Climate extremes constrain agency and long-term health: A qualitative case study in a Pacific Small Island Developing State

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ABSTRACT

Vanuatu, a Pacific Small Island Developing State, has high exposure to climate extremes, such as tropical cyclones and interannual rainfall variability, which can have devastating short- and long-term impacts on food and nutrition security (FNS). This paper presents local experiences of the effects of climate extremes on FNS in Vanuatu through a case study of two recent events: Tropical Cyclone Pam (2015) and an El Niño-induced drought (2015–2017). A qualitative research approach, using a range of data collection methods, was used to document people’s lived experiences in two villages in Vanuatu. This study found that climate extremes affected the FNS of people in the two study villages directly, with effects on gardens and food production, and indirectly, by exacerbating the nutrition transition, a shift away from traditional diets energy-dense imported food that is already progressing in Vanuatu. These effects undermine long-term FNS and health. Climate extremes also eroded food-related cultural practices and traditions and constrained local agency to make food choices. The magnitude and extent of these impacts, however, are influenced by structural vulnerabilities and local resiliencies. The adaptive capacity and resilience of communities needs to be strengthened in a way that allows people to exercise agency in their responses to climate extremes and to promote FNS, including cultural acceptability and food preferences, and long-term health.

1. Introduction

Vanuatu, a Pacific Small Island Developing State (SIDS), has high exposure to natural hazards, including extreme weather and climate events (‘climate extremes’), such as tropical cyclones and drought. Vanuatu has been ranked as the most vulnerable nation globally to natural hazards (Day et al., 2019). Similar to many SIDS, it is also particularly vulnerable to the adverse effects of climate change, including increased intensity, frequency, and duration of climate extremes (Vanuatu Meteorology and Geo-hazards Department (VMGD) et al., 2015). When a vulnerable socio-ecological system interacts with climate extremes, it can have devastating short- and long-term impacts on food and nutrition security (FNS) and diet-related health outcomes. This paper explores the effects of climate change on FNS in Vanuatu through a case study of the lived experiences of two recent climate extremes: Tropical Cyclone (TC) Pam (2015) and an El Niño-induced drought (2015–2017).

Food security is defined as “a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”; and comprises four dimensions: food availability; access; utilisation; and the stability of these over time (FAO 2019 p.186). Nutrition security is implicitly encompassed in all four dimensions. It includes cultural and social acceptability of food, hygiene, food and water safety, sanitation, food and nutrition literacy, and dietary diversity and quality (Hwalla et al., 2016; Noack and Pouw 2015; Slater and Yeudall 2015).

Climate change is one of many factors that influence FNS, and a significant body of literature describes the effects of climate change on food production and access, and projected increases in undernutrition under various climate change scenarios (Costello 2009; Myers et al., 2019; Porter et al., 2014; WHO 2019). Climate change is projected to decrease global and localised food production and access through its impact on agriculture, fisheries, and livestock, leading to reduced yields, nutrient content, and increased price volatility (Myers et al., 2019; Porter et al., 2014). Increasingly, the impacts of climate change on all
forms of malnutrition, including overweight and obesity and diet-related non-communicable diseases (DR-NCDs), are being explored (Frumkin and Haines 2019; Savage et al., 2020a; Springer and Elliott 2019; Swinburn et al., 2019). In the Pacific region, a review found that potential pathways for climate to undermine FNS and drive DR-NCDs include impacts on agriculture, impaired fisheries, climate-induced migration, particularly urbanisation; and ‘unhealthy’ food aid provided following climate extremes (Savage et al., 2020a).

Climate extremes, particularly back-to-back events with little recovery time, can undermine communities’ resilience and adaptive capacities to respond to future climate extremes and long-term climate change (Ebi and Bowen 2016). Climate change resilience is a complex and contested concept (Bahadur et al., 2013; Matin et al., 2018; Ols0son et al., 2014); however, in this paper, the definition of the Intergovernmental Panel on Climate Change (IPCC) is used: “the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain a widespread conversion to Christianity, changing and declining existing vulnerability as a product of the socio-ecological system and the consequences of adaptation, learning and transformation” (IPCC 2014 p.1772). Adaptive capacity, linked to resilience, can be defined 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” (IPCC 2014 p.1758).

These simple definitions overlook some of the complexities of resilience and adaptive capacity, including social aspects such as power and agency, and do not emphasise the importance of structural vulnerability. The magnitude of the impacts of climate extremes also depends on existing vulnerability as a product of the socio-ecological system and the relative power of individuals, communities, and nations to access resources and exercise agency to make optimal choices for their wellbeing (Ensor 2016; Matin et al., 2018). In the context of FNS, climate extremes often exacerbate existing drivers of food and nutrition insecurity and further entrench existing power differentials and inequities (Jackson et al., 2019; Savage et al., 2020b). In exploring resilience, adaptive capacity, and vulnerability, it is critical to consider the socio-ecological context and the power and agency of various actors within the system.

1.1. Context: Vanuatu

Vanuatu, a Least Developed Country (LDC), is an archipelago of over 80 islands - 65 of which are inhabited - and has a population of approximately 270,000 people (Fig. 1) (GoV 2017a; OECD 2020). Subsistence farming remains a critical livelihood in Vanuatu. An estimated 75% of ni-Vanuatu (meaning ‘of Vanuatu’ refers to the peoples of Vanuatu) reside in rural areas (which includes peri-urban areas) and approximately 90% of all households, and 97% of rural households, engage in crop production (GoV 2017a).

