



The role of fish and fisheries in recovering from natural hazards: Lessons learned from Vanuatu



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ABSTRACT

Coastal fisheries provide staple food and sources of livelihood in Pacific Island countries, and securing a sustainable supply is recognised as a critical priority for nutrition security. This study sought to better understand the role of fish for Pacific Island communities during disasters and in disaster recovery. To evaluate community impacts and responses after natural disasters, focus group discussions were held with men and women groups at ten sites across Shefa, Tafea, Malampa and Sanma provinces in Vanuatu. The combined impacts of category 5 Tropical Cyclone Pam (TC-Pam) in March 2015 and prolonged El-Niño induced drought have had a profound impact across much of Vanuatu. Terrestrial systems had been disproportionately impacted with substantial shortages in drinking water, garden crops, cash crops and damage to infrastructure. Localized impacts were noted on marine environments from TC-Pam and the drought, along with an earthquake that uplifted reef and destroyed fishing grounds in Malampa province. Communities in Malampa and Shefa provinces also noted a crown-of-thorns outbreak that caused coral mortality. The significant reduction in terrestrial-based food and income generation capacity generally led to increased reliance on marine resources to cope and a shift in diets from local garden food to rice. However, limited market access, lack of fishing skills and technology in many sectors of the community reduced the capacity for marine resources to support recovery. A flexible management approach allowed protected areas and species to be utilized as reservoirs of food and income when temporarily opened to assist recovery. These findings illustrate that fish and fisheries management is at the center of disaster preparedness and relief strategies in remote Pacific Island communities. High physical capital (e.g. infrastructure, water tanks and strong dwellings) is key for disaster preparedness, but supporting community social capital for the purpose of natural resource management and human capital for diverse adaptation skills can also improve community resilience. Recognizing the humanitarian value that well managed fisheries resources and skilled fishers can play to disaster relief adds another dimension to the imperative of improving management of coastal fisheries and aligning policies across sectors.

1. Introduction

The effect of natural disasters on rural and coastal communities in low-income and developing countries in the Indo-Pacific is an evolving arena for research and policy (e.g. Pomeroy et al., 2006; Da Silva and Yamao, 2007; Tewfik et al., 2007; Mills et al., 2011; Abdullah et al., 2016). The catastrophic 2004 tsunami that impacted across parts of Southeast Asia, and the typhoons that regularly devastate Philippines or cyclones that make annual landfall at the highly populated Bay of Bengal have naturally attracted the most attention due to their massive scales of impact. In comparison, there have been far fewer evaluations

of how Pacific Island communities cope and recover from natural disasters, despite high frequency of disasters and vulnerability. Notably, when evaluating exposure to natural hazards and societal vulnerability, four out of the ten countries at greatest risk in the world are located in the Pacific, and the population in Vanuatu is at highest risk in the world to suffer from natural hazards (UNU-EHS, 2015). Year 2015 saw Vanuatu hit by the worst cyclone in its history (category 5 Tropical Cyclone Pam), and in February 2016 Fiji was impacted by the most powerful cyclone ever recorded in the South Pacific Basin (category 5 Tropical Cyclone Winston). Both weather events left a swathe of lost lives, destroyed infrastructure and ruined livelihoods.

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Pacific Island populations are concentrated along the coasts where they rely heavily on fisheries resources for their livelihoods and food security (Govan, 2009; Foale et al., 2013; Sulu et al., 2015). But here, they are also exposed to rapid environmental change and natural hazards (Bell et al., 2011). For Pacific Island communities, the effects of climate change – including increase in temperature, increased frequency of extreme weather events, changing chemistry of oceans, sea level rise and increasing unpredictability of rainfall – pose serious threats to coastal ecosystem goods and services (Bell et al., 2016). There is a need for evaluations of impacts and coping strategies that are attuned to the Pacific way of life, with its high reliance on natural resources, and its unique customary practices for governing resources. Prompted by TC-Pam, this study sought to understand the impacts of shocks in communities and the role of fish in Ni-Vanuatu lives as they persevere and recover.

Vanuatu has a long history of customary coastal management practices (Johannes, 1998, 2002; Foale et al., 2011). The customary tenure, traditional ecological knowledge, and existing leadership structures are the foundation of community-based fisheries management in Melanesia (Govan, 2013). While fish is an important resource for daily life in Vanuatu, Ni-Vanuatu communities build their livelihoods from a range of natural assets, and fish and fishing must therefore be considered within a broader livelihood framework. This reasoning aligns with the requirement for integrated understandings about livelihoods and disaster coping strategies (Pomeroy et al., 2006). Therefore, this study assesses impacts across the five key livelihood capitals that constitute the asset pentagon in the sustainable livelihoods framework (e.g. DFID, 1999; Allison and Ellis, 2001). In addition, while TC-Pam was a historical event in Vanuatu's history of natural disasters, the assessment in this study sought to evaluate shocks and their impacts beyond the singular event of TC-Pam. Our study analyzed three dimensions of disaster and coping processes in Vanuatu between March 2015 and August 2016:

1. Shocks and their impacts
2. Assessment of impacts on livelihood capital assets
3. Strategies to cope with impacts

The study analyzes these three dimensions to answer the key question on what roles fish and fishing play during and after periods of hardship. In answering this question, we identify new lessons to guide current fisheries policy and future disaster relief interventions.

2. Methods

2.1. Study sites and data collection

Focus group discussions were conducted 25 August to 29 September 2016 at ten sites across Shefa, Tafea, Malampa and Sanma provinces in Vanuatu (Fig. 1). The sites were selected to cover a range of circumstances and distances to the path of TC-Pam. Six sites were located within 60 km of the path of TC-Pam and were considered significantly impacted, while four sites were located 140 km or more from the central path of TC-Pam and were considered relatively un-impacted.

