



# Community-based adaptation to climate change in villages of Western Province, Solomon Islands

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## ABSTRACT

People, local cultures and the environments they live in are complex and dynamic social-ecological systems that have evolved together over time and are continually affected by a myriad of factors, including climate and global changes. Escalating climate and global changes present an imminent threat to Pacific communities, particularly for food security, livelihoods, health and safety, cultural identity and biodiversity conservation. A participatory community-based climate change adaptation planning process was used to engage with communities on Rendova Island in Western Province, Solomon Islands to identify local adaptation priorities. The methodology recognized that local community members are the managers of the resources they use daily, have direct knowledge of the status of key local resources and have direct influence over ongoing resource governance. The study focused on two objectives: (1) identifying community priorities and documenting them in adaptation plans intended for local implementation, and (2) evaluating whether community adaptation priorities addressed key vulnerabilities identified independently using a semi-quantitative vulnerability assessment.

The adaptation priorities identified by the communities encompassed: governance, leadership and planning; farming and livestock; sustainable livelihoods; natural resource management; and youth capacity building. The community adaptation priorities were found to address the key climate change vulnerabilities identified in the semi-quantitative assessment and also addressed additional drivers of social vulnerability and adaptive capacity. This finding reiterates the importance of fully inclusive and participatory vulnerability assessments and community-identification of adaptation priorities coupled with scientific climate projections to comprehensively assess the complexity of social-ecological systems. The climate change adaptation priorities have informed ongoing local actions and are intended to be used by communities, government and NGOs to focus local effort, funding and project development. A review of the suitability of the adaptation priorities by similar villages on neighbouring islands would determine the utility of scaling-up and applying these adaptations to other rural communities in the Solomon Islands, and possibly more widely in other Pacific communities.

## 1. Introduction

Coastal and inland populations of the Solomon Islands are primarily subsistence-based communities, relying on local fisheries and household gardens for food, with minimal involvement in cash-based economies (DFAT, 2019, SINSO, 2017, Bell and Taylor, 2015). In 2019, the population in Solomon Islands was 670,000 with an estimated growth rate of 2.2%; one of the highest growth rates in the Pacific region (ADB, 2019). Over 80% of the population is living in rural communities with limited access to basic services such as sanitation, water,

electricity and communications. Governance tends to be local with more than 90% of inshore coastal areas (both land and sea) under customary tenure as recognized in the Solomon Islands National Constitution (Govan et al., 2013). Dependence on local resources is therefore high with 75% of fish and invertebrates caught in the Solomon Islands used for subsistence food by coastal communities, providing an average of 115 kg/person/year, and small-scale coastal fisheries are an important source of local income (Bell et al., 2018; Johnson et al., 2017).

These social-ecological systems (SES) are continually changing due

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to dynamic local ecological processes, natural resource availability, resource management, population pressures, cultural practices, governance, and external drivers. As part of this dynamic SES, traditional knowledge, social structures and culture have developed in accordance with the local environment and through generations of experience with managing natural resources and coping with climate variability and extreme events (Cinner and Aswani, 2007; Malsale et al., 2018).

The global issue of climate change is increasingly becoming a local concern as Solomon Island communities experience impacts. For example, communities in the Western Province report unpredictable weather patterns, increasingly intense storms, drought, coral bleaching, sea level rise and inundation, and coastal erosion. Resources that are instrumental to local livelihoods, including fisheries and agriculture, are directly affected by climate variability and change, including altered rainfall patterns, increased storm intensity, increased air and sea temperatures, saltwater intrusion and ocean acidification (BOM and CSIRO, 2014; Bell et al., 2013, 2018).

Climate variability and change cause reef habitat and productivity declines negatively impacting coastal fisheries (Goby et al., 2013; BOM and CSIRO, 2014; Bell et al., 2013, 2018). Increasing village populations also continue to place pressure on these coastal fisheries (Bell et al., 2011a, 2011b, 2018; Bell and Taylor, 2015) and other natural resources (Albert et al., 2012; Bell et al., 2015). The projected declines in coastal fish and invertebrates due to climate change will widen the gap between fish needed by growing human populations and sustainable harvests, with shortages expected in Solomon Islands as early as 2035 (Bell et al., 2011b; Bell and Taylor, 2015).

Climate change also affects the agricultural sector by threatening crop viability. Agricultural commodities that are important as food (e.g. sweet potato, yam) and cash crops (e.g. coconut, cocoa) are expected to decline due to climate impacts (Bell and Taylor, 2015; Taylor et al., 2016), further exacerbating the demand on limited natural resources. Drinking water supplies may be threatened by drought, increased intensity of rainfall events resulting in increased flooding, runoff and reduced groundwater recharge, and saltwater intrusion in aquifers. Homes and community infrastructure (e.g. cemeteries, village halls) on low-lying land are also exposed to higher seasonal extreme tides and increased storm surge, exacerbated by sea-level rise and increased storm intensity (BOM and CSIRO, 2014).

Global change, including the growing presence of market economies, adds further complexity to local system dynamics. External markets may increase the economic value of resources previously used for subsistence and cultural purposes, thus increasing resource exploitation for cash income (Friedlander et al., 2013). Communities may choose local leaders whom have knowledge of market economies and a western education over leaders whom have traditional knowledge. These changes in valuation and governance could influence the traditional management of local resources and could affect the balance of the SES, including local cultural identity.

These emerging factors can influence social-ecological resilience, “the capacity of the system to continually change and adapt and yet remain within critical thresholds” (Berkes and Ross, 2013), or increase vulnerability, “susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt” (Adger, 2006) of a community. Communities with lower resilience and increased vulnerability are most at risk from global climate change.

According to Berkes and Ross (2013), increasing resilience “...can be accomplished by actively developing and engaging the capacity to thrive in an environment characterized by change.” The key attributes that engender resilience in social-ecological systems (Ostrom, 2009), and specifically in Pacific communities (Ensor et al., 2016), include:

- Good governance and leadership involving inclusive decision making that considers short- and long-term perspectives, implementation and enforcement,

- Cultural identity encompassing social structure, traditional ecological knowledge, cultural pride, and land rights,
- Inclusive communities harbouring gender inclusion, partnerships, and communication,
- Access to clean water, sanitation, health care, and food,
- Sustainable management of natural resources to meet local needs,
- Shared community long-term vision,
- Learning-by-doing and/or via connections to others, and
- Ability to stabilize favourable situations, navigate change and alter unfavourable situations.

