



Is there any chance for the poor to cope with extreme environmental events? Two case studies in the Solomon Islands

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ABSTRACT

Our paper analyses the patterns and factors that explain households' responses to extreme environmental events (EEEs) in two case studies of indigenous communities in the Solomon Islands. We used the ethnographic approach to describe the case studies and carried out thematic analysis to disentangle the factors that explain such responses. The first case was that of a rural community from Ranogha Island in the Western Province that was hit by the Tsunami of April 2007; the second was of a community settled in an informal development on a flood-prone area in peri-urban Honiara that was hit by a flash flood in April 2014. Drawing from the villagers' experiences, we found that aid and support from family and community, referred to by the respondents as the "wantok" system, was key to recovering from the disasters. Many respondents identified climate change as one leading factor that explained such catastrophic events. The social cooperation system, the government's role in responding to catastrophes and household net worth were identified among the main components of household responses. These constitute an effective engine to build palliative and preventive responses against catastrophic events and climate change risks. In spite of the extreme poverty observed, and the lack of government assistance, we conclude that amenities obtained from the community (through the wantok system) and household net worth (including the availability of common pool resources) enabled them to cope with the catastrophes. These factors are critical for long-term adaptation to EEEs and climate change risks. The community responses analysed with thematic analysis showed to be consistent with the conceptualization led by a farm-household model, and the household net worth as a source of income appears to be the correct measure of wealth instead the level of income in these less monetarised communities. Learning from how these communities and households responded to such EEEs provides evidence on how other communities could successfully adapt to increasing climate change risks.

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1. Introduction

The United Nations Framework for Climate Change Convention (UNFCCC) calls for the development and enhancement of the endogenous capacities and technologies of developing countries to support their adaptation and mitigation efforts to climate change (Liu & Liang, 2011). Adaptation refers as "the process of adjustment to actual or expected climate and its effects". This definition distinguishes adaptation in human systems from natural systems. In the first ones, "adaptation seeks to moderate or avoid harm or exploit beneficial opportunities", while in natural systems,

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"human intervention may facilitate adjustment to expected climate and its effects" (IPCC, 2014). In addition, the "adaptive capacity" is defined by IPCC (2014) as "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences", i.e., the ability to adapt. Pelling (2011) distinguishes three levels of adaptation: "as resilience", "as transition", and "as transformation". Resilience refers to short-term adaptation; transition refers to adaptation involving intermediate and incremental changes, and transformation refers to irreversible and radical regime changes, conducting to long-lasting adaptation. In this context, if no adaptation occurs then the human or natural system stays vulnerable.

Vulnerability is understood as "the propensity or predisposition to be adversely affected" (IPCC, 2014), this includes the "lack of

capacity to cope and adapt”, e.g., resilience is positively correlated to socioeconomic level and negatively to vulnerability (Cutter, Boruff, & Shirley, 2003). The concepts of vulnerability, resilience and adaptive capacity are still not well articulated in the literature (Cutter et al., 2008), due to different author's visions, research perspectives, and the scale of analysis. Cutter et al. (2008) propose a conceptual framework “for natural disaster resilience” that focuses on the resilience at the community level, which is drawn from “the global change, hazards, political ecology, ecosystems and planning literatures”. The community resilience and vulnerability interact dynamically over time. Therefore, the disaster impact and adaptive capacity can affect future responses to EEEs by changing the community's vulnerability and resilience, and this can happen both in the short and longer term. Therefore, the responses can lead to adaptation from building resilience up to transformation or long-term resilience.

Since social vulnerability limits community response to disasters (Bergstrand, Mayer, Brumbach, & Zhang, 2015), the improvement of households' socio-economic level and food security appear to be underlying factors for improving the response of such communities to extreme environmental events (EEEs) and climate change impacts (Smith & Pilifosova, 2003). Therefore, in order to respond effectively to disasters in Pacific Island Countries, the focus should be on building resilience at community level (Coles & Buckle, 2004).

The main concerns rose by climate change risks, and other non-climatic catastrophes, are the expected negative impacts on the poor (McAdam, 2017; Rosenzweig, Iglesias, Yang, Epstein, & Chivian, 2001); in other words, the poor are more affected by disasters than the wealthy (Masozera, Bailey, & Kerchner, 2007; Mendelsohn, Dinar, & Williams, 2006). This is true even in rich countries. For example, in the USA, the majority of the victims of Hurricane Katrina were poor people and Afro-Americans (Logan, 2006).

Household and community responses to hazards and disasters vary because of their different attributes (Leal Filho et al., 2018; Masten & Obradović, 2008). Understanding the patterns and factors that explain their responses to EEEs could assist both governments and threatened communities in their endeavours to build resilience. In terms of the institutional framework, redesigning climate change institutions to improve community access to public assistance is crucial (Brunner & Lynch, 2013). This can be achieved by linking local, regional and national institutions to ensure that households can respond timely and effectively to disaster events (Twigger-Ross et al., 2015); and by creating the necessary economic instruments and incentives.

About 12 per cent of the Solomon Islands population still live below the poverty line (Kimi, 2012), and the majority depend on the environment for their livelihood and sustenance (Aswani, 2002). Furthermore, the country is exposed to a wide range of geological, hydrological and climatic hazards, including tropical cyclones, landslides, floods and droughts (Lal, 2011). For example, between 1980 and 2009, the country experienced 17 disaster events, costing over USD 20 million and affecting over 300,000 people, i.e., to around 60 per cent of the country's population. Of these events, six were major natural disasters: two earthquakes and four tropical cyclones, with associated floods and storms that directly impacted over 100,000 people and caused over 100 deaths (Lal & Thuraijah, 2011). Coastal communities are more vulnerable to the impacts of climate change and EEEs than inland locations (Keener, 2013); this is a source of concern since in Pacific Island Countries, including Solomon Islands, the majority of the people live near the coast.

The vulnerability of coastal communities can be analysed from the perspective of traditional economics – for example, with a farm-household model as used by Lopez (1984, 1986), in which

it is assumed that a typical household in an indigenous community, living under a subsistence or semi-subsistence regime, can be producers and also consumers of their own production, or of a share of such production. Viewed from an economic perspective, these households try to maximize their level of utility and also their production, in conjunction, under constraints imposed by the life-in-community and the surrounding resources. However, this economic conceptualization may fail when applied in less monetarised systems. In the developed world, household wealth is a measure of economic wellbeing (Wolff & Zacharias, 2009), and the margin by which the wealth of the household is greater than its liabilities is a measure of the household's capacity to absorb and face economic stresses (Wolff, 1998); however, it is difficult to measure the level of wealth in less-monetarised economies, such as some areas of the Solomon Islands, since many aspects that increase a household's wealth are unobserved or not easily interpreted in monetary terms (any valuation is endogenous and thus unobservable), as is the case of social and cultural assets and non-market natural capital. Only marketable goods and services obtained from the surrounding environment (natural capital) can be translated into economic value (Bateman et al., 2011). Thus under subsistence and semi-subsistence systems, this translation may result in an underestimation of economic value (Claessens et al., 2012).