Two focus group discussions (FGD) were held at each site with groups of women and men separately. Each FGD was comprised of 4–8 individuals selected by community leaders to represent a cross section of the community. The field team consisted of three scientists experienced in FGD methodology, and at least one provincial fisheries officer. Focus group discussions were held in Bislama, the *lingua franca* of Vanuatu, with translation into local vernacular as required. Each FGD lasted for approximately 40–70 min and was audio recorded.

The FGDs aimed to understand the recent history of natural disturbances (shocks) at each site, how these had influenced livelihoods and natural resources and what role natural resources (specifically fisheries) played in recovery alongside other external support. To

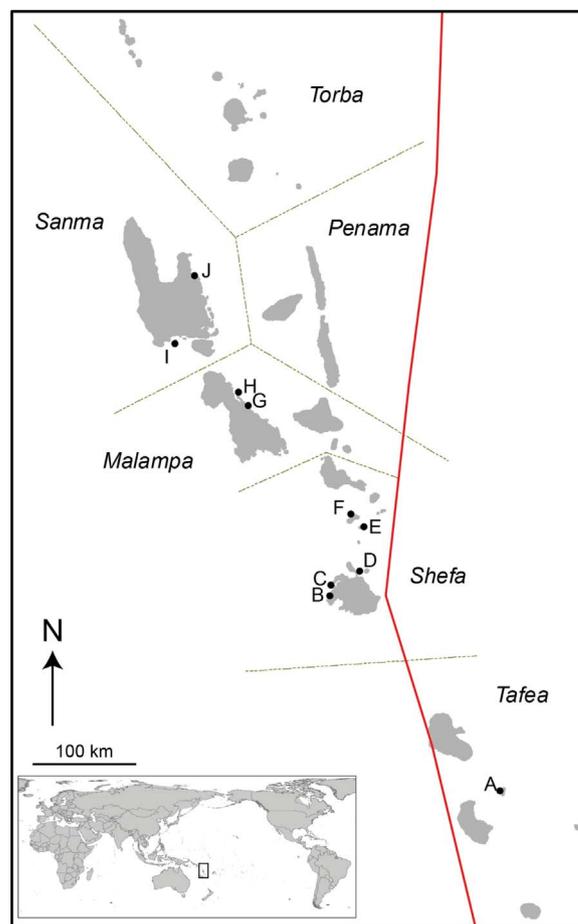


Fig. 1. Map of Vanuatu in the South Pacific. Sites are labeled A–J. The red line through the map represents the approximate path of TC-Pam in March 2015. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

complement the FGDs, informal discussions were held with community leaders to elicit general information on population, access to health, education, water and other key features of the village.

This study did not collect information at the household level: the findings in this study are indications of impacts and coping strategies built on the descriptions of community members in group conversation. As a result, we may not have captured the full picture of coping strategies that individuals or households may have taken.

2.2. Analytical framework

The assessment was structured using the livelihood assets component of the sustainable livelihoods framework. This component is considered a core element of the bigger framework (e.g. 1999), and comprises five key capital assets that construct livelihoods within an external context. This mix of capital assets is commonly illustrated as a pentagon where each tip of the pentagon represents each of the livelihood assets (Fig. 2):

The assets component is now an established framework that has been used to guide livelihood assessments in a myriad of contexts (e.g. Morse and McNamara, 2013). It was used in this study to organize the assessment of existing assets in study communities, and how these assets have been impacted by shocks at the time of the assessment.

The status of, and access to, assets prior to shocks and currently was qualitatively assessed and ranked upon completion of the FGD at a site. The audio recording of the FGD was used if required to confirm the thematic conversations and assist in the assessment. Informal conversations with community leaders were used to further clarify or confirm

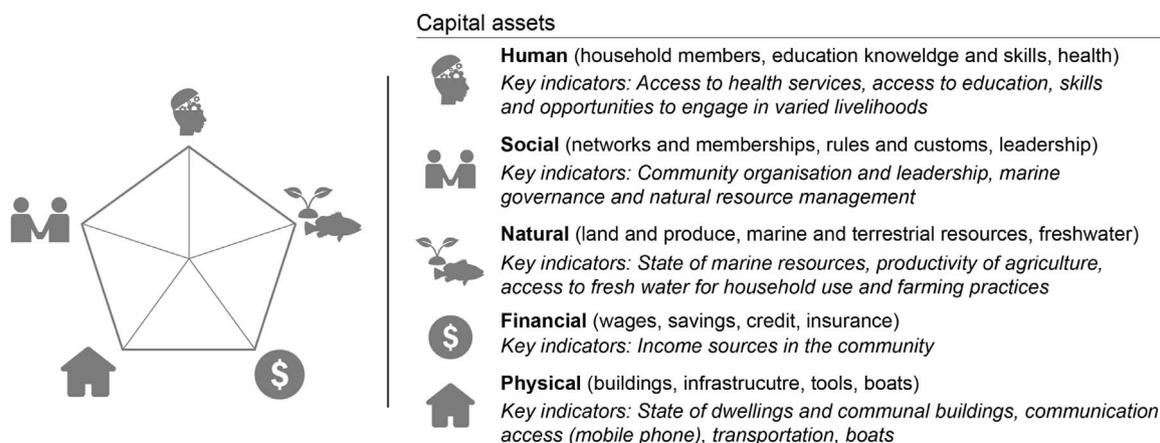


Fig. 2. The livelihood capital assets “pentagon”, with illustrative examples for each asset. Key indicators used in the assessment are listed. See DFID (1999) for more detailed description about the context of the pentagon illustration of the five capital assets.

information from the FGD. The assessment of each asset was based on the relative ranking of access to these assets based upon the diagnosis by the target group. Ranking was done on a scale of 1 to 5, where 1 = No access and 5 = Very good access. The lower the rating of each asset base, the closer the target group is to poverty. These ranking were conducted retrospectively of conditions prior to the shock and at the time of the assessment.