The community-based climate adaptation planning process discussed in this paper was designed to support these key attributes, drawing on local expertise and customary resource management knowledge and thus increasing community resilience to climate change (McMillen et al., 2014; Ensor et al., 2016). As an inherently place-based approach, the planning process must account for the complexity of local social-ecological dynamics and priorities. This integration is achieved through a high level of trust and community engagement and input, over a long duration to establish meaningful relationships and understand community priorities and drivers. Communities living on traditionally-managed lands in Solomon Islands are not only local natural resource managers but also, through the collective experiences of the community, community members can be considered local experts on the current status of resources and potential strategies for adaptation (McMillen et al., 2014). Community member participation and initiative, with representation of the various sectors of the community and marginalized groups, is therefore instrumental to identifying relevant adaptation actions (Berkes, 2017; Forsyth, 2017) that can build and sustain social-ecological resilience in the face of climate challenges. Drawing on these foundations, and recognizing the paucity of published papers on community-led participatory processes in this field, the findings presented here are intended to contribute to our knowledge of community-adaptation processes and place-based priorities in the Pacific region.

### 1.1. Overview: Rendova Island, Western Province, Solomon Islands

Baniata and Lokuru are communities on Rendova Island, in the Western Province (Fig. 1), northwest of the capital, Honiara. Baniata village has a population of 533 people (approximately 342 adults), and Lokuru is considered a district, divided between eight communities, with a total population of 1065 people.

The Baniata community is largely subsistence, relying on locally caught fish and shellfish, garden crops, forest nuts, and groundwater for food, water, construction materials and livelihoods. The primary cash expenses are school fees, supplemental food and fuel for sea transport. Income is primarily generated through sale of copra, garden produce and forest (*ngali*) nut. Village leaders and key decision makers are the heads of the various tribes within the community and church leaders. Climate events and other natural disasters have been a feature of the village history with tropical cyclones, tsunamis and earthquakes all experienced in the last 50 years. Many changes to natural and social resources in Baniata have been observed and are expected to continue due to both social and climate factors.

While the Lokuru community has traditionally been largely subsistence-based, there is a growing dependence on a cash income, earned primarily by the sale of copra and complemented by the hosting of events and sale of garden produce. There is also significant dependence on locally caught fish and shellfish, garden crops, forest nuts and groundwater for food, water, construction materials, and livelihoods. However, community members report inadequate coconut plantations to supply the district's coconut consumption and copra production and inadequate forest resources, which necessitates the purchase of building materials. Expenses include school fees, supplemental food and fuel for sea transport. When copra prices are high, gardens are left unattended

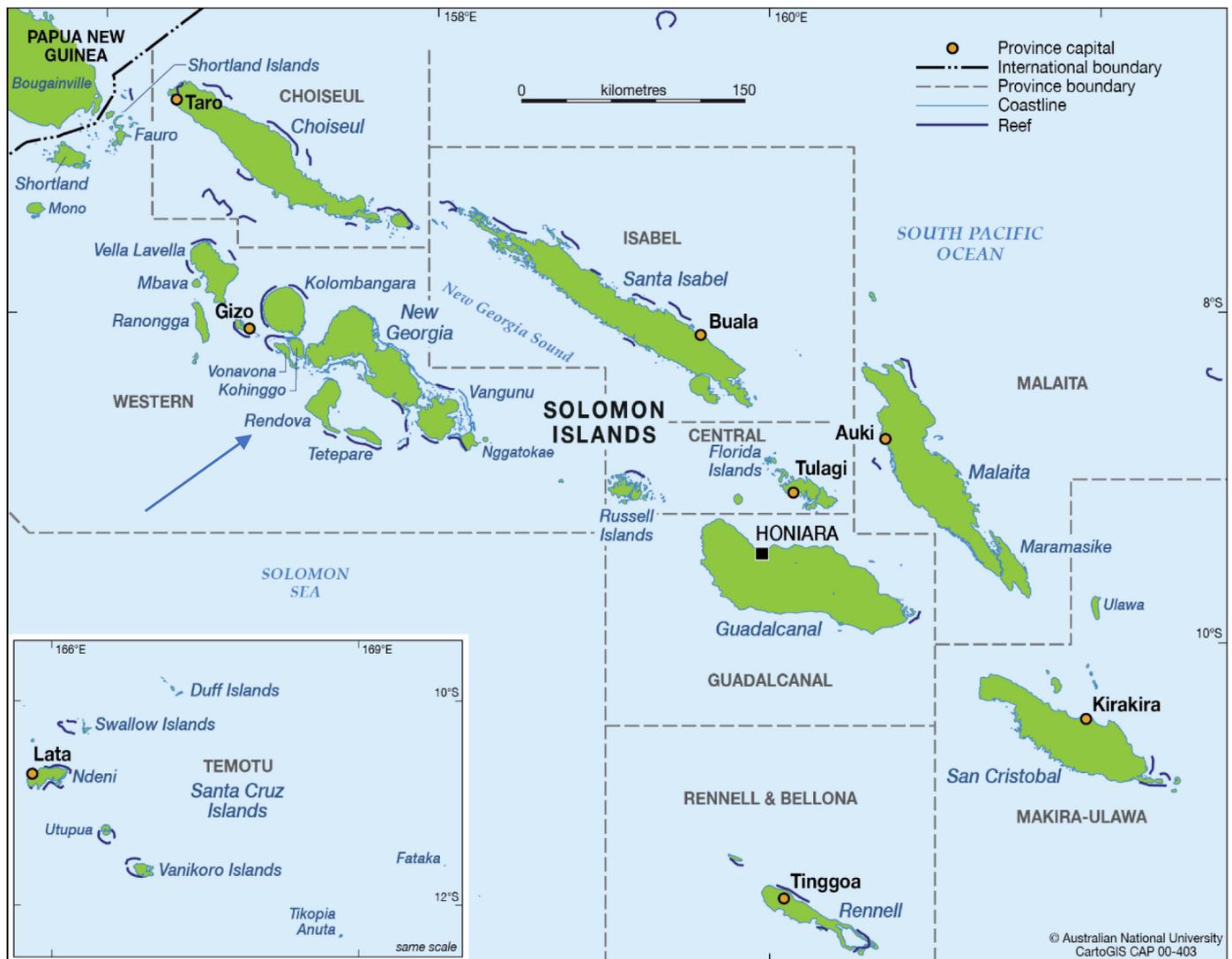


Fig. 1. Map of Solomon Islands and location of Rendova Island in the Western Province.