In our research, we describe the situation revealed by fieldwork using the ethnography of the study sites; we then apply the thematic analysis approach to discover how indigenous households (and communities) perceived and responded to two EEEs, which we use as natural experiments. We propose that by comparing the themes resulting from the thematic analysis against a traditional economic behavioural model at household level (farm-household model) we can learn how consistent the behaviour of these indigenous households is with economic theory. Therefore, our main research hypothesis is that we can discover and learn about the main factors determining households' responses by applying thematic analysis, a qualitative approach, and use the findings to validate a conceptual economic model of household behaviour, in an analytical approach. These two approaches complement one another by uniting two methods from different disciplines with radically different approaches. Given the direct correlation of poverty and vulnerability with EEEs and climate change risks, our second research hypothesis states that an effective way to build resilience to EEEs is to improve and increase community and household wealth. Improvements in any of the several dimensions for community resilience, e.g., ecological, social, economic, institutional, infrastructure and, the community competence, would become an engine for building resilience to EEEs and climate change.

The objective of our study is to analyse the factors related to the community and household responses to EEEs and climate change in two indigenous communities of the Solomon Islands, and compare the consistency of such discovered factors (themes) with a traditional farm-household model. The first specific objective is to identify the main themes related to the adaptation responses of households and the community; the second is to analyse the role of such themes in adaptation responses; and the third is to compare the consistency of these themes with a traditional farm-household model.

Among the themes discovered in our research it is the relevance that *wantok* system has as a social cooperation system embedded in the local culture that is instrumental to the community and the families assisting each other's after the catastrophe, and therefore to increasing the level of community resilience. Another theme discovered was in regards the importance of considering the household net worth, and not the level of income, as the correct way to measure the level of community and households wealth.

This is because, in less monetarized economies like the ones in our study, the source of food and sustenance i.e., the endowment of local natural resources, gains more relevance than level of income for determining the level of wealth. Perhaps the most controversial finding of our thematic analysis is in regards the role of government. On one hand it represents who to blame for any failure in the post-catastrophe response and also for the lack of preventive actions; who to blame, accompanied by frustration and resignation for not doing anything to prevent acts of God. In spite the crucial role that government should play in providing education and awareness on the risks from EEEs, our observations show that government seems to be of little help and rather an obstacle to any adaptation measure to climate change and the EEEs.

2. Study area

Solomon Islands is located in the Southwest Pacific, about 1900 km northeast of Australia, and consists of 996 islands stretching in a 1450-kilometer chain southeast from Papua New Guinea (Coleman & Kroenke, 1981). The country has a population of around 537,000 inhabitants who share a total land area of approximately 27,500 km². The majority (85%) of the population lives in rural villages or communities (Gagahé, 2011).

The research covers the responses of two communities to EEEs in the Solomon Islands. The first EEE was a tsunami that affected rural villages on the Coast of Ranogha Island in the Western Province (Site 1), and the second was the flash flood that affected an informal development along the Mataniko river side, in peri-urban Honiara (Site 2).

At Site 1, Mondo village was struck by the 2007 tsunami and villagers had to move to Keigold, a safe new location located inland, about 145 m above sea level. Two people lost their lives during the disaster. After the tsunami, most of households stayed at higher locations for more than a month. It was during this period that Chief Kana offered his tribal land for a safe, permanent location, now called Keigold. Thus, the 103 households agreed to move from Mondo to Keigold. However, as months went by 21 households decided to return to Mondo.

At site 2, we describe the movement of 246 households from an informal settlement on the riverside of Mataniko River, in Honiara, to a safe location at April Ridge, in East Honiara, after the 2014 flood destroyed their village. The flood damaged houses, food gardens and sources of livelihood along the riverside and claimed 23 lives. Most of the affected households were poor, with low income and high dependence on casual income sources.

3. Methodology

3.1. Data collection and questionnaire design

In order to understand households' actions taken in response to the disasters, we applied semi-structured interviews targeting key informants, including local authorities and household heads who held a special position in the community, such as the chief and influential community members. Focus group meetings targeted heads of households and family members who acted as family representatives. We also carried out a survey at household level to obtain each household's socioeconomic description and perceptions of the adaptation process to the EEEs. The following steps were adopted for data collection:

Step 1: Designing the measurement instruments. We first designed the questionnaires for the semi-structured survey (interviews) and the structured survey. The first consisted of a short list of open questions that allowed the respondents to provide open answers. This was applied in the form of interviews with

key informants, who were also household heads; the questions were open in order to elicit their views at household and community level, about income levels, the impact of the extreme events on their livelihoods, the types of assistance received and the importance of the social cooperation network after the disasters.

We also designed a structured survey questionnaire with closed questions, including typical questions for collecting socioeconomic information at household level and information and perceptions on their response to the disaster. We asked the victims to rank the level of assistance received from authorities and relatives after the disasters, and included questions on their knowledge about climate change and how to mitigate damage from catastrophes in the future. The survey also included some open questions on their perceptions or beliefs about the possible causes of these disastrous events. The survey was applied through interviews in order to cope with the expected level of illiteracy of respondents; assistance was available to help them fill in the questionnaires, which were prepared in English and also translated into the local Pidgin language. A local interpreter was hired in order to assist the researcher during the whole fieldwork process (during the focus group meetings, interviews with key informants and the application of the survey).

We included questions about the availability of natural resources for community and household sustenance (local natural capital), and the availability of other community resources such as social and cultural assets. We considered local natural resources to include garden areas, fishing grounds and coconut trees. Social and cultural assets included the benefits they receive from cooperation among community members through any medium, i.e. family, community, tribe and church members.

We tested the questionnaires with college students in order to identify ambiguities in the wording and ensure that the questions were clear, and to calibrate the time required and the consistency of the questions.

Step 2: Obtaining the necessary consents for the fieldwork. Permission to conduct fieldwork was requested from and granted by, respective community leaders and local government authorities, i.e. Honiara City Council and Western Provincial Assembly. After consent was given at these administrative levels, we sought another tier of permission to enter to the villages through respective ward members. After these ward members had granted permission to continue our study, we liaised with village chiefs on the detailed schedule of the visits. At this stage, the chiefs were presented with some tokens, permitting our research team to freely interview members of the community. Once in the field, before applying focus group meetings and interviews, we first obtained the informed consent of the participants.