From the FGDs we organize the discussed coping strategies as typologies: “Fishing strategies for food and income”, “Non-fishing strategies for food and income” and “Shelter and infrastructure for rebuilding”. We also structure the coping strategies based on three dimensions of adaptive capacity to assess the sector of adaptive responses for each of these typologies (e.g. Allen et al., 2014): Autonomous (Individual), Collective (Community), or Institutional (Government and non-government). This methodology allowed us to assess the types of responses of different sectors.

3. Results

3.1. Shocks and their impacts

Focus group participants identified up to four shocks that they had experienced over the previous 18 months; TC-Pam, El-Niño induced drought, earthquake, and crown-of-thorns starfish (COTS) outbreak. These shocks had been experienced differently at different sites (Fig. 3). TC-Pam mostly impacted the six southern sites within Tafea and Shefa provinces. These sites experienced severe impacts to dwellings, communal buildings, infrastructure and boats (Fig. 4A–C). The cyclone also destroyed crops and therefore ruined a considerable source of income from marketable vegetables and commercial agriculture. Across all sites, the impact from the drought during the 2016 El-Niño was emphasized. The drought stalled the anticipated recovery of garden crops, and led to water scarcity. Severe shortage of freshwater was an additional time-consuming burden that has hindered other activities to source food and income. A 7.0 magnitude earthquake hit Malampa province in April 2016. This led to coastal uplift with associated coral death, loss of fishing grounds and reduced sea access for fishing (Fig. 4D). Sites G and D had also experienced COTS outbreaks that led to severe coral mortality. Minor coral bleaching was mentioned at sites C and H, but community members did not identify this as a shock.

3.2. Assessment of impacts on livelihood capital assets

Natural capital suffered the most severe impacts across all sites, irrespective of the shock (Fig. 5). The combined impacts of TC-Pam and El-Niño induced drought have been: loss of most garden crops (manioc and banana have been the most resilient for replanting), cash crops (e.g.

kava, coconut, cocoa, sandalwood), fruit trees (e.g. mandarin and mango), pandanus leaves for weaving, and critical water shortage that has placed increased burden on people’s time for sourcing drinking water. The most severe reduction in natural capital was felt at Site I, where severe water shortage had flow-on effects on all sectors of community life (Fig. 4E). In addition, some impacts were noted by COTS due to El-Niño driven warm waters, wave damage to fringing reefs from TC-Pam and short-term impacts on fishing efficiency due to dirty waters in the weeks following TC-Pam. However, in all cases fishers reported that fishing had returned back to normal and no on-going legacy impacts from TC Pam were noted, with the exception of some loss of existing fishing areas.

Initial reports in the wake of TC-Pam identified greatest impacts across locations near the swathe of TC-Pam (OHCA, 2015), which destroyed weak infrastructure and buildings with relatively simple construction materials. During our assessment, 18 months after the cyclone, at the majority of sites impacted by TC-Pam (sites A, B, C, D, E and F) physical assets were back to a status similar to that prior to the shock. Communication had been restored, transport routes were re-established and the majority of dwellings reconstructed. In some cases (e.g. Site D on North Efate) disaster relief had actually improved physical assets through the provision of rainwater collection tanks and provision of building materials for houses. At other locations (Sites E and F), while the provision of building materials for communal dwellings had improved overall community physical capital, many households remained living in houses under disrepair due to lack of materials (locally sourced roofing materials such as sago palm leaf had not yet regrown) and human resources (as community members were expected to assist with the rebuilding of the communal dwellings). The loss of paddle canoes and motor vessels remained a significant impact on many communities as fishers sought to recoup losses from destroyed gardens through fishing. Interestingly, for those sites with the available knowledge and skills (e.g. Site A) fishers were able to rebuild lost canoes in a relatively short time frame. No major impact on physical capital was noted from the earthquake in Malampa Province.

The impacts on natural capital brought with it knock-on effects on financial capital because sources of incomes from growing and marketing cash crops were lost. This was not felt as hard at Site J because this site has a relatively thriving tourism industry with several income earning opportunities from selling handicrafts, working at bungalows and preparing seafood (e.g. reef fish, lobsters) along with cattle farming and coconut production. Tourism was only briefly interrupted after TC-Pam, and appears to have remained un-impacted during the El-Niño drought. Financial capital is also under further pressure where the drought has interrupted kava production (e.g. Site F), as men are purchasing kava from other areas thereby placing further burden on household finances.