as community members dedicate their time to copra production, leading to food shortages a few months later. Village leaders and key decision-makers are the heads of the different tribes within the community and church leaders. Climate events and other natural disasters have been features of the district's history with tropical cyclones, tsunamis and earthquakes all experienced in the last 50 years. Many changes to natural and social resources in Lokuru district have been observed and are expected to continue due to both social and climate factors.

## 2. Methods

The selection of the two communities that were selected to participate in the climate change vulnerability assessment, adaptation planning and implementation of actions was based on factors considered to be prerequisites for success (e.g. strong leadership, willingness to participate, existing governance structures, feasible logistics etc.). Additionally the selected community members were aware and concerned about climate change impacts, and had specifically indicated interest and support to address these concerns. Furthermore, they had demonstrated a commitment to manage local resources by maintaining a conservation project on nearby Tetepare Island, as well as a turtle conservation program on local beaches, for over 10 years. The remoteness of these villages also meant that local capacity and self-reliance will be important for building community resilience to climate change. These factors were considered key to selecting these communities and delivering a successful project.

Developing a relationship with the two communities built on the work of the Solomon Islands Community Conservation Partnership (SICCP), that had an existing 5-year relationship with the communities, that helped establish a strong trust base for the study. The adaptation planning process built upon these well-established relationships and also utilised local community coordinators to help facilitate gaining trust and permissions. The Community Coordinators also understood

**A Portrait of Daily Life:** As a Solomon Islander on Rendova Island, most of the food you eat comes from what your family produces in a small household garden and what you catch from the surrounding ocean. Changing rains are affecting how much food you can harvest. Rising sea temperatures and ocean chemistry are threatening the coral reefs and fisheries you depend on. More intense storms can turn your drinking water brackish (Drawn from LEAP workshop participant statements in Baniata and Lokuru communities, March 2017). What can you do within your own community to protect yourself against these challenges? How can local government or NGOs support you? And, how do we know that actions are actually going to help?

local governance and decision-making structures. One male and one female Community Coordinator (from each community) were nominated by village leaders and received training at a 3-day workshop on climate variability and change by external technical experts. Coordinators had an ongoing role in the village to deliver awareness on climate issues and actions, and to support implementation of adaptation actions within each of their own communities. Representatives from two other communities (Mbiche and Peava on Gatokae Island) were also provided an opportunity to participate in the workshop with the intention of facilitating both broader climate change awareness, and the development of a knowledge exchange and learning network in the region.

After the Coordinator training, 3-day community workshops with village participants were conducted, facilitated by the Community Coordinators. The objective of the workshops was to complete the first stages of the planning process: assess vulnerability and identify priority adaptation actions to be later used by village leadership to finalize a community-based adaptation plan to be implemented by the community. To meet the objective, the workshops were designed to: (1) provide participants with a basic knowledge of climate change and what impacts are expected in their own village, (2) document the key resources (social, human, financial, physical, and natural) in each village, (3) document changes observed to date and discuss whether these changes are driven by climate and (4) identify priority adaptation actions intended to minimise the potential future impacts of climate change. The workshops were accompanied by awareness sessions with the broader community to deliver information on climate change, potential impacts, and what other Pacific communities are doing to address climate impacts.

Awareness sessions avoided scaring communities about climate change, but rather emphasised the slow onset nature and possible benefits, and community observations of actual changes, while also highlighting the need for adaptation actions. Awareness raising and participatory planning were designed to empower community members and recognize the importance of their own existing expertise and traditional knowledge for adapting to the challenges associated with climate variability and change. Equally important was the inclusion of vulnerable and marginalized groups, with special attention dedicated to gender (Kleiber et al., 2019) and youth (Schwarz et al., 2014) through direct invitation to the assessment and implementation process, and smaller targeted discussion groups where male and female participants worked separately to generate information and identify adaptation actions.

Over a 10-month period, background information on the community structure, governance and use of natural resources was collected from interviews with all relevant groups within the two communities (including decision-makers, men and women, elders and youth). Information was also collected from Provincial and National Governments, where available, including but not limited to data on fisheries, land use, forestry, agriculture and health. The data were triangulated for verification, and every effort was made to identify jurisdictional and geographic boundaries of each community, and the relevant neighbouring communities that may share resources and influence upstream and downstream dynamics. Local and national governments were also engaged in the project planning and implementation stages and participated in community meetings and technical workshops. An analysis of Solomon Islands government and community climate change priorities and strategies was also incorporated into the project planning.

After background information was collected and analysed, two parallel vulnerability assessments were used: (1) a modified Local Early Action Planning (LEAP) methodology completed with workshop participants and (2) a semi-quantitative vulnerability assessment completed by facilitators. The LEAP constituted an initial assessment of community-identified key vulnerabilities and priorities. The semi-quantitative assessment independently calculated key vulnerabilities to address in

the community. Results from the semi-quantitative assessment were shared with the workshop participants and, in conjunction with the LEAP-generated results, were used by the participants to identify local priorities for adaptation actions. The community-identified and selected actions were intended to be implemented by the community and/or with the support of local organizations and government. The priority adaptation actions identified through the methodology were immediately delivered to local leadership by the Community Coordinators at the end of the 3-day workshop.