Step 3: Familiarisation with the data and generation of initial codes of the thematic analysis. For this we used two types of instruments: "face to face" interviews with key informants using the semi-structured questionnaires; and "focus group discussions (FGD)". The first interviews were with key informants from selected organisations such as Honiara City Council, NGOs and church groups; however, once at the study sites, our targets were household heads who were also local village leaders. Focus group discussions were organised and targeted at small groups of 5 to 10 people, who were also heads of households. The instruments were applied at Site 1 from 15 September to 9 October 2015, and at Site 2, from 19 October to 19 November 2015.

We performed 110 interviews with key informants and organized 14 focus group meetings, eight at Site 1 and six at Site 2 (See Table 1), consisting of five to eight people each. In total, 85% of those convened attended the interviews and 66% attended the focus group meetings.

We adopted an ethnographic observation approach, in which we took notes and engaged in meaningful conversation. The interviews were recorded and the recordings were kept in a log for later

Table 1
Respondents per measurement instrument, study site and population.

Instrument	Site 1		Site 2		Total
	Keigold	Mondo	April Ridge	Mataniko Riverside	
Sample:					
Semi-structured interviews	35	15	24	36	110
Focus groups (participants)	5 (25)	1 (6)	4 (24)	4 (28)	14 (83)
Survey questionnaires	29	9	38	44	120
Population:					
Total households	82	21	116	130	349
Total people	(480)	(111)	(769)	(851)	(2211)

Source: Household survey September 2015.

analysis. All the interviews were applied in Solomon Islands Pidgin and took 40–90 min each; the field notes and all the responses from audio recordings were transcribed into English. When questions or answers were not clear during the interviews, the research assistants assisted in their interpretation and or translation.

Field notes were revised on a daily basis before proceeding with the next day's fieldwork to look for any misinterpretation or need for clarification, and to further recode any point from the day that needed revision.

Step 4: Identifying and selecting a sample of households for survey application. We identified the families affected and targeted family heads as our key respondents, but in the absence of family heads we also interviewed family representatives. The survey was applied at Site 1 from 26 December 2016 to 30 January 2017, and at Site 2 from 25 January to 13 March 2016. During this stage we generated and improved the initial codes, and also started the process of searching for and defining themes among the codes.

We distributed 230 questionnaires among selected household heads: 80 at Site 1 (Mondo and Keigold) and 150 at Site 2 (Mataniko riverside and April Ridge). Responses were received from 120 households: 38 from Site 1 and 82 from Site 2 (See Table 1). The total population of households in the two study sites was 349, involving 2211 people. Thus the survey sample covered 34.4% of the population. All the household heads were requested to participate and we distributed questionnaires among all those who were available during the visit or keen to participate (230 survey questionnaires); however, only 120 responded (34.4% of total households). This participation was considered adequate, considering that 30 per cent of the sample would fairly represent the total population (Kotrlik & Higgins, 2001).

3.2. Data analysis approach

We prepared our report based on the ethnography of the study sites and thematic analysis. For the thematic analysis, we performed the six typical steps described by Braun and Clarke (2006) (See Table 2). In the process, we coded the responses and grouped the raw data under emerging themes by recognizing important moments in the data and depth of responses prior to interpretation. In our thematic analysis we adopted a concept similar to Norris, Stevens, Pfefferbaum, Wyche, and Pfefferbaum (2008) and Gottschalck (2008).

4. Results

4.1. Results of the thematic analysis

The results are presented in the same order as the six phases described in the methodology, as follows:

Phase 1: Familiarisation with the situation. Based on media information, preliminary interviews with government officers

Table 2
Phases of Thematic Analysis as per Braun and Clarke (2006).

Phases	Process	Result	Reflexivity Journal Entries
1	Familiarisation with the data	Assignment of preliminary codes	Re-reading the interview questions and questionnaires, noting initial concepts/ideas
2	Generation of initial ideas	Data are given codes and collated into similar codes	Determine why certain data will be amalgamated, how researcher is asking questions and why codes are interrelated
3	Searching for themes	Lists of candidate themes for further analysis	The RJE needs to disclose how codes were combined and interpreted
4	Reviewing themes	Review patterns developed and realigned wherever possible	Justify how and why codes were assigned and how the data answers the research questions
5	Defining and naming themes	Themes are selected and refined for clear directions	The researcher provides description of the themes developed
6	Producing the report	A detailed description of the results	Note why some themes are more useful to the study than others

and NGO employees, and word of mouth, we had a preconceived preliminary idea of the situation experienced by the communities after they were struck by the tsunami of 2007 and flash flood of 2014 respectively. In fact, this preliminary information motivated our study.

After passing all the bureaucratic and accessibility barriers to make direct contact with the affected villagers, we established a baseline of information to familiarize ourselves with the study sites in the field. Although we anticipated easy access to the people at the study sites, once in the field we realized that bureaucracy was a difficult barrier which had to be overcome before any data could be collected; for example, the involvement of the local city councillor who tried to influence our decision on which households to interview or not to interview, due to his wish to include those households whose comments on the authorities would be positive. We finally used our own selection criteria.

Phase 2: Generation of preliminary codes. Initial ideas were translated from interviews, focus group discussions and sample surveys into our preliminary codes, listed in Table 3. The preliminary codes are annotated (in parentheses) with the number of respondents who mentioned the corresponding ideas.

Phase 3: Searching for themes. In this phase we allocated initial codes to emerging themes. We then grouped the codes in terms of the explanatory factors by which people explained the catastrophic event experienced, and why it happened to them. Once proposed, we then reviewed our themes again and realigned them

Table 3
List of preliminary codes.

Code	Code
1	No need to build good houses as they will be destroyed by disasters anyway (78)
2	Government should assist communities affected by a catastrophe (81)
3	Family support is very important during disaster times (95)
4	All the communities are vulnerable to climate change and EEEs, therefore there is no escape (65)
5	Community chief plays a role in caring for the community – Mondo and Keigold communities (45)
6	Climate has changed and has become more extreme – rain is heavier, storms are stronger (78)
7	Education is important to support adaptation (56)
8	We need to change the way we face catastrophes (68)
9	We know it is risky but this is the way we have always lived (56)
10	Government took too long in assisting the village after the tragedy (91)
11	If our family and community had not helped we would have been lost (86)
12	Response of family and community to the disaster was crucial (77)
13	Preparation for future catastrophes? Yes/no?? (52)
14	Economically desperate households arriving from the country mostly settle illegally in informal developments in disaster-prone areas, forming communities on the outskirts of the growing city. This situation could be avoided or prevented (68)
15	The purpose of the earlier settlements at these locations was economically motivated (85)
16	People must live within their means and control their expenses (45)
17	Income is important for a better livelihood (77)
18	In spite of disasters, people will prevail, generation after generation (66)
19	God is punishing this world – End of time is near (59)
20	Leaders are rebellious – thus we have to face all these punishments (68)
21	The world has been here for thousands of years: therefore climate change is not real (47)
22	We are poor and we do not have many choices to protect ourselves from disasters (79)
23	We rely on fishing for a living, that's why we need to live near the shore (71)
24	Everyone is going to die one day (66)
25	The aid was insufficient (92)
26	Many lives were saved because of family and friends' aid (82)
27	Climate change is a scam (67)
28	What needs to be done to avoid such catastrophic impacts in the future? (45)
29	The legal authority of the City Council is weak – they fail to prevent households from settling in vulnerable or disaster-prone areas (52)
30	The government promised to help the affected communities (79)

as preliminary themes according to the main explanatory factors expressed in respondents' perceptions of the catastrophic events. The Phase 3 and 4 results are summarised in [Table 4](#).

