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researchonline@jcu.edu.au

**Livelihoods-Based Risk Profiling:
A Holistic Approach to Support Adaptation
Planning for Rural Community Livelihoods in
Solomon Islands**

Submitted by

Bethany Smith

In fulfilment of the requirements for the degree of

Doctor of Philosophy

College of Science and Engineering

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Reports

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Abstract

Rural livelihoods in the Pacific Islands are increasingly threatened by unprecedented challenges, driving the need for effective adaptation responses. Recognising the importance of local solutions, policy and funding directives have shifted to prioritise community-based adaptation initiatives. Vulnerability assessments have emerged as a key tool in guiding these efforts, evaluating the factors influencing livelihood impacts to guide adaptation. However, most existing assessments are limited by their narrow focus on climate change as the sole challenge to livelihoods, overlooking other critical hazards. Additionally, they often lack a thorough analysis of socioeconomic factors and fail to account for the spatial and temporal dynamics that influence vulnerability.

As a result, vulnerability assessments do not provide a complete picture of the factors influencing rural livelihoods, which can lead to adaptation strategies that are either ineffective or maladaptive, ultimately hindering the communities they aim to support. To address this, it is essential to develop more holistic approaches that capture the diverse factors influencing rural livelihood impacts. Such approaches must also tackle the implementation gap that exists in translating complex assessment outputs into practical adaptation outcomes on the ground. Without this focus, holistic approaches risk becoming academic exercises rather than practical tools that support communities in responding to evolving challenges.

This thesis aims to address the theoretical and practical limitations of vulnerability assessments by developing, implementing and applying the Livelihoods-Based Risk Profiling Framework (LRPF). This effort was guided by four major objectives: i) to determine whether vulnerability assessment limitations persist, ii) to develop and implement the LRPF to overcome these limitations, iii) to critically evaluate the implications of addressing the identified limitations, and iv) to create an approach for applying LRPF outputs to guide rural livelihoods adaptation.

The first objective was achieved through a systematic review of a decade's worth of rural livelihoods vulnerability assessments utilising popular frameworks. This review confirmed the persistence of existing limitations, thereby justifying the need for this research. In response, the LRPF was developed as a holistic approach and implemented through a series of case studies in three rural communities in Western Province, Solomon Islands. This used a mixed-methods approach, incorporating household surveys, focus group mapping workshops, and informal conversations to gather data on risk.

The LRPF provided comprehensive insights into complex risk drivers, highlighting the critical impacts of non-climatic hazards, such as commercial logging, on rural livelihoods. The LRPF also illustrated the intricate connection between rural livelihoods and exposed natural resources, and established the complex socioeconomic factors that shape a community's ability to respond to and recover from hazard

events. Finally, by incorporating spatial and temporal dynamics, the LRPF revealed important landscape level interactions, cumulative impacts, and the evolving nature of vulnerability.

To achieve the third objective, the LRPF's outputs were compared with those from the Intergovernmental Panel on Climate Change's (IPCC) AR4 and AR5 frameworks. This comparison demonstrated the additional depth of information captured by the LRPF, emphasising the value of holistic approaches that yield richer insights into the complex factors influencing rural livelihood impacts. Consequently, the LRPF can guide adaptation strategies that are more robust in their reflection of the unique challenges faced by communities.

To address the practical limitation of vulnerability assessments, the LRPF was combined with an adaptation pathways approach, which identified adaptation priorities for a community based on current and future hazards, as well as broader development needs. This provided a mechanism for applying LRPF outputs, while enriching the pathways approach by demonstrating how different risk factors could affect adaptation priorities, including possible unintended consequences. This process also provided a mechanism to clearly communicate local risk drivers to community members.

The results of this thesis demonstrate the critical importance of adopting holistic vulnerability and risk assessment approaches to achieve effective adaptation outcomes. Through the development, implementation and application of the LRPF, I demonstrate how a holistic approach can support communities in collaboratively identifying their adaptation needs. This process aims to support communities in taking an active role in their adaptation efforts, fostering ownership over the decisions that impact their lives. Additionally, the LRPF aims to support communities in clearly communicating their needs to external stakeholders who fund adaptation efforts. This can help ensure that funding opportunities align with a community's genuine priorities and are responsive to the evolving challenges faced by rural livelihoods.

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List of Acronyms

AHP	Analytic Hierarchy Process
AR4	AR4 Vulnerability Assessment Framework
AR5	AR5 Risk Assessment Framework
CAPSI	Community Adaptation Pathways in Solomon Islands
CBVA	Community-Based Vulnerability Assessment
CBRA	Community-Based Risk Assessment
CCA	Climate Change Adaptation
IPCC	Intergovernmental Panel on Climate Change
LRPF	Livelihoods Based Risk Profiling Framework
LRP	Livelihood Risk Profile
LSO	Livelihood Security Objective
LVI	Livelihoods Vulnerability Index
MCE	Multi-Criteria Evaluation
NGO	Non-Governmental Organisation
SDG	Sustainable Development Goals
SLF	Sustainable Livelihoods Framework

Chapter One

Introduction



Chapter One: Introduction

Background

Challenges to Rural Livelihoods: Pacific Perspectives

Nearly half of the global population (~3.4 billion people) depend on rural livelihoods for their subsistence and well-being (World Bank 2024). In the Pacific Islands region, rural livelihoods are particularly vital (McNamara et al. 2020), representing an individuals' ability to secure essential needs, such as food, water, and shelter (Ellis 1998). In these rural settings, activities like small-scale farming, fishing, and forestry are crucial for accessing essential resources (Tambe 2022). However, hazards like climate change pose a significant challenge to rural livelihoods in the Pacific (Agrawal and Perring 2009; Basel et al. 2020; Piya et al. 2019). Despite climate change impacts being felt worldwide, Pacific Island countries are often disproportionately impacted due to several unique factors (Gonzalez 2015; Leal-Filho et al. 2021).

First, the Pacific Islands region is prone to climate-induced hazards, such as tropical cyclones, which are intensified by climate change (Kumar 2020). Second, the region's dependence on agriculture and fisheries, sectors highly sensitive to climate variability, can drive major disruptions for livelihoods (Maharjan and Joshi 2013). Pacific Island countries (bar Fiji) are also classified as Low and Middle-Income Countries (LMICs). As LMICs, these countries face significant socioeconomic challenges, including limited access to livelihood resources and infrastructure, and insufficient institutional capacity (World Bank 2024). Historical factors, such as colonialism and unequal economic structures have significantly contributed to these challenges, particularly when compared to Global North countries (Engerman and Sokoloff 2005).

In Pacific Island rural communities, climate change is increasingly impacting daily life (Piya et al. 2019). Farmers face unpredictable weather patterns and shifting growing seasons, leading to reduced crop yields (Maharjan and Joshi 2013). Similarly, fishers grapple with changing ocean currents and warming waters, disrupting fish stocks (Tambe 2022). Rivers, once dependable sources of drinking water, now frequently run dry (Anthonj et al. 2020). Adding to these challenges are non-climatic hazards such as commercial logging, mining, and industrial fishing, which further deplete natural resources, amplifying the impacts of climate change and placing livelihoods at greater risk (Hilson 2016; McCubbin et al. 2015). The Pacific Island region is also susceptible to seismic activity, volcanic eruptions, and other extreme weather events, such as those influenced by El Nino, which further impact communities (Hinga 2015; Murphy et al. 2014). The combined outcomes of these hazards drive significant environmental degradation, erode cultural and social cohesion, and threaten traditional practices, making it increasingly difficult for communities to sustain their way of life (Smith-Hall et al.

2023). Moreover, socioeconomic challenges such as poverty, limited healthcare access, and inadequate infrastructure magnify impacts, reducing local capacity to adapt to changing conditions (Berkhout et al. 2014).

Together, these factors create a cycle of vulnerability, where rural communities' sensitivity to impact from hazard exposure is compounded by their limited capacity to adapt. This combination makes it increasingly challenging for individuals to sustain their livelihoods (Adger 2006). Differential vulnerability also exists, with marginalised groups (including women and people with disabilities) more likely to experience greater vulnerability from hazard exposure (Arora-Johnson 2011; Abbott and Porter 2012; Kuran et al. 2020). Given the unprecedented challenges facing Pacific Islands rural communities, there is an urgent need for adaptation strategies that address current hazards and build resilience to an uncertain future (Preston et al. 2011). In this context, resilience is defined as a system's ability to absorb shock and stressor events (such as climate change), while retaining its basic function, structure, and identity (Holling 1973). This definition encompasses not only the capacity of livelihoods to adapt to hazard events, but also, where necessary, the ability to transform to sustain and maintain these livelihoods over time (Engle et al. 2014; Lin et al. 2017). In this context, adaptation strategies that strengthen resilience will help rural livelihoods thrive despite the increasing risks from climate change and other locally relevant hazards (McNamara et al. 2020; Sen et al. 2023).

Approaches for Rural Livelihoods Adaptation

Livelihoods adaptation, defined as 'actions to moderate the potential damages from hazard exposure' is implemented across all levels of Pacific Islands governance (Preston et al. 2011). However, challenges often arise in translating broad, high-level plans into actionable strategies within communities to effectively address the needs of rural livelihoods (Nalau et al. 2015; Nunn and Kumar 2019). This has led to an increasing focus on local-scale adaptation efforts, with higher levels of governance providing essential funding, technical expertise, and support for their implementation (McNamara et al. 2020; Mullan et al. 2013; Parsons and Nalau 2019).

At the local scale, community-based adaptation approaches are recognised as a key tool to support rural livelihoods adaptation (Bosomworth et al. 2017; Ensor and Berger 2009). These approaches focus on identifying, developing, and implementing strategies to help strengthen a community's resilience to hazard exposure (Kirkby et al. 2018). By engaging communities through participatory methods, these approaches aim to tailor adaptation strategies to local contexts and needs, though the extent to which this occurs in practice varies, with adaptation strategies often pre-dictated by the external stakeholders that fund the process (Ayers and Forsyth 2009). However, when co-implemented effectively with communities, these approaches have been shown to enhance both the effectiveness and sustainability of local adaptation efforts (Forsyth 2013; McNamara et al. 2020).

Participatory methods, that actively engage community members, offer several benefits. They can help foster local ownership over adaptation processes, enhance agency, motivation, and accountability for implementation (Barrowman and Butler 2016; Ensor et al. 2018a; McLeod et al. 2015), and strengthen social cohesion when communities collaborate towards shared goals (Bene et al. 2016). These methods also promote inclusivity by ensuring that marginalised voices are heard and considered in adaptation processes (Araos et al. 2021). However, the effectiveness of participatory methods can be limited by existing power dynamics and resource constraints, which may prevent these benefits from being fully realised (Golob and Giles 2013; Shaw et al. 2020).

Community-based adaptation approaches face several additional challenges (Dodman and Mitlin 2013). For example, focusing exclusively on local-scale adaptation can overlook broader structural issues and political transformations that influence community vulnerability (Fook 2017). Local initiatives may also fail to consider necessary support from higher governance levels, or, conversely, be heavily influenced by external actors in the direction of local adaptation initiatives (Eversole and Schofield 2006; Leck and Simon 2013). Recognising and addressing these challenges is crucial to ensure that community-based adaptation approaches can positively contribute to achieving equitable, effective, and sustainable adaptation outcomes for rural livelihoods (Dodman and Mitlin 2013).

The Role of Vulnerability Assessments

Across the Pacific Islands, community-based vulnerability assessments (CBVAs) have become a popular method for guiding adaptation (Hay and Mimura 2013; McLeod et al. 2015; McNamara et al. 2020). These assessments provide a structured framework for analysing a community's vulnerability to hazard exposure by assessing three key components: exposure to hazards, sensitivity to impact, and capacity to respond (Adger 2006). By collecting data on the environmental and socioeconomic factors that influence these components, CBVA's can identify key vulnerability drivers and address them within adaptation efforts, targeting the most pressing issues facing a community (Begum et al. 2014; Kelly and Adger 2000). In doing so, CBVAs serve as an essential tool for enhancing rural livelihoods resilience (Thiault et al. 2021), ensuring that adaptation strategies are relevant and effective in helping communities navigate the complexities of global change (Adger 2006).

Two dominant CBVA approaches exist in the livelihoods space: the Sustainable Livelihoods Framework (SLF) (DFID 1999) and the IPCC AR4 Vulnerability Assessment Framework (IPCC 2007). These frameworks adopt separate approaches to assessing vulnerability. The SLF conceptualises vulnerability as an internal socioeconomic condition, focusing on how access to livelihood assets (such as human, financial, social, physical, and natural capital) shape household vulnerability to shock and stressor events (O'Brien et al. 2007). The SLF has been widely applied across the Pacific, identifying actions that strengthen access to these assets as a means of reducing vulnerability (e.g., Becker 2017; Diedrich et al. 2019; Erickson et al. 2017; Piggot-McKellar et al. 2019). However, the framework has been

critiqued for its narrow framing, as it pays limited attention to the characteristics of external shock and stressor events (e.g., climate change) that drive livelihood impacts (Dilley and Boudreau 2001; Mensah 2011). In contrast, the AR4 framework adopts a hazard-based framing, centred on understanding external shock and stressor events as a core component of vulnerability (O'Brien et al. 2007). The AR4 has been applied across the Pacific to assess climate change impacts and inform adaptation planning by identifying strategies that reduce the likelihood of negative impacts on livelihoods (e.g., Begg et al. 2021; Rosegrant et al. 2015). While this provides a clearer understanding of how specific shock and stressor events influence vulnerability, the AR4 has been criticised for overlooking the underlying socioeconomic characteristics that influence the extent of local impact (Ford et al. 2018; McDowell et al. 2016).

CBVA outputs can be used in two key ways to support adaptation. First, they can be used to identify priority adaptation responses tailored to the specific drivers of vulnerability within a community (Westoby et al. 2019). Second, they can be used to assess how pre-designed adaptation strategies might interact with vulnerability drivers identified through CBVAs, ensuring that such strategies do not inadvertently exacerbate existing vulnerabilities or create new challenges (Werners et al. 2021). As previously noted, however, a gap often exists between CBVA outputs and their application at the community scale (McLeod et al. 2015), which can limit their effectiveness as tools for informing adaptation decisions (Dubois et al. 2019; Nunn and Kumar 2019). This thesis seeks, in part, to address this gap through the consideration of vulnerability drivers with community-based adaptation planning approaches.

Embracing Holistic Perspectives

Despite the widespread use of CBVAs, there is growing recognition of the need for more holistic approaches that consider a broader range of factors influencing rural livelihoods (Ford et al. 2018). In the context of this thesis, a holistic approach 'addresses vulnerability as a complex, multifaceted process encompassing a wide range of socioeconomic and environmental factors, while also considering how these factors interact'. This goes beyond a comprehensive approach (which ensures that a broad range of factors contributing to vulnerability are considered) by also examining the relationships that occur between these factors (Pescaroli and Alexander 2018).

The need for a holistic approach arises from several theoretical limitations of CBVAs, which I detail in the following section. These limitations have prompted calls to shift from vulnerability to risk assessment (Fuchs et al. 2012; Wolf 2012), as risk is believed to offer a more comprehensive evaluation of the various factors influencing rural livelihoods (Buchtman et al. 2023). In this context, risk refers to 'the possibility of harmful consequences or expected losses resulting from interactions between hazards, vulnerable conditions, and the capacities of the affected system to cope with the impacts of the hazard' (IPCC 2014). By obtaining insight into not only the vulnerability of livelihoods, but also the

likelihood of a hazard occurring, its potential severity, and how exposed a community is to its impacts, risk provides a broader perspective that can support more informed decision-making for adaptation (Buchtmann et al. 2023). A shift to risk assessment would be particularly beneficial in Pacific Islands contexts where national adaptation policies increasingly emphasise risk reduction (Quinn and Lees 2022; World Bank 2020).

As such, this thesis develops and presents a holistic risk-assessment approach designed to provide a deeper understanding of the factors that influence rural livelihoods likelihood of impact from global change. In doing so, this research aims to support more effective and sustainable adaptation strategies, ultimately leading to better outcomes for rural livelihoods. Additionally, this thesis aims to bridge the gap between vulnerability and risk assessment outputs and their practical application in guiding adaptation. This was achieved by integrating these outputs with adaptation planning approaches and developing decision support tools that provide guidance on priority adaptation initiatives and the key risk drivers that may influence their implementation.