The methodology applied incorporated two complementary vulnerability assessment methods to increase the rigor of results. First, a community-based assessment (CBA) method – LEAP (Local Early Action Planning) (Gombos et al., 2013) – was applied as a participatory and inclusive tool. The principal learning from previous use of the LEAP in Solomon Islands (and other Pacific nations) is that the methodology is overly complicated in the community context (Cohen et al., 2014). Therefore, a simplified version was used, particularly with a focus on the language and key messages delivered to ensure better understanding and engagement by communities. Awareness materials were in Solomon Islands Pidgin with special attention paid to language being simple, accurate and easily understood. Awareness sessions included interactive and experiential activities with demonstrations, videos, and local examples of traditional actions. A variety of educational techniques were used to facilitate a complete understanding of the materials and increase engagement by communities. In gender-divided breakout groups of approximately 5–7 individuals, workshop participants completed the following activities adapted from the LEAP methodology (Gombos et al., 2013): (1) through drawing a map of the community, breakout groups identified key resources that community members perceive as being most important to local livelihoods and well-being, (2) breakout groups created a seasonal calendar to identify the expected versus the actual status of key resources through the seasons and (3) breakout groups drew a disaster timeline outlining the community's living memory of natural disasters, responses strategies, and resources for disaster recovery. After completing each of the above activities was completed in the breakout groups, the breakout groups reconvened as a larger group to discuss the results of each group and synthesize activity results to represent the larger group. Finally, the larger group participated in a facilitated discussion to identify key and current livelihood and resource challenges.

During each activity, facilitators captured data on uses, trends and status of key resources, experienced seasonal changes, observations of climate impacts and local knowledge, in addition to data on historical and existing adaptive capacity. The process resulted in a participant-generated assessment of the community's key vulnerabilities, priorities, and an initial identification of potential adaptation actions.

Concurrently with workshop activities, a semi-quantitative vulnerability assessment (Johnson et al., 2016) was also implemented. The assessment evaluated available data, including scientific information such as climate change projections, climate hazards, condition and trends of key resources, resource dependence, governance, education and health. Additionally, the data collected during the LEAP process were analysed according to the method outlined in Johnson et al. (2016) that uses multiple indicators for exposure, sensitivity and adaptive capacity to identify key resources that are most at risk from projected climate change, and the underlying drivers of this vulnerability. Rigorously assessing sensitivity and exposure of the system and community to climate change to determine the vulnerability or risk (e.g. Johnson et al., 2016; Cinner et al., 2013) was an important component of the assessment.

The community-based and semi-quantitative vulnerability assessment methods were combined to: (1) allow for comparing assessment results and increasing the probability of identifying adaptation priorities that were most likely to address key vulnerability, were locally appropriate and could facilitate positive adaptation (for full method see Johnson et al., 2016) and (2) identify targeted actions that were

**Table 1**  
Highly vulnerable resources in two study sites, and underlying causes, based on vulnerability assessment results.

Vulnerable resources	Source of vulnerability – Baniata	Source of vulnerability – Lokuru
Garden crops	<ul style="list-style-type: none"> <li>• Exposure to climate hazards</li> <li>• Exposure to non-climate hazards</li> <li>• Need for improved/best gardening practices</li> <li>• Limited alternatives to food crops</li> </ul>	<ul style="list-style-type: none"> <li>• Exposure to climate hazards</li> <li>• Exposure to non-climate hazards</li> <li>• Need for improved/best gardening practices</li> <li>• High dependence on crops for food</li> </ul>
Coral reefs and fish	<ul style="list-style-type: none"> <li>• Reef condition declines</li> <li>• No current management</li> <li>• Limited alternative to fish for protein</li> </ul>	<ul style="list-style-type: none"> <li>• Poor reef condition</li> <li>• No current management</li> <li>• Limited alternatives to marine resources for protein</li> </ul>
Water sources	<ul style="list-style-type: none"> <li>• No current water management</li> <li>• High community dependence on vulnerable water resources</li> </ul>	<ul style="list-style-type: none"> <li>• No current water management</li> <li>• Water sources and infrastructure exposed to climate and non-climate hazards</li> <li>• High community dependence on vulnerable water resources</li> </ul>
Rivers and streams	<ul style="list-style-type: none"> <li>• No protection of buffer/riparian zone</li> </ul>	<ul style="list-style-type: none"> <li>• Decline in quality of water resources</li> <li>• Exposure to climate and non-climate hazards</li> <li>• No protection of buffer/riparian zone</li> <li>• Decreased integrity of riverbed</li> </ul>
Beaches and shoreline	<ul style="list-style-type: none"> <li>• Exposure to climate hazards</li> <li>• No current management</li> </ul>	<ul style="list-style-type: none"> <li>• Exposure to climate and non-climate hazards</li> <li>• No current management</li> </ul>
Village infrastructure	<ul style="list-style-type: none"> <li>• Some parts of the village, including important infrastructure, in low-lying areas</li> </ul>	<ul style="list-style-type: none"> <li>• Degraded coastal reefs reducing coastal protection</li> <li>• Some parts of the village, including important infrastructure, in low-lying areas</li> </ul>

identified and agreed to by communities and will be implemented according to the priorities, expertise, and traditional practices of the community, using local knowledge, capacities and resources.

The results of the semi-quantitative vulnerability assessment were presented to the communities in the subsequent workshop session. Drawing from the results of both vulnerability assessments, workshops participants were then facilitated to identify locally-appropriate possible adaptation actions to address each key vulnerability. Once possible adaptation actions were identified, the community participants and facilitators evaluated the potential actions for possible co-benefits and maladaptation outcomes before selecting priority actions. In cases where maladaptation outcomes were possible, more sustainable versions of these actions were explored (e.g. an agro-forestry or eco-timber approach instead of indiscriminate clearing, agroecological farming methods to “increase crop productivity” rather than applying chemical fertilisers, sustainable sources of firewood to address “not enough firewood” instead of cutting trees, using sustainable fishing practices and protecting juvenile fish to improve “food security” instead of using more destructive practices like small mesh nets and small hooks). Finally, priority adaptation actions were delivered by Community Coordinators to local leaders and councils for internal discussion among the community and the development of a community-led adaptation plan.