Phase 4. Review of theme patterns. In this phase we present the rationale of how and why codes were given to each emerging theme, and discuss how the field information answers the research questions. The preliminary themes and the associated codes are summarised in [Table 4](#).

Family and community aid and support during disaster times are of key importance in responding to catastrophes. Respondents explained that without family and community support and assistance after the catastrophic event, they would have not survived and recovered (Codes 3, 5, 11, 12). For example, many lives were saved because of family and friends' assistance (Code 26); as declared by respondents, aid from the family arrived before

Table 4
Searching for emerging themes.

Preliminary theme	Description	Associated codes (See Table 3)
(i)	Family and community aid and support during and after disasters are of key importance in responding to catastrophes	3, 5, 11, 12, 26
(ii)	Call for a major role of government in disasters (in prevention and in assistance before and after the catastrophe)	2, 10, 25, 29, 30
(iii)	Nothing can be done about climate change and natural catastrophes (Resignation and acceptance of the situation)	1, 9, 4, 18, 19, 20, 24, 21, 27
(iv)	Climate change is the topic of the discussion (Proponents and detractors of Climate Change)	4, 6, 21, 27
(v)	Need for a change in how we face catastrophes	7, 8, 13, 28
(vi)	Poverty is a determinant of vulnerability to disasters	14, 15, 16, 17, 22, 23
(vii)	Dependence on natural resources. Disaster-prone location was necessary because of the availability of land for gardening; natural resources as source of food.	9, 14, 23
(viii)	Dependence on the social network. Disaster-prone location was necessary due to the need to live together as a community.	3, 5, 11

aid from the government. Respondents also emphasized the key role of the community chief in responding to the disaster (Code 5).

Social support was referred to by the respondents as the “*wan-tok*” system. Of the underlying reasons why cooperation is important mentioned by [Norris et al. \(2008\)](#), we think that the following are most significant in this discussion: (a) cooperation provides social and economic security to households and the community; (b) cooperation provides autonomy to the community, enabling it to act even in cases when the government fails to provide assistance; and (c) cooperation provides a means for better income distribution.

Call for a major role of government in disasters. We realised that respondents would have liked the government to be available in disaster prevention and in assisting the communities before and after the catastrophes (Code 2), providing immediate response when it was needed (Code 10). Also, the assistance should have been sufficient to work a change in the victims' situation, but it was insufficient (Code 25). If the government assumes commitments to the affected communities, then such commitments should have been fulfilled as promised (Code 30). The local authorities (City Council) should have played a better role in preventing risk situations, e.g. preventing people from settling in high-risk areas, or at least warning them of the risks they faced (Code 29).

Nothing can be done about climate change and natural catastrophes. We discovered that one of the most controversial themes to emerge from this research was the respondents' belief that not much can be done to prevent disasters. Statements such as “disasters will destroy everything, therefore there is no reason to prepare for them” or “there is no need to build good houses as they will be destroyed by disasters anyway” (Code 1) are an explicit recognition of their own vulnerability to natural disasters, and therefore to climate change risks. Going further, some respondents had a more elaborate notion of climate change, and their opinions reinforced the idea that “All the communities are vulnerable to climate change and EEEs, therefore there is no escape” (Code 4), revealing “resignation” to the problem. Other statements such as: “In spite of disasters, people will prevail, generation after generation” (emphasising that people are resilient) (Code 18), also reveals

some “optimism”. Beliefs that all disasters occur because “God is punishing this world – End of time is near” (Code 19), therefore people must face these catastrophic events as the fulfilment of the Bible, and that “punishments from God occur because leaders are rebellious” (Code 20), denote a sentiment of resignation and guilt, as if humans have failed in such a way that they must be punished.

Other “controversially optimistic” reasons given for inaction were that “the world has been here for a long time (therefore it will remain for a long time and in consequence climate change is not real or won't really change things)” (Code 21). The idea that climate change is a scam was reinforced in their discussions repeatedly (Code 21 and 27). Other statements reinforcing the sentiment of simple resignation were of the type: “everyone is going to die one day (in one way or another) (Code 24). The sentiment of accepting reality, just as it is, plays against any response to disasters. For example, some respondents recognized that they knew the risks of living in flood-prone areas and coastal lowlands, “but this is the way we have always lived” (Code 9).

Climate change is the topic of the discussion. Many respondents identified climate change as one leading factor that explained catastrophic events, especially in the case of the flash flood of 2014. Although the tsunami was not associated with climate change, it opened the way to discussion on the risks of living in low-lying coastal lands. We found that climate change had proponents and detractors in these communities. On the side of the proponents, it was identified as the main reason for most of the catastrophic events they had faced over the years, declaring that “climate has changed and has become more extreme over time – rain is heavier and storms are stronger” (Code 6). In consequence, all communities are vulnerable to climate change and EEEs; therefore there is no escape (Code 4). On the other hand, many of the detractors declared that “climate change is a scam” (Code 27); “maybe climate change is not real because the world has been here for long (so climate change is not real)” (Code 21).

Need for a change in how we face catastrophes. We learnt from respondents that there is concern about the need for more (environmental) education to support adaptation processes (Code 7). In spite of the existing sentiment of resignation (and even frustration), respondents declared that they were conscious of the need to change the way in which they face catastrophes (Code 8), for example by changing their inaction or the simple acceptance of risks which leads them to go on as usual (Code 9). Therefore there was recognition of the need to take preventive actions, adapt to changes and be constantly prepared for future catastrophes (Code 13). For example, opinions that discussion should be focused on what would be needed to avoid the negative impacts of future catastrophic events (Code 28) denote awareness or concern about the need to talk about prevention (and adaptation).

There were some respondents who revealed that due to their experience with previous catastrophes, their awareness of them has created growing concern. Therefore, in spite of the negative experience, they recognized the existence of civic benefits to the communities, in terms of learning about the risks and impacts of climate change and EEEs, and also in the form of increased discussion in the community about the adaptation strategies needed to prevent or diminish the negative impacts of future catastrophic events.