In this chapter, I justify the need for this research by further describing the theoretical and practical limitations of CBVAs and their implications for community-based adaptation. I then highlight the research gaps in addressing these limitations. Finally, I discuss the value of a holistic risk assessment approach for enhancing the effectiveness and sustainability of adaptation efforts, ultimately contributing to the strengthening of rural livelihoods resilience.

Research Justification

CBVAs aiming to support rural livelihoods adaptation planning face several theoretical limitations that limit their ability to capture the full range of factors influencing vulnerability (Ford et al. 2018). These limitations stem from the origins and trajectory of the vulnerability concept within the fields of rural livelihoods and climate change adaptation (CCA) and are threefold. First, CBVAs often focus on climate change, while neglecting non-climatic hazards that drive additional or cumulative livelihood impacts (Bennett et al. 2016). Second, many assessments overlook the full range of socioeconomic factors that contribute to vulnerability (Ford and Pearce 2012; O'Brien et al. 2007). Third, many CBVAs fail to consider how vulnerability evolves over time and across space (Thiault et al. 2018a; Fekete et al. 2010). By ignoring these limitations, CBVAs may fail to capture the key drivers of vulnerability affecting communities (Ford et al. 2018). This can result in ineffective adaptation strategies, wasted resources, and even maladaptive outcomes that further exacerbate vulnerability (Castree et al. 2014; Magnan et al. 2016; Murphy 2011).

As CBVAs continue to gain popularity as tools for supporting adaptation in the Pacific Islands (many of which are categorised as LMICs) addressing their limitations is crucial (Kim et al. 2021; McNamara et al. 2020). Communities in the region face a complex interplay of challenges, including the

intensification of climate change, impacts from non-climatic hazards such as resource exploitation, and persistent socioeconomic disparities including unequal access to education, healthcare, income, and essential services (Van der Ploeg et al. 2020a). Together, these factors can exacerbate vulnerability and limit adaptive capacity, driving severe impacts for livelihoods (Msimanga and Mukwada 2022). When CBVAs fail to adequately assess vulnerability, communities may be left unprepared to navigate these complex challenges (Ford et al. 2018). Without robust adaptation strategies, the consequences for livelihoods can worsen, resulting in outcomes such as food and water insecurity, among other issues (Basel et al. 2020).

The consequences of CBVAs' theoretical limitations have been widely evidenced. For example, in Fiji, efforts to combat sea-level rise through seawall construction inadvertently increased the vulnerability of nearby residents by obstructing drainage, leading to flooding and altered sediment deposits that negatively affected the local fishery (Piggott-McKeller et al. 2020). In Bangladesh, the introduction of shrimp aquaculture intended to enhance food security exacerbated local inequities by overlooking socioeconomic conditions, leaving the poorest community members more vulnerable (Abdullah et al. 2016). While in Papua New Guinea, a sport fishery initiative failed because it did not account for landscape-level interactions, resulting in long-term sedimentation from upstream locations that ultimately collapsed the fishery (Diedrich et al. 2022). Collectively, these cases illustrate CBVAs limitations, particularly their failure to capture the diverse factors and interactions that shape vulnerability, which can undermine the effectiveness of adaptation measures (Ford et al. 2018). This highlights the need for holistic CBVA approaches that incorporate a wider range of locally relevant factors and their interactions.

However, addressing CBVA's theoretical limitations is only part of the challenge. The complexity of CBVAs can make it difficult to translate their outputs into actionable insights for decision-making, reducing their overall value (Dubois et al. 2019). This difficulty is compounded when external stakeholders treat CBVAs as a tool for generalised adaptation recommendations across regions, rather than guidance for local responses (Van der Ploeg et al. 2020a). Failing to effectively communicate CBVA findings may leave communities without the support they need to navigate complex adaptation challenges, threatening long-term resilience (Westoby et al. 2019).

To make CBVA findings more useful, many studies use indicator-led assessments, which apply predefined, quantifiable metrics to evaluate vulnerability (Nguyen et al. 2016). These indicators focus on key socioeconomic and environmental factors relevant to local contexts (Eriksen and Kelly 2007; Tate 2012). This approach is valued for its structure and reproducibility, making it suitable for large-scale assessments or situations requiring comparability (Nguyen et al. 2016). As a result, indicator-led assessments are useful when CBVA outputs intend to inform broader scale governance decisions (e.g.,

regional or national adaptation planning) or guide funding allocations for community-based adaptation (Hinkel 2011).

Despite their value, indicator-led assessments can be rigid and may overlook the nuanced, context-specific factors that contribute to local vulnerability (Barnett and Fry 2008). To address this, some CBVAs use subjective assessment methods, which prioritise the lived experiences and local knowledge of community members (Nef et al. 2023). Subjective approaches typically use qualitative methods to explore how vulnerability is shaped by unique social, cultural, and environmental contexts (Singh et al. 2019). While this can offer a deeper, more contextually relevant understanding of vulnerability, subjective approaches have been criticised for lacking objectivity (Maxwell 2018). This can result in CBVA outcomes that reflect the personal feelings, opinions, or biases of community members and researchers, rather than impartial evidence (Madill and Jordan 2010; Thogersen 2011).

This thesis adopts a hybrid approach that combines elements of both indicator-led and subjective assessments. By using locally relevant indicators to measure key aspects of vulnerability, it draws on the comparability and objectivity of the indicator-led approach, supporting the communication of results to communities as well as high-level stakeholders, including government and NGOs involved in livelihoods adaptation (Nguyen et al. 2016). Simultaneously, incorporating local knowledge ensures that subjective and context-specific factors shaping vulnerability are captured, which might otherwise be overlooked (Singh et al. 2019). This combination provides a more comprehensive understanding of vulnerability, guiding the development of adaptation strategies that are context-sensitive and responsive to local needs (Ahmed and Kelman 2018; Reed et al. 2013). Such a nuanced approach aims to foster long-term resilience by promoting solutions tailored to the specific challenges faced by rural livelihoods (Rahman and Hickey 2020).

Research Gaps

Scholars have advocated for holistic approaches to address the theoretical limitations of CBVAs (Guerrero et al. 2018; Singh et al. 2017; Thiault et al. 2021). Despite this, many assessments continue to encounter these limitations (Ford et al. 2018). One promising way to address them is through the concept of risk, which adopts a multidisciplinary perspective and provides greater insight into the factors shaping rural livelihood impacts (Fuchs et al. 2012; Wolf 2012). This was recognised by the Intergovernmental Panel on Climate Change (IPCC), who moved from their widely applied fourth assessment report (AR4) Vulnerability Framework (IPCC 2007) to a risk-based framework in their fifth assessment report (AR5) (IPCC 2014). The IPCC suggests that this risk-based approach enables a more holistic understanding of system dynamics by integrating environmental and socioeconomic factors more comprehensively (Buchtman et al. 2021).

Despite the theoretical advantages offered by the AR5 framework, its implementation remains limited (Estoque et al. 2023). Researchers have identified several reasons for this, including a preference for established CBVA methods, and a lack of clear guidelines for using the AR5 framework (Ishtiaque et al. 2022). At the community scale, an additional barrier arises from the framework's design, which was primarily intended for regional and national applications, making it less suited to rural livelihood contexts (Das et al. 2020). Consequently, the AR5 may require specific adaptations or expansions to enhance its relevance and utility for community-based risk assessment (CBRA). Moreover, further steps may be necessary to ensure that CBVA limitations are adequately addressed within the AR5. By taking these steps, the AR5 has the potential to become a valuable tool for guiding decision making in rural livelihoods adaptation (Ford et al. 2018; Singha et al. 2023).

As previously noted, challenges in effectively communicating complex CBVA outputs hinders their practical application (Arteaga et al. 2023; Kumar 2020). In the Pacific Islands, this limitation persists despite an emphasis on using CBVAs to inform rural livelihoods adaptation (McNamara et al. 2020; Schipper et al. 2014). Where CBVAs or CBRAs are applied, it is therefore essential to develop methods that can effectively translate outputs into actionable guidance for local-scale decision making (Dubois et al. 2019). A key approach may involve the creation of decision support tools that directly apply assessment outputs into guidance for prioritising adaptation efforts (Eriksen et al. 2021). These tools can support communities in identifying their most pressing adaptation needs (Adger 2005; 2006). Additionally, there is an opportunity to integrate assessment outputs into existing adaptation strategies developed independent of the assessment process. This can provide communities with insights into how pre-established strategies might interact with local vulnerability and risk drivers (Werners et al. 2021), helping to prevent unanticipated negative outcomes that could undermine effectiveness (Colloff et al. 2024). This approach is particularly valuable when pre-designed strategies have not accounted for multi-hazard exposures, relevant socioeconomic factors, or spatial and temporal dynamics, factors that are explicitly addressed through holistic CBVA and CBRA approaches (Werners et al. 2021).

Research Implications

Developing a holistic risk assessment approach that addresses the theoretical and practical limitations of CBVAs can support more effective and sustainable adaptation outcomes for rural livelihoods (Fuchs et al. 2012; IPCC 2014). As mentioned, this is particularly crucial in the Pacific Islands region, where climate change and other environmental challenges are rapidly degrading the natural resources that communities depend on for their livelihoods, threatening resilience (Kumar 2020). In such instances, a more detailed understanding of the factors contributing to risk can support communities in better anticipating and responding to complex, evolving challenges (Adger 2006; IPCC 2014).

By addressing CBVAs' theoretical limitations, this research can support communities in developing adaptation strategies that are better aligned with local needs, thereby strengthening rural livelihoods resilience (Van Aalst et al. 2008). This requires a deeper understanding of local hazards, socioeconomic characteristics, and spatial and temporal dynamics, enabling the design of targeted adaptation strategies that respond to the complex, interconnected factors influencing rural livelihoods (Ford et al. 2018). Such an approach can help Pacific Islands communities adapt effectively amid unprecedented challenges (McNamara et al. 2020). Specifically, by addressing vulnerability and strengthening local capacity to cope with hazards, tailored adaptation strategies can enable communities to absorb, recover from, and adapt to future challenges, laying the foundation for long-term resilience (Engle et al. 2014; Lin et al. 2017; Ngoma et al. 2023). Flexible, sustainable, and context-specific strategies can also support communities in navigating uncertain and rapidly changing environments with greater confidence (Schwarz et al. 2011).

The focus on risk assessment in this thesis aligns with the growing emphasis on risk reduction in national policies across the Pacific Islands region (Quinn and Lees 2022; World Bank 2020). By developing a holistic approach for community level implementation, this thesis provides valuable evidence on local adaptation needs (Bosomworth et al. 2017). Applying this evidence to guide decision making at broader governance scales can help ensure that funding, technical expertise, and other forms of support for local adaptation are context-specific and effectively address the complex and unique challenges faced by rural livelihoods (Mullan et al. 2013).

By employing a participatory approach, this thesis aims to outline contextually relevant and culturally appropriate adaptation measures that reflect the lived experiences of community members (McLeod et al. 2015). Direct engagement in the CBRA process can also empower community members to take ownership of adaptation efforts, increasing their likelihood of success (Bene et al. 2016). The participatory approach applied in this thesis further seeks to transform the CBRA from an academic exercise into a practical tool that supports communities in making informed adaptation decisions (Dubois et al. 2019). I acknowledge, however, that participatory processes do not automatically guarantee inclusivity or empowerment. For instance, the thesis' focus on the community scale has resulted in limited exploration of how vulnerability and risk vary within a community, including across genders, disabilities, and other marginalised groups. While this analysis was beyond the scope of the thesis, data were systematically collected with these dimensions in mind, providing a foundation for future research.

As previously noted, the practical application of CBRAs can be enhanced through decision support tools that clearly convey outputs and guide priority adaptation actions based on a comprehensive understanding of risk (Eriksen et al. 2021). These tools can improve adaptation decision-making by ensuring that key risk drivers are addressed and by reducing the likelihood of unanticipated outcomes

through the consideration of influencing risk factors (Ford et al. 2018; Werners et al. 2021). Ultimately, such tools enhance the value of CBRAs for guiding adaptation and strengthen the effectiveness and sustainability of efforts to support rural livelihoods resilience (Adger 2006).

Thesis Aims and Objectives

This thesis adopts a realist approach to understanding the dynamics of rural livelihoods risk. Realism, as a meta-theoretical position, provides an ideal framework for examining the complex interactions that drive rural livelihoods risk (Manicas 2009; Owens 2011). While risk can be observed and measured through quantitative data, a realist perspective supports a deeper exploration of the underlying socioeconomic mechanisms and structures that influence rural livelihoods in the face of hazard exposure (Bhaskar 2013). By focusing on the observable and underlying forces that shape these outcomes, realism can support a more holistic understanding of the various socioeconomic and environmental factors that influence risk (Miyaguchi and Uitto 2017).

Situated at the intersection of several research fields, including livelihoods and development, climate change adaptation, vulnerability and disaster risk reduction, this thesis adopts an interdisciplinary approach. It integrates insights from these fields to address the theoretical and practical limitations of CBVAs and to support improved outcomes for rural livelihoods adaptation. To achieve this, I developed a holistic risk assessment approach that expands the AR5 Risk Framework (IPCC 2014) to rural livelihoods contexts in LMICs. I implemented this framework in the Solomon Islands to support rural livelihoods adaptation and evaluated how a holistic perspective can enhance decision making and contribute to more effective and sustainable adaptation outcomes. To apply CBRA outputs, I developed an approach for prioritising adaptation based on key risk drivers and assessed how risk may give rise to unanticipated consequences from adaptation efforts.

In my thesis, I aimed to address the theoretical and practical limitations of CBVAs through four research objectives, addressed in four corresponding data chapters:

1. Systematically evaluate if and how researchers are addressing CBVA limitations in contemporary studies (*Chapter Two*).
2. Develop and implement a holistic risk assessment framework to address CBVA limitations in the context of rural livelihoods (*Chapter Three*).
3. Critically evaluate how this holistic framework contributes to more effective and sustainable adaptation outcomes for rural livelihoods compared to prior frameworks (*Chapter Four*).
4. Develop an approach to apply framework outputs within adaptation pathway approaches, supporting enhanced decision-making for rural livelihoods adaptation (*Chapter Five*).

Study Region

The research for Chapters Three to Five was conducted in Solomon Islands, a Pacific Island country in the Melanesian Island group, located north-east of Australia (FAO 2016). According to recent census data, 74% of the population is rural, residing outside of the main urban areas, with subsistence agriculture, forestry, livestock farming, and handicrafts comprising the primary livelihood activities (Solomon Islands National Statistics Office 2020). This context is central to my research objectives for several reasons.

First, given that Solomon Islands is projected to experience some of the most severe impacts of climate change (Kumar 2020), developing effective and sustainable adaptation responses in rural areas is crucial. Rural livelihoods in Solomon Islands are heavily reliant on local ecosystems and their resources (Basel et al. 2020), making them highly vulnerable to hazards, such as climate change, which degrade natural resources (Marshall 2011; Piya et al. 2019). This vulnerability is further exacerbated by non-climatic hazards, including commercial logging, mining, and fishing, which have caused widespread environmental impacts (Filho et al. 2020; Minter and Van der Ploeg 2023). In addition, complex socioeconomic challenges, such as limited access to income, infrastructure, healthcare and education, reduce local capacity to respond effectively (Malherbe et al. 2020).

Second, the participatory, community-based approach adopted in this thesis aligns with a shift towards localised adaptation efforts in Solomon Islands (Van der Ploeg 2020a). This shift has largely been driven by the under-resourcing of local government, creating a gap between national adaptation plans and their local-scale implementation (Govan and Bennett 2014). In response, funding bodies have increasingly promoted community-based adaptation initiatives throughout Solomon Islands, along with evolving policy frameworks designed to support these efforts (McNamara et al. 2020). By aligning with these emerging funding structures, this thesis is more likely to make a meaningful contribution to local resilience building efforts. Additionally, community-based adaptation efforts may be more compatible with the complex and often undefined customary land tenure systems in Solomon Islands, as they can better engage with locally recognised governance structures and traditional practices regarding land use rights (Schwarz et al. 2020; Pickering 2017).