During workshop activities, the discussions focused on the main vulnerabilities and key steps that might be taken to reduce sensitivity and increase adaptive capacity, thereby increasing resilience and building a ‘stronger’ community. The process supported local communities to be able to generate an adaptation plan based on the vulnerability assessment results with specific adaptations actions for food and water security, livelihoods, health and conservation. The focus on local traditional knowledge, resources and community implementation was aimed at increasing community-level adaptive capacity and ownership rather than relying on external support or resources. Reducing this reliance on external support also avoids creating new vulnerabilities or dependencies that then need to be addressed or minimised.

The methodology used was designed to identify priority adaptation actions that are intended to be appropriate for the local social-ecological context, however, it is recognized that there are challenges for implementation. For example, results may not represent all of the knowledge and priorities within the community because of internal divisions between community members or groups and cultural gender roles (Forsyth, 2017). Similarly, priority adaptations may require some

initial resources or skills that are not available. These factors need to be considered when implementing adaptations.

### 3. Results

The 3-day participatory workshops at each project village site had representatives from a range of local groups, religious denominations and community roles, as well as government partners, including Western Provincial Government and the National Ministry for Environment, Climate and Disaster Management. Approximately 40% of the community representatives that participated as Community Coordinators and workshop participants were female. The workshops provided multiple opportunities for community members to share knowledge and experiences in coping with changes in climate, seasons and resources, and local practices they currently adopt to cope with climate variability and uncertainty. The outputs of the LEAP process were a series of traditional knowledge products developed by participants in gender separated breakout groups. These products helped to focus workshop discussions and inform the adaptation planning process. The products included: (i) community maps of important local resources and observations of how these have changed over time, (ii) a historic timeline that recorded key events, particularly extreme climate hazards, within living and ‘story’ memory (including major impacts of these events and how people prepared beforehand or coped afterward), (iii) seasonal calendars that documented ‘normal’ yearly weather patterns, key ecological events and productive activities (allowing identification of changes that are occurring and the resulting ecological and social impacts) and (iv) diagrams of a ‘strong’ (resilient) community and a ‘weak’ community, with discussions about what makes communities stronger in the face of climate-related and other changes.

All participants were active contributors to the workshop activities and discussion. Participants collectively agreed that awareness had been greatly increased about climate change implications for Baniata and Lokuru and that they would maintain an active role in implementing adaptation actions.

#### 3.1. Vulnerability assessment results – Baniata & Lokuru

The participative assessment based on the LEAP (Gombos et al., 2013) and the semi-quantitative method outlined in Johnson et al. (2016) used multiple indicators for exposure, sensitivity and adaptive capacity to identify key resources that are most at risk from projected

climate change, and the underlying drivers of this vulnerability (Table 1).

In the participatory activities, community representatives identified current issues and climate impacts on key resources, based on local experience. These representatives then incorporated the results of the vulnerability analysis to systematically identify potential adaptation actions to minimise negative impacts and promote a resilient community. The list of potential adaptation actions was extensive and covered all resources that had been identified as important in each village. Given the large scope of potential adaptation actions, participants were facilitated to critically review all potential actions and select priority actions that could be implemented locally with minimal cost, including making requests to appropriate institutions for capacity building workshops. Finally, an implementation schedule was drafted by the participants. To facilitate the ease of implementation, the schedule identified tasks, subtasks, timelines, the responsible individual and the resources necessary to accomplish the action. This preliminary plan was then offered by the Community Coordinators to the village members for approval during the community council in each respective community, and consequentially, implementation was overseen by the Community Coordinators. Once approved, the written plans were displayed publicly in each community.

### 3.2. Community adaptation priorities

Overall, adaptation priorities selected from this process were consistent between the two communities. Here they can be grouped into the following categories: (1) Governance, leadership and community planning, (2) Improved health and sanitation (3) Farming and livestock, (4) Sustainable livelihoods, (5) Natural resource management and (6) Youth capacity building.

#### 3.2.1. Governance, leadership and community planning

Governance, leadership, and community planning were identified as being foundational to successful long-term adaptation in relation to community cohesion, local resource management (forest, water and fisheries), and disaster risk reduction. The participants expressed the need to improve leadership and community cohesion, especially between church leadership and the organization of the community. To this end, participants suggested leadership training and joint meetings. Capacity building workshops (including how to make traditional cyclone shelters) were also identified as a priority action that could improve disaster preparedness and reduce disaster risk. Participants suggested further reducing disaster risk by increasing tele-communications through VHF radios and/or phone towers, which have been previously offered to the community by the local telecommunications provider. However, participants also highlighted that the installation of phone towers has received local resistance because of cultural beliefs. The installation of towers would require awareness raising and gaining community-wide approval.

#### 3.2.2. Improved health and sanitation

Both communities suggested health workshops building knowledge and awareness about the negative impacts of store-bought foods versus traditional foods on health. Improved drinking water quality, water sources, sanitation and water supply systems and the protection and replanting of riparian/buffer areas were also identified as key priorities. Results also suggested that waste management plans could help address concerns related to health.

#### 3.2.3. Farming and livestock

Both communities are heavily reliant on small-scale agricultural production for subsistence with limited access or links to market economies. According to participants, a growing population has increased the area under cultivation, decreased fallow times, decreased soil productivity, decreased agricultural yields, and increased

deforestation. They also attributed reduced production to moving away from traditional production methods, including the tools used, and changing rainfall patterns. Participants reported that changing farming practices are also negatively impacting the integrity of the water catchment, quality and quantity of drinking water and increasing the occurrence of erosion and landslides.

Given these current challenges and projected future climate impacts on agricultural production, participants agreed on the need for improved farming practices based in agroecological and traditional methods. Possible improved practices they identified included: diversifying cultivars, traditional management of pests, and increasing yields in smaller areas. There was also interest, on a pilot basis, in establishing permanent farming plots, made possible by using agroecological techniques to build organic material, retain soil moisture, increase available nutrients and improve soil health, instead of the current rotational production system.