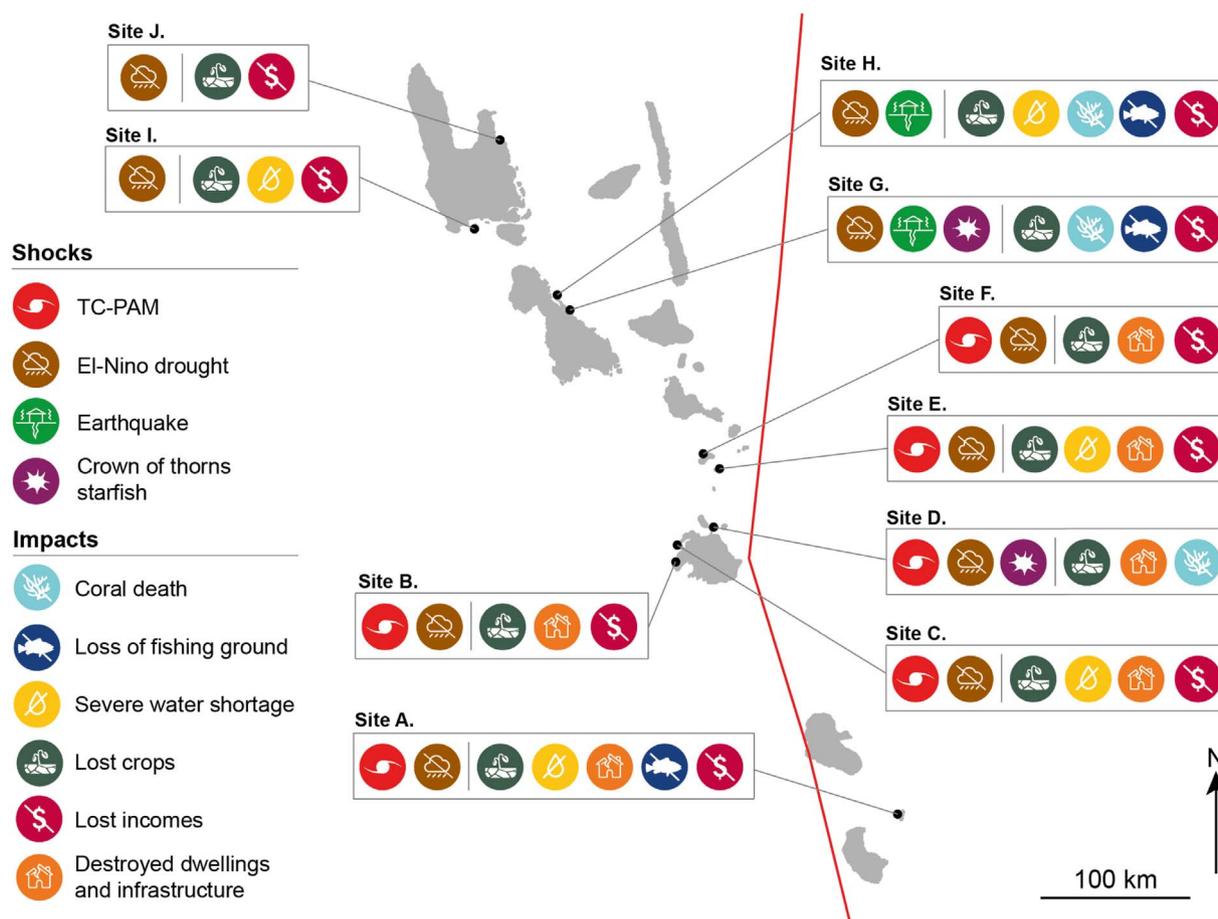


Fig. 3. Shocks that had occurred within the last two years (2015–2016), and their impacts on daily life, identified by focus group participants at ten sites in Vanuatu in 2016. The red line through the map represents the approximate path of category 5 tropical cyclone Pam that hit Vanuatu in March 2015. Note that the map does not contain the northern Torba province, as there were no study sites there. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Human capital was compromised at some sites because donor expectations that community members would participate in rebuilding community buildings and infrastructure by materials provided by donors. This had led to families at both sites E and F still residing in temporary shelters delivered after TC-Pam, while new communal buildings had been constructed (Fig. 4F–I). Communal obligations placed additional strain on households and individuals, particularly for women to oversee household activities (sourcing of food and fresh water, family cooking and washing), while living under unusually difficult conditions.

Social capital was the only community asset that didn't appear impacted in the assessment.

3.3. Strategies to cope with impacts

Fishing had returned to normal after TC-Pam at the time of our assessment and only minor impacts on fisheries were identified with respect to the El-Niño induced drought. The impacts on both gardens and terrestrial income sources were more substantial and ongoing. These impacts had resulted in higher demands on income required to replace food shortages with store bought foods (e.g. rice) and to replace income from lost cash crops, market garden, or weaving. In the 1–2 months after TC-Pam severely impacted communities largely depended on food and basic necessities supplied through the relief operation. Those impacted only by the drought did not receive any relief supplies. In many cases, fishers indicated it was several weeks before they returned to the sea for fishing after TC-Pam. However, once relief supplies were exhausted, marine resources were viewed as the most readily available option to fill this gap in household food and finances at most

sites. Fisheries were thus a central element of coping strategies, due to the high impact on terrestrial natural capital, irrelevant of the type of shock. There were, however, some sites where fisheries were not the central element for coping with the shock, as these sites were able to utilize other available livelihood opportunities that were relatively unimpacted by the shocks. For example at the North Santo site (J), people relied on a variety of income generating activities including cattle, copra and tourism. At North Efate, access to overseas income from seasonal work (fruit picking in New Zealand through the RSE Policy; Gibson and MacKenzie, 2013) also offered an alternative to marine resources.

Many different types of fishing activities were used in response to the impacts and these tended to be associated to a local environment, resource, or with gears delivered in TC-Pam relief supplies (Table 1; Fig. 4J). When relatively novice fishers are looking to extract marine resources to replace lost income from the terrestrial livelihoods they typically utilized simple fishing methods to maximize catch per unit effort. The two most common forms of fishing that appear to be used in this scenario were night spearfishing and nets. Several communities advised they had been provided both spearguns and nets as part of their TC-Pam relief supplies. Both night spearfishing and netting are considered relatively destructive forms of coastal fishing due to placing pressure on herbivores across all size classes. Across the study sites, however, few sites had sufficient specialist fishers that were readily able to increase effort to maintain household income. The opportunity to gain income from fishing was restrained by the limited access to fish markets where catches could be sold.