Western Province was selected as the study region within Solomon Islands due to its diverse marine and terrestrial ecosystems, which support rural livelihoods, particularly through small-scale fisheries and subsistence agriculture (Bennett et al. 2014). The province has also experienced significant livelihood impacts from changing weather patterns and extractive activities, making it a relevant location to examine the risks such hazards pose to rural livelihoods (Basel et al. 2020; Ha'apio et al. 2019). Furthermore, the provincial government is actively promoting community-based adaptation initiatives, providing an enabling environment for research that can support and inform these adaptation efforts (Diedrich et al. 2024).

Within Western Province, three communities were selected as study sites. This selection was guided by the local research partner, Ecological Solutions Solomon Islands (ESSI), and advice from Provincial government to ensure alignment with local priorities. Criteria for selection included rural location, high dependence on natural resources for livelihoods, and willingness to participate in adaptation planning. The communities represent diverse development profiles, with varying engagement in fishing, tourism, marine resource management, and responses to logging pressure. Although no previous project has specifically addressed vulnerability and risk in these communities, this thesis builds on broader regional initiatives, including the Community-Based Resource Management (CBRM) programme, to support rural livelihoods adaptation in Solomon Islands (Govan and Lalavanua 2023).

While this research is situated in Solomon Islands, its findings contribute to broader discussions on rural livelihoods adaptation across the Pacific Islands. Countries such as Vanuatu and Tuvalu face similar challenges, including climate-change, environmental degradation, and complex governance systems for managing adaptation responses (Islam et al. 2023; Nef 2022). By addressing the limitations of CBVAs and developing a risk assessment approach tailored to rural livelihoods, this research provides insights that may inform rural livelihoods adaptation strategies in comparable socioeconomic contexts across the region.

Research Context

The research presented in this thesis was conducted as part of the Australian Centre for International Agricultural Development (ACIAR) small research activity FIS-2020-111, titled “Spatially integrated approach to support a portfolio of livelihoods”, which funded the fieldwork. The ACIAR project aimed to develop an approach to diagnose and navigate the interrelated and cumulative impacts, trade-offs, and co-benefits of interacting livelihood activities occurring in coastal areas of Solomon Islands.

I identified an opportunity to contribute to the ACIAR project based on challenges I had observed while working on a fisheries vulnerability assessment in Myanmar (Dubois et al. 2020). Through this work, I became increasingly aware of the limitations of vulnerability assessments in complex, dynamic livelihood systems, particularly where multiple interacting hazards are involved. These insights led me to propose a holistic approach to addressing these limitations, which I presented to my supervisory panel at James Cook University. The idea aligned well with the ACIAR project and was integrated into its broader objective. Specifically, my thesis contributed by providing a framework to assess risk within coastal livelihood systems, addressing limitations in previous vulnerability and risk-based research. While the ACIAR project focused on developing a diagnostic tool to support livelihoods, my research added a targeted method for evaluating how local hazards may impact these livelihoods.

The ACIAR project was conducted under James Cook University human research ethics approval H8497. Ethical considerations were central to the research design and implementation. The ethics

process ensured that all participants were fully informed about the research purpose, methods, and potential impacts. Informed verbal consent was obtained from all individuals involved, with a clear understanding of their right to withdraw from the study at any time. Confidentiality was strictly upheld throughout the research with all personal information anonymised and access to sensitive information limited to the research team from James Cook University and ESSI. The findings were shared with the communities in a way that preserved individual anonymity while facilitating the sharing of insights that could be beneficial. In compliance with Solomon Islands legal and ethical requirements, a formal research permit was obtained from the government before the research commenced.

Navigating the cross-cultural context of this research involved close collaboration with ESSI, an NGO in the Solomon Islands who co-designed and co-implemented the project. The motivation for this collaboration stemmed from a deliberate decision to use co-production in the research. Co-production provides a collaborative framework that can help ensure research is contextually relevant, culturally sensitive, and aligned with local priorities (Bremer and Meisch 2017; Dannevig et al. 2020; Singh et al. 2021). Building strong relationships with community leaders and stakeholders was key to the success of this research and ESSI were instrumental in establishing these connections. I worked closely with ESSI to ensure that the research approach aligned with local norms and values. This included adapting the research methods to ensure that they were relevant to the communities' knowledge systems and communication styles. Under ESSI's guidance, we co-developed participatory techniques and data collection tools that were tailored to the specific needs of each community.

Beyond the academic objectives of this research, a key aim of the ACIAR project was to establish mechanisms and identify capacity needs to sustain the project's outcomes. This involved equipping ESSI and local stakeholders with the tools, knowledge, and support necessary to utilise the project's outputs. Throughout this thesis, I have referenced these capacity-building objectives and included associated outputs in the appendix. As part of the ACIAR project, I specifically contributed to capacity-building efforts by implementing an introductory QGIS mapping course for ESSI, which aligned with the research process outlined in Chapter Three and addressed additional spatial mapping skills deemed relevant for their research activities.

A significant challenge during this research was the global COVID-19 pandemic, which imposed travel restrictions and suspended in-person engagement, an essential component of the study. Face-to-face meetings with community members, workshops, and field data collection were not possible during the initial stages of the research. To accommodate these constraints, the ACIAR project timeline was extended. As in-country travel within Solomon Islands was still permitted, the ESSI team led early engagement activities without Australian team members, particularly in identifying and establishing relationships with participating communities.

Positionality Statement

As the primary author of this thesis, I acknowledge that my background, experiences, and perspectives have influenced the research process. My academic training in the biological, marine, and social sciences, along with previous experience working in the research-for-development sector, has shaped my understanding of rural livelihoods, vulnerability, and risk. This background informed my decision to develop the holistic risk assessment framework presented in this thesis.

Throughout my PhD, I have been mindful of my position as an external researcher in Solomon Islands. While I aimed to approach the research in a participatory and collaborative manner, I acknowledge that my values and cultural background may have intersected with local knowledge systems. To mitigate this, I worked closely with local researchers in Solomon Islands, whose expertise and insights were integral to the research design and methodology. These researchers helped ensure that the voices of the communities we engaged with were heard and reflected in the research outputs. This included ensuring we had team members who spoke all relevant languages and were experts in local facilitation processes. Additionally, I collaborated with an Australian supervisory team experienced in Pacific Island contexts, whose guidance was invaluable in navigating cultural nuances and ensuring that the research process was inclusive and respectful. Despite this support, I remain conscious of the limitations inherent in conducting research within complex, culturally diverse communities, as well as the potential for my perspectives to influence the interpretation of data. To address this, local researchers were involved in reviewing and contributing to data interpretation in Chapters Three to Five.

This study greatly benefitted from the trust and collaboration of the rural communities involved. I am committed to presenting their knowledge and experiences accurately and respectfully, acknowledging that this research is shaped by both my academic journey and the contributions of the participating communities. Research in the Pacific has often been extractive, and I recognise that presenting this work as my thesis could fall into that pattern. At the conclusion of the research, I returned with ESSi to share the results and discuss the findings with each community, ensuring the process was respectful of community perspectives, while taking local priorities and cultural norms into account. Although these steps do not eliminate the inherent power dynamics in research, they reflect my efforts to engage collaboratively and to acknowledge each community's contributions throughout the research process.

Thesis Structure

The objectives of my thesis are addressed through four data-based research chapters (*Chapters Two – Five*). Each chapter is structured as an adaptation of a scientific paper, formatted for publication in peer-reviewed journals. These chapters employ a mixed-methods approach, combining qualitative and quantitative methods to assess community level risk and adaptation strategies for rural livelihoods. The

thesis concludes with a discussion chapter (*Chapter Six*), which summarises the main findings of each data chapter, discusses their implications for supporting rural livelihoods adaptation, details the practical application of thesis outputs in Solomon Islands, and suggests opportunities for further research (Figure 1).

To justify the need for this research, in *Chapter Two* I conducted a systematic review of a decade's worth of rural livelihoods-based CBVAs (Smith and Diedrich 2024). This involved a structured scoping exercise, systematic screening, and content analysis process which explored if, and how, studies addressed the theoretical limitations of CBVAs. The findings revealed limited progress in this area, highlighting the need for holistic approaches to support more effective and sustainable adaptation outcomes for rural livelihoods.

In *Chapter Three* I developed the Livelihoods-Based Risk Profiling Framework (LRPF) to address the theoretical limitations of CBVAs. To do so, I expanded the pre-existing IPCC AR5 Risk Framework (IPCC 2014) to fit the context of rural livelihoods. To implement the LRPF, I designed a mixed-methods approach applied in three rural communities in Western Province, Solomon Islands. Focus group mapping workshops identified community-specific hazards, while household surveys provided quantitative data on vulnerability factors including sensitivity, adaptive capacity, and source dependence. A vulnerability index was constructed using standardised indicators and a multi-criteria evaluation approach and combined with hazard exposure data to develop risk-based decision support tools. These tools included risk profiles and vulnerability index tables that informed priority adaptation initiatives for each community. Additionally, qualitative insights from informal conversations contextualised risk dynamics, ensuring a more nuanced understanding of interactions across risk components. This approach demonstrated the value of holistic assessments in capturing the multiple factors shaping rural livelihoods risk.

In *Chapter Four* I conducted a comparative analysis of the LRPF against the AR5 Risk Framework (IPCC 2014) and its predecessor, the AR4 Vulnerability Framework (IPCC 2007). I first examined the differences in these frameworks based on their components for assessing vulnerability and risk. Using the data from Chapter Three, I then implemented each framework (using a multi-criteria evaluation approach) and summarised their outputs to explore and compare how the results of each framework can inform decision-making for rural livelihoods adaptation, while also highlighting their respective limitations. Through this analysis, I demonstrated that holistic approaches, like the LRPF, can help achieve more effective and sustainable adaptation outcomes.

Finally, in *Chapter Five*, I combined the LRPF with an adaptation planning approach tailored to the context of Solomon Islands. This approach aimed to devise climate-resilient development strategies for a community by applying a participatory learning cycle that supports communities in developing priority adaptation strategies through a collaborative decision-making process. To increase the

likelihood of success for these strategies, I used data from each community's risk profile to systematically evaluate how hazard exposure, sensitivity, and adaptive capacity may influence adaptation. This analysis allowed me to identify potential unanticipated outcomes of desired adaptation actions and propose adjustments to enhance the long-term effectiveness and sustainability of these initiatives.

In *Chapter Six*, I explored how this research contributes to more effective and sustainable adaptation outcomes for rural livelihoods. I discussed how the findings contribute to a deeper understanding of the challenges faced by communities, emphasising the value of holistic perspectives, such as those provided by the LRPF. I also discussed the implications of bridging the gap between theory and practice to ensure that CBRA outputs can inform decision making for rural livelihoods adaptation. Finally, I addressed the policy implications of the research and its global contributions, exploring how the findings can inform and influence adaptation strategies at both local, regional, and global scales.

Thesis Chapters

Thesis Objectives

Chapter One Introduction	
Chapter Two A Systematic Review of Current Progress in Community-Based Vulnerability Assessments	<i>(1) Systematically evaluate if scholars are addressing CBVA limitations in contemporary studies.</i>
Chapter Three Navigating Risk: A Holistic Framework for Supporting Rural Livelihoods Adaptation in Solomon Islands	<i>(2) Develop and implement a holistic risk assessment framework to address CBVA limitations in the context of rural livelihoods.</i>
Chapter Four From Vulnerability to Risk: Evaluating the Role of Holistic Risk Assessment for Livelihoods Adaptation Planning	<i>(3) Critically evaluate how this holistic framework contributes to more effective and sustainable adaptation outcomes for rural livelihoods compared to prior frameworks.</i>
Chapter Five Building Stronger Futures: Combining Risk Assessments and Adaptation Pathway Approaches for Rural Livelihoods Resilience in Solomon Islands	<i>(4) Develop an approach to apply framework outputs within adaptation pathway approaches, supporting enhanced decision-making for adaptation.</i>
Chapter Six General Discussion	

Figure 1: Overview of thesis chapters and corresponding research objectives.

Chapter Two

A Systematic Review of Current Progress in Community-Based Vulnerability Assessments



Chapter Two: A Systematic Review of Current Progress in Community-Based Vulnerability Assessments

Foreward

This chapter investigates if researchers are addressing the theoretical limitations of community-based vulnerability assessments (CBVAs) when implementing popular frameworks. I provide justification for my thesis by confirming that these limitations persist in the current literature. This reflects the need for holistic frameworks that can achieve a more comprehensive understanding of the factors influencing rural livelihoods vulnerability. This chapter has been published in *Regional Environmental Change*¹¹.

Abstract

This systematic literature review critically evaluates the extent to which community-based vulnerability assessments are progressing towards holistic approaches that address multiple exposures, a broader range of socioeconomic factors, and spatial and temporal dynamics. The review focuses on studies applying widely implemented frameworks in the research fields of livelihoods (Sustainable Livelihoods Framework (SLF) n=72), and climate change adaptation (IPCC AR4 Framework (AR4) n=101) published between 2014 and 2023. The review found that few studies are addressing theoretical limitations, particularly regarding spatial dynamics (SLF =1%, AR4 =5%), future temporal dynamics (SLF =4%, SLF =7%) and exposure to multiple hazard events (AR4 =7%, SLF=8%). However, progress has been made in overcoming narrow perspectives that previously led to the exclusion of external hazards (SLF) or socioeconomic factors (AR4) in assessments. Despite this progress, AR4 based studies were found to neglect critical components of adaptive capacity, particularly in relation to natural, financial, and social capital. To address these theoretical limitations, researchers should adopt more holistic frameworks that integrate perspectives from both the livelihoods and climate change adaptation (CCA) fields and employ non-static approaches that address the dynamic nature of vulnerability. In doing so, researchers can reduce the likelihood that assessments will lead to ineffective or maladaptive outcomes.

¹¹ **Smith, B.** and Diedrich, A., 2024. A systematic review of current progress in community-based vulnerability assessments. *Regional Environmental Change*. 24(1). 1-17.

Introduction

The application of community-based vulnerability assessments (CBVAs) as a tool to guide positive development outcomes is on the rise in low-income rural environments (Thiault et al. 2021; Winfeld et al. 2019). These assessments aim to support local communities in achieving livelihood goals such as poverty reduction, sustainable natural resource use, or adaptation to global change by evaluating their likelihood of impact following exposure to hazard events (Adger 2006; Serrat 2017; Smit and Wandel 2006). CBVA outputs are commonly applied to inform the design and development of adaptation by offering insights into the structural factors that drive vulnerability (Fussel and Klein 2006; Johnson et al. 2016; Thiault et al. 2020).

In recent decades, there has been growing popularity in the use of CBVAs that focus on climate change vulnerability or the capacity to meet Sustainable Development Goals (SDGs) (Ford et al. 2018; Zhang et al. 2019). This has led to the implementation of CBVAs from the perspectives of climate change adaptation (CCA) or livelihoods and development (from here on referred to as a livelihoods perspective). The former aims to support adaptation to physical shock and stressor events (Adger 2006), while the latter aims to address socioeconomic issues like poverty (Scoones 2009). However, distinct limitations in CBVAs applied within these fields has led researchers to question if outputs can capture the complexities of vulnerability (McDowell et al. 2016; O'Brien et al. 2007). These limitations include: i) the failure to integrate a comprehensive range of biophysical and socioeconomic factors driving vulnerability (Ford and Pearce 2012; Ford et al. 2018), ii) inadequate consideration of spatial and temporal dynamics that drive feedback effects for communities (Fekete et al. 2010; Thiault et al. 2018b), and iii) the inability to address vulnerability in the context of multiple hazard events (Bennett et al. 2016). If these limitations persist, CBVA outputs may inform adaptation decisions that lead to ineffective or maladaptive responses (Castree et al. 2014; Magnan et al. 2016; Murphy 2011).

The origins and trajectory of the vulnerability concept in the livelihoods versus CCA field has led to distinct perspectives and desired outcomes for CBVAs (Adger 2006; Hufschmidt 2011; Janssen and Ostrom 2006). For example, from a livelihoods perspective, vulnerability is framed as an internal socioeconomic condition, measured by quantifying a household's access to a pre-defined list of assets considered important for livelihoods (O'Brien et al. 2007). These assets, as outlined in the Sustainable Livelihoods Framework (SLF) typically include human, social, natural, physical, and financial capital (DFID 1999). Vulnerable households are identified as those with limited access to these assets, making them more likely to experience undesirable social conditions such as poverty or food insecurity (Scoones 2009). The outcomes of livelihoods-based CBVAs aim to enhance access to assets within a community (e.g., through the development of fair and just livelihood portfolios) and often give specific focus to the SDGs (Morse and McNamara 2013).