There was also concern about the productivity of coconut plantations, as coconut is a key agricultural crop on Rendova Island for local consumption and for the production of copra for sale, one of the few cash crops produced in the villages. Coconut plantations are senescent since the traditional practice of continually planting new trees has been lost in recent decades. Participants identified the need for replanting and/or rehabilitating coconut plantations.

#### 3.2.4. Sustainable livelihoods

The need to promote sustainable livelihoods was highlighted in the adaptation planning process. Participants emphasised the need to strengthen and diversify livelihoods while improving links to local markets. Possible alternative livelihoods that the community expressed interest in are: (i) honey farming, which if done appropriately and with careful consideration of not disrupting endemic pollinators, may support local, production, biodiversity and climate resilience, (ii) *ngali* nut production and sale, (iii) eco-tourism with a focus on local reefs and turtles, (iv) local handicrafts (*lavalava* dyeing, floral arts, carving, sewing, weaving baskets, etc.), (v) baking and (vi) poultry and pig production for sale.

#### 3.2.5. Natural resource management

Community members agreed the improved management and protection of natural resources, for the sustainable use of these resources, as well as for disaster risk reduction, is necessary. Shorelines require increased protection, including the replanting of trees and coastal vegetation to stabilize sediment. Forest resources, currently used for building, traditional medicine, cooking fuels and timber sales, need equitable, inclusive, and sustainable community forestry management plans. These could include sustainable teak forestry and/or other sustainable harvesting of trees and forest resources. Improved forestry management was identified as also being important for protecting the water catchment, increasing water quality and availability and reducing erosion and landslide risk.

Given current pressures and climate projections, participants recognized the need for a fisheries management plan, including a community-based marine protected area and fisheries harvest restrictions. This adaptation priority would need to build on the existing structure of *tabu* (no take) areas, a traditional resource management practice that has been used less frequently and effectively in recent years due to cultural change and weakened local governance systems.

#### 3.2.6. Youth capacity building

The final category that was emphasised in the adaptation priorities was youth capacity building. Youth capacity building was discussed in terms of: (i) institutionalised education and the need to generate income to pay for school fees and (ii) youth learning about the importance of healthy water catchments, protecting riparian zones, agroecological/traditional farming practices, sustainable fisheries and marine habitats, waste management (reducing-reusing-recycling), not

littering and traditional knowledge and culture.

#### 4. Discussion

The priority adaptations identified by the communities of Baniata and Lokuru represent a comprehensive set of actions that address the climate vulnerabilities detected by the LEAP and semi-quantitative assessment. In addition to addressing these vulnerabilities, community priorities also recognize social drivers of vulnerability and resilience that are important for building stronger communities in the face of future change.

The results suggest that the use of the semi-quantitative assessment can complement the LEAP methodology as a means of validating whether priority adaptation actions are likely to facilitate positive adaptation outcomes and target key vulnerabilities for ecological and natural resource-related drivers. Additionally, this combination of methods also addresses one of the limitations of CBAs; that traditional knowledge is the generational and localized experience of communities and may not be able to predict or fully account for future climate and global changes. This necessitates the integration of scientific climate change projection data, traditional knowledge and local experience of current and historical impacts to develop appropriate adaptation options. The LEAP methodology calls for the collection and incorporation of this scientific data; the semi-quantitative assessment met this need.

A key finding is that the adaptation actions identified by community participants address key social factors that were not included in the scope of vulnerability evaluated in the semi-quantitative assessment. This included leadership and youth capacity building. Key social factors underpin a community's adaptive capacity and must remain healthy/strong to maintain a resilient community. These factors are high education rates (including local and traditional knowledge), a healthy population and good governance. In 2017, only 28% of adults in Baniata have completed high school and as few as 8% have a tertiary education, thus these factors were potential drivers of vulnerability. As a result, the implementation of actions that address social factors, as well as the management of key natural resources, is important.

The use of the two methods – the semi-quantitative assessment and the LEAP – is an effective combination for a fully inclusive and participatory process. Including a representation of the diversity of groups in the community, particularly gender (Kleiber et al., 2019) is also essential to collect a complete and meaningful data set and facilitate the development of an appropriate local adaptation plan. As previously discussed, community-driven adaptation is important for generating successful adaptation outcomes, and is also central to identifying additional social drivers, or other local drivers, that are not accounted for in the current version of the semi-qualitative vulnerability assessment. This study indicates that the combined methodology allows for a comprehensive vulnerability analysis and adaptation planning process that is scientifically rigorous and also place-based, specifically accounting for the local context and culture.

The results of this study confirm that Rendova communities rely heavily on local natural resources for food, income and wellbeing. This confirms the importance of supporting sustainable natural resource management by local resource managers (WorldFish, 2013), by building local capacity and reversing the loss of traditional knowledge and governance that has been attributed, in part, to rapid urbanisation and an emphasis on western science (Brahya, 2006; Plotz et al., 2017). Ostrom (2009) argues that the ability to self-organize effectively for the traditional management of local natural resources is central to the sustainability of a SES, necessitating the need to strengthen leadership and governance and have good succession planning in communities. Additionally, the community priority of building capacity in youth as future natural resource managers is the cornerstone of long-term sustained resilience of the local system. Community discussions and adaptation priorities did not limit the need for youth capacity building to increasing rates of secondary and tertiary education but instead

highlighted the need to educate youth about local ecological, production and traditional knowledge – the totality of the SES of which they are an integral part.

While the participatory process discussed in this paper focused on developing and identifying priority adaptation actions to address current and expected climate-related impacts, completely isolating and differentiating climate-factors from non-climate factors that are driving community vulnerability is neither possible nor desirable. As a result, a prioritisation process to identify adaptation actions that could address both climate and non-climate drivers, and therefore holistically increase community resilience to a range of future shocks and changes, is important. For example, degraded coastal reefs that provide protection from large storm events, or that are important for food resources, may be degraded as a result of both poor management and climatic factors. Addressing this vulnerability through improved management and minimising impacts can positively influence food security, livelihoods, governance and disaster risk reduction. This integration of results to deliver both climate and non-climate benefits to communities is key to engendering ownership and long-term sustainability of actions.