Poverty is a determinant of vulnerability to disasters. We found two totally different situations: one in a peri-urban location, the Mataniko riverside settlement; and the other rural, the village in Ranogha Island. The informal settlement on the riverside is explained by economically desperate families who, in spite of the risks, had no other choice than to settle in a flood-prone location (Code 14). The rural community was located on low-lying coastal land, basically because of their dependence on coastal and marine

resources as a food source and because of their traditional customs (Code 23). However, both communities were poor. According to respondents, they were conscious on their state of poverty and also, because they were poor, felt that they had few choices when assessing the risks of their decisions (Code 16, 17, 22).

Dependence on natural resources. We discovered that although poverty forced them to choose either a flood-prone or a lowland coastal area, their primary motivation for choosing a location was the availability of resources to make a living. For example, in the riverside location they found enough land to grow their own food (Code 14), space to build their homes and surrounding land to collect firewood. It was also a strategic location near enough to the city for people to find casual jobs. In the case of the coastal rural community, the respondents stated that their lives have traditionally been focused on land and fishing grounds from which to make a living (Code 23). In both cases, we learnt from respondents' answers that households lived under subsistence, or at best a semi-subsistence regime, i.e. they cropped and fished for their own consumption, and production surpluses were mostly for sharing rather than for trading. Respondents recognised that these locations were risky; however, they were willing to accept the risks because “this is the way they have always lived” (Code 9).

Dependence on the social network. We learnt from respondents that apart from their poverty and the need of food sources near their homes, one crucial factor in the location decision was to find a site large enough to contain not only an individual household, but the whole community. They declared that the chosen location at the riverside was necessary because of the need to live together as a community (Codes 3, 5, 11). In the other study site in Ranogha Islands, the initial decision to move to a safe location was taken by the whole village. Respondents from both study sites agreed in believing that family (Code 3, 11) and community (Code 5, 11) support are necessary and of key importance, especially during and after disasters.

Phase 5 and phase 6: Defining and naming themes and producing the report. At this stage, we present a revised and refined set of themes to describe, according to the respondents' own perception, the factors explaining their response to the catastrophes at household and community level. These revised themes are three in number: the social cooperation system, the role of the government and household net worth.

Social cooperation system. We combined the preliminary themes: (i) “family and community aid and support during and after disasters is of key importance in responding to catastrophes” and, (viii) “dependence on the social network” into “the social cooperation system” or *wantok* system. The *wantok* system appears to be the key factor in explaining the level of adaptation of households when coping with the catastrophic events, and the mitigation response. Since this cooperation network is deeply embedded in the local culture, despite a certain lack of awareness among many respondents of real risks of climate change and EEEs, the *wantok* system is the key for securing long-term adaptation to climate change. The *wantok* system explains the ability of local households and communities to respond to catastrophic events.

Role of the Government. We combined the preliminary themes: (ii) “call for a major role of government in disasters (in prevention and in assistance before and after the catastrophe)”, (iii) “nothing can be done about climate change and natural catastrophes”, “(iv) “climate change is the topic of the discussion” and (v) “need for a change in how we face catastrophes”. The latter was included in this theme because it is not only the local civilian population but also the government that must change how it faces climate change risks and future EEEs, which will inevitably continue to affect the Solomon Islands population.

The government has a crucial role to play in providing education and awareness on the real risks that the population faces.

The fact that we could still find people who are sceptical about climate change risks denotes such a level of misinformation that we can only wonder why the government has not taught them about the real risks; for example, the implementation of simple evacuation protocols could save many lives. On the other hand, everything suggests that the sentiment of resignation and acceptance of the risks of climate change and EEEs is more a sentiment of frustration than lack of awareness. This is reinforced by the belief that nothing can save them, given the lack of hope that the government can do something for them.

According to respondents' opinions, the role played by the government in preventing disasters and assisting the victims displays many shortcomings, and appears to be failing households. Since government has proved ineffective and inopportune in implementing preventive measures and mitigation actions, it seems to be of little help and rather an obstacle to any measure of long-term adaptation and, therefore, to any spontaneous response of households to climate change and the EEEs.

Household net worth. We realized that the main source of households' strength is the source of worth and wealth they obtain from the endowment of assets, through the *wantok* system (as a source of wealth and social security), and from natural assets (their sources of food and sustenance). Preliminary themes (vii) "dependence on natural resources" and (viii) "dependence on the social network" support our proposition that net worth is provided by these assets and not by their cash income, which appears to be insufficient. Furthermore, since most households do not depend entirely on their cash income for a living, measuring poverty in terms of cash income would be incorrect in this less-monetarised economy.

According to respondents' perceptions, the destruction of their homes and their community by catastrophic events was due to their poverty, which forced them to settle on vulnerable sites; furthermore, if they had had a higher income they would have had more chance of responding to the disaster (e.g. see Preliminary Theme: (vi) "Poverty as a determinant of vulnerability to disasters"). However, under the circumstances, they appear to have responded quite well to events.

4.2. Descriptive analysis

The focus of our analysis is a description of some demographic attributes (see Table 5): income distribution, level of income, households' expenditure, income gap between income and expenditure, household assets and net worth.

The rural community presents a lower level of literacy than the peri-urban population (52% versus 70.5%). Since these figures reflect values for household heads, the figures may change at individual level. The male/female ratios (70:30 and 69:31) reflect the fact that 70% of the household representatives were men. The age range also refers to household representatives. Families were less numerous in the rural community, explained basically by one adult per household fewer than in the city.

Table 5
Some population demographics.

Socioeconomic Attribute for household representatives	Site 1: Keigold and Mondo Villages	Site 2: April Ridge and Mataniko Riverside
Literacy	52%	70.5%
Male:female ratio	70:30	69:31
Age range (years)	21–60	31–50
Number of family members (average)	5.8	6.5
Number of adult members per family (average)	2.6	3.7

Income distribution. Monthly income ranged from US\$103 to US\$600 or more per household at the two study sites (see Figure 1). The majority of the households (80%) had an income ranging from US\$125 to US\$490, which is US\$4.2 to US\$16.3 per day per household. Considering the family sizes of 5.8 and 6.5 members, this implies that the per capita income of 80% of the population ranges from US\$0.64 to US\$2.51 per day in the rural village and about US\$0.72 to US\$2.82 in the peri-urban area of Honiara. Thus under the criteria of 1 and 2 dollars per day, most of them are extremely poor or poor. The majority of respondents indicated that their monthly income was not enough to meet even their basic needs, and therefore they had no surplus for either investing or spending on security against risks from catastrophes.