Limitations of livelihoods-based CBVAs stem from their failure to consider how the broader context (i.e., hazards that are present in the environment) influences vulnerability (Dilley and Boudreau 2001; Mensah 2011). By focusing solely on internal socioeconomic conditions, these CBVAs are unable to understand how external hazards, including shocks, seasonality, and trends, might impact a community (McLean 2015). Yet these events, including extreme weather, seasonal patterns, shifts in monsoonal periods and climate change, all have profound impacts on livelihoods (DFID 1999). Additionally, the static nature of these assessments means that the factors influencing vulnerability across various spatial (e.g., institutional and governance contexts) and temporal (e.g., changing resource availability) scales are often neglected (Natarajan et al. 2022).

CBVAs that apply a CCA perspective explicitly focus on the broader context of vulnerability that a community operates within (Burton et al. 1978; O'Brien et al. 2007). These assessments typically evaluate spatial and temporal variation in climate-based hazards, before integrating this with a basic analysis of the socioeconomic conditions that are likely to be impacted by exposure to these events. This approach enables climate-based CBVAs to predict a community's vulnerability to future hazard events and develop adaptation aimed at reducing the socioeconomic impacts of exposure (e.g., resilient livelihood portfolios) (Adger 2006; Fussler and Klein 2006; Kelly and Adger 2000).

Limitations of climate-based CBVAs stem from an analytical focus on the biophysical characteristics of hazard events, paired with an incomplete and static picture of internal socioeconomic conditions (Ford and Pearce 2012; Ford et al. 2018; McDowell et al. 2016). This narrow focus can guide maladaptive actions that fail to recognise the full extent of climate change impacts on a community (Ford et al. 2018). Maladaptation may also arise from the mismatch that occurs when pairing predictions of future hazards with current socioeconomic conditions (Jurgilevich et al. 2017). Furthermore, by focusing on climate as the primary driver of global change, CBVAs often overlook non-climatic hazards such as resource extraction, land use change, and socioeconomic issues (Bennett et al. 2016). This narrow focus has persisted despite an increased awareness of the cumulative impacts that result from multiple interacting drivers of global change (Ford et al. 2018; Rasanen et al. 2016).

In response to these limitations, researchers have supported a transition towards holistic CBVA frameworks that merge perspectives from the livelihoods and CCA fields (Ford et al. 2018; Guerrero et al. 2018; Singh et al. 2017; Thiault et al. 2021). This integration allows CBVAs to better incorporate the diverse biophysical and socioeconomic factors that drive vulnerability (McDowell et al. 2016; McLean 2015). By examining both internal socioeconomic conditions (i.e., livelihoods-based CBVAs) and exposure to external hazard events (i.e., climate-based CBVAs), these combined assessments can provide a more comprehensive understanding of vulnerability (O'Brien et al. 2007). Additionally, researchers have emphasised the need for methods that address spatial and temporal dynamics

(Jurgilevich et al. 2017) and assess exposure to multiple types of hazard events (Orr et al. 2020). By applying these methods, CBVAs can better capture the complexities of vulnerability (Ford et al. 2018).

Over the past decade, numerous frameworks and methodologies have emerged that adopt a holistic perspective, attempting to capture the socioeconomic factors, spatial and temporal dynamics, and multiple exposures that drive vulnerability (e.g., Berrouet et al. 2018; Birkmann et al. 2013; Cinner et al. 2013; IPCC 2014; Marshall et al. 2013; Naylor et al. 2020; Thiault et al. 2018b). However, CBVA critique articles spanning the early 2000s to late 2010s continue to highlight these limitations within studies, indicating little progress in addressing these issues within the broader literature (Dilley and Boudreau 2001; O'Brien et al. 2007; Fekete et al. 2010; Ford and Pearce 2012; Cameron 2012; Morse and McNamara 2013; Bennett et al. 2016; McDowell et al. 2016; Ford et al. 2018; Thiault et al. 2018). This persistence may be associated with the popularity of CBVA frameworks originating from the livelihoods (i.e., Sustainable Livelihoods Framework (SLF) (DFID 1999)) and CCA (i.e., Intergovernmental Panel on Climate Change (IPCC) AR4 Framework (IPCC 2007)) fields that are subject to the previously mentioned limitations.

To reiterate, for SLF-based studies limitations include: i) failure to incorporate the broader vulnerability context (i.e., hazard events), and ii) failure to consider spatial and temporal dynamics (Mensah 2011). In contrast, for AR4-based studies limitations include: i) an incomplete and static analysis of socioeconomic vulnerability, and ii) a singular focus on exposure to climate change (McDowell et al. 2016; Jurgilevich et al. 2017). Despite significant efforts to highlight these limitations (Ford et al. 2018; Thiault et al. 2021), the SLF and AR4 persist as the most commonly applied CBVA frameworks, with limited insight into if, and how, authors are attempting to overcome their limitations.

In this review, I aim to systematically identify, analyse, and critically evaluate if researchers are addressing CBVA limitations within contemporary studies that implement the SLF and AR4 Framework. I discuss the implications of not addressing these limitations and present methodological approaches that can support researchers in overcoming these issues (Figure 2). In doing so, I contribute to the body of work that supports CBVAs in achieving more effective adaptation outcomes. As this chapter focuses on the SLF and AR4 Framework, I acknowledge that I do not capture trends across the entire CBVA literature. However, examples of other CBVA frameworks are provided to contextualise my findings within the broader literature.

Disciplinary Perspective	Disciplinary Limitations	Potential Maladaptation	Solutions
Climate Change Adaptation (e.g., IPCC AR4 (2012)) - Aims to support climate change adaptation. - Vulnerability addressed as the impact of exposure to climate change. - Measured by quantifying the biophysical characteristics of climate change, paired with a basic understanding of internal socioeconomic conditions.	Fails to comprehensively address internal socioeconomic vulnerability ¹ . Fails to consider temporal variation in socioeconomic vulnerability ² . Fails to address non-climate events that drive exposure to multiple shocks and stressors ³ .	Adaptive actions reduce the impact of climate change but worsen socioeconomic conditions for some of the population ⁵ . Adaptation aiming to pair present day socioeconomic conditions with future climate fails due to changes through time ⁶ . Adaptation fails to consider how climate interacts with additional shocks and stressors resulting in unidentified impacts ³ .	Develop approaches that combine disciplinary perspectives with those of livelihoods and development ^{9,10} . Integrate qualitative methods (e.g., scenario planning ¹¹ , longitudinal approach ¹²) to address temporal scale. Consider locally relevant shock and stressors and their potential interactions with climate change ³ .
Livelihoods & Development (e.g., SLF (DFID 1999)) - Aims to reduce poverty. - Vulnerability addressed as an underlying and internal socioeconomic condition. - Measured by quantifying household access to assets that are important for livelihoods.	Fails to assess exposure to external shocks and stressor events ⁴ . Fails to address the impact of spatial scale on internal socioeconomic vulnerability ² . Fails to address the impact of temporal scale on internal socioeconomic vulnerability ² .	Adaptation improving socioeconomic conditions fails due to negative impact from shock and stressor events ⁴ . Adaptation fails due to the impact of cross-scale interactions with landscape level ecological processes and governance ⁷ . Adaptation fails due to a lack of consideration of historical perspectives and future trajectories ⁸ .	Develop approaches that combine disciplinary perspectives with those of climate change adaptation ^{9,10} . Develop approaches that contextualise vulnerability in relation to the broader environment ^{9,13} . Develop qualitative approaches that contextualise vulnerability in relation to past and future conditions ^{11,12} .

1. Ford et al. (2018) 2. Thiault et al. (2018) 3. Bennett et al. (2016) 4. McLean et al. (2015); 5. Magnan et al. (2016) 6. Conway et al. (2019) 7. Cummings et al. (2006) 8. Eklom (2012); 9. Marshall et al. (2013) 10. IPCC (2014) 11. Butler et al. (2020) 12. Archer et al. (2017) 13. Brown & Kyttä (2018) /

Figure 2: Limitations emerging from climate change adaptation (e.g., IPCC AR4) and livelihoods and development (e.g., SLF) community-based vulnerability assessment frameworks, with associated maladaptation potential and suggested methodological solutions.

Methods

I conducted a systematic literature review to identify, examine, and critically evaluate CBVAs implementing the SLF and AR4 Framework in rural low-income environments between 2014 and 2023. This review was conducted in four steps: (1) a scoping exercise to confirm the novel contribution of the review to the literature and confirm that the SLF and AR4 are the most commonly implemented frameworks in CBVA research, (2) a systematic literature search for CBVAs implementing the SLF and AR4, (3) application of inclusion and exclusion criteria to the systematic search results, and (4) data extraction and content analysis to answer key research questions regarding the extent to which contemporary CBVAs tackle their theoretical limitations. Details of each step are provided in the following subsections, with an overview of the process shown in Figure 3.

Scoping Exercise

I conducted a scoping exercise using the Web of Science (Core Collection) to identify systematic literature reviews that assessed CBVAs over the last decade. Of the 22 identified reviews (see Appendix 1), none focused on critically evaluating the extent to which CBVA limitations have been addressed in the SLF and AR4 Framework. This scoping review also guided the development of the systematic search strategy, database selection, timeframe, and inclusion criteria, by consulting past review methodologies. Given the popularity of CBVAs as a tool for supporting adaptation, I decided to focus on the most commonly applied frameworks in the CCA (i.e., the AR4), and livelihoods (i.e., the SLF) fields. A second scoping exercise was conducted to compare these frameworks to other popular CBVA approaches (e.g., Birkmann et al. 2013; Cinner et al. 2013; Marshall et al. 2013; Thiault et al. 2018b). This exercise was subject to the same systematic search strategy and screening process applied to the full review process described below.

Systematic Search Strategy

The Voyant Text Mining tool was used to select relevant keywords for each framework. Search strings were then developed and pre-tested within selected databases (Web of Science (Core Collection), Scopus, and Google Search Engine). Additional keywords were included to reflect the focus on community-level assessments. For example, the search strings for the SLF included terms like “sustainab” AND “livelihood” OR (“sustainable livelihood” OR “SLF”) AND various terms related to poverty, vulnerability, and rural communities. Similarly, for the AR4 framework, search strings used keywords such as “vulnerab” AND (“assess” OR “framework”) AND “climat*” or “climate change” along with terms like “communit*” and “rural”. Final search strings for both frameworks are provided in Appendix 2. The literature search was completed in March 2023, and was restricted to journal articles and conference papers published between 2014 and 2023. This date range was chosen to reflect the

publication of the IPCC's 2014 AR5 Risk Framework (IPCC 2014), marking a seminal transition towards a more holistic approach (Sharma and Ravindranath 2019). By focusing on post 2014 literature, this review offers a contemporary analysis of CBVAs during a period of increased attention on vulnerability assessment limitations. I acknowledge that the search strings may have resulted in the exclusion of some cross-scale studies that address community level vulnerability alongside other administrative units.

Screening Process

I applied a systematic approach to literature screening following PRISMA guidelines (Page et al. 2021). I first removed duplicate studies, before progressively examining the title, abstract, and full text of each CBVA based on a pre-defined list of inclusion and exclusion criteria (see Appendix 2). Examples of these criteria include timeframe, study type, context, scale, location and data type of a study. The screening process resulted in the identification of 173 CBVAs for inclusion within the review. Of these studies, n=72 applied the SLF, and n=101 applied the AR4 Framework (Figure 3), a reference list of these studies is provided in Appendix 3.

Data Extraction & Content Analysis

I developed a structured approach to extract, analyse, and critically evaluate qualitative and quantitative data from CBVAs. This was applied to determine bibliographical and methodological trends across SLF and AR4-based studies and to examine if these studies are addressing CBVA limitations. To guide this process, I applied the following thematic questions to data extraction and content analysis:

1. How are SLF and AR4-based CBVAs distributed across time (i.e., year of publication)?
2. Are there any methodological trends (i.e., common patterns or approaches in research methods) in CBVAs applying the SLF and AR4 Framework?
3. Do SLF-based CBVAs tackle limitations including a failure to address: i) the broader vulnerability context (i.e., hazard exposure), and ii) temporal and spatial dynamics.
4. Do AR4-based CBVAs tackle limitations including a failure to: i) adequately address socioeconomic vulnerability and its temporal components, and ii) exposure to multiple drivers of global change.

To extract the data, I analysed the methods and supplementary information of each study. Data were collected using N-Vivo 12 and later exported into Microsoft Excel for further analysis. Content analysis was then used to compile and group the data, which included collating vulnerability assessment indicators into the major components of the AR4 (i.e., exposure, sensitivity, and adaptive capacity), and SLF (i.e., human, financial, social, physical, and natural capital) (Table 1). Under these components, indicators were classified into groups based on common themes (e.g., age, gender, education, ethnicity,

and religion were grouped to represent sociodemographic profile). This allowed me to evaluate how: i) SLF-based studies incorporated the broader vulnerability context (i.e., hazard exposure), and ii) AR4-based studies assessed socioeconomic vulnerability (i.e., including sensitivity and adaptive capacity indicators).

The analysis of exposure indicators was used to evaluate if studies addressed multiple drivers of global change. Finally, content analysis was used to identify the use of spatial (e.g., landscape interactions, and multi-level governance dynamics) and temporal (e.g., historical climate variability and future climate projections) dynamics. The full method used for data extraction and content analysis is provided in Appendix 2.

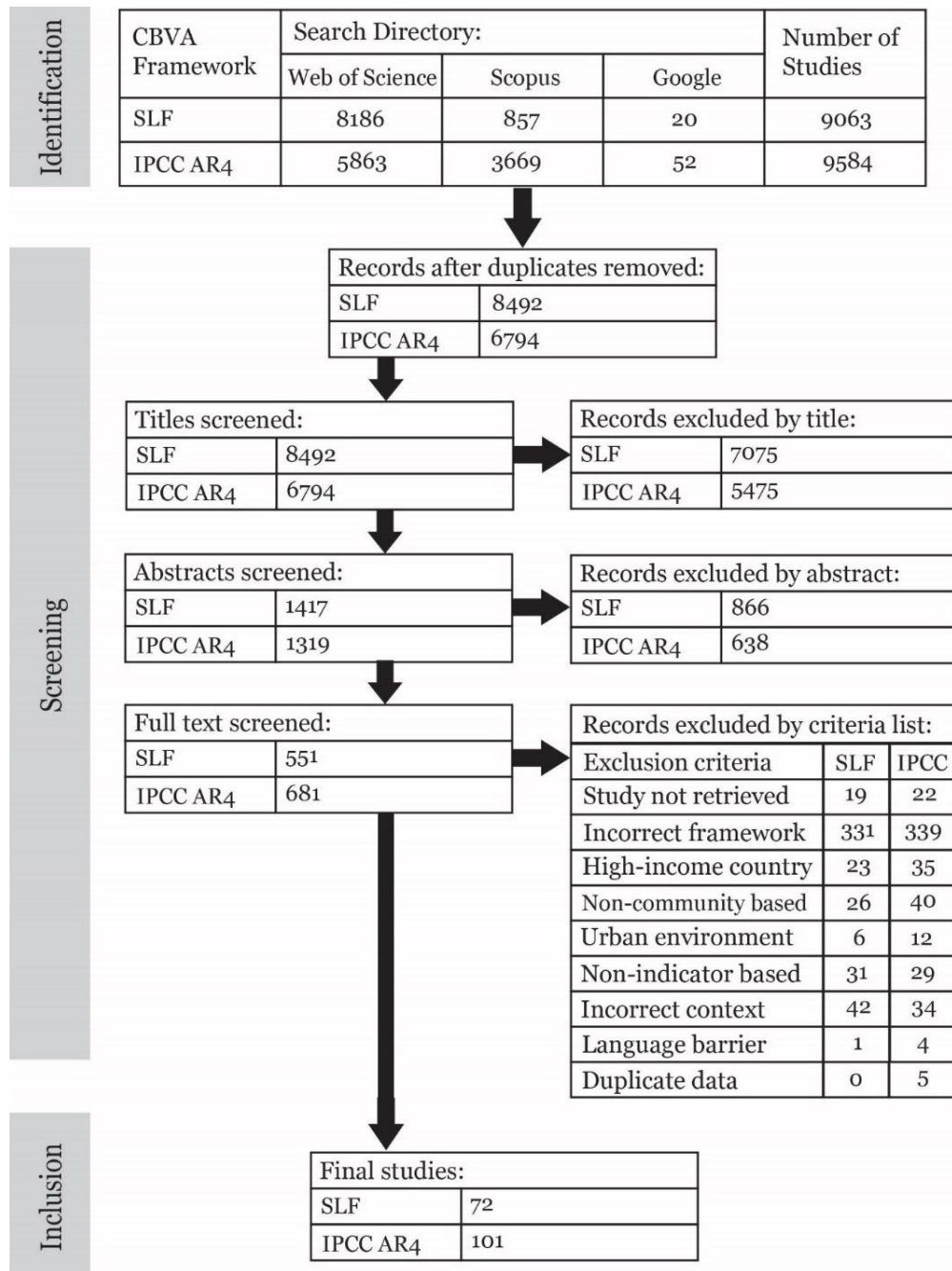


Figure 3: The screening process (based on PRISMA (2020) guidelines) used to identify CBVAs applying the Sustainable Livelihoods Framework (DFID 1999) and IPCC AR4 Framework (IPCC 2007) between 2014-2023.