#### 5. Conclusions

Our findings suggest that successful community-based adaptation planning processes: (1) account for the complexity of SES, (2) comprehensively address local social-ecological drivers of vulnerability and resilience including food security, governance, health and education and traditional knowledge, (3) account for scientific projections of impacts from climate and global change and (4) give the community ownership of the assessment, planning and implementation process. Successful adaptation can be supported through increasing awareness, engagement, empowerment, local governance systems and youth leadership and capacity, especially as related to the management of local natural resources. The empowerment of place-based and culturally-derived resource management and adaptation actions are central to achieving sustainable outcomes. Valuing actions that are not focused only on climate impacts can also positively influence the adaptive capacity and resilience of the community to multiple pressures.

A whole-systems approach was effectively achieved through the combined use of the LEAP and semi-quantitative vulnerability assessment. This combined approach can be beneficial to future projects if special attention is given to accounting for key social drivers in the development of community adaptation priorities.

According to our findings, initiatives in Rendova communities that aim to reduce vulnerability while increasing adaptive capacity and resilience to climate and non-climate related impacts should focus on actions that promote: (1) Strengthening of governance, leadership and community planning, (2) Improved health and sanitation, (3) Improved farming practices based on agroecology and traditional methods that will increase soil health, crop diversity and resilience against climate impacts, (4) Culturally appropriate sustainable livelihoods, (5) Improved natural resource management including the local management of marine resources and (6) Building the awareness and capacity of community youth, through access to secondary and tertiary education and also knowledge of the sustainable management of local ecosystems and natural resources, within the context of the culture and incorporating traditional and place-based knowledge.

Adaptation actions also need to align with other local and national priorities in order to ensure long-term sustainability and maximise efficiencies. The Solomon Islands Government National Coordinating Committee's role is to align projects with national policy and plans, and to maximise effectiveness of investment. This is further supported by the engagement of government officials throughout the project cycle. Recent and/or active local programs on Rendova that may also support implementation of the priority adaptation actions include the protection of Tetepare Island, and the associated local leatherback turtle conservation and hatchery project operated by the Tetepare

Descendants Association (TDA), Zainatina training in organic farming and ngali nut production in 2016 and the UNICEF rainwater tank program. All these programs have the potential to contribute to implementing adaptation actions and increasing the resilience of communities on Rendova to climate change.

The adaptation plans for each village were intended to cover a two-year period, with practical and achievable actions identified and overseen by the Community Coordinators. While some items are actionable immediately by the community, others (as outlined in the implementation plans) require the Community Coordinators to request capacity building workshops. The implementation of the plans will be further supported by existing relationships and initiatives, including the relationship with SICCP, the existing conservation programs, and government programs aimed at increasing knowledge and capacity to utilize improved and agroecological farming practices, promote ecotimber forestry and improve water security. The adaptation plans will require monitoring and evaluation after the two years to determine which adaptation actions were implemented, success of the actions in building community resilience and future actions to progress.

Ideally, the suitability of the priority adaptation actions identified by Baniata and Lokuru communities would be reviewed by other communities in neighbouring islands (e.g. Gadokae Island) to determine the utility of these priority adaptation actions to enhance resilience in other villages. The results from this could inform whether the results can be scaled-up and applied to other rural communities in the Solomon Islands, potentially through a learning network, and in fact other Pacific Island nations. The scaling-up and application of these results would still require engagement in each community to identify and prioritize local adaptation actions to ensure community-driven implementation but without the need to conduct lengthy resource-intensive assessments.

#### CRediT authorship contribution statement

**Britt P. Basel:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Supervision. **Gillian Goby:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing, Funding acquisition. **Johanna Johnson:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Supervision, Project administration, Funding acquisition.

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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.