Social assistance was shown to play an important role as an income source, in the form of family loans; thus 36 per cent of borrowings were from family members and about 28 per cent from non-financial institutions (church group, tribe, *wantok*). From the researcher's perspective, we think this has a reciprocal rather than a financial connotation. Since the household's payback capacity is limited, borrowing money means that that family is in debt to the lender and is under the liability to pay back the loan by lending something in turn, assisting, or in some way compensating the lender; hence reciprocal assistance is assured.

We also present the distribution of household expenditure per month (See Fig. 2). This is quite similar to the income distribution, except in the lowest income range, indicating that some households that earn more, spend less indicating a small income surplus; however, since it is the lowest range the amounts involved are minimal. Also, it may be due to unobserved expenditures or charity.

Villagers from the peri-urban location depend basically on casual wages and food gardening. Their choices for cropping, fishing or collecting food from the surrounding natural resources are limited. Among the most important items of households' expenditure in the peri-urban village are food, shelter, utilities, drinking water bills, school fees, transport expenses and charity (mainly church and family donations). Therefore, as declared by respondents, everything indicates that most of their income was spent and no income gap was left for savings or investments, or for adaptation purposes.

Unlike households in the peri-urban location, households in the rural village live under subsistence conditions, basically relying on what they collect, crop, fish or share; they do not depend largely on cash to survive. Therefore, their economy is even less monetarised than in the peri-urban location. However, both the rural and the peri-urban households invest in their social network through communal work, by assisting their tribesmen and families. Through this network based on reciprocity, they assist each other both in making a living and in times of need. Such assistance and social security is often unquantifiable.

In spite of their poverty, households from both locations manage to survive, relying either on home-produced food or food-gathering from the surrounding environment. Even in the peri-urban location, they chose the flood-prone area because of the availability of land for growing their own food.

According to household respondents, the availability of food collected from the surrounding environment and of land on which to grow their own food is even more important as source of livelihood than their precarious cash income. Assessment of the economic value of such assets, which are the source of their sustenance, would be the correct way to estimate their equivalence in income, for example the production factors explaining household self-production of market and non-market goods for consumption, and even some economic surplus for trading. In this case, to estimate correctly the net income they obtain from their natural resources and social capital, the respective non-market val-

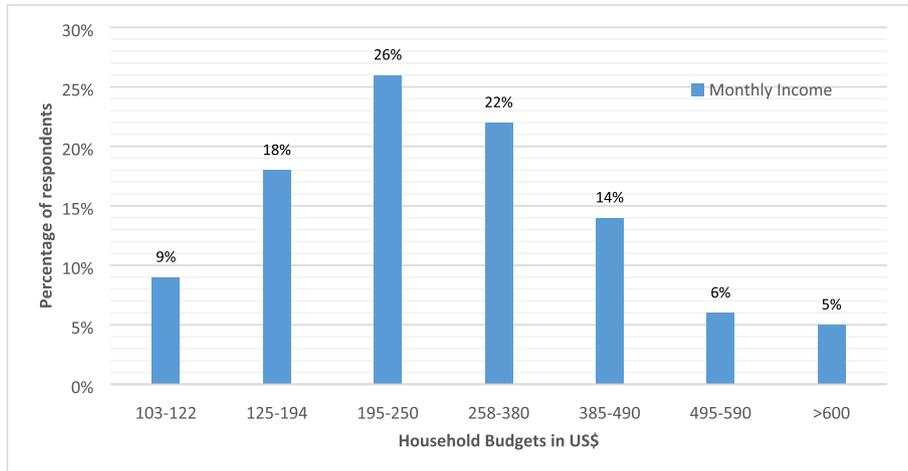


Fig. 1. Average monthly household income.

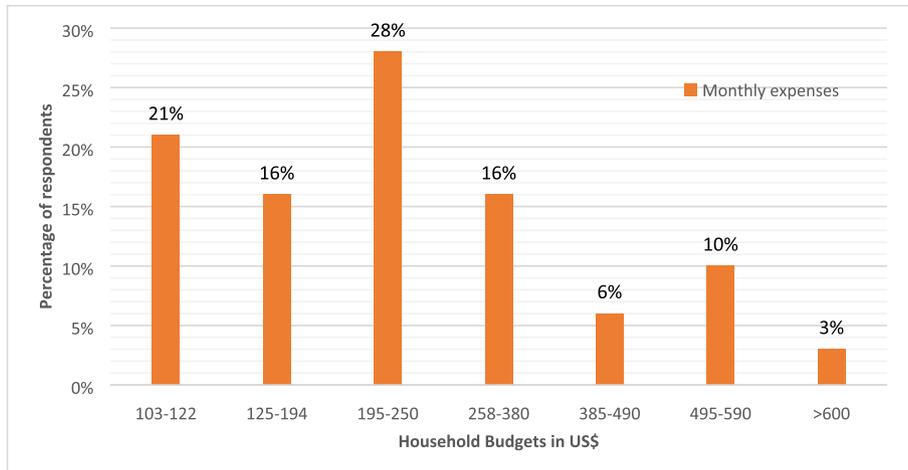


Fig. 2. Average monthly household expenses.

ues must be included. In other words, the estimation of this income must include the value of home-grown food, firewood collected, fish and seafood caught, and also non-pecuniary benefits from the environment and from the social assistance received from relatives and community through the *wantok* system.

5. Farm household model

Borrowing from the literature on farm-household models (Lopez, 1984, 1986) and collective household models (Van Klaveren, Van Praag, & van den Brink, 2008; Vermeulen, 2002), we propose a non-separable farm-household model to explain the situation of households from the study sites, in which decisions on production, labour supply and consumption are interdependent, allowing for differences in preferences between on-farm and off-farm labour as in Lopez (1984). Due to the absence of markets or imperfect access to them, the prices that guide decisions are endogenous to each household (and community) rather than exogenous. Hence, households do not consume own-produced food and market-purchased food indifferently. As in Chiappori (1988), we assume that bargaining within the household results in Pareto efficient decisions.

Following Lopez (1984, 1986) we assume a household trying to maximize utility (*U*) in the level of consumption, which is a monotonically increasing and strictly quasi-concave farm-household's utility function, given by,

$$\max_{C_t^H} \int_{t=0}^{\infty} U(C_t^H; Z) e^{-\lambda t} dt$$

Subject to:

$$p_t^m C_t^m + \gamma C_t^x + \varphi C_t^q \leq \pi(x_t^*, q_t^*, L_t^{f*}) + w_t^o L_t^o + Y_t \quad (\text{Budget constraint})$$

$$T_t - L_t^f - L_t^o - C_t^l \geq 0 \quad (\text{Time constraint})$$

$$L_t^f \geq 0; L_t^o \geq 0; C_t^m \geq 0; C_t^x \geq 0; C_t^q \geq 0; C_t^l \geq 0$$

where household consumption (C_t^H) is a broad set of consumption goods consisting of purchased goods (C_t^m), self-produced market goods (C_t^x), non-market goods (C_t^q) and leisure (C_t^l), and *Z* is the set of household attributes. In the budget constraint, p_t^m is the vector of exogenous market prices, γ is the vector of shadow prices for self-produced market goods, φ is the vector of shadow prices for self-produced non-market goods. Due to limited access to markets, the endogenous price γ differs from market prices p_t^m . In the case of non-market goods, endogenous prices φ are relevant for the household's consumption-production decisions although they do not hold any apparent relevance for the market.