Table 1: The components used to structure content analysis based on the AR4 Framework (IPCC 2007) and the Sustainable Livelihoods Framework (DFID 1999).

Component	Definition
AR4 Framework (IPCC 2007)	
<i>Exposure</i>	The degree to which a system is exposed to shocks and stressors.
<i>Sensitivity</i>	The degree to which a system is affected by exposure to shocks and stressors.
<i>Adaptive Capacity</i>	The ability of a system to adjust to exposure to shocks and stressors, moderate potential damage, take advantage of opportunities, or cope with consequences.
Sustainable Livelihoods Framework (DFID 1999)	
<i>Human Capital</i>	The skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives.
<i>Physical Capital</i>	The basic infrastructure and producer goods needed to support livelihoods.
<i>Social Capital</i>	The social resources people draw on in pursuit of their livelihood objectives.
<i>Financial Capital</i>	The financial resources that people use to achieve their livelihood objectives.
<i>Natural Capital</i>	The stocks of natural resources from which resources flow and services useful for livelihoods (e.g., nutrient cycling, erosion protection) are derived.

Results

Trends in Framework Application

Results from the scoping exercise support the assumption that the SLF (38%) and AR4 (53%) are the most popular CBVA frameworks adopted in studies within the livelihoods and CCA fields. For the AR4 this was particularly evident between 2011 and 2016, where 60% of all studies implemented this framework. In contrast, the SLF decreased in popularity by 7% during this period. While the AR4 and SLF experienced a steep decline in popularity in 2022, the number of CBVAs applying other frameworks grew. This was mainly due to the increased implementation (n=5) of Birkmann et al.'s (2013) MOVE Framework. Despite the IPCC's transition to risk in their AR5 framework (IPCC 2014), no community-based studies implementing this framework were identified (Figure 4).

Methodological Approaches for CBVAs

CBVAs across both frameworks primarily applied a mixed methods approach to data collection, accounting for 72% (n=124) of all studies. The most widely applied methods included household surveys (55%, n=84) and focus group discussions (56%, n=97). The majority of CBVAs assessed vulnerability using generic indicator sets established by prior studies (66%; n=115). However, some CBVAs incorporated additional context specific indicators tailored to the local context. Where this

occurred, indicators were selected through literature reviews (38%; n=66), local knowledge (38%, n=66), and expert knowledge (37%; n=64).

The majority of SLF-based studies presented CBVA results as descriptive statistics (63%; n=45). In contrast, AR4-based studies developed composite values for vulnerability based on index calculations (100%; n=101). The most popular index methods were the Livelihood Vulnerability Index (LVI) (55%; n=56) (Hahn et al. 2009), and Pandey and Jha's (2012) Climate Vulnerability Index (10%; n=10).

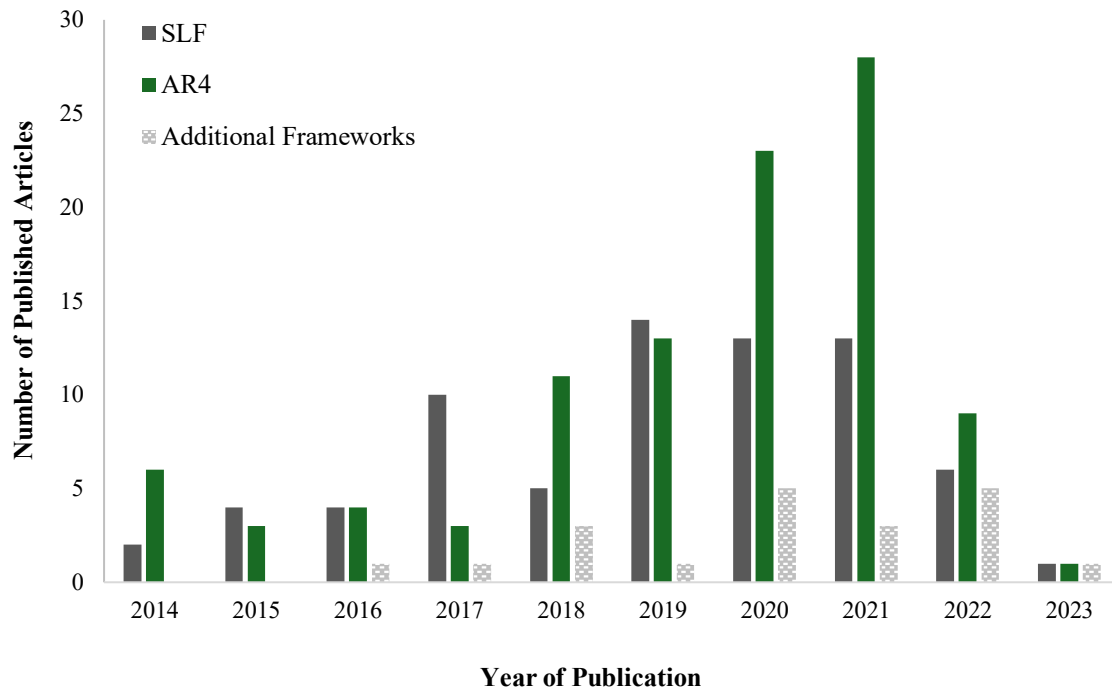


Figure 4: Trends in the number of CBVAs published between September 2014 and March 2023 that apply the SLF (DFID 1999), AR4 (IPCC 2007), and other popular CBVA frameworks (i.e., Birkmann et al. 2013; Cinner et al. 2013; Marshall et al. 2013 and Thiault et al. 2018b).

Evaluating the Persistence of CBVA Limitations

Limitation 1: Narrow Perspectives on Vulnerability

Do AR4-Based Studies Adequately Evaluate Socioeconomic Vulnerability?

All AR4-based studies assessed socioeconomic indicators related to adaptive capacity. However, SLF-based studies conducted a more extensive analysis, with significant variation observed in the number and types of adaptive capacity indicators applied across frameworks. For example, AR4-based studies were less likely to measure financial capital (57%; n=56) and natural capital (28%; n=28) compared to SLF-based studies. Additionally, while a comparable percentage of studies addressed social capital (AR4 = 84%; n=87, SLF=89%; n=64), AR4-based studies lacked key aspects of community cohesion

(e.g., capacity building, collective action, and decision-making) (11%; n=11), and social relationships (e.g., trust, sense of belonging, social networks, and attitudes) (13%; n=13) (Figure 5).

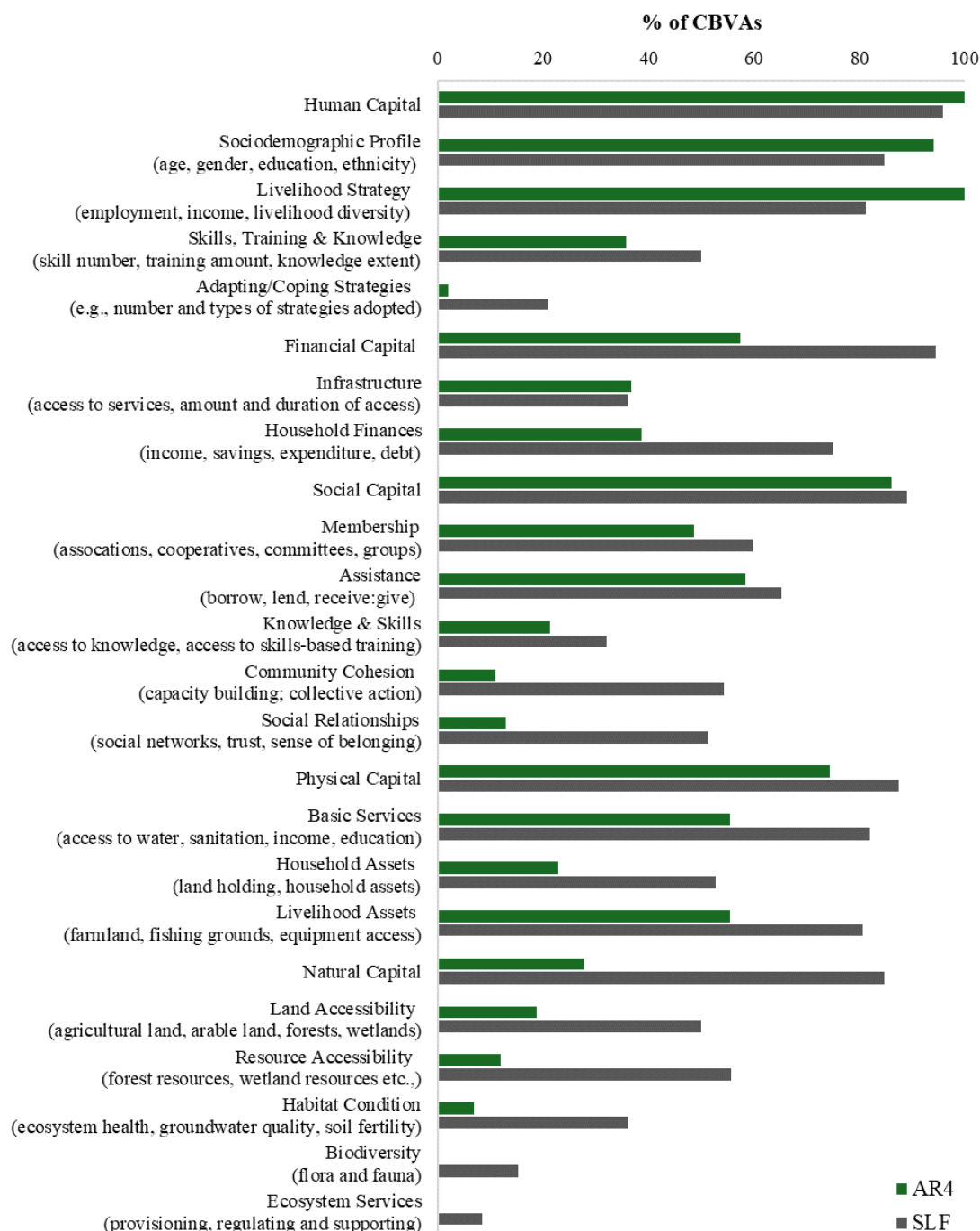


Figure 5: The types of adaptive capital indicators applied within AR4 and SLF-based CBVAs represented as the percentage of studies applying each indicator group. Indicators are categorised based on capital asset types defined in the SLF including human, financial, social, physical, and natural capital (DFID 1999).

The majority of AR4-based studies included socioeconomic measures of sensitivity (90%; n=91), compared with 67% (n=48) of SLF studies. Sensitivity indicators focused on key livelihood security objectives (LSOs) that may be impacted by hazard exposure (i.e., food, water, housing, and health security). Food and water security were the most widely assessed LSOs within AR4-based studies, with associated indicators found in 73% (n=74), versus only 15% (n=11) of SLF-based studies. Limited comparability existed in the types and number of sensitivity indicators applied across frameworks. For example, SLF-based studies tended to adopt a singular measure for a given LSO such as food security (e.g., food sufficiency), whereas AR4-based studies used a broader range of measures, including household food production, food accessibility, and seed storage (Figure 6).

The application of the LVI (Hahn et al. 2009) within 62% (n=63) of AR4-based studies influenced the results. In studies applying this index, indicators were selected according to the LVI methodology and were analogous across studies. As the LVI emphasises measures of sensitivity, this influenced the number of AR4-based studies assessing this component of vulnerability. For example, water security indicators were included within 96% (n=97) of AR4-based studies that applied the LVI, versus 32% (n=32) of studies that did not apply this index.

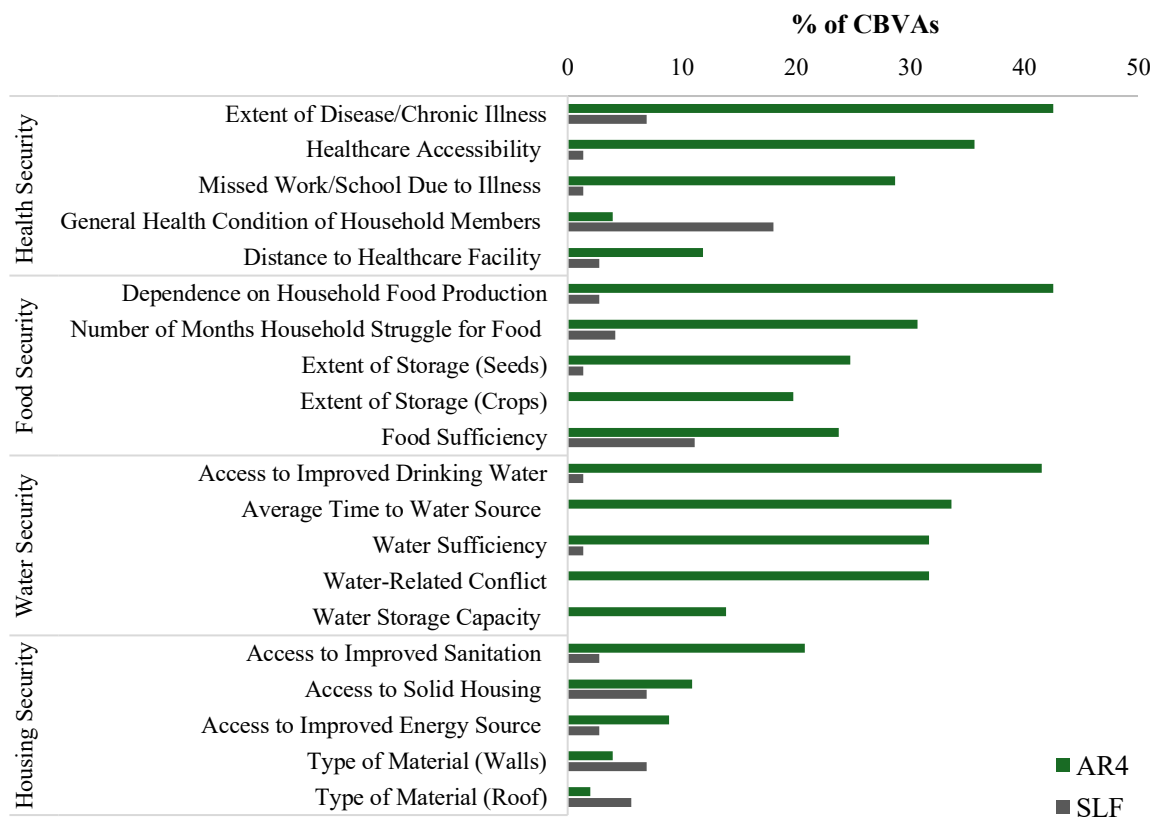


Figure 6: The percentage of SLF and AR4-based CBVAs that applied sensitivity indicators relating to health, water, food, and housing security.

Do SLF-based Studies Assess the Broader Vulnerability Context?

All SLF-based studies framed vulnerability in relation to exposure to the broader vulnerability context, which encompassed external hazard events. This primarily included exposure to natural hazards (e.g., flooding and drought) (57%; n=41), resource exploitation (e.g., commercial logging, mining, and fishing) (43%; n=31), and social issues (e.g., crime and conflict) (89%; n=90). In contrast, AR4-based studies tended to focus on climate change exposure (89%; n=90), with resource exploitation and social issues addressed in only 7% (n=7) of studies (Figure 7).

