in anticipation of a Cyclone Pam 2015? of a Cyclone Pam 2015? Rank what you would protect first, starting with 1. Ignore items that you do not own.	
	1 High value durable items (TV, radio, fridge, computer)	Rank:
	2 Documentation (other important documents e.g. passports, birth certificates, transcripts, etc.)	Rank:
	3 Jewelry	Rank:
	4 Vehicles (bicycle, motorcycle, car)	Rank:
	5 Others	Rank:
F6	Have you undergone any training or capacity building programme conducted for cyclone response?	
	Some training	1
	No training	2
	If so, which agency conducted it?	

	Government	1
	NGOs	2
	Other	3
F7	Were you aware of any nearby temporary safe shelter during cyclones?	
	Yes	1
	No	2
F8	Did you receive warnings about cyclone risks? IF NO, GO TO F11	
	Yes	1
	No	2
F9	If yes, how did you receive the warnings? (tick multiple responses if applicable) did you stay without access to the following?	
	Community alarm	1
	Cell phone	2
	Local cable network	3
	Radio/TV	4
	Local government	5
	Police	6
	Other	7
F10	If yes, how long in advance were you warned of the Cyclone Pam 2015?	
	Less than fifteen minutes	1
	Less than an hour before	2
	12 hours before	3
	24 hours before	4
	48 hours beforet	5
F11	If you needed to obtain a loan after a cyclone, what is the first source would you go to?	
	Family/friends	1
	Informal money lender	2
	Formal bank	3
	Microfinance institution or NGO	4
	Government	5
F12	During a cyclone, where is the safe shelter located and how long would it take for you to shift to it from your house?	
	Location of the safe shelter:	
	Time to reach in minutes:	
F13	What were the reasons that may prevent you from moving	

	to safe shelters?	
	Lack of security of belongings in house	1
	Poor living conditions in shelter	2
	Shelter too far away	3
	Shelter not safe	4
F14	Have you ever shifted to this temporary shelters during cyclones?	
	Yes	1
	No	2
F15	Which agency did you contact when you needed help during Cyclone Pam 2015?	
	Government office	1
	Disaster Committee	2
	Police station	3
	Fire brigade	4
	Island councils	5
F16	Do you think that reducing disaster risk associated with a cyclone is the responsibility of?	
	Government	1
	Island councils	2
	NGOs	3
	Community	4

G: RELOCATION AS AN OPTION

G1	Have you ever considered moving out of the cyclone prone area? IF YES, GO TO G3	
	Yes	1
	No	2
G2	If no, what are the reasons? (Tick multiple options as applicable)	
	Do not have enough financial resources to shift	1
	Cannot avail of loan to move to another house	2
	School/college is nearby	3
	Do not feel comfortable shifting to another location	4
	Transportation will be very costly if shifted to another area	5
	Other services like water, electricity, monthly	

	maintenance will be costlier in another area	6
	Have strong social network of neighbours and friends in this area	7
G3	If your family is given an option of relocation by the government, would you consider it?	
	Yes	1
	No	2
G4	Consider a hypothetical situation of you being given a) chance to move to a safer house without additional burden on the family. What are the three most important factors influencing your decision to move?	
	Job opportunities	1
	Yes	Rank:
	No	Rank:
	Cost of living should not increase	2
	Yes	Rank:
	No	Rank:
	Access to transportation	3
	Yes	Rank:
	No	Rank:
	Cheaper transport options	4
	Yes	Rank:
	No	Rank:
	Access to good schools/colleges	5
	Yes	Rank:
	No	Rank:
	Medical facilities	6
	Yes	Rank:
	No	Rank:
	Clean surroundings	7
	Yes	Rank:
	No	Rank:
	People with similar background nearby	8
	Yes	Rank:
	No	Rank:
	People from the same community nearby	9

	Yes	Rank:
	No	Rank:
	H: LOSS AND DAMAGE	
H1	Have you ever considered moving out of the cyclone	
	Yes	1
	No(Go to H3)	2
H2	What losses and damages incurred during the Tropical Cyclone Pam 2015. If YES, estimate the total value for loss and damage.	
	Residential house	1
	Yes	Est. Value:
	No	Est. Value:
	Local kitchen hut	2
	Yes	Est. Value:
	No	Est. Value:
	Outbuilding toilet	3
	Yes	Est. Value:
	No	Est. Value:
	Water storage tank	4
	Yes	Est. Value:
	No	Est. Value:
	Livestock	5
	Yes	Est. Value:
	No	Est. Value:
	Root crops	6
	Yes	Est. Value:
	No	Est. Value:
	Fruits/Vegetables	7
	Yes	Est. Value:
	No	Est. Value:
	Fruit tree	8
	Yes	Est. Value:
	No	Est. Value:
	Boat/Canoe	9
	Yes	Est. Value:

	No	Est. Value:
	Others	10
	Yes	Est. Value:
	No	Est. Value:
H3	Did your household receive any assistance after the Tropical Cyclone 2015?	
	Yes	1
	No(Go to H6)	2
H4	Where did you receive the assistance from?	
	Government	1
	Yes	
	No	
	NGOs	2
	Yes	
	No	
	Family	3
	Yes	
	No	
	Friends	4
	Yes	
	No	
	Development partners	5
	Yes	
	No	
	Remittances	6
	Yes	
	No	
H5	What kind of assistance did you receive? If any, estimate the total value received from the assistance.	
	Money	1
	Yes	Est. Value:
	No	Est. Value:
	In-kind	2
	Yes	Est. Value:
	No	Est. Value:
	Other	3

	Yes	Est. Value:
	No	Est. Value:
H6	Do you have insurance on your properties damaged by Tropical Cyclone Pam 2015?	
	Yes	1
	No(Go to I1)	2
H7	What type of insurance? If any, estimate the total value you received from insurance.	
	Home	1
	Yes	Est. Value:
	No	Est. Value:
	Vehicle	2
	Yes	Est. Value:
	No	Est. Value:
	Boat	3
	Yes	Est. Value:
	No	Est. Value:
	Other	4
	Yes	Est. Value:
	No	Est. Value:

I: SUGGESTIONS

I1	Do you have any suggestions for the authorities or the people to improve the cyclone situation in future?