#### References

- ADB [Asian Development Bank], 2019. Basic statistics 2019. Retrieved 12 June 2019. <https://www.adb.org/mobile/basic-statistics-2019/>.
- Adger, W.N., 2006. Vulnerability. *Glob. Environ. Chang.* 16 (3), 268–281. <https://doi.org/10.1016/j.gloenvcha.2006.02.006>.
- Albert, J.A., Trinidad, A., Boso, D., Schwarz, A.J., 2012. Coral reef economic valuation and incentives for coral farming in the Solomon Islands. In: Policy Brief. CGIAR Research Program on Aquatic Agricultural Systems. Penang, Malaysia. AAS-2012-14.
- Bell, J., Taylor, M., 2015. Building climate-resilient food systems for Pacific Islands. In: WorldFish, Penang, Malaysia. WorldFish Program Report: 2015–15.
- Bell, J.D., Johnson, J.E., Hobday, A.J., Ganachaud, A., Gehrke, P., Hoegh-Guldberg, O., Le Borgne, R., Lehodey, P., Lough, J., Pickering, T., Pratchett, M., Waycott, M., 2011a. Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change: Summary for Countries and Territories. Secretariat of the Pacific Community, Noumea, New Caledonia.
- Bell, J.D., Johnson, J.E., Hobday, A.J., 2011b. Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change. Secretariat of the Pacific Community, Noumea, New Caledonia.
- Bell, J.D., Ganachaud, A.S., Gehrke, P.C., Griffiths, S.P., Hobday, A.J., Hoegh-Guldberg, O., Johnson, J.E., Le Borgne, R., Lehodey, P., Lough, J., Wabnitz, C., 2018. Adaptations to maintain the contributions of small-scale fisheries to food security in the Pacific Islands. *Mar. Policy* 88, 303–314. <https://doi.org/10.1016/j.marpol.2017.05.019>.
- Berkes, F., 2017. Environmental governance for the Anthropocene? Social-ecological systems, resilience, and collaborative learning. *Sustainability* 9 (7), 1232. <https://doi.org/10.3390/su9071232>.
- Berkes, F., Ross, H., 2013. Community resilience: towards and integrated approach. *Soc. Nat. Resour.* 26 (1), 5–20.
- BoM [Australian Bureau of Meteorology], CSIRO, 2014. Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports. Chapter 16: Vanuatu. Pacific-Australia Climate Change Science and Adaptation Planning Program Technical Report, Australian Bureau of Meteorology and Commonwealth Scientific and Industrial Research Organisation, Melbourne, Australia.
- Brahy, N., 2006. The contribution of databases and customary law to the protection of traditional knowledge. *Int. Soc. Sci. J.* 58, 259–282. <https://doi.org/10.1111/j.1468-2451.2006.00618.x>.
- Cinner, J.E., Aswani, S., 2007. Integrating customary management into marine conservation. *Biol. Conserv.* 140 (3–4), 201–216. <https://doi.org/10.1016/j.biocon.2007.08.008>.
- Cinner, J.E., Huchery, C., Darling, E.S., Humphries, A.T., Graham, N.A., Hicks, C.C., Marshall, N., McClanahan, T.R., 2013. Evaluating social and ecological vulnerability of coral reef fisheries to climate change. *PLoS One* 8 (9), e74321.
- Cohen, P., Schwarz, A.M., Boso, D., Hilly, Z., 2014. Lessons from implementing, adapting and sustaining community-based adaptive marine resource management. In: CGIAR Research Program on Aquatic Agricultural Systems. Penang, Malaysia. Lessons Learned Brief: AAS-2014-16.
- DFAT [Australian Department of Foreign Affairs and Trade], 2019. Solomon Islands country brief. Retrieved August 18, 2019, from Department of Foreign Affairs and Trade website. <http://dfat.gov.au/geo/solomon-islands/Pages/solomon-islands-country-brief.aspx>.
- Ensor, J.E., Park, S.E., Attwood, S.J., Kaminski, A.M., Johnson, J.E., 2016. Can community-based adaptation increase resilience? *Clim. Dev.* 1–18. <https://doi.org/10.1080/17565529.2016.1223595>.
- Forsyth, T., 2017. Community-Based Adaptation to Climate Change. <https://doi.org/10.1093/acrefore/9780190228620.013.602>.
- Friedlander, A., Shackelford, J., Kittinger, J., 2013. Customary marine resource knowledge and use in contemporary Hawai'i. *Pac. Sci.* 67 (3), 441–460. <https://doi.org/10.2984/67.3.10>.
- Goby, G., Hilly, Z., Abernethy, K., Topo, S., Schwarz, A., Wini-Simeon, L., Posala, R., Sibiti, S., Apusae, T., Tekatoha, F., 2013. Community-based adaptation to climate change in Solomon Islands: Lessons learned from Gizo communities, Western Province. In: Report to the Asian Development Bank (ADB) by WorldFish, Solomon Islands.
- Gombos, M., Atkinson, S., Wongbusarakum, S., 2013. Adapting to a Changing Climate: Guide to Local Early Action Planning (LEAP) and Management Planning. Micronesia Conservation Trust: Pohnpei, Federated States of Micronesia. (99 pp).
- Govan, H., Schwarz, A.M., Harohau, D., Oeta, J., 2013. Solomon Islands National Situation Analysis. CGIAR Research Program (AAS-2013-16).
- Johnson, J.E., Welch, D.J., Maynard, J.A., Bell, J.D., Pecl, G., Robins, J., Saunders, T., 2016. Assessing and reducing vulnerability to climate change: moving from theory to practical decision-support. *Mar. Policy* 74, 220–229. <https://doi.org/10.1016/j.marpol.2016.09.024>.
- Johnson, J.E., Bell, J.D., Allain, V., Hanich, Q., Lehodey, P., Moore, B., Nicol, S., Pickering, T., 2017. Chapter 11 – The Pacific Islands: fisheries and aquaculture and climate change. In: Phillips, B., Ramirez, M. (Eds.), *Climate Change Impacts on*

- Fisheries & Aquaculture: A Global Analysis. Wiley Pubs, New York, USA.
- Kleiber, et al., 2019. Gender-Inclusive Facilitation for Community-Based Marine Resource Management. An Addendum to “Community-Based Marine Resource Management in Solomon Islands: A Facilitators Guide”.
- Malsale, P., Sanau, N., Tofaeono, T.I., Kavisi, Z., Willy, A., Mitiepo, R., Lui, S., Chambers, L.E., Plotz, R.D., 2018. Protocols and partnerships for engaging Pacific Island communities in the collection and use of traditional climate knowledge. *BAMS* 99, 2471–2489. <https://doi.org/10.1175/BAMS-D-17-0163.1>.
- McMillen, H.L., Ticktin, T., Friedlander, A., Jupiter, S.D., Thaman, R., Campbell, J., Veitayaki, J., Giambelluca, T., Nihmei, S., Rupeni, E., Apis-Overhoff, L., Aalbersberg, W., Orcheron, D.F., 2014. Small islands, valuable insights: systems of customary resource use and resilience to climate change in the Pacific. *Ecol. Soc.* 19 (4), 44. <https://doi.org/10.5751/ES-06937-190444>.
- Ostrom, E., 2009. A general framework for analyzing sustainability of social-ecological systems. *Science* 325 (5939), 419–422. <https://doi.org/10.1126/science.1172133>.
- Plotz, R.D., Chambers, L.E., Finn, C., 2017. The best of both worlds: a decision-making framework for combining traditional and contemporary forecast systems. *J. Appl. Meteorol. Climatol.* 56, 2377–2392. <https://doi.org/10.1175/JAMC-D-17-0012.1>.
- Schwarz, A., James, R., Teioli, H.M., Cohen, P., Morgan, M., 2014. Engaging Women and Men in Community-Based Resource Management Processes in Solomon Islands. CGIAR Research Program on Aquatic Agricultural Systems, Penang, Malaysia (Case Study: AAS-2014-33).
- Solomon Islands National Statistics Office, 2017. Solomon Islands Ministry of Health and Medical Services and the Pacific Community. Solomon Islands Demographic and Health Survey, 2015.
- Taylor, M., McGregor, A., Dawson, B., 2016. Vulnerability of Pacific Island Agriculture and Forestry to Climate Change. Pacific Community (SPC), Noumea, New Caledonia.
- WorldFish, 2013. Implementation of Community Based Marine and Coastal Resource Management in Western Province, Solomon Islands. Final Report to DSEWPAC, Australian Government Support to the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI).