

## Appendix 1

This appendix expands on the description of seven recommendations that were identified from a comprehensive literature review, and which need to be considered when applying vulnerability and resilience frameworks. This review was conducted using scientific databases to identify peer-reviewed publications in the past 10 years focused on the operationalization of the concepts of vulnerability and resilience, with an emphasis on their use to support climate change adaptation planning in social-ecological systems (SES).

We use the STARLITE framework (Booth 2006) to report the approach and characteristics of the review conducted.

Element	Explanation
S = Sampling Strategy	Purposive sampling identified for climate change adaptation applications in SES. Studies were sorted by relevance and sampling was conducted until no more relevant articles appeared in a search results page.
T = Type of studies	Studies included were reviews, case studies and conceptual papers.
A = Approaches	Hand search for relevance to the topic and research questions.
R = Range of years	Ten years (2009 to 2019).
L = Limits	Only documents available in full-text online and in English were considered.
I = Inclusion and exclusions	Inclusion of articles was limited to studies in which the concepts were used in support of climate adaptation planning, the studies referred to SES the application was relevant to planning processes at the local or community scales.
T = Terms used	Terms used were “vulnerability” AND “resilience” AND “community”, “assess*” AND “climate change”
E = Electronic sources	Databases used to conduct the search were SCOPUS and Web of Science.

The following 7 recommendations summarize the results of the review and point to the ways in which the recommendations were utilised in the case study.

## **1 Frame the analysis to tangible development outcomes and define a purpose**

Vulnerability and resilience should be referred to as a qualities that allow or hinder the achievement of one or multiple development outcomes (Fröde et al. 2013). Initiatives aimed at increasing a system's resilience or reducing vulnerability will be conducive to the achievement of development goals, while dealing with climate change (Castells-Quintana et al. 2018). For example, a development outcome could be the achievement of food and nutritional security or increasing household incomes. Since not all adaptation strategies will be conducive to achieving multiple goals, it is important to analyse potential trade-offs (Donner and Webber 2014, Johnson et al. 2016, Hsu et al. 2017). Resilience is the capacity that allows the system to achieve the development outcome under likely shocks or pressures, while vulnerability drivers could reduce the capacity of the system to achieve the same outcome. In the application of the conceptual model it is important that a development outcome is clearly identified and communicated. This means identifying if the model is being used to define a baseline, as part of a monitoring and evaluation system, or as part of an adaptation planning process.

### ***1.1 How was this recommendation applied in the study?***

In the application of the conceptual framework two development objectives were identified through focus group discussions with the communities: (i) securing sources of livelihood and income and (ii) being able to sustain households and current way of living in the villages in the face of the manifest climate-driven environmental changes. These objectives were prioritized by participants as the two main driving forces that concerned them in their plans for the development of their villages. This means that in the study vulnerability and resilience are not framed as the outcomes of interventions, but as attributes that can be modified to allow the systems to achieve those two development goals under shocks and pressures. The purpose of the study was twofold, from a research perspective, the study aimed to test and improve the conceptual framework and from a practical perspective the aim was to assess adaptation planning processes in the villages by reflecting on the management and adaptation decisions carried out, and how they have amplified or diminished resilience and vulnerability drivers.

## **2 Integrate subjective perspectives**

Perceptions of shocks, desirable states and thresholds are all relative to subjective values, hence these should be understood and integrated into the analysis (Béné et al. 2016, Clare et al. 2017). Subjective perspectives can be gathered through participatory methods designed for the collection of qualitative data in a way that is culturally appropriate and accepted. This allows for vulnerability and resilience drivers to be context specific and to capture what stakeholders value as being at risk and needs to be preserved.

### ***2.1 How was this recommendation applied in the study?***

The way in which questions were asked in the study and the community engagement methods used (such as *Talanoa*) allowed for researchers to give priority to the subjective perspectives of the participants. Instead of developing pre-conceived ideas of what drives vulnerability and resilience in those settings and trying to measure it, the framework was used

to gather those perspectives and discuss them with community members. This also allowed participants to define limits of the system themselves (e.g. the reluctance of relocating communities outside the island), and to understand what communities value and what their aspirations are.

### **3 Promote systemic analysis and represent complex relationships**

The application of the model should catalyse a better understanding of system dynamics and address the complex relationships between attributes, assets and processes within the system being analysed (Darnhofer et al. 2010, Resilience Alliance 2010, Liu 2014). This is a key aspect when applying the model in the context of SES. Research processes would benefit from integrating multiple disciplines, as assessing only social or environmental aspects of the system will likely misrepresent risk and potential impacts (Metcalf et al. 2015, Quinlan et al. 2016).