The above formulation implies that households self-purchase their self-production for consumption. On the right-hand side of

the budget constraint, the level of income is endogenous rather than exogenous, since it depends on production decisions at household level, through farm profits $\pi(x_t^*, q_t^*, L_t^{f*})$, which are assumed to be optimal subject to a community-predetermined maximum production quota (per household). The solution is an optimal production level of market x_t^* and non-market goods q_t^* , and optimal allocation of on-farm labour L_t^{f*} . The income from off-farm labour is given by the exogenous net wage (w_t^o) and time allocated to off-farm work (L_t^o). Finally, non-labour net income Y_t includes returns from financial assets and remittances from relatives and *wantoks*, aid from government and NGOs, and pensions.

The level of leisure consumed is given by the total time available (T_t) minus on-farm labour (L_t^f) and off-farm labour (L_t^o). We assume that the wage for on-farm labour is the shadow price of time allocated to on-farm work (w^f) and the wage for off-farm labour is exogenously given (w^o). In the case of the rural community, the off-farm labour may be less important at first glance; however, our model allows for skilled members of working age to participate in the off-farm market, e.g. by moving to the city or industrialized areas, while still remaining part of the community through the *wantok* system, by sharing part of their surplus with the community through remittances. Also, considering the higher transaction costs of moving off-community, we assume that only the better-skilled have the chance to participate in the labour market, leaving the rest of the labour force trapped in on-community labour.

The model can be seen as a very small general-equilibrium model (Taylor & Adelman, 2003). We assume that the maximum level of household self-production is given by the maximum time available for on-farm labour (T_t) (i.e. $L_t^f = T_t$; for simplicity, we do not consider the possibility of hiring labour), and the endowment of production factors such as natural resources (S_t) and capital (K_t) (i.e. land, boats, etc.), so that $x_{max} = x(\bar{T}, S_t, K_t)$ and $q_{max} = q(\bar{T}, S_t, K_t)$. A household production quota implies a pre-established level of catch, hunting or collection (\bar{x}, \bar{q}), presumably set by the community at a lower level than the maximum possible, so that $\bar{x} \leq x_{max}$ and $\bar{q} \leq q_{max}$.

Therefore production decisions are given by the joint maximisation of household profits such that:

$$\pi(x_t^*, q_t^*, L_t^{f*}) = \max_{x_t, q_t} (\gamma \cdot x_t(L_t^f, S_t, K_t) + \varphi \cdot q_t(L_t^f, S_t, K_t) - w_t^f L_t^f),$$

subject to

$$x_t(L_t^f, S_t, K_t) \leq \bar{x} \quad (\text{On - farm production constraint of market goods})$$

$$q_t(L_t^f, S_t, K_t) \leq \bar{q} \quad (\text{On - farm production constraint of non - market goods})$$

$$L_t^f \leq T_t; x_t \geq 0; q_t \geq 0$$

The model allows for households to obtain market surpluses (MS_t) when self-production is larger than self-consumption of certain market goods, so that $MS_t = p_t^m(x_t^* - C_t^x) > 0$; otherwise, $MS_t \leq 0$. If $x_t^* = C_t^x$, which determines a subsistence regime ($MS_t = 0$) or $x_t^* \leq C_t^x$, hence $C_t^m = (x_t^* - C_t^x) \geq 0$.

Given the community-predetermined constraints, the production-consumption solution (x_t^*, q_t^*, C_t^{H*}) is (recursively) consistent with a maximum level of community welfare.

It may be noted that vector (x_t^*, q_t^*, C_t^{H*}) allows the inclusion of production-consumption decisions on a set of palliative and adaptation goods against impacts from climate change and EEEs.

Therefore the responses to EEEs and climate change can be analysed as the subset of optimal vector (x_t^*, q_t^*, C_t^{H*}), allocated either as adaptation to or palliative against EEEs. Moreover, this optimal set is subject to endowment of natural resources (S_t), capital (K_t), on-farm labour (L_t^f) and other assets (social capital). The latter could be easily reformulated in order to include assistance from other households that could increase the optimal production level of (x_t^*, q_t^*). Therefore the negative impacts of EEEs and climate change can compromise the level of households' utility, but the better protected these assets' endowments are, the more resilient households are to the impacts of EEEs and climate change.

Equity in access to income and environmental goods is required to sustain the proposed collective household model to both households and communities. Our proposed conceptual model assumes the existence of social capital as an essential condition for cooperation among households in the community. Social capital is a valuable public good that assists communities in achieving better levels of shared well-being (Adler & Kwon, 2002; Aldrich, 2012; Lin, 1999; Seibert, Kraimer, & Liden, 2001), and provides an opportunity to adopt collective action. This social capital has dimensions of economic and cultural capital led by reciprocity, trust and cooperation (Nowak, 2006).

The conceptualization led by the farm-household model is consistent with our findings led by thematic analysis. The respondents recognize economic value in their available assets (their natural resources and social capital); however, when asked, they attributed value basically to home devices, house properties, farm produce, tools, livestock and farm animals such as pigs and poultry, i.e. private belongings whose market value is easy to interpret. For example, they interpreted farm produce as valuable, but did not recognise the value of land (as the source of value). Thus correct estimation of land value would allow us to make a correct estimation of land rent. This estimation must also include the liabilities attached to each asset. Despite the difficulty of estimating monetary value, we present here the distribution of the economic value of household net worth as perceived by respondents, in which about 51% of households perceived their net worth to be in the range of US\$1950–US\$3800, while 25% of the estimates were in the range US\$3820–US\$5800 per household, in present terms value (see Fig. 3). Only 4% perceived the value of their property at US\$13,000 or more in terms of household assets.

6. Discussion and conclusions

We have described the household and community factors related to their responses to catastrophic events: a flash flood and a tsunami. In both cases, the villages were destroyed and casualties occurred, and the response consisted in moving the village to a safe place. At first glance, it would appear that both situations could have been prevented (Why not move the village before the catastrophe?). We have attempted to disentangle the factors that led to these catastrophes, and also to understand the people's response decisions and how they can be described as adaptation actions against EEEs.

The answers to the first research question on which are the main themes related to the adaptation responses of the households and the community are proposed in Phases 3 and 4 of our thematic analysis, summarised in Table 4. Government inaction to prevent the catastrophes (Preliminary Theme ii) appears to be one determinant, however the inaction of households and communities, even when they are aware of the nature of risks (Preliminary Theme iii), is also important and arises from a feeling of resignation and acceptance of potential risks, especially from EEEs. Lack of information, inadequate education, extreme poverty and desperation,

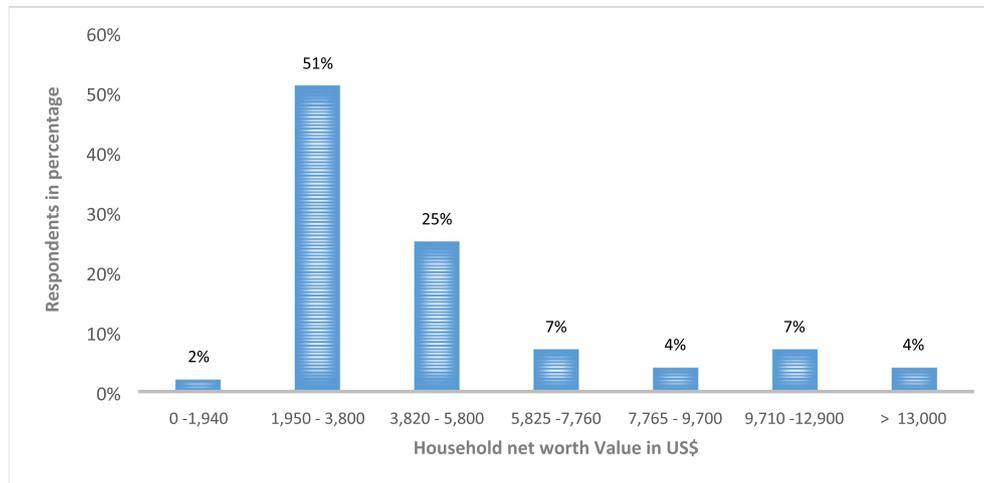


Fig. 3. Household total net worth assets.

including unawareness of or scepticism about the risks of climate change; appear to be strong explanations of the failure to take preventive action. The other preliminary themes appear to explain possible solutions (mitigation) rather than the problem itself (lack of preventive action or adaptation).

The answer to the second research question, i.e. analysis of the response to the catastrophe and how this response can be described as adaptation against catastrophes, is basically given in the definitive themes where the focus was on discussing what would be needed for a good adaptation response to such catastrophes. From the research we identified three themes as crucial for adaptation: the social cooperation system (*wantok* system) in the community, the role of the government and the household net worth. According to Nicholson (2004), the *wantok* system could be grounded as a political and socio-economic fabric of Melanesian society. This social cooperation system appears to be the key factor for adaptation, since social security and the opportuneness of assistance after the catastrophe are already inherent in the local *wantok* system, which must therefore be instrumental in implementing prevention and resilience-building programmes. The need for a change in how communities face catastrophes can be also channelled through the *wantok* system in the form of education on environmental risks and risk management training.

As perceived by respondents, changes in the role played by the government in risk prevention and management are also a necessary condition for ensuring adequate adaptation to EEEs. Specific institution-building to address adaptation issues and channel international aid must be carried out by the government in order to make progress in addressing “the need for a change in how communities face catastrophes”.

The use of household net worth as a measure of households' ability to respond to disasters considers not only cash income but also other sources of marketable and non-marketable assets available to households in the form of natural resources and social capital. Although these are not easy to measure in monetary terms, they can provide a more realistic vision of response capacity than the level of cash income. Dependence on natural resources and the *wantok* system for life in the community appears to offer advantages rather than disadvantages for better adaptation responses.

How households from these indigenous communities, living below the poverty or extreme poverty line, can show an adequate response to EEEs despite their circumstances, can be understood under the perspective of a traditional farm-household model that considers the production and consumption decisions of households

living under subsistence and semi-subsistence regimes in conjunction. Both the thematic analysis and the economic theory analysis are consistent with an increase in the level of household wealth as the endowment of natural and social capital increases. Since income level is apparently not a good measure of the wealth of these households, it appears that considering the household net worth would be the correct measure of wealth for this situation. This basic principle could be used to study the level of vulnerability and also the potential adaptation capacity of indigenous communities that live under subsistence and semi-subsistence regimes in the Pacific Islands.

Finally, the adaptation responses observed in both case studies appear to be adequate, especially under their precarious circumstances (of poverty). The response by the rural community was a self-initiative led by the village chief, a community self-response that occurred in spite of government inaction or inefficiency in delivering aid opportunely. However, after the decision was taken they received support for the move from the government and aid-agencies. We think this is a genuine self-initiative for long-term adaptation. On the other hand, the response initiative to the flash flood of 2014 came from the government, which offered to move the victims from the flood-prone area to a safe location. The community was also part of the decision process, and no disadvantages were seen at the time the decision was taken. However, by the time of our study, households were complaining about the lack of assistance and aid from the government in terms of financial support, e.g. construction materials to rebuild their homes or help in covering the expenses involved in the move. In spite these difficulties, they did move to the safe location, but once they were in April Ridge land ownership problems arose, and at the date of our fieldwork the government had not been able to solve the problem, creating uncertainty about the feasibility of the solution offered. The respondents expressed insecurity and frustration in view of the government's unmet promises and bureaucracy. In the researchers' view, this was a well-intended and potentially long-term government-led initiative that was jeopardized by the lack of appropriate implementation. Another aspect is that nothing is being said about preventing new households from settling in the flood-prone area along the riverside. It will only be considered a genuine long-term initiative after the pending issues have been addressed and aid is properly delivered.

7. Policy implications

The findings of the study point to four recommendations:

- (i) Firstly, it would be cheaper for the government to focus on disaster prevention rather than mitigation, especially when its financial and administrative inability to respond to disasters in time and with sufficient resources has been shown; and also in the realisation that the destruction of the community by the flash flood at least could have been prevented by controlling illegal settlement on the flood-prone areas.
- (ii) Secondly, the research findings suggest that communities and authorities should consider opportunities for increasing the value of household net worth as a strategy for resilience-building. It may be noted that to achieve this, it is essential to consider the sustainable management of local natural resources (natural assets) in order to secure food sources.
- (iii) The government should create the conditions to enable communities and local governments to organize themselves and respond with self-initiatives for adaptation measures, custom-made for the specific local contexts, rather than focusing on centrally-planned mitigation.
- (iv) Further investigation into the cooperation mechanisms of the traditional *wantok* system can be used to build long-term adaptation among communities.

Declaration of Competing Interest

None.

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