While all SLF-based studies framed vulnerability around hazard events, this did not always result in an empirical measurement of exposure. Attempts to measure exposure were made in 47% (n=34) of SLF-based studies and were typically related to the frequency of climate-based events (17%: n=12). However, empirical analysis of social issues and resource extraction were conducted in only 10% (n=7) of SLF-based studies. In contrast, exposure was empirically measured in 100% of AR4-based studies. Additionally, these studies applied an average of 3 ± 2 indicators to assess the characteristics of a hazard event (e.g., magnitude, frequency and duration), whereas SLF-based studies commonly applied a single indicator.

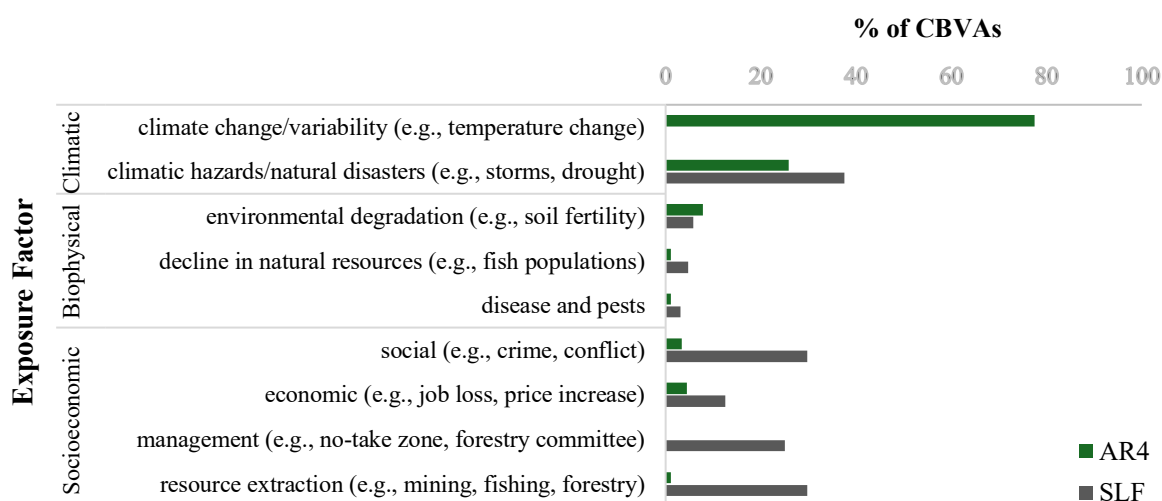


Figure 7: The percentage of AR4 and SLF-based CBVAs framing vulnerability around exposure to external hazard events.

Limitation 2: Incorporation of Spatial and Temporal Dynamics

Do SLF-based Studies Incorporate Spatial and Temporal Dynamics?

Indicators related to spatial and temporal dynamics were measured in only 1% (n=1) and 19% (n=14) or SLF-based studies respectively. When temporal dynamics were assessed, the focus was primarily on understanding past exposure to climate variability or natural hazard events (e.g., floods and droughts).

Only one study (Huq et al. 2015) attempted to analyse future dynamics of vulnerability using scenario planning methods.

Spatial dynamics were inherent within exposure-based indicators, which reflected the place-based characteristics of hazard events. However, few SLF-based studies considered spatial dynamics in relation to sensitivity and adaptive capacity indicators. Where this type of analysis occurred, it was limited to a measurement of multiscale governance dynamics (as an indicator of adaptive capacity). Similar trends were found in AR4-based studies, where spatial dynamics were only included within 5% (n=5) of all studies.

Do AR4-based Studies Address Temporal Variation in Socioeconomic Vulnerability?

Although the results indicated that a greater percentage of AR4-based studies addressed temporal dynamics (54%; n=55), these focused exclusively on temporal variations in hazard exposure. Specifically, AR4-based studies examined past climate variability (51%; n=50), with few studies incorporating future projections of climate change (7%; n=6). There was no temporal analysis of socioeconomic indicators observed in AR4-based studies.

Limitation 3: Analysis of Multi-Hazard Exposure

Do AR4-based Studies Assess Exposure to Multiple Hazard Types?

A limited number of AR4-based studies assessed how exposure to multiple hazard types might impact vulnerability (7%; n=6). In cases where this occurred, studies focused on the presence of natural hazard events (e.g., floods or droughts) (4%; n=4) or environmental issues (e.g., pollution) (7%; n=6), alongside climate variability. Studies that did assess multiple exposures focused on the frequency with which communities experienced simultaneous hazards over a specified time period. However, no study attempted to assess the interactions and cumulative impacts resulting from these multiple exposure events.

Discussion

The increasing number of CBVAs implementing the SLF and AR4 Framework indicates their continued popularity. This underscores the need to assess whether studies applying these frameworks are addressing their respective limitations. Notably, the AR4 remains widely applied despite the IPCC's transition to the AR5 Risk Framework (IPCC 2014), which attempts to tackle AR4's limitations (Mach et al. 2016; Sharma and Ravindranath 2019). Research by Ishtiaque et al. (2022) and Estoque et al. (2023) identifies three key reasons for the limited uptake of the AR5, including: i) reluctance to abandon the established AR4 method, ii) confusion and lack of awareness about the AR5 and iii) ongoing demand for clearer methodological guidelines to implement the AR5 framework. These barriers to uptake need

to be acknowledged by researchers. Where the AR5 has been implemented in other contexts, limited progress has been seen in addressing the AR4's limitations, with limited analysis of exposure to multiple hazard types and failure to incorporate a broader range of socioeconomic indicators across studies (Alam et al. 2022; Bera et al. 2022; Malakar et al. 2021; Singha et al. 2023). Further research is therefore needed to determine if the AR5 can effectively overcome the AR4's limitations.

The recent decline in the SLF and AR4's implementation is likely related to the COVID-19 pandemic, although further bibliographical analysis is required to confirm this trend. This chapter also noted the growing popularity of the MOVE Framework (Birkmann et al. 2013), with studies citing its ability to better integrate spatial dynamics and socioeconomic vulnerability as key reasons for its adoption (Hamidi et al. 2022; Van et al. 2022; Sultana et al. 2023). This trend suggests a slow shift towards the implementation of more holistic CBVA frameworks.

Overall, this review revealed modest progress in overcoming the limitations of the SLF and AR4 Framework. The greatest advancement was observed with respect to overcoming narrow research perspectives. AR4-based studies moved beyond a focus on biophysical indicators, to include a well-developed analysis of socioeconomic vulnerability, although a comprehensive analysis of adaptive capacity remains lacking. Around half of the SLF-based studies assessed the broader vulnerability context (i.e., hazard exposure), but did not fully capture sensitivity to these hazards. Studies applying both frameworks continued to face limitations in integrating spatial and temporal dynamics, as well as addressing multiple exposures. I explore the implications of these persistent limitations in the next sections and suggest methodological steps to overcome them.

Limitation 1: Overcoming Narrow Perspectives

Addressing AR4 Perspectives

The tendency for livelihoods and CCA studies to narrowly focus on either the social (i.e., the SLF) or biophysical (i.e., the AR4) components of vulnerability is the most common limitation directed at CBVAs (Ford et al. 2018; Sejersen 2015). However, the results suggest that most studies are tackling this limitation. This was particularly evident for AR4-based studies, which incorporated a broad range of socioeconomic indicators. This was attributed to the popularity of the LVI as an assessment method, which explicitly focuses on bridging the gap between research perspectives (Hahn et al. 2009). To do so, the LVI incorporates SLF-based indicators within the AR4 Framework, providing a more holistic approach that better integrates socioeconomic and biophysical components of vulnerability within CBVAs.

The popularity of the LVI suggests a general recognition of the benefits of adopting holistic CBVA methods. However, strict adherence to the LVI method may limit the depth of analysis of some critical factors, including adaptive capacity (Hahn et al. 2009). This is concerning, given the foundational role

that key indicators of financial and social capital, overlooked in the LVI, play in shaping vulnerability (Azad and Pritchard 2022; Freitag et al. 2014; Pelling and High 2005). Reliance on predefined LVI indicators also restricts the use of site-specific indicators, which are essential for developing a contextualised understanding of vulnerability (Hinkel 2011; Nguyen et al. 2016). To address this, researchers implementing the LVI (and the overarching AR4 Framework) should further expand the indicators applied within CBVAs, with specific attention on adaptive capacity. This would enable the AR4 to better support decision making for adaptation that accurately reflects local socioeconomic characteristics (Adger 2006; Currenti et al. 2019; Sidle et al. 2013). This can help ensure that resulting adaptation interventions best match local needs (Cameron 2012; Hall and Sanders 2015).

Expanding adaptive capacity indicators can also provide a mechanism to frame CBVA outputs in a way that empowers communities by highlighting their strengths (Bene et al. 2016). This includes incorporating additional components that are often overlooked, such as local knowledge, skills, social relationships, and community capabilities. These elements of adaptive capacity are essential for understanding how communities can respond to challenges but are often excluded in favour of factors that influence a community's sensitivity to hazard exposure (Kirkby et al. 2018). By integrating these indicators, CBVAs can shift away from the passive and negative focus that occurs when assessments centre on sensitivity to impact from hazard exposure (Bennet et al. 2016). Rather than focusing solely on sensitivity, this approach highlights the strengths within communities, empowering them by recognising their capacity to respond and adapt (Haalboom and Natcher 2012). It is important to note that this does not mean that CBVAs should overlook barriers or challenges to adapting; instead, they should aim for a more balanced view that acknowledges both strengths and barriers, offering a more comprehensive understanding of adaptive capacity.

Addressing SLF Perspectives

By framing vulnerability around exposure to external hazards many SLF-based CBVAs have expanded their scope to include the broader vulnerability context. This marks a shift from the original SLF approach, which focused on how internal socioeconomic factors associated with adaptive capacity contribute to vulnerability (DFID 1999). By expanding the concept of vulnerability, researchers within the livelihoods field are acknowledging the interconnection between global change drivers and socioeconomic conditions, which need to be addressed in tandem (Natarajan et al. 2022). However, as only half of the reviewed SLF-based studies translated this broader framing into an empirical analysis of exposure, this limitation ultimately still applies to their outputs. Additionally, the use of a single indicator to measure exposure can underplay the severity of hazard events. This has been implicated in the development of inadequate adaptation responses (Magnan et al. 2016), particularly in regard to natural resource management (Morand et al. 2012; Roscher et al. 2021).

The limited inclusion of sensitivity indicators in SLF-based studies further reflects the framework's original focus on adaptive capacity (DFID 1999). However, framing vulnerability around hazard exposure necessitates a greater focus on sensitivity, as sensitivity assesses the socioeconomic factors that influence the likelihood of being impacted by hazard events (IPCC 2007). This provides a deeper understanding of how hazard exposure may influence factors like poverty and the ability to meet essential LSOs such as water, food, and housing security (Mensah 2011). By incorporating sensitivity indicators into SLF-based studies, CBVAs can guide more targeted adaptation responses that focus on the specific aspects of a community that are likely to be impacted, while leveraging adaptive capacity to implement these responses effectively (Mazibuko 2013).

Limitation 2: Incorporating Spatial and Temporal Dynamics

The neglect of spatial and temporal dynamics within CBVAs was observed across frameworks, with most studies treating vulnerability as a static concept. This has occurred despite widespread literary recognition of the critical role these dynamics play in shaping vulnerability (Fekete et al. 2010; Jurgilevich et al. 2017; Keinberger et al. 2013). While numerous CBVA frameworks have been developed that explicitly address spatial and temporal scale (e.g., Archer et al. 2017; Butler et al. 2020a; Fawcett et al. 2017; Naylor et al. 2020), their uptake has been limited.

Addressing Spatial Dynamics

Several key spatial dynamics that require attention include multiscale governance interactions (Carina and Keskitalo 2008; Wellstead et al. 2013) and landscape-level ecological processes (Carmenta et al. 2020; Sayer et al. 2013). While some studies did include governance considerations (e.g., Baffoe and Matsuda 2018; Busse et al. 2017; Gentle et al. 2014; Maleki et al. 2018), these were often limited to basic perception-based questions on leadership. Given the key role governance dynamics play in shaping adaptive capacity, their inclusion within CBVAs is essential (Carina and Keskitalo 2008; Keskitalo 2012). However, difficulties exist in pigeon-holing complex governance factors into quantitative indicators (Oulahan et al. 2018). As such, these dynamics may be better integrated as qualitative CBVA components, enabling vulnerability to be contextualised within local governance structures when applied to guide adaptation (Ford et al. 2018). Doing so can improve adaptation effectiveness by clarifying connections between community and broader scale governance mechanisms (Jurgilevich et al. 2021; Wellstead et al. 2013).

Failure to consider landscape-level interactions is concerning, as spatial mismatches often exist between social and ecological processes (Cumming et al. 2006; Fekete et al. 2010; Sidle et al. 2013). Overlooking such interactions has been implicated in maladaptation, demonstrated by Diedrich et al. (2016a; b) and Minter et al. (2018) in a community-based adaptation project in Papua New Guinea, where upstream land use change resulted in significant socioeconomic impacts in downstream locations

that eroded adaptive capacity. By engaging with methods to address landscape-level interactions, CBVAs can identify such mismatches and better support decision makers in navigating trade-offs across space (Diedrich et al. 2022). Numerous CBVA frameworks have been developed that engage with landscape level processes by mapping vulnerability in the context of social-ecological systems (Cinner et al. 2013; Marshall et al. 2013; Thiault et al. 2018b). However, these frameworks have had limited uptake. This may be attributed to the complexity of assessing the ecological aspects of vulnerability, which requires data on ecosystem dynamics, species assemblages, and biological characteristics that are often not readily available (Thiault et al. 2018a).

An alternative approach, likely more suited to the logistical constraints of CBVAs, involves using ethnographic research methods, such as participatory mapping, to establish landscape level interactions (Brown and Kytta 2018; Cutter et al. 2008). This method can utilise local knowledge to map the location of key livelihood assets and overlay this with a map of hazard exposure (Sullivan-Wiley et al. 2019). Participatory mapping has gained popularity in recent years as researchers acknowledge the role of spatial dynamics in driving vulnerability (Meenar 2017; Thomas et al. 2018). This was explicitly recognised by the IPCC in their AR5 Risk Framework, where exposure was reframed as a spatial concept (IPCC 2014). This reframing allows AR5-based studies to automatically address landscape level interactions.

Addressing Temporal Dynamics

Temporal dynamics were addressed in a greater number of CBVAs than spatial dynamics and primarily focused on historical exposure to climate change. While this data is useful for predicting patterns of hazard exposure (Berz et al. 2011), its value would significantly increase if it were combined with data on how exposure impacted local sensitivity and adaptive capacity (Ekblom 2012). This could improve the ability of CBVAs to predict the potential socioeconomic impacts of future hazard exposure, leading to more informed and effective adaptation strategies (Bussey et al. 2012). Qualitative research methods, such as key informant interviews, offer a valuable way to contextualise the outputs of static indicator-based CBVAs in relation to historical shifts in socioeconomic conditions (Ford and Goldhar 2012).

In contrast to historical analyses, future projections of vulnerability were neglected from the majority of CBVAs. For SLF-based studies, this likely stems from the livelihood fields focus on present-day socioeconomic conditions (Conway et al. 2019). However, many broader scale CCA vulnerability assessments have applied modelled projections of climate change to predict potential future impacts from hazard exposure (Warren et al. 2018). Such projections were absent in AR4-based studies, likely due to this chapter's focus on the community scale and the challenges of downscaling global climate models for local application (Giorgio 2018). Where such downscaled data is unavailable, its generation requires significant resources, which often exceeds the capacity and scope of CBVAs (Wilby et al. 2004).

At the community scale, ethnographic methods provide an alternative approach to incorporate futures analysis. A key example is scenario planning, a participatory approach that helps communities envision their futures based on a range of possible trajectories (Bennett et al. 2016; Birkmann et al. 2015; Butler et al. 2016a). By envisioning future trends in biophysical and socioeconomic conditions, scenario planning connects present-day vulnerability with qualitative interpretations of the future (Butler et al. 2016a; 2020a). This method also fills the gap regarding socioeconomic vulnerability projections, which are currently missing from CBVAs (Nicholls et al. 2018). Given the dynamic nature of vulnerability, longitudinal research approaches should also be considered (Fawcett et al. 2017; 2018). These allow for the repeated implementation of CBVAs over time, enabling ongoing monitoring and evaluation to occur, which can help ensure that adaptation actions remain relevant and effective in the long-term (Archer et al. 2017).

Limitation 3: Addressing Multi-Hazard Exposure

The final limitation of CBVAs is the lack of progress in assessing exposure to multiple hazard types. This issue was evident across both frameworks, and likely stems from the research focus of a given CBVA (Bennett et al. 2016). For example, AR4-based studies tended to concentrate exclusively on climate change exposure, reflecting their focus on CCA (IPCC 2007). However, this overlooks additional critical hazards, such as resource exploitation, that communities frequently prioritise in terms of adaptation (Aalst et al. 2008; Tiepolo et al. 2019). Neglecting these non-climatic hazards also prevents an understanding of the interactions and cumulative impacts resulting from multiple exposure events, which can limit the effectiveness of CCA-based adaptation strategies (Rasanen et al. 2016). A holistic approach that incorporates diverse hazard types will enable CBVAs to identify situations where adaptation for one issue, such as climate change, may be undermined by other locally relevant hazard events (Sherman et al. 2015; Thulstrup 2015).

Several approaches have been developed to integrate multiple exposures into CBVAs using bottom-up methods for community-led hazard identification (Bennett et al. 2016; Lede et al. 2021; Lung et al. 2013; Simpson et al. 2021). These approaches enable researchers to consider large-scale exogenous issues, such as climate change, while also considering locally relevant hazard exposures that operate at different scales and speeds (Kittinger et al. 2013). Lede et al. (2021) emphasise the importance of integrating these local hazard perceptions into CBVAs through their research in the Western Canadian Arctic. In this instance, the authors analysis of multiple exposure types identified local-scale socioeconomic hazards that impacted Inuit livelihoods and their capacity to respond to climate change. This informed long-term adaptation that effectively addressed both challenges.

Conclusions

The ability for CBVAs to identify where, how, and why people are vulnerable and apply this information to support adaptation has been widely acknowledged (Thiault et al. 2021; Winfield et al. 2019). This chapter confirmed a growing trend in the use of the SLF and AR4 Framework for guiding adaptation in rural livelihood contexts. However, progress in addressing the theoretical limitations of vulnerability assessments within associated CBVAs was minimal, despite numerous attempts to raise awareness of and combat these issues (Castree et al. 2014; Ford et al. 2018; Magnan et al. 2016; McDowell et al. 2016; Muphy 2011). Most notably, limitations persisted in the neglect of spatial and temporal dynamics and multi-hazard exposures. However, AR4-based studies had made some advances in analysing socioeconomic vulnerability and SLF-based studies had begun to address vulnerability in relation to external hazard events.

Overall, this chapter confirmed the need for holistic CBVA approaches that integrate perspectives from the livelihoods and CCA fields. This would facilitate an increasingly comprehensive analysis of the underlying socioeconomic characteristics that make households vulnerable to undesirable conditions like poverty, while additionally addressing how these vulnerabilities may be exacerbated by exposure to external hazards (O'Brien et al. 2007). Researchers should be mindful of and leverage existing efforts aimed at a holistic approach, such as the IPCC AR5 Risk Framework (IPCC 2014), while striving to better incorporate spatial and temporal dynamics and multiple exposures. Doing so would transform CBVA outputs from a static to a dynamic understanding of vulnerability, enhancing their ability to capture complex interactions between vulnerability drivers (Bennett et al. 2016; Jurgilevich et al. 2017).

I acknowledge that this chapter does not capture all trends within the CBVA literature, nor does it address all limitations associated with CBVAs. However, the persistent limitations of SLF and AR4-based studies underscores the need for researchers to actively engage with these issues. Where limitations exist, it is essential to recognise their potential implications when using CBVA outputs to guide adaptation efforts. Given the increasing rates, scales, and connectivity of global change processes, particularly in the context of climate change, addressing CBVAs' theoretical limitations should be a top priority. Without such progress, researchers must question whether CBVAs remain a valuable tool for guiding effective and sustainable adaptation outcomes.

Chapter Three

Navigating Risk: A Holistic Framework for Supporting Rural Livelihoods Adaptation in Solomon Islands



Chapter Three:

Navigating Risk: A Holistic Framework for Supporting Rural Livelihoods Adaptation in Solomon Islands

Foreward

This chapter addresses the need for holistic approaches to overcome the theoretical limitations of community-based vulnerability assessments (CBVAs). In response to these limitations, I developed the Livelihoods-Based Risk Profiling Framework (LRPF). This chapter provides a detailed overview of the LRPF, focusing on the method for its implementation. To illustrate the framework's utility, this chapter also explores how the LRPF outputs can support more effective and sustainable adaptation outcomes for rural livelihoods. Given the framework's complexity, this chapter is supplemented by comprehensive supporting materials in Appendices 4-7 which offer detailed explanations of the data collection and analysis methods that underpin the framework. This chapter has been published in *AMBIO*².

The research presented in this chapter was conducted in collaboration with Ecological Solutions Solomon Islands (ESSI), an NGO based in Solomon Islands with extensive experience in environmental and community-based research. This collaboration ensured that local researchers were involved in all stages of the research, from methodological design and data collection to interpretation and knowledge sharing. ESSI's in depth understanding of the local context was invaluable in shaping the types of vulnerability indicators used in this chapter, ensuring they were culturally relevant and aligned with the realities of the local communities. The ESSI team also played a crucial role in the data collection process, helping to ensure that local voices were effectively heard and represented throughout the research.

The results presented in this chapter are valuable from both an academic and practical perspective; however, I recognise that their complexity may pose challenges for practical application within communities. To address this, I collaborated with ESSI and community members in Solomon Islands to co-design knowledge sharing outputs that transformed the LRPF results into practical tools for

²Smith, B., Duce, S., Boseto, H., Vavu, A., Peters, A. and Diedrich A. *In Review*. Navigating risk: A holistic framework for supporting rural livelihoods adaptation in Solomon Islands. *AMBIO*. 54. 1496-1513.

community-led adaptation. This involved a series of feedback sessions, where community members provided input on the most relevant and accessible ways to present the findings. This collaborative effort resulted in the creation of risk profile reports and visually engaging risk posters translated into Solomon Island Pijin. These materials were shared with each community during a final field visit in March 2024. An example of these materials can be found in Appendix 8.

Abstract

This chapter presents the Livelihoods-Based Risk Profiling Framework (LRPF) to support rural livelihoods adaptation in Western Province, Solomon Islands. The framework addresses narrow research perspectives to provide a more comprehensive understanding of risks to rural livelihoods. I expand previous climate-focused frameworks by incorporating non-climatic hazards and key socioeconomic factors that influence vulnerability. I employed a mixed-methods approach using focus group workshops and household surveys to assess risk across three rural communities. The data were analysed to produce decision support tools including livelihood risk profiles, vulnerability index tables, and risk interaction diagrams. These tools identified priority adaptation initiatives targeting key local risk drivers, demonstrating the LRPF's capacity to support communities in addressing complex risks and aiding external stakeholders to better align their interventions with local realities. By adopting a holistic perspective, the LRPF can enhance the robustness of adaptation planning, leading to more effective and sustainable adaptation outcomes for rural livelihoods.

Introduction

As climate change impacts proliferate, a growing body of research has focused on understanding challenges to rural livelihoods (Msimanga and Mukwada 2022), comprising the capabilities, assets, and activities required for a means of living (DFID 1999). Community-based adaptation planning (from here on referred to as adaptation planning) plays a crucial role in addressing these challenges (Barrowman and Butler 2020). Specifically, adaptation planning engages communities in identifying potential climate change impacts and developing strategies to reduce their likelihood (Butler et al. 2016a). This participatory approach promotes adaptation that is tailored to local contexts and priorities, thereby increasing its long-term effectiveness (Werners et al. 2021).

To date, the concept of vulnerability has been widely applied to support adaptation planning (Kim et al. 2021). At the local scale, community-based vulnerability assessments (CBVAs) provide a framework for understanding and analysing local sensitivity and capacity for adaptation to the impacts of climate change (Adger 2006). However, climate-based CBVAs have been limited by narrow perspectives that fail to consider the full range of factors contributing to vulnerability (Smith and Diedrich 2024). Specifically, this includes: i) a focus on climate change as the main challenge for livelihoods, ii) limited

consideration of local socioeconomic characteristics, and iii) failure to address spatial and temporal dynamics (Ford et al. 2018; Jurgilevich et al. 2017; McDowell et al. 2016). These narrow perspectives have caused CBVAs to guide ineffective or even maladaptive outcomes for the communities they aim to support (Ford et al. 2018).

Climate-based CBVAs commonly apply (Smith and Diedrich 2024) the Intergovernmental Panel on Climate Change's (IPCC) AR4 Vulnerability Framework (IPCC 2007). However, in 2014 the IPCC transitioned from assessing vulnerability to climate change, to evaluating the risks posed by climate change, captured in their AR5 Risk Framework (IPCC 2014). This transition aimed to address the narrow perspectives of the AR4 by incorporating holistic concepts from the disaster risk reduction field (Reisinger et al. 2020). In this context, a holistic approach refers to an integrated perspective that considers all relevant components within a system (e.g., social, economic, environmental etc.,) and the interconnections between them (Amini 2001). Unlike CBVAs, community-based risk assessments (CBRAs) aim to predict potential livelihood impacts by comprehensively evaluating locally relevant multi-hazard exposures and the underlying socioeconomic characteristics that influence the likelihood these impacts will occur (Gero et al. 2010). Given this holistic perspective, risk is increasingly viewed as a more robust concept for supporting adaptation planning (Van Aalst et al. 2008; Marin-Puig et al. 2022). However, the AR5 has not yet been applied to rural livelihoods contexts (Smith and Diedrich 2024) and a lack of clear guidelines for its implementation masks potential benefits (Ishtiaque et al. 2022).

CBRAs may be particularly valuable in remote countries, such as Solomon Islands, which are at high risk of impact from climate change (Msimanga and Mukwada 2022). This heightened risk is partly due to dependence on the natural environment to meet livelihood security objectives (LSOs) (i.e., the ability of a household to meet its basic needs) (Frankenberger and McCaston 1998) including access to food, water, housing, energy, and income (SPC 2016). This dependence increases local exposure to climate change, as livelihoods rely on ecosystem services that are sensitive to hazards like sea-level rise, extreme weather events, and shifts in temperature and rainfall patterns (Marshall et al. 2013). Recognising these risks, Solomon Islands has prioritised national efforts towards adaptation planning (Solomon Islands Ministry of Environment 2023). However, many of these efforts overlook the impact of non-climatic hazards on rural livelihoods (McNamara et al. 2020; Minter and Van der Ploeg 2023).

This chapter aims to support adaptation planning by developing and implementing the Livelihoods-Based Risk Profiling Framework (LRPF), which applies and expands the AR5 Framework (IPCC 2014) to rural livelihoods. The LRPF specifically addresses CBVA limitations to illustrate how a holistic risk-based approach can achieve more robust outcomes for adaptation planning. To achieve this, I address both climatic and non-climatic challenges to rural livelihoods, along with a comprehensive analysis of the socioeconomic characteristics that contribute to vulnerability. While the LRPF focuses on risks to

rural livelihoods, its outputs are designed to help communities meet their basic needs rather than provide adaptation insights for specific activities like farming or fishing. Additionally, while the framework acknowledges external threats, such as market issues, it does not directly address these drivers. Instead, the emphasis is on strengthening a community's capacity to manage risks within their control, recognising that broader structural factors often fall beyond the scope of local-scale adaptation efforts. In doing so, the LRPF aims to support community-based livelihoods resilience in the face of global change (Butler et al. 2016).

In this chapter, I introduce the LRPF and provide a detailed step-by-step method for its implementation. The LRPF was applied in three rural communities in Western Province, Solomon Islands, to produce a range of decision support tools for each community that summarise risk. I interpret these tools to demonstrate how the LRPF's holistic perspective provides more comprehensive guidance for adaptation planning than prior CBVAs subject to the narrow perspectives I outlined above. At the community scale, I use these tools to identify priority initiatives to guide adaptation and describe the underlying risk drivers that necessitate these initiatives. At a broader scale, I discuss how a holistic perspective on risk can guide external stakeholders to better align adaptation support with local realities. Through these interpretations, I reflect on how the LRPF can support more effective and sustainable adaptation outcomes for rural livelihoods.

Methods

This chapter employed a mixed-methods research design to assess community-level risks to rural livelihoods using the LRPF. Below, I outline this framework, with a specific focus on expansions made to the AR5, before detailing its implementation. The LRPF assesses risk by combining qualitative data from focus group mapping workshops and informal conversations, with quantitative data obtained from household surveys. This mixed methods design facilitated the creation of decision support tools that assist in selecting priority adaptation initiatives for rural livelihoods.

Livelihoods-Based Risk Profiling Framework

The LRPF is an expanded version of the AR5 Risk Framework (IPCC 2014) that is oriented towards understanding community-level risk in the context of rural livelihoods (Figure 8).

In the LRPF, risk represents the 'potential for impacts where rural livelihoods are at stake and the outcome is uncertain'. Risk in the AR5 is comprised of hazard exposure and vulnerability, and vulnerability is comprised of sensitivity and adaptive capacity. I adapted the AR5 definitions of these components of risk to fit the rural livelihood's context. This included adopting a holistic approach that encompassed both climatic and non-climatic hazard exposure. I also expanded the types of socioeconomic indicators that contribute to vulnerability. Specifically, this included the introduction of

composite LSO indicators to assess sensitivity (i.e., water, food, housing, energy, and income insecurity) (SPC 2016), and composite capital asset indicators to assess adaptive capacity (i.e., human, financial, social, physical, and natural capital) (DFID 1999).

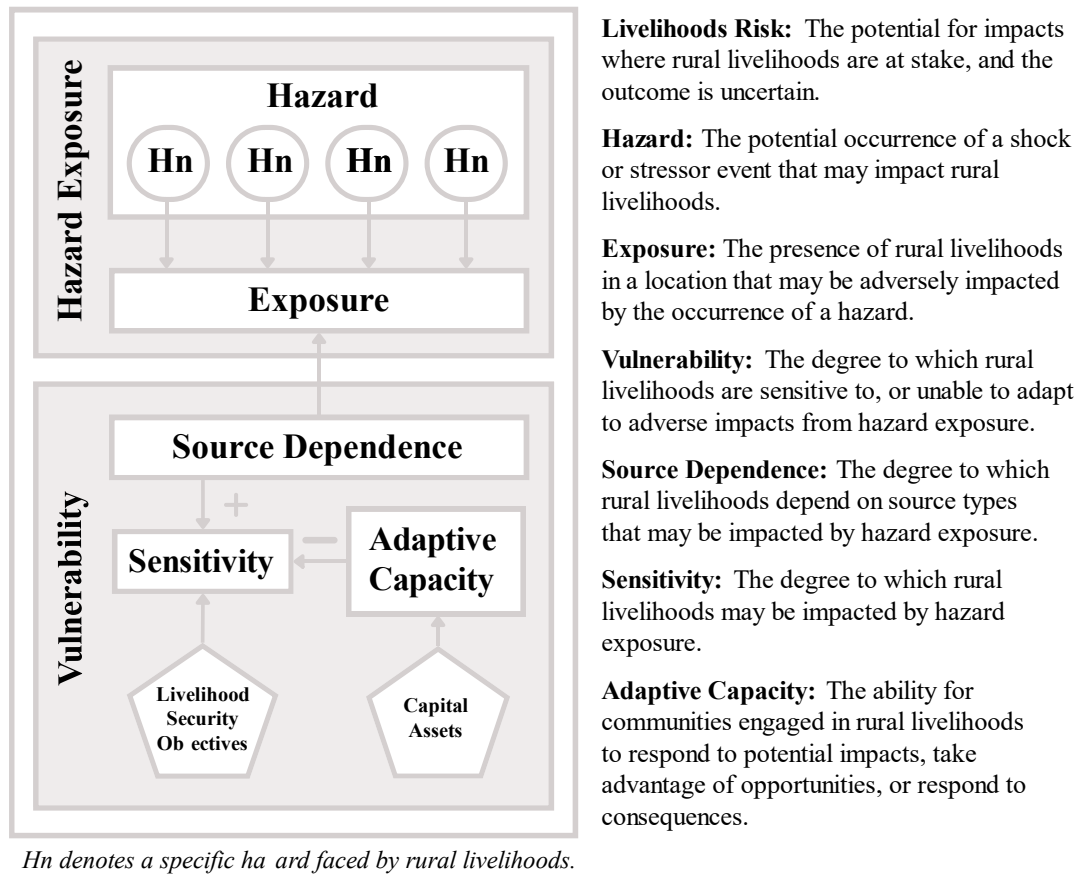


Figure 8: The Livelihoods-Based Risk Profiling Framework (LRPF) and associated definitions of the components that define risk.