#### ***3.1 How was this recommendation applied in the study?***

In the application of the conceptual framework researchers engaged in transect walks and participated in daily activities of life in the villages, such as fishing, farming and village celebrations. This research approach provided a better understanding of the way in which communities interact with the environment and the definition of ecosystem services use, and delivery and how they are affected by different management decisions. This is something that can then be further developed by establishing local monitoring systems to assess the status of key ecosystems such as mangroves and reefs.

### **4 Specify shocks and stressors**

The purpose of the model is to support climate adaptation planning processes; therefore, climate hazards and shocks should be explicitly identified (Wolf et al. 2013, Liu 2014, Weis et al. 2016). Through this process is possible to answer the question “resilience and vulnerability to what?” implying shocks need to be defined and quantified. It is also important to determine the magnitude and direction of changes in key climatic variables and if the analysis is being conducted under current climate variability conditions or including future climate change projections (Jurgilevich et al. 2017). This reinforces the need for detailed and specific impact models and information to strengthen the understanding of how specific shocks could impact the systems being analysed. Clearly defining and identifying shocks and stressors will contribute to determine how climate change might change the magnitude of shocks and how that could shift tipping points and vulnerability and resilience attributes.

#### ***4.1 How was this recommendation applied in the study?***

In the study, shocks and stressors were defined both by community members and by reviewing available literature on downscaled projections of changes in climate attributes. When discussing drivers of vulnerability and resilience the discussions were focused on how those related to the identified climate hazards. Additional non-climatic stressors were also included in the discussion, such as difficulties associated with market access and changes in fisheries regulations that affected the systems. Consequently, the different elements of the model were

discussed in the context of each hazard and interactions between climate and non-climatic shocks.

## **5 Define desirable and undesirable states**

A system can return to an undesirable state of stability after a shock, hence it is important to establish what is desirable or not for each system (Shah et al. 2017). This decision needs to be through participatory processes, allowing the perspectives of stakeholders to be captured (Clare et al. 2017). It is also important to determine what can be acceptable levels of residual risk that cannot be covered by planned adaptation strategies (Kelman et al. 2015).

### ***5.1 How was this recommendation applied in the study?***

The recommendation to define desirable and undesirable states was included when discussing community members' goals for the villages, and how they envisioned their communities should develop. This topic was particularly relevant when discussing community relocation. Participants expressed the willingness to relocate within the island but were more reluctant to options of relocation outside their traditional lands and clan ties. This finding suggests that there are some residual risks that need to be managed, even after communities relocate to the interior of the island.

## **6 Capture interaction across time and scales:**

Resilience and vulnerability can be expressed at different scales (individual, household or community for example) (Johnson et al. 2016, Otto et al. 2017). Therefore, when applying the model, it should be acknowledged in a transparent way for which scales the results of the assessment are valid and relevant. To achieve this aim, the boundaries of the system that is being analysed need to be defined. However, it is relevant to recognize when changes outside the system being studied could have an impact on resilience and vulnerability drivers (Thiault et al. 2018). Drivers of vulnerability and resilience are also dynamic and will change over time. Assessments need to be able to acknowledge changes in time and be transparent about the moments in time the data is collected and what they can represent or not (Bousquet et al. 2016). Some information might only be relevant for specific timeframes. It must be understood that as conditions change due to internal and external pressures in a system, the assessed resilience and vulnerability will also change.

### ***6.1 How was this recommendation applied in the study?***

Because of the limitation in downscaled climate projections, the study was limited to discuss general scenarios where existing hazards could increase. For example, that sea level rise continues to exacerbate coastal erosion and coastal flooding. When discussing climate hazards, the study was limited to information recalled by participants on changes in climate hazards in the past 10 years. The cyclone that occurred in 1979 was the only event that participants referred to that was outside of the 10-year period, probably because of the devastating effect it had on the island. The study has also limited its conclusions and recommendations to the 3 villages that were included in the study. While it is suggested that the model can be applied and adapted to similar settings, the recommendations are limited to

the communities in which the study was conducted and are not aimed to be generalized to all remote island settings in the Pacific. In the study we also discuss cross-scale interactions of villages receiving support from national level governments and donors and regulation at the national level that affects governance of resources at the local levels.

## **7 Capture heterogeneity:**

Even households or communities with similar levels of exposure to shocks can express different levels of vulnerability and resilience (Baptiste and Kinlocke 2016, Weis et al. 2016). While the application of the model will imply different levels of aggregation of information, particularly when the model is applied at larger scales, a careful balance should be applied to ensure that the model is not being used to make broad generalizations of communities or populations.

### ***7.1 How was this recommendation applied in the study?***

In line with the previous recommendation, the study was used to characterize drivers of vulnerability and resilience in three neighbouring villages. While there might be some intra-village heterogeneities that could modify drivers of vulnerability and resilience ( for example household level networks with other households outside of the villages exchanging goods and services), this was outside of the scope of the study and the results presented are to be interpreted only in the context of the studied villages.

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