In communities with high human capital within the fisheries sector (e.g. Sites A, E, and I) there were no significant constraints on utilizing

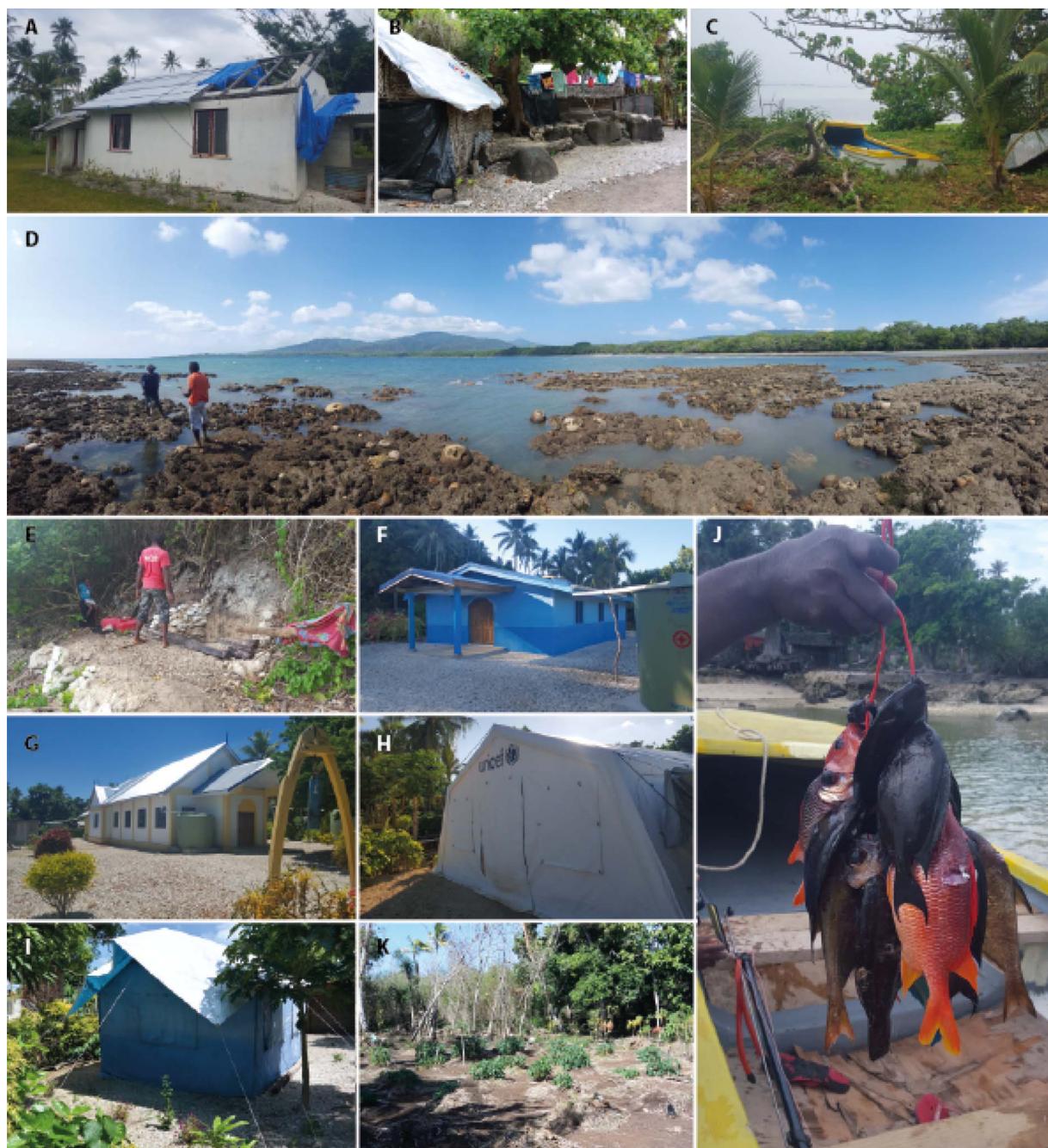


Fig. 4. Photos from the shocks: A Residential house at site D destroyed by TC-PAM that has not been rebuilt, B Dwellings at site D impacted by TC-Pam still in disrepair, C Boat destroyed by TC-Pam at site F, D Uplifted reef at site G, E Well dug near shore with salty ground water at site I, F and G communal buildings at site E, H and I temporary shelters still used as dwellings at site E and F, J catch at site D using spearguns delivered as part of relief packages, K mounding and mulching of manioc to retain soil moisture at site A. Photos: Simon Albert.

marine resources to cope. In communities with families that had previously lived off copra, kava or market gardens the transition to fishing for income had been more challenging. For women, the access to money for critical household needs and school fees had been severely restricted across all sites where market gardens were impacted. Diving for lobster, spearfishing, trolling and deep sea fishing are generally male dominated activities so men therefore were better able to respond to these impacts. One clear exception was Site C where the women were introduced to a new innovative fishing method for scads (*Carangidae*) that had increased their access to fish for food and income – a timely introduction in the wake of TC-Pam.

The Government of Vanuatu lifted the ban on *beche-de-mer* (sea cucumber) harvest and export to allow fishers to earn additional income. In response to this temporary opening, 71 t of *beche-de-mer* –

valued at an estimated USD \$3 M was exported in 2015. This catch substantially exceeded the original quota of 21 t. The Government also delivered fishing gear in their relief supplies and recommended that communities opened their marine protected areas to provide a much-needed source of food and income. In some cases (Sites B, C, F, and I), communities opened their *tabu* areas (fishing grounds temporarily closed to fishing; see Foale et al., 2011; Cohen and Alexander, 2013) for several months after TC-Pam and expressed that this reservoir of fish was important for their short-term needs. In other sites, such as Site A, the protected areas were based on traditional closures linked to specific seasonal events (e.g. Yam harvest) and given their existing high human capital (in particular fishing skills) and alternative fishing areas the local leaders did not see the need to alter their normal schedules for opening *tabu* fishing grounds.

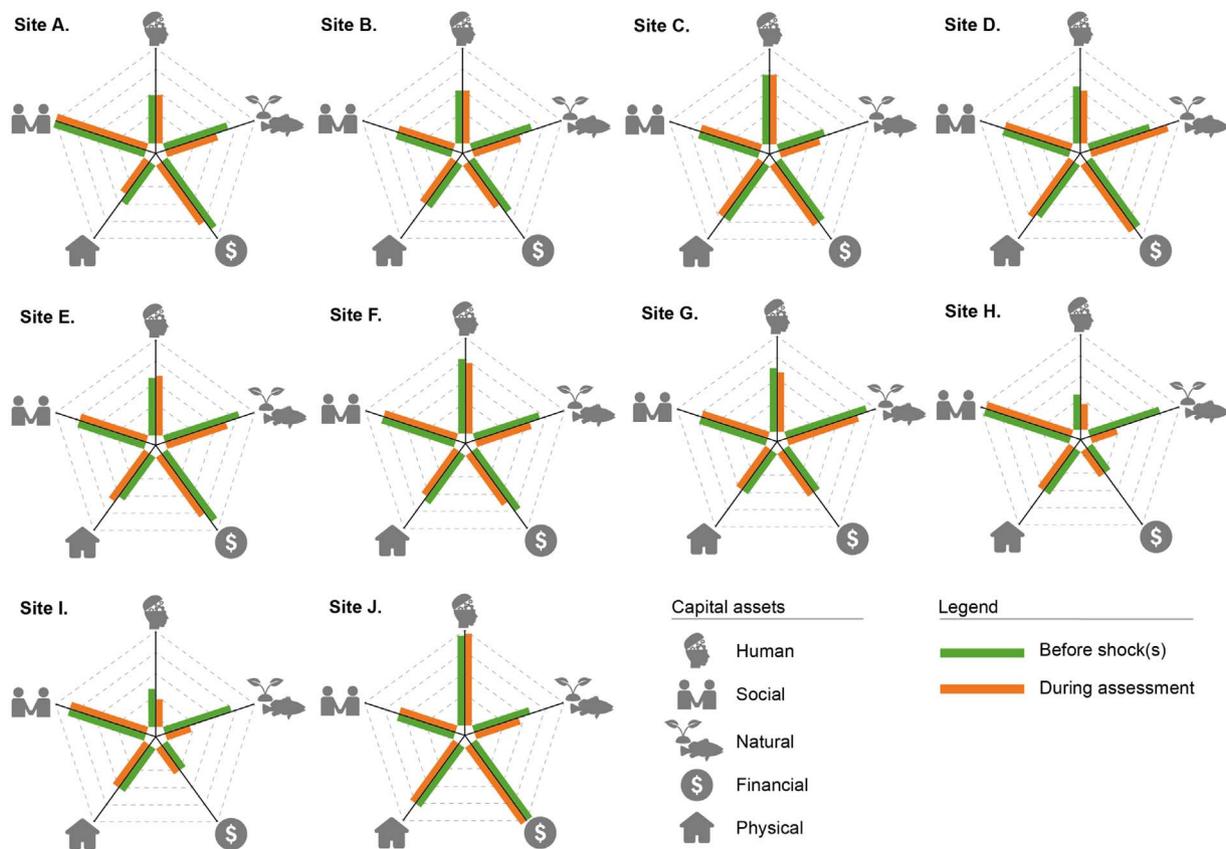


Fig. 5. Assessment scoring of impacts on the five livelihood capitals for each of the ten sites.

4. Discussion

4.1. Shocks are felt differently, but fishing is a central coping strategy

In our assessment of natural disasters in Vanuatu, we note both acute (TC-Pam) and prolonged (drought) shocks, which were both local (earthquake and COTS) and extensive (TC-Pam and drought) in nature. The impacts from the shocks have been felt differently at different sites. TC-Pam brought a lot of international humanitarian relief. Australia provided \$50 million AUD (DFAT, 2017). But despite the drought being

a greater impact for many communities, it has gone largely unnoticed by the international community. While large areas of nearby Great Barrier Reef were bleaching during 2016 (Hughes et al., 2017), participants in our study only made comment about minor bleaching at two sites and we were not able to locate evidence of bleaching occurrence at Vanuatu.

Resilience theory holds that diversity is an attribute that enhances adaptive capacity (Biggs et al., 2015). Following TC-Pam, commentaries quickly pointed out Vanuatu’s over-reliance on tourism for economic growth and development, asking for economic diversification

Table 1

Description of coping strategies after shocks, told by men and women in focus group discussions in ten communities in Vanuatu. The typologies are further described by three categorical dimensions of adaptive capacity (Autonomous, Collective, and Institutional) following Allen et al. (2014).

Coping typology	Autonomous (individuals)	Collective (communities)	Institutional (government, non-government organization)
Fishing strategies for food and income	<ul style="list-style-type: none"> ● Increase in fishing effort ● Change in fishing methods (e.g. from fishing on reefs to a new fishing technique targeting scads (Carangidae) or speargun fishing for reef fish using donated equipment) ● Fishing efforts targeted non-reef species not impacted by COTS 	<ul style="list-style-type: none"> ● Reviewing <i>tabu</i> areas (some communities opened <i>tabu</i> areas, while others left them closed to support ecosystem recovery). ● Community leaders allowed new fishing techniques in new areas (for scads) 	<ul style="list-style-type: none"> ● Government donated fishing equipment (e.g. spearguns, nets, lines) ● Government opened the closed beche-de-mer fishery ● Government encouraged community fishing <i>tabu</i> areas to be opened ● Establishment of village based fisheries market house (with solar freezers)
Non-fishing strategies for food and income	<ul style="list-style-type: none"> ● Seeking jobs in Port Vila ● Marketing food and handicrafts for tourists ● Relocation of gardening effort to more fertile soils on mainland ● Overseas seasonal work ● Donations and support from individual expats 	<ul style="list-style-type: none"> ● Sharing of food and water to support families most impacted ● Donations and support from community members living in diaspora 	<ul style="list-style-type: none"> ● Establishment of women’s market house to provide income ● NGO facilitated training for alternative food and income sources (e.g. chicken farms, food preservation, soil and pest management)
Infrastructure and shelter for rebuilding	<ul style="list-style-type: none"> ● Relied on their existing skills and knowledge from living under harsh and isolated conditions to rebuild houses, canoes and communal infrastructure 	<ul style="list-style-type: none"> ● Strong sense of community ensured external aid resources were utilized 	<ul style="list-style-type: none"> ● Emergency supplies of food and water ● Emergency supplies including tents, water, garden tools, clothes ● Communal buildings funded by government and donors

and development, for example, of the agriculture sector (Cheer, 2015). This commentary was met with more nuanced policy reflection emphasizing that diversification is also associated to risk that shouldn't be ignored in the diversification paradigm (Doorman and Newton Caine, 2015). We found that tourism was only briefly interrupted after TC-Pam, and appears to have remained un-impacted during the El-Niño induced drought. In contrast, the agriculture sector had suffered a severe and prolonged impact from both the cyclone and the drought. While tourism has unequal benefit across the country (IFC, 2014) – only one of our ten sites benefit significantly from tourism – these impact patterns are case-in-point that other sectors are also exposed to significant risk from natural hazards. National economic policy should take into account that diversification does not always mean risk reduction, and that diversification should not come at the expense of a significant and relatively functioning industry.

Coupled with this national pattern, household livelihood strategies are also exposed to different risks associated with natural hazards. Diverse household livelihood portfolios are often said to increase resilience to shocks by increasing adaptive capacity (e.g. Béné et al., 2015). However, the normative language of diversification as a process for increasing resilience has limitations depending on social-ecological context (Goulden et al., 2013). Fish farming households in Aceh that were unsettled by the 2004 Indian Ocean tsunami appear to have coped to varying degrees based on the composition of their livelihood portfolio (Mills et al., 2011). Notably, it was not necessarily the number of livelihoods *per se* that provided household resilience, but rather what the actual livelihoods were and the sectors that they spanned across. When livelihoods rely on the same sector or productive environment there is naturally a greater exposure to risk (Béné et al., 2011). Resilience can also be influenced by social stigma associated with engaging in certain activities seen as compromising to social status (Abdullah et al., 2016). When practices are disrupted, and needs greater, households are forced to negotiate day-to-day life given the options that are available to them. This may entail opportunistically shifting effort to relatively un-impacted resources. In Vanuatu, coastal marine resources provided this 'safety net'. However, the limited fishing skills among some farming communities constrained their recovery. In these communities, livelihood mixture associated to human capacity – skills in extracting food and income from varying methods of fishing and farming – seem to have been advantageous.

Social capital was the only capital asset that remained without impact, and sites where social capital was high tended to also show communal capacity for dealing with the shocks. The literature supports this finding. For example, social capital related to natural resource management was shown to amplify recovery in Chilean fishing communities after the 2010 tsunami (Marin et al., 2015). In Sri Lanka, the capacity to rebuild community livelihood assets after the 2004 tsunami was supported by experienced fishers and strong fishing organizations (Da Silva and Yamao, 2007).

Ni-Vanuatu people have shown remarkable perseverance, balancing the nation's label as at "highest risk" from natural hazards in the world (UNU-EHS, 2015). Living under remote and harsh conditions can build resilience to variability and uncertainty through experience (Maru et al., 2014). At Site A, the most remote site of this study, a FGD participant stated that "Disaster is in the blood of the people from [here] – it is what it is, we rebuild and move on". This statement is exemplified by that people initially resorted to diving and shore-based fishing while rebuilding their fleets, showing adaptation pathways supported by human capital (multiple fishing skills). Their houses were torn down, but they repaired and re-built them with limited support from foreign aid. Similarly, gardening at this site showed signs of resilience and innovation. As the island receives low rainfall, people have adopted methods of mounding manioc to keep crops cool and mulching the mounds with banana leaves to retain soil moisture (Fig. 4K).

4.2. Strategies in resource governance to facilitate recovery

Marine management initiatives that existed prior to TC-Pam appear to have supported post-disaster recovery in some cases. The immediate opening of the full closure of *beche-de-mer* throughout Vanuatu for four months provided an opportunity for a rapid injection of income into struggling communities. The same strategy of opening the closed sea cucumber fishery was adopted in Solomon Islands when the earthquake and following tsunami hit in 2007 (Garofe and Tiroba, 2007). In Fiji, the sea cucumber fishery has never been closed and the impact assessment from cyclone Winston in Fiji indicated that in many places fishers were less able to utilize sea cucumber as an income source after the cyclone (Chaston et al., 2016). The sea cucumber example showcases the importance of maintaining harvestable resources as a 'safety net' to lessen hardship in remote areas, and also that Government policy for rebuilding post-disaster can include easing of fishery regulations.