The significance of local food production is evident in the work of Calandra (2019), who found that in Vanuatu, the concept and meaning of ‘disasta’ (directly translated to ‘disaster’) are related to the extent of damage to gardens; with the means of food production being the “principal frame of reference” used to define the occurrence of such an event (Calandra 2019 p.6).

In recent decades Vanuatu has experienced a range of social changes, many stemming from colonisation, which drive the underlying vulnerability of FNS to the impacts of climate extremes. These changes include a widespread conversion to Christianity, changing and declining kustom, increased settlement of coastal areas, population growth, urbanisation, and increasing participation in the cash economy (GoV 2017a; Komugabe-Dixson et al., 2019; MacClancy 1981; Trundle et al., 2019). Similar to other SIDS, these social trends have been driving the nutrition transition in Vanuatu, a shift away from traditional, locally grown foods to a diet high in energy-dense, nutrient-poor imported foods (Charlton et al., 2016; James 2016; Martyn et al., 2015; Savage et al., 2020b).

Locally grown produce, especially in urban areas, is increasingly replaced by a limited array of imported foods such as rice, bread, instant noodles, and tinned fish and meat (James 2016; Martyn et al., 2015; James et al., 2016; Martyn et al., 2015; Savage et al., 2020b). This change in Vanuatu’s diet has been associated with increased DR-NCD risk (Nurse et al., 2014 p.1616). Vanuatu is particularly exposed to climate extremes such as tropical cyclones, droughts, and floods (Lafale et al., 2018; Day et al., 2019; VMGD et al., 2015). The season for tropical cyclones in Vanuatu is November to April with an average of 24 cyclones per decade since 1969/1970, and 41% of the 71 cyclones from

Fig. 1. Map of Vanuatu source: CartoGIS, the Australian National University.

Pacific SIDS have been managing the effects of climate extremes on FNS throughout history and have established a range of traditional strategies such as seasonal calendars for gardens, nature-based early warning systems, food preservation and storage, food sharing and trading, coastal management practices, amongst others (Campbell 1990; Jackson 2017; Savage et al., 2020c). However, traditional knowledge changes, adapts, and is eroded by modernisation, there is uncertainty regarding its limits in the face of the accelerating magnitude of climate and cultural changes (Davies 2015; Granderson 2017; Komugabe-Dixson et al., 2019; Nunn et al., 2014; Savage et al., 2020c).

1.2. Vanuatu: climate change and climate extremes

The IPCC reports, with high confidence, that “current and future climate-related drivers of risk for small islands during the 21st century include sea level rise (SLR), tropical and extratropical cyclones, increasing air and sea surface temperatures, and changing rainfall patterns” (Nurse et al., 2014 p.1616). Vanuatu is particularly exposed to climate extremes such as tropical cyclones, droughts, and floods (Lafale et al., 2018; Day et al., 2019; VMGD et al., 2015). The season for tropical cyclones in Vanuatu is November to April with an average of 24 cyclones per decade since 1969/1970, and 41% of the 71 cyclones from
1981/1982 to 2010/11 were severe (Category 3 or stronger) (Australian Bureau of Meteorology (BOM) and CSIRO 2014). Vanuatu has experienced two Category 5 cyclones, the highest intensity on the scale, in the last five years (World Meteorological Organization 2015; Government of Vanuatu (GoV) 2020). Studies report that globally, the maximum wind speed and precipitation rate of tropical cyclones is projected to increase, and tropical cyclones’ frequency is projected to decrease or remain unchanged (low confidence) (IPCC 2018; Wong 2014). In Vanuatu, the number, and temperature, of extremely hot days is expected to increase (very high confidence) (BOM and CSIRO, 2014). Annual rainfall, and the frequency and duration of drought events, are projected to remain mostly unchanged (low confidence) (BOM and CSIRO, 2014). The El Niño Southern-Oscillation (ENSO) has a significant effect on the inter-annual weather variability in Vanuatu, and there is high confidence that ENSO-driven events will continue to occur in the future (BOM and CSIRO 2014). Some more recent research suggests that climate change will result in an increased frequency of extreme ENSO-driven events - related to drought conditions in the South Western Pacific; however, the confidence of these projects is uncertain (Cai et al., 2014, 2017).

The IPCC states that “a changing climate leads to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events, and can result in unprecedented extreme weather and climate events” (IPCC 2012 p.7). A critical issue for Vanuatu is the occurrence of back-to-back climate extremes and their interaction with existing vulnerability, which often impedes recovery and further increases vulnerability (Ebi and Bowen 2016). Cumulative impacts of extreme events contribute to climate change vulnerability and undermine adaptive capacity; and vice versa, the effects of climate change will influence the ability to face climate extremes (Ebi and Bowen 2016; IPCC 2012).

1.3. Tropical Cyclone Pam and the 2015–2017 El Niño drought

TC Pam struck Vanuatu with wind speeds of approximately 250 km/h and peak speeds of 320 km/h, causing widespread damage to agriculture, infrastructure, and livelihoods (GoV 2015). Twenty-two of the country’s islands were in the cyclone’s path, including Efate, where the cyclone’s western eyewall travelled over the island (GoV 2015). Eleven fatalities were recorded, around 15,000 buildings were damaged or destroyed, approximately 65,000 people were displaced, and an estimated 195,000 people experienced impaired livelihoods (GoV 2015). Up to 96% of crops were destroyed in some areas, resulting in significant increases in local food prices, and around 50% of agricultural households lost all or part of their produce (GoV 2015; James 2016; SPC 2016). It is reported that 3 174 metric tons of food aid was distributed to the four provinces most severely affected (SPC 2016). Loss and damage of the cyclone was estimated at VTS48.6 billion (US$449.4 million), approximately 64.1% of the country’s GDP (GoV 2015). In 2017 the Vanuatu government stated that “the scale of the damage means that the country is still recovering from the effects two years later” (GoV 2017b).

Following TC Pam, a severe El Niño event commenced across the Pacific Ocean, placing further pressure on a country in recovery (BOM 2016; Thomalla and Boyland 2017). This El Niño event was reported as “one of the three strongest El Niño events since 1950” (BOM 2016), and it is categorised as ‘very strong’, the highest-ranking of the US National Oceanic and Atmospheric Administration (National Oceanic and Atmospheric Administration 2020). On several islands, including Efate, the drought significantly hampered cyclone recovery. People experienced water shortages and food crop failure (after large-scale destruction of crops by TC Pam), leading to food and nutrition insecurity and malnutrition (UNOCHA 2015). While the impacts of climate extremes on food availability are well documented, the experiences and consequences of food and nutrition insecurity at the village and household level are less understood.

This study investigates the experiences of climate change on FNS through a case study of these two climate extremes in two settings in Vanuatu: a peri-urban and a remote village. We aimed to explore the question: How are the effects of climate extremes on FNS experienced at the community level? We investigate the direct impacts of climate extremes experienced in each village, the coping and adaptation strategies adopted, and differences in the two geographical settings’ experiences. Potential implications for short- and long-term FNS and related health outcomes of increased frequency, duration, and intensity of climate extremes with accelerated climate change are also presented. The results of this study are aimed at development practitioners, climate change adaptation and health professionals, and policy- and decision-makers, both in Vanuatu and the wider Pacific region.

2. Methods

2.1. Study sites

Data was collected in two communities in Vanuatu: Village A, a peri-urban village with a population of 5,211, located on the outskirts of the country’s capital, Port Vila; and Village B, a remote village with a population of 136, located on the West Coast of Espiritu Santo (Fig. 1). These two villages were selected to facilitate an urban-remote comparison and further explore the interaction between different social trends and vulnerabilities and the impacts of climate extremes. Table 1 describes the characteristics of these two villages. TC Pam severely impacted only Village A, and both islands experienced the 2015–2017 El-Niño-induced drought.

2.2. Study design and data collection

This study is part of an ethnographic, qualitative research project

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Table 1

| Summary of study sites (Savage, Bambrick, et al., 2020b). |
|------------------------------------------------------------|
| **Village A** | **Village B** |
|---------------|---------------|
| **Island** | Efate | Espiritu Santo |
| **Village type** | Peri-urban | Remote |
| **Population** | 5211 people | 136 people |
| **Closest city** | Port Vila, capital city | Luganville |
| **Access to city** | Port Vila centre: 20–30 min drive | Luganville: 3–4 h truck ride on unpaved roads; and 2–4 h boat trip |
| **Regular local buses** | | Private chartered transport |
| **Cost: USD1.30 each way** | | Cost: approximately USD165.00 each way |
| **Electricity access** | Municipal electricity | No electricity supply |
| **Water supply** | Municipal water supply | Small solar lights |
| **Main source of household income** | Wages/salary | One solar inverter |
| **Main cooking method** | Gas stove | Open fire inside a hut (kitchen)/outside near the house |
| **Food storage** | Very few refrigerators – can rent space in a refrigerator/freezer | Traditional storage e.g. yam beds |
| **Preservation** | Dry storage – no preservation | Harvest as needed |

1 Defined by the IPCC (2012 p.116) as “The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. For simplicity, both extreme weather events and extreme climate events are referred to collectively as ‘climate extremes’”.

2 Kastom can be described as ni-Vanuatu ways of life that originate from the period before European contact (Davies 2015; and MacClancy 1981; Regenvanu & Vanuatu Cultural Centre 2005); however, this definitions does not capture the depth and nuance of kastom, an exploration of which is beyond the scope of this paper.
investigating climate change impacts on FNS and diet-related NCDs in Vanuatu. Study design prioritised the collection of rich data to present the lived experiences of participants. Various data collection methods were employed (Fig. 2), including field observations, storian, and group workshops, and data was collected by the lead author with the support of local field assistants.

Field notes were recorded daily during residential and day visits, and observations included conversations, observed practices, interactions, and personal reflections; particularly those related to food and nutrition; climate and weather; and local institutions, structure, and culture. Storian were informal, one-on-one (or with the presence of a field assistant) conversations of 45–90 min informed by the life history approach (Besel et al., 2017). Storian were conducted orally with handwritten notes, a format promoting a comfortable atmosphere aligned with the local cultural practice of storytelling. Group workshops, based on the Climate Change & Food Security Vulnerability Assessment (Ulrichs et al., 2015), of two to 6 h each, were conducted in both villages and researcher notes, and group outputs were produced. Workshops included: a transect walk; village map; historical timeline; wellbeing ranking; livelihoods strategies and seasonal calendar; climate risk ranking and coping mechanisms matrix; food systems diagram; and institutional mapping.

In Village A, one-on-one storian were readily accepted and found to be more effective than group workshops; and a shorter residential experience was appropriate. In Village B, however, there was a high engagement in group workshops, but people were more hesitant to participate in storian, which were viewed as formal ‘interviews’. An extended residential experience was necessary for Village B because of the remote location. Consequently, greater workshop and field observation data was collected in Village B, and more storian were conducted in Village A. Bislama was the primary language used for data collection. The first author is proficient in Bislama, and local research assistants supported group facilitation in both villages and Indigenous language interpretation in Village B.

Ethics approvals were obtained from the University of Queensland (2017001510) and Queensland University of Technology (1900000071) Human Research Ethics Committees. Individual written consent was obtained for each storian and group workshop participant. The village chief of both villages, and the elders of Village B, provided written consent for observational data collection.

2.3. Data analysis

Reflexive thematic analysis was employed, beginning with data familiarisation and inductive coding, followed by the development of themes (Braun and Clarke 2006; Saldanha 2016). Theme development was consistently discussed between DG and AS with reflexive interrogation of individual frames of reference and co-creation of themes. Final themes were agreed upon by all authors. Participants’ voices are highlighted throughout the paper through the use of quotations. Participants remained anonymous, and quotations are referenced as follows: storian, ‘S’ and a unique number; field observations, ‘FO’; and workshops, ‘WS’ and a number.

3. Results

The most apparent impact of climate extremes on FNS was the physical stresses on gardens and the coping and adaptation strategies employed by villagers in response to these effects. Climate extremes also affected FNS by constraining agency to make food choices, eroding cultural practices and traditional knowledge, and exacerbating the very structural vulnerabilities that undermine the ability to cope with climate extremes, adapt to climate change, and manage food and nutrition insecurity. A discussion of these four themes follows below.

3.1. Loss of food production

Local agriculture, commonly termed “gardens”, is central to ways of life in Vanuatu, even in Village A, where a decline in subsistence gardening due to a range of socioeconomic shifts was described. The
effects of climate extremes on gardens and food availability was the primary impact identified by villagers.

In Village A, damage to gardens by TC Pam was almost universal. “Pam destroyed everything” (S11). Several months after TC Pam, the El Niño-induced drought began, rendering garden recovery difficult. Additionally, new and unfamiliar pest infestations in crops manifested following the cyclone. Villagers explained that:

“... it was hard because nothing would grow — you would plant, but then everything just died” (S4).

Following these extremes, villagers experienced yield reductions, lower-quality produce, loss of particular crops, and long crop recovery periods. Fruit trees were destroyed, such as mangoes and breadfruit, resulting in reduced availability that continued three and a half years after the cyclone. Traditional resilience strategies, such as food preservation, were not mentioned.

In contrast, Village B was not significantly affected by TC Pam; however, the ensuing drought had devastating effects. One community elder emphasised that “when there is no drought or cyclone, the food here is good” (FO). The extended dry period, from 2015 to 2017, was frequently linked to stories of food shortage and hardship. Villagers described the significant loss of staple crops, particularly water taro and yam, during this period.

“In 2016, there was a disaster from the sun, and all the yam died in the ground. We lost all yam and water taro gardens” (S21).

The drought was the first instance in many people’s living memory of not having sufficient food. To emphasise the severity of the event, a village elder explained that “people nearly died” (FO). During the two years of the drought, villagers could not grow an adequate quantity of food in Village B and reduced yields, smaller produce, and difficulties in growing some produce continued after recovery.

3.1.1. Coping strategies

The main coping strategies in Village A were food aid and increased food purchases — predominantly imported food. Villagers described relying on food aid and store-bought food for three to six months until crops began growing again. Food aid packages consisted mainly of white rice, tinned fish and meat, breakfast crackers (plain white flour biscuits), sugar, flour, and 2-min noodles. Seeds were also supplied, and for some people, this provided fresh produce early in the recovery period. Overall, food aid was viewed by villagers as a welcome safety net; however, the absence of local food in the market was often mentioned. During cyclone recovery, locally grown food was generally only available if saved from before the cyclone or collected from destroyed gardens.

Following TC Pam and during the drought, villagers increased their food purchases, particularly a small number of imported products: rice, bread, breakfast crackers, and tinned fish and meat. Before the extreme events, many people in Village A derived part, or all, of their income from selling produce. The combination of reduced income and increased food purchases was financially difficult for many villagers.

“We ate more rice at this time than things from the garden. It was hard to buy so much rice” (S4).

The cost of local food in the markets in Port Vila increased dramatically after TC Pam. It remained high for several years, significantly affecting access to local food in Village A. The diet during the recovery period comprised primarily of imported food products, prices of which remained stable and low. Many villagers were unable to afford fresh fruit and vegetables.

“It [local produce] was very, very expensive. But we could buy rice because it was cheaper” (S6).

Many participants said that local food prices remained well above pre-cyclone prices four years after the cyclone; however, others stated they had regularised. This difference is likely explained by varying capacities to absorb even small price increases. Prohibitive local produce prices significantly reduced dietary diversity and quality, at least in the short-term, as cheaper, energy-dense nutrient-poor store-bought foods replaced local produce. Many, but not all, participants reported returning to a diet of increasing proportions of local food as gardens recovered.

Although most villagers described difficulties in food production as a result of the cyclone and drought, there were varying experiences. Villagers discussed the use of the seeds provided in the food aid package, increased papaya fruit yields following the cyclone, shaded crops continued to grow well, and shorter recovery times. These differential experiences appeared to result in varying capacities to pay for water for irrigation during the drought, differing reliance on gardens for food and livelihoods, and varied land access.

Some villagers coped with the loss of gardens by increasing fishing and drawing on social safety nets, such as food sharing; however, despite specific questioning, these were rare. In one workshop, participants described community members helping each other re-build houses after the cyclone but explained for FNS that it was “food from the store only” (FO). It is likely that changes in the social and familial organization in urban areas, such as larger, less-tightknit villages, along with food aid and access to store-bought food have rendered traditional social safety nets less crucial in Village A.

Village B, however, did not receive food aid, and few people were able to purchase food. Villagers lived a subsistence way of life and coped with reduced food production by consuming less food and significantly reduced diet diversity. Wild foods, such as wild yam and Fijian taro, were also a coping strategy during the drought; however, these crops were located “in the bush,” a considerable distance from the village. The importance of physical proximity of food to the village appeared to be multi-layered: as a concern for vulnerable populations, such as the elderly; as problematic in a changing socio-economic context with increasing demands on, and thus the value of, people’s time; and as representing a certain social status. At the peak of the drought, lasting four to seven months, villagers could eat only one or two types of crops, such as bananas or manioc (cassava).

“The whole village only ate manioc for about four months. Some of this was planted, but much was just growing wild” (S23).

“I ate bananas only. I didn’t buy any food because I don’t have any money” (S22).

Some families with access to a small amount of money increased their consumption of rice during the drought:

“Our family only started eating rice ... because of food shortages due to the El Niño drought... Now we like the taste of the rice and eat it a little” (S24).

Social safety nets, particularly sharing within family groups, were commonly mentioned in Village B. Sharing within familial groups was customary; however, intra-village sharing was also commonplace.

“My brother, who lives higher up in the bush where there is a small water source, had good bananas so he would bring some for us to eat” (S26).

While most participants described hardship experiences related to the drought, one young villager (24 years) described not experiencing any effects. This may be due to specific characteristics of individual resilience, or because of their relatively young age, their perception of the ‘status quo’ may differ from older generations.

3.1.2. Adaptation

Many gardens in Village A did not begin to ‘kam gud’ (come good) until two to three years after TC Pam, rendering some coping mechanisms ‘normal’ ways of life. Food aid after TCs Pam, Christophe in 1959
and Uma in 1987, contributed to long-term changes to diets, as food preferences and habits began to change:

“We lived just off the rations [after Pam] which was a different diet but even after the rations finished, we then paid for more rice afterwards ... now more rice is eaten” (S12).

“After Cyclone Uma, we ate more store-bought food than before the cyclone – even after the recovery period finished. This is because we tried to plant the gardens again but, although things did grow well again, it takes years after a cyclone to recover” (S9).

With more frequent climate extremes, coupled with the increased availability and access to store-bought foods, villagers described ceasing to cultivate certain crops, such as yams, and decreased motivation to continue tending gardens:

“Now, after Cyclone Pam, we no longer make gardens because it’s too hard” (S18).

In Village B, villagers described long crop recovery times, such as yam yields not returning to pre-drought levels for 1–2 years, and continued difficulties in growing certain crops. Although food aid was not a coping strategy for the case study in Village B, several villagers recalled earlier experiences of a food package similar to that provided in the TC Pam response. Food aid appeared to have contributed to a more regular presence of rice in the diet, even after just one exposure:

“The first time I ever tasted rice was after Cyclone Nigel in 1985 as it was given as food assistance. After this, we bought rice every now and again – mostly because we like it” (S27).

In Village B, villagers adapted to the impacts of the drought, trends of longer dry seasons, the drying up of water sources, and population pressures by relocating gardens higher up the mountains (see Fig. 3). This land had a better climate for crops and improved access to water; however, it was considerable walking distance from the village through steep terrain. This change in gardening practices was mentioned regularly by villagers because it was recent and had a significant impact on everyday life. The change was perceived negatively due to the increased time and energy needed to reach the gardens and the difficulties for some populations, like the elderly. Due to the relocation, and other social changes, villagers were tending to gardens less frequently and beginning to alter other traditional practices, such as re-using land in closer proximity, thereby reducing fallow periods. Nevertheless, produce yields and quality improved with this adaptation, and the gardens were more protected from climate extremes contributing to FNS resilience.

Several other adaptation strategies were implemented following the drought, including crop spacing, crop diversification, and planting of ‘sun-resistant’ crops, such as manioc and dryland taro. The existing diversity of crops grown in the gardens seemed to be a protective factor during the drought.

3.2. Erosion of cultural practices and traditional knowledge

FNS is inextricably linked to culture and tradition, and food is an integral component of cultural celebrations and social cohesion. People in both villages lamented the loss of traditions arising from changing ways of life, which were exacerbated by climate extremes. For example, climate extremes altered the availability of particular foods used for celebrations and ceremonies. The losses of many varieties of yam, culturally-important produce, following TC Pam were described in Village A. Yams were destroyed in the cyclone and were too expensive to replant. It appeared that trading and kin networks were no longer able to provide rhizomes for replanting, as participants discussed the prohibitively high cost of purchasing new roots. Furthermore, the threat of future climate extremes was described as a deterrent to investing the significant time and labour required for yam gardens. Villagers also discussed difficulties in the preparation of traditional dishes such as laplap (grated root vegetables wrapped in a specific leaf and baked in a stone oven: see Fig. 4), and nalot (roasted breadfruit pounded into a gelatinous mass, covered with coconut milk and eaten communally), due to loss of key ingredients, laplap leaf and breadfruit, after TC Pam and the El Niño event.

Most people in both villages preferred island food and displayed a sense of pride in local dishes. Climate extremes exacerbate ongoing social changes and, in Village A, women described the loss of traditional knowledge as methods were no longer passed down to their daughters. In discussions, the loss of traditional knowledge encompassed the erosion of social aspects of food preparation: spending hours together preparing the hot stones, grating manioc, ‘scratching’ coconuts for milk, gathering banana and laplap leaves, and finally, sharing food from the communal ‘plate’; all while talking, laughing and sharing stories. These social practices are waning as traditional, slower cooking methods become less routine, and as necessary produce becomes less available.

Land and gardens are also deeply rooted in Vanuatu culture and ways...

Fig. 3. (L-R) Gardens relocated to higher ground in Village B; Village B set in front of mountainous terrain.
of life, and, as such, the effects of climate extremes on gardens was not solely an issue of food production but one of profound cultural change and loss. This sentiment was apparent in how villagers expressed changes to gardens and the challenges caused by climate extremes. In one *storian*, a villager explained: “*graon hemi laef*” ("land is life") (S8). The loss of links to the land, driven by social changes, and exacerbated by the impact of climate extremes, threatens the spirituality and ways of life of these villages.

### 3.3. Maladaptation: long-term health

The coping strategies employed by people in both villages were determined by the resources and assets available to them and their environment. As a result of the climate extremes studied, diet diversity and quality was significantly reduced in the short-term. In Village A, people increased their reliance on a small number of store-bought food products and had little access to fresh fruit and vegetables; while in Village B, the less food was consumed and the diversity was reduced to one or two food items for extended periods. While there was no reported nutrition surveillance in these villages, there was likely an increase in acute forms of malnutrition, such as underweight and micronutrient deficiencies, leading to long-term health impacts for those in a vulnerable life stage during this period. People were also unable to meet their food preferences or produce their food, activities that are both culturally important and connected to livelihoods.

Despite the seemingly short-term impact of climate extremes, there was evidence that these coping strategies were becoming adaptive and likely to undermine long-term FNS and compromise health. Furthermore, as climate extremes become more frequent and intense, with insufficient recovery time, susceptibility to future extreme events and climate change will be further increased. In Village A, food aid and food purchases as coping strategies over several decades have contributed to a greater dependence on imported food products that are normalised as the ‘local’ diet. The integration of rice in local diets was not a recent phenomenon in Village A and was described as beginning in the 1960s. The beginnings of this trend can be seen in Village B.

It is likely that some adaptations to gardening practices, such as an increasing reluctance in Village A to plant gardens in the face of climate extremes and the relocation of gardens in Village B, were also contributing to a shift away from local produce. In Village A, a participant described:

> “They make gardens, but because of climate change, things don’t grow well so people must buy food from the store. Some people don’t have gardens anymore” (FO).

However, these links with climate change must be understood in the context of high awareness of climate change, but limited understanding, at the local level and the socioeconomic factors also driving reduced subsistence gardening and increased food purchases, such as increased participation in the cash economy, less time for gardening, changing land uses, amongst others.

Exacerbation of the dietary transition by climate extremes further undermines long-term health and is likely to contribute to increased chronic malnutrition and DR-NCDs, such as hypertension, overweight and obesity, diabetes, and cardiovascular disease. The prominence of these diseases was evident in Village A, and almost all participants shared personal stories of family members, friends, or themselves, suffering from DR-NCDs.

### 3.4. Limiting agency in food choice

The impacts of climate extremes limited individual agency and disempowered villagers in their ability to make food choices for a healthy, nutritious diet that met food preferences. This ultimately undermined their ability to protect their health and wellbeing. In Village A, people were reliant on food aid, a pre-determined package of food items, and food purchases, which were determined by food prices, and a food environment dominated by one major supermarket chain and smaller stores with cheap, imported products.

> “We couldn’t eat island food from the garden for some time because we didn’t have manioc or taro. We had to pay for island food at the market, and it was expensive” (S6).

In Village B, agency to make food choices was severely constrained by the drought, and people had little choice but to eat what was available. Life on the outer islands was often described in Vanuatu as an ‘easy’ life because the land provides everything you need: food, water, shelter (using traditional materials). This was prominent in Village B, as one elder explained:

> “… in other parts of Vanuatu, you have to pay for everything, but here we just go to the garden, and it gives us food, and it’s free” (FO).

However, this sense of security was eroded by the drought and the inability of gardens to provide FNS disempowered people in Village B. With limited food options, diet adequacy and diversity were severely constrained. Older people were particularly vulnerable and relied on food that was physically accessible or shared by family members. Furthermore, the impacts of climate extremes exacerbated the transition away from subsistence gardening, reducing healthy food options in the long-term.
Climate extremes also exacerbated other structural constraints to agency such as the food environment, poverty, and access to resources. Despite an overall shared experience of impacts of climate extremes on FNS within the study villages, some differences among individuals, households, and the two villages were evident. Limited financial resources of some participants in Village A resulted in an inability to purchase and consume local fresh food (which, due to their scarcity, attracted a price premium) and a reliance on cheap imported foods, regardless of food preferences. Agency to make food choices was further limited by impaired livelihoods from the absence of produce sales as an income source, the necessity to buy more food than usual, and the significant rise in local food prices following the cyclone. In Village B, cash-poverty rendered most villagers with no agency to choose food purchases as a coping strategy.

In Village A, some participants experienced the recovery of gardens within months, while others described years before gardens were back to ‘normal’. The differences in these experiences likely arise from differing resources and underlying vulnerability, such as more or superior land, the ability, or inability, to pay for water to irrigate, and differing degrees of reliance on gardens for food and livelihoods. In Village A, land is allocated through the traditional kastom process; however, due to an influx of migrants to Port Vila, foreign developers, and an increased need for cash income, much land has been sold, resulting in less land for both kastom and migrant landowners. In Village B, land ownership occurs through kastom procedures; however, there were differences in the grade of land, such as fertility and proximity to water sources and the village, among the four tribes.

4. Discussion

This exploration of experiences of TC Pam and an El Niño-induced drought in Vanuatu found that climate extremes interacted with, and exacerbated, social changes driving a dietary transition away from local produce, towards a greater reliance on imported, store-bought foods; and disempowered people to make optimal food choices. The most prominent theme was the direct effects on food production; a prominence due in part because of the relationship between subsistence gardening and food availability and access, but also due to the importance of gardens in ni-Vanuatu culture and ways of life. As a response to food production impacts, people employed coping strategies and specific climate change adaptation measures, such as climate-resilient crops. Coping strategies often fulfilled short-term nutrition goals of sufficient caloric intake but became maladaptive, contributing to dietary shifts that undermine long-term health and create path dependencies that lock-in the nutrition transition trajectory. Climate extremes also contributed to the erosion of local food-related cultural practices and traditional knowledge. Finally, individual agency and empowerment to make healthy food choices that meet food preferences were constrained by the impacts of climate extremes, which also exacerbated existing structural vulnerabilities and constraints to agency.

The complexity of the interactions between climate extremes and socioeconomic trends has been found in other studies. Kelman (2019) also explored the El Niño phenomenon in the Pacific region and described it as “a driver of climate-related hazards … [it] interacts with many other creeping processes, trends and cycles, sometimes making it hard to decouple El Niño’s influence from the others” (Kelman 2019 p.411). Kelman asserted, for example, that El Niño responses in the Pacific are rooted in a hazard-based approach, and underlying causes are overlooked, with “a disconnect appear [ing] to be emerging between hazard and vulnerability with respect to El Niño” (Kelman 2019 p.417). Kelman’s paper highlights the need to address structural vulnerabilities, harness inherent resiliencies, and acknowledge the interactions and connections between vulnerabilities and resiliencies to support preparedness, not just for El Niño-related events, but long-term DRR and climate change adaptation (Kelman 2019).

Similar conclusions have been drawn regarding TC Pam and climate change in Vanuatu (Jackson et al., 2017; Rey et al., 2017; Trundle et al., 2019). For example, Jackson et al. (2017), using TC Pam in Vanuatu as a case study, promoted a holistic approach to examining disaster vulnerability that recognizes the range of threats faced by communities that shape their ability to respond (Jackson et al., 2017). Komugabe-Dixson et al. (2019) found that natural hazards and climate-related impacts was one of four drivers of environmental change in peri-urban Efate. It found that effects of TC Pam and the El Niño-induced drought were not only on crops, but on fisheries, and other resources and livelihoods, such as firewood and basket-making materials, which also impact FNS (Komugabe-Dixson et al., 2019). In rural Vanuatu, another found that food insecurity following a tropical cyclone, and a perceived diminished local capacity to manage such climate stresses, were driven by rapid social, economic, and cultural changes resulting in less food self-sufficiency (Warrick 2009). Our results also highlight the need for a broad approach to managing climate extremes beyond technocratic agricultural strategies or traditional disaster risk reduction (DRR) and encompasses socioeconomic interactions and feedbacks.

Gardens are often viewed as a source of resilience to a range of shocks in Vanuatu and provide access to diverse, local produce, reducing vulnerability, and improving health outcomes (Feeny 2013; Savage et al., 2020b). The typical attitude in Vanuatu of an ‘easy’ life on the islands arises from the embeddedness of gardens and land in the culture and ways of life in Vanuatu; however, climate extremes are threatening this sense of security (Savage et al., 2020b; Wentworth 2014). The effects on gardens were deeply felt, not just as a loss of food production but because the impacts of climate extremes exacerbated changing ways of life and a shift away from subsistence gardening.

In the face of climate extremes, subsistence gardens may also be a source of vulnerability. For example, Calandra (2019) found that the very classification of an event as a disasta (disaster) was determined by the extent of damage to gardens, rather than the effect on infrastructure or property. A characteristic of disasters in this context was the occurrence of damage out of the regular season or unforeseen damage that cannot be prepared for (Calandra 2019). Climate change is thus raising the stakes for what is required for gardens to contribute to resilience and adaptive capacity. In the remote village, food consumption and dietary diversity were severely restricted for several months, which could significantly impact long-term health. For example, in-utero and child-hood undernutrition is a risk factor for obesity and diet-related NCDs over the life course (Adair 2013; Black 2013). There was evidence of adaptations in gardening, and coping strategies that have become adaptive and contribute to resilience; however, some adaptations may be maladaptive for long-term health by promoting the nutrition transition.

Furthermore, climate extremes constrained the agency of people to make food choices beneficial to their health. Food aid, for example, was found to limit local agency and exacerbate the nutrition transition by promoting a lower quality diet comprising of increasing proportions of store-bought foods. In this study, many participants from both villages related stories of their introduction to rice through food aid following a climate extreme and increased consumption following the event. An increasing body of literature explores how food assistance undermines long-term FNS in the Pacific (Ahlgren 2014; Campbell 2015; Jackson 2019; Seiden 2012; Wentworth 2019). For example, Wentworth (2019) found that food assistance provided following TC Pam contradicted nutrition education campaigns and did not meet the health needs or food preferences of families in and around Port Vila. She also found that existing inequalities were intensified following the cyclone, such as the increased inability to access local produce due to significant price increases; and people’s inability to exercise agency in food choices. “When a community is overwhelmed in the wake of a disaster, choosing only from the same handful of packaged, unhealthy foods can exacerbate feelings of disempowerment” (p.13).

The reliance on, and the expectation of, food aid has also contributed to the erosion of traditional strategies for resilience to climate extremes.
such as food preservation and food stockpiling, and overall waning of gardening in areas with greater access to store-bought foods (Campbell 2015; Jackson 2019; Wentworth 2019). Jackson et al. (2019) found that emergency food assistance in rural Papua New Guinea exacerbated vulnerability drivers, such as reduced self-reliance and adaptive capacity. Food aid provision may also further entrench existing inequalities where local power structures and institutions are not well-considered, and conflict and inequity in distribution arise, exacerbating vulnerabilities for some people (Jackson 2019; McDonnell 2019). Nevertheless, this is not to say that food aid should not be provided; indeed, in this study, food aid was generally perceived as positive and necessary to meet short-term, emergency food needs. However, the approach to food aid must be re-examined to encompass consideration of structural vulnerabilities, food preferences, and the long-term effects on FNS (Jackson 2019; Warrick 2011; Wentworth 2019).

We found that the effects of climate extremes had other impacts on culture and tradition, particularly with the loss of culturally-important foods, such as laplap leaf and various varieties of yam. However, it is difficult to extricate the effects of climate extremes from broader social changes contributing to a changing diet. In Village A, rice has been regularly consumed for decades and is a part of daily life. Changing food preferences were evident, with younger generations preferring rice over local root vegetables. This has been observed in other PICs, such as the Marshall Islands and Papua New Guinea (Ahlgren 2014; Jackson 2019). Culture is adaptable and ever-changing, and in both villages, the adaptation of culture and local customs was evident in the use of rice for celebrations and ceremonies. In the face of social and environmental pressures on local food production, rice allows people to maintain traditional food sharing and feasting (Wentworth, 2016). A study in Malo, Vanuatu, found the current food system, a mix of imported food and local produce, to be more resilient than pre-colonial times; and that the people of Malo have developed “innovative solutions that have adapted “traditional” practices and institutions” (Allen 2015, p.1 341).

In planning climate change adaptation for FNS, the crucial question is: how can communities and individuals be empowered to exercise agency in their food and health choices in the face of a changing climate and the nutrition transition? This question forces us to rethink what adaptive capacity, and therefore resilience, means for FNS. For example, while nutrition and health education are necessary for people to make informed food choices, it is not sufficient when agency is so constrained to make healthy choices an impossibility. Climate change “adaptation in a local context requires processes to address social and cultural issues as well as climatic ones, enabling communities to deal better with environmental uncertainty in a way that suits them, without losing the value systems and practices that underpin their way of life. In short, ‘adaptation’ should be about adjusting to both climate and social change” (Warrick 2012, p.5). Structural vulnerabilities, including, but not limited to, the food system and environment, access to education, and poverty, must be also be addressed. Ebi and Bowen (2016); in their exploration of drought as a source of health vulnerability, also highlight structural constraints to agency, stating: “determinants of coping capacity include access to education, economic wealth, a healthy population, good governance, and high levels of human and social capital” (p. 100). As climate change accelerates, the potential for gardens to contribute to resilience, including the maintenance of a diverse and high-quality diet, is likely to diminish unless strategic, well-planned adaptation is undertaken.

5. Study limitations

There are some limitations to consider in the use of these study results. Respondent bias may have potentially affected the results in two ways. First, the broader study from which the results were drawn focused on the effects of climate change on FNS, of which participants were aware, and this emphasis may have influenced participant responses. To moderate potential bias, several data collection methods were employed, and a wide range of data was collected that covered FNS, climate change, livelihoods, socioeconomic drivers of vulnerability and observations of everyday village life. Second, the results present the lived experiences of participants, which are shaped by their perceptions of the world, past experiences, and personal situation. This was an intentional methodological decision to provide a greater depth of understanding, and conflicting stories demonstrate the plurality of experience. The researchers’ worldviews also influence the recounting of stories; however, continuous reflexivity and awareness of this bias were built into the study design.

This study focused on only two villages in Vanuatu, a country that is diverse linguistically, culturally, and geographically. However, there were approximately 40–50 participants in each village across the range of data that was collected and the study sites were also purposively selected for specific geographical, socioeconomic, and cultural characteristics, both to be representative and to reflect the diversity and urban-rural differences. Additionally, some valuable data was likely missed during field observations as many village interactions took place in Indigenous languages.

This study is not intended to be exhaustive but to share the lived experiences of inhabitants of these two villages. While the specific local context may not be widely generalisable, the overall results of this study are likely applicable to other Pacific nations and SIDS, with their shared characteristics, such as small widely-dispersed coastal populations; similarities in traditional diets and farming methods; increasing urbanisation; and a dietary transition away from a local traditional diet towards a diet high in energy-dense, nutrient-poor, foods.

6. Conclusion

This study found that climate extremes affected the FNS of people in the two study villages both directly, with effects on gardens and food production; and indirectly, by exacerbating the nutrition transition that is undermining long-term FNS and health; erosion of food-related cultural practices and traditions; and constraining local agency to make food choices. The magnitude and extent of these impacts, however, are influenced by structural vulnerabilities and local resilientities. Adaptive capacity and resilience of communities need to be strengthened in a way that allows people to exercise agency in their responses to climate extremes and to promote FNS, including cultural acceptability and food preferences, and long-term health.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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