Vanuatu has a long and complex history of community-based marine resource management (Johannes, 2002; Foale et al., 2011), which was evident across all study sites through an array of either traditional (e.g. *tabu* sites) or more recently introduced management of marine resources. At all sites this management approach was seen as a valuable mechanism to support community recovery during difficult periods, either through the opening of *tabu* sites or through its ongoing maintenance of fish stocks. There is support in our study that strong community governance (social capital) with marine resources under flexible management (open/closed *tabu* areas) is advantageous during periods of hardship and in disaster recovery. In places where such customary practice to reduce fishing pressure was strong this was seen to have provided sufficiently healthy stocks of coastal fish to aid recovery. This is further support to the regional Nouméa coastal fisheries strategy (SPC, 2015) that seeks to better assist Pacific Island communities to govern resources. Under Vanuatu's ongoing community CBFM support model (VFD, 2016; Baereleo et al., 2016), there is opportunity to incorporate enhanced disaster preparedness into governance for natural resource management.

Small-island developing states (SIDS) fisheries policy can learn from Vanuatu's experiences by incorporating conservative, but not permanent, regulation that can be lifted under a flexible open/closed management approach to increase access to fish for food and incomes during emergencies. Spatial closures can then be re-established once the crisis has passed. Boosting capacity to meeting immediate needs for recovery, while not resulting in longer-term unsustainable fishing patterns is a challenge. For example, after the tsunami ravaged fishing fleets in Aceh, boat stocks were augmented without consideration of former structure of the fleet, which increased the risk of unsustainable practices (Tewfik et al., 2008). Whilst the supply of fishing gears in Vanuatu has no doubt supported the recovery of both food and income, consideration should also be given to the longer-term impacts of more destructive fishing gears such as nets and spearguns. Following Cyclone Winston in Fiji care was taken to distribute 'sustainable' fishing gear to affected communities to support their recovery while limiting impacts on already degraded reefs (Chaston et al., 2016).

In the immediate post TC-Pam impact assessment, fish aggregating devices (FADs) were identified as a means to provide access to an alternative source of fish (open ocean pelagic fish such as tuna) while giving time for reef fisheries to recover (Bell et al., 2017). Whilst the Vanuatu Fisheries Department recognized the role of nearshore FADs in fisheries management, and there were many FADs in place prior to TC-Pam, most were lost during the cyclone. However, despite equipment being provided to the Government of Vanuatu for post TC-Pam FADs, the lack of human resources to deploy the FAD materials provided has meant the desired outcome was not reached, at least not in the short to mid-term. The Vanuatu Fisheries Department is now putting strategies in place to deploy FADs more quickly in the event of disasters (Bell et al., 2017). This scenario is synergistic with the provision of materials for communities to rebuild common infrastructure lost such as schools

and community halls, while households were left to rebuild their own homes with limited material and human resources to do so. While the provision of materials is of great importance in a post-disaster context, there is also a need for donor and disaster recovery teams to consider the broader limitations on human resources in the recovery phase. The multiplicative impact of first the cyclone and then the drought, added up to a significant burden and allocating time to prioritized activities was a noted issue. Time constraints lead to people wanting to maximize direct benefit (e.g. food or shelter) from their input, and this is an important factor to consider when designing disaster relief programs. For example, fishers are more likely to resort to established and proven fishing practices, rather than picking up new skills while they are recovering from disasters.

5. Conclusions

This study illustrates that fish, fishing, and fisheries management is at the center of disaster relief and recovery for Pacific Island communities. Recognizing the humanitarian value that well managed fisheries resources can play while coping with hardship from natural hazards adds another dimension to the imperative of improving management of coastal fisheries and aligning policies across sectors.

The management strategy taken in Vanuatu exemplifies how areas and species that have been under protection can constitute a ‘safety net’ if allowed to be accessed to cope with natural hazards. Protected areas are often implemented across a range of environments under rigid ‘no-access’ or ‘no-take’ rules to meet conservation goals. During times of crisis, this restriction of access to natural resources can exacerbate hardship (McSweeney, 2005; Naughton-Treves et al., 2011). As experienced in Vanuatu, a more flexible management approach allowed protected areas to be utilized as reservoirs of food and income when temporarily opened to assist recovery. This approach may generate a greater level of legitimacy and societal support for protected areas.

What lessons have materialized about the role of fish in post-disaster recovery, and how can those lessons be used to guide future interventions? Given the tendency for natural disasters to have disproportionate impacts on terrestrial food and income generation systems, marine resources have played an important role in post-disaster recovery in Vanuatu. Consideration for policy and planning should be given to:

- High value commodity species such as sea cucumber (*beche-de-mer*) and trochus can provide an opportunity for rapid injection of cash into communities in the short-term (1–6 months) after a disaster. The role of these resources for this purpose should be considered in their management.
- Provision of fishing gear to aid recovery can be an important recovery tool however care should be taken to ensure ‘sustainable’ gear is provided and gear does not exceed that which existed prior to the event.
- Fish aggregating devices have potential to aid in recovery in the medium term (6–12 months) if they are deployed immediately after the event. Priority needs to be given to not only equipment provision but also resources to rapidly deploy FADs in target areas, and ensure physical capital (e.g. vessels) is sufficient to access FADs. Catch augmenting initiatives must be accompanied with appropriate safety training and equipment to ensure that communities can fish safely around FADs.
- Implement fishing method training programs to ensure all sectors of the community have an opportunity to utilize fisheries to recover from disasters and more sustainable or underutilized fisheries can be accessed (e.g. scads).
- Lack of access to markets is currently limiting the use of fisheries for income and distribution of nutritious fish in post-disaster recovery in rural Vanuatu. But caution is required when providing physical capital that enhances efficiency (e.g. solar freezers) to improve market access as this can lead to further overexploitation of reef

resources.

- For SIDS, fisheries policy and disaster preparedness could consider flexible use of spatial closures through the opening of protected areas by governments and communities to increase access to fish for food and income during emergencies.

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