Finally, I introduced source dependence as an additional component of vulnerability in the LRPF. This encompassed the natural or modified ecosystems and artificial infrastructure that a community relies on to meet their LSOs. I regarded source dependence as influencing sensitivity to hazard exposure. For example, a community that depends on coral reef fisheries for food security may be more sensitive to climate change impacts on these fisheries than a community that depends on a variety of food sources. By incorporating source dependence, the LRPF establishes a direct link between exposure to a specific hazard and vulnerability, which was absent in the AR5 (Filho et al. 2020; Kim et al. 2021).

I developed an index to assess the vulnerability component of livelihoods risk based on the systematic review results presented in Chapter Two (Smith and Diedrich 2024). In Chapter Two, I identified key socioeconomic indicators that influence vulnerability but are often overlooked in IPCC-based assessments. I selected the most prevalent indicators from this review and confirmed their contribution

to rural livelihoods vulnerability through an extensive review of the literature (see Appendix 4). These indicators were incorporated into the LRPF, where they were further refined to the local context via a consultative process with local researchers from Ecological Solutions Solomon Islands (ESSI) who bring a combination of scientific expertise and community-based conservation experience.

During this process, local researchers used their deep understanding of the community context to assess the relevance and appropriateness of each indicator. For instance, they identified that healthcare-related indicators might not be suitable due to cultural sensitivities around discussing health. This collaborative refinement ensured the indicators were contextually relevant and aligned with local norms. Table 2 presents the final list of adaptive capacity (n=19) and sensitivity (n=10) indicators included in the vulnerability index and their definitions. These indicators were selected based on their established linkages to the socioeconomic characteristics that underly a rural community's vulnerability to various hazards, as evidenced in the literature. Further details about each indicator's origins, contribution to vulnerability, data collection, and analysis methods can be found in Appendix 4.

While source dependence contributes to a community's sensitivity, it was not included as a component of the vulnerability index (Figure 8). This decision reflects the 'generalised' perspective of adaptive capacity and sensitivity indicators utilised in the LRPF, which encompass socioeconomic characteristics impacted by various types of hazards. In contrast, source dependence was treated as a hazard specific component of vulnerability, directly linked to a specific hazard type. By omitting source dependence from the vulnerability index, I aimed to clearly distinguish between general vulnerability indicators and those specific to a particular hazard event.

Table 2: The underlying components, composite indicators, and indicators comprising the LRPF vulnerability index. Weighting values (W%) represent the values assigned to aggregate these elements into an overall vulnerability index score. The steps involved in weighting the indicators are described in detail in the data analysis section, with further information on each indicator, their contribution to vulnerability, and the data collection and analysis methods provided in Appendix 4.

Indicator	Definition	W%
Adaptive Capacity	The ability for communities engaged in rural livelihoods to respond to potential impacts, take advantage of opportunities, or respond to consequences.	50%
Human Capital	The skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives.	8%
HC1: Dependency Ratio	The ratio of dependent (i.e., non-working adults) to non-dependent household members (i.e., working adults).	6.7%
HC2: Health Condition	The number of times in the last year household members missed their livelihood responsibilities due to being sick, ill or injured.	6.5%
HC3: Access to Healthcare	The amount of time a household can access healthcare in times of need.	10.1%

HC4:	Livelihood Diversity Index	The number of unique livelihood activities that members of a household are engaged in.	23.3%
HC5:	Extent of Coping Strategies	The extent to which a household believes they can cope with locally relevant hazard exposures.	53.4%
Financial Capital		The financial resources that people use to achieve their livelihood objectives.	24.7%
FC1	Household Savings	The total amount of savings accumulated by a household.	45%
FC2	Household Income	The amount of income a household acquires in a one-month period.	16.7%
FC3	Household Expenditure	Household monthly expenditure on basic needs (e.g., food, water, housing, energy, and healthcare).	9.8%
FC4	Income Satisfaction	The extent to which a household is satisfied with their ability to purchase basic goods.	2.7%
FC5	Access to Financial Services	Household access to key financial services including bank accounts, pensions, and loans.	25.8%
Social Capital		The social resources upon which people draw in pursuit of their livelihood objectives.	13.6%
SC1	Social Networks	The number of social relationships a household can turn to for support in times of need.	13.2%
SC2	Inclusion in Decision Making	The extent of household satisfaction with their inclusion in community decision making.	9.8%
SC3	Local Institutional Memberships	Household membership in local institutions (e.g., groups, organisations, and associations).	6.4%
SC4	Satisfaction with Leadership	The extent to which a household is satisfied with the leadership in their community.	3%
SC5	Trust	The level of trust a household has in community members and leaders.	14.6%
SC6	Collective Action	The extent to which a household participates in community-based activities.	22.1%
SC7	Perceptions of Fair Access to Livelihood Opportunities	Household perception of fair access to livelihood opportunities within their community.	30.9%
Physical Capital		The basic infrastructure and goods needed to support livelihoods.	7.8%
PC1	Access to Livelihoods-Based Assets	Household access to key assets required to support livelihoods.	100%
Natural Capital		Fair access of households to stocks of natural resources that are important for livelihoods.	45.9%
NC1	Perceptions of Fair Access to Natural Resources	Household perception of fair access to natural resources within their community.	100%
Sensitivity		The degree to which rural livelihoods may be impacted by hazard exposure.	50%
Water Security		Access to adequate quantities of acceptable quality water for sustaining livelihoods and ensuring protection against water borne diseases.	52.8%
WS1	Access to Drinking Water	Household has access to improved sources of drinking water within a 30-minute return distance.	10.8%

WS2	Water Sufficiency	Household has access to sufficient quantities of water to meet basic needs.	38.9%
WS3	Water Quality	The extent to which a household is satisfied with the quality of their drinking water.	42.7%
WS4	Access to Sanitation	Household has access to an improved form of sanitation.	7.6%
Food Security		Access to sufficient, safe, and nutritious foods to maintain a healthy and active lifestyle.	25.1%
FS1	Food Sufficiency	Household has uninterrupted access to sufficient volumes of food to meet household requirements.	80%
FS2	Food Consumption Score	The frequency of consumption of different food groups during the previous 7 days.	20%
Housing Security		Access to adequate housing	5.7%
HS1	Housing Condition	The type of material used for the roof, flooring, and walls of a household's shelter.	100%
Energy Security		Access to uninterrupted energy sources	4%
ES1	Cooking Sufficiency	The amount of time a household has problems accessing cooking fuel.	87.5%
ES2	Lighting Sufficiency	The amount of time a household has problems accessing lighting.	12.5%
Income Security		Access to reliable and stable income that can meet basic needs.	12.4%
IS1	Income Stability	The extent to which household income has fluctuated over the previous 12 months.	100%

Study Communities

The LRPf was applied in three rural communities in Western Province, Solomon Islands. Two were located in Bilua Ward on the island of Vella La Vella (C1 and C2), and one in Ghizo Ward (C3) on an island approximately 5km from the provincial capital of Gizo (Figure 9).

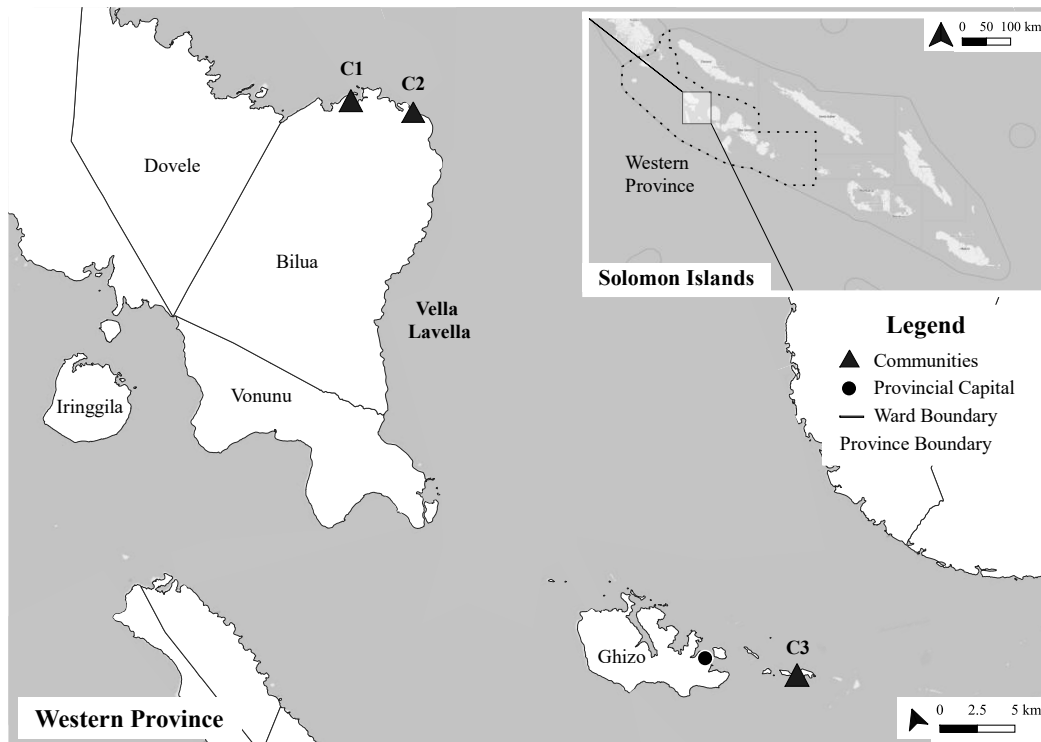


Figure 9: The location of the LRPf study communities in Western Province, Solomon Islands.

The communities were selected based on their rural location, high dependence on natural resources for livelihoods, and having an interest in participating in community-based adaptation planning. The communities differed in size, comprising 150 (C1), 141 (C2), and 50 (C3) households. Community livelihoods were primarily subsistence, centring around gardening and selling produce at market in C1, gardening and cash crop farming in C2, and coastal fishing in C3. For all communities, access to basic utilities was limited, with households reliant on locally sourced natural resources to access water, food, building materials, cooking fuel, and income (Table 3). The remoteness of the communities limited their access to facilities such as healthcare centres, markets, shops, and banks located in Gizo town.

Table 3: Demographic characteristics of survey respondents across the three study communities.

Characteristic	C1	C2	C3
Number of households interviewed	63	76	50
Total number of households	150	141	50
Percentage of households interviewed	42	54	100
Percentage of male respondents	43	41	54
Age of respondent			

20-29 years old (%)	19	13	18
30-39 years old (%)	25	25	42
40-49 years old (%)	22	22	12
50-59 years old (%)	24	21	8
Over 60 years old (%)	10	19	20
Size of Household			
1-3 household members (%)	8	9	22
4-6 household members (%)	46	58	42
7-9 household members (%)	32	30	28
10 or more household members (%)	14	3	8
Percentage of non-resident households ^a	17	16	22
Subsistence level ^b	2.06	1.96	2.78
(SD)	0.66	0.59	1.03
Primary livelihood activity			
Food gardening (%)	48	43	14
Fishing (%)	3	5	56
Cash crop farming (%)	5	38	0
Market seller (%)	21	4	10
Use of local ecosystems for access to essential needs			
Water (%)	100	100	100
Food (%)	98	100	54
Housing materials ^c (%)	60	65	37
Cooking fuel (%)	100	100	98
Lighting (%)	0	0	0
Income (%)	92	91	84

^aNon-resident households did not originally reside in the community.

^b Five-point ordinal scale representing the % of food that a household produces or catches that is sold at market (5 represents where 100% of food is sold at market).

^cPresented as the average dependence across roofing, walls, and flooring materials.

Data Collection

Unlike the AR5, the LRPf does not assign a single empirical value to risk but rather summarises quantitative and qualitative data through a suite of decision support tools. I designed a mixed-methods approach to gather the data underlying the LRPf using established methods for CBVAs (Smith and Diedrich 2024). To facilitate the practical implementation of the LRPf, I developed a user manual that provides clear guidelines and best practices for implementation. This manual is intended to help researchers and practitioners effectively implement the LRPf in their own settings. An abridged version is available in Appendix 5.

Qualitative data, including community perceptions, experiences, and priorities related to hazard exposure, as well as spatial data including maps of hazard-prone areas and resource distribution, were collected through focus group mapping workshops to gain a detailed understanding of each community's experiences with hazard exposure. While a household level survey was conducted to

gather data on vulnerability. This survey collected quantifiable information on source dependence, adaptive capacity, and sensitivity, as well as household level hazard exposure, enriching the data obtained from the focus group workshops. Finally, qualitative data from informal conversations and observations during fieldwork were incorporated to further contextualise risk.

Data collection occurred from March to September 2022 under James Cook University's human ethics protocol H8497 ensuring adherence to all relevant ethical considerations, including informed consent and confidentiality. To safeguard the communities involved, their names have been omitted from the thesis in line with the ethical guidelines outlined in the ACIAR project protocol (FIS-2020-111) under which this research was conducted. All research activities were facilitated by local researchers from Ecological Solutions Solomon Islands and conducted in Solomon Island Pijin and Bilua, the Vella La Vella dialect. The local research team comprised biologists, ecologists, conservation practitioners, social scientists and experts in gender, equity, inclusion, and diversity. All team members worked closely with the communities in Western Province to develop and deliver results.

Focus Group Mapping Workshops

Focus group mapping workshops were conducted to elicit local perceptions on the main types of hazards communities were exposed to. Participants and groupings were selected with community leaders' support to ensure representation across the community's demographic and spatial extent. The workshops comprised twelve individuals, including six males and females, four youth, adults, and elders, and representatives from a range of livelihood activities. These categories were selected as they reflect key demographic and social divisions that influence vulnerability and risk within Solomon Islands communities. I acknowledge that additional categories such as disability and sexual orientation would provide valuable insights. However, they were not included due to cultural considerations and logistical constraints related to the scope of the research. Workshops were held in a community gathering space, with groups sex-disaggregated based on local advice.

During the first workshop activity, participants received cards representing eight hazards identified by local experts to impact rural livelihoods in Western Province. These hazards included commercial logging, coastal fishing, sea level rise, flooding, increased rainfall, decreased rainfall, temperature increase, and COVID-19. In this context, coastal fishing was viewed as both a livelihood activity and a hazard due to declines in wild fish availability driven by overexploitation (Gillet and Tauti 2018). An expert-led approach (run by ESSI) was employed to ensure participants understood the scope of hazards that should be considered in the exercise, reducing the risk of confusion or misinterpretation of the activity's objectives. Participants also received blank cards and were encouraged to list additional hazards impacting local livelihoods. Participants were given 45 minutes to rank the cards from highest to lowest concern based on each hazards perceived livelihood impact. Pre-listed hazards deemed irrelevant by the community were excluded from the ranking process. Consensus ranking scores for

male and female groups were reached through facilitated discussions, this allowed for collective agreement on the most pressing hazards facing each community. Local facilitators supported these discussions to ensure all voices were included in the final hazard rankings.

Following the ranking exercise, participants engaged in two mapping activities, each lasting about an hour. Using coloured pens, participants marked up Bing or Google Earth satellite images (depending on image quality) of a community's land and marine areas, printed and laminated onto A0-sized posters. The extent of these areas was confirmed by community leaders during preliminary site visits in March 2022. Before mapping commenced, local researchers oriented participants by highlighting key landmarks on the images. Participants then drew the locations of the top-ranking hazards from the previous activity. Only hazards exhibiting spatial variation at the community scale, such as sea-level rise, were mapped, excluding those with broader-scale variations, like temperature change. Upon completion, I photographed the marked images for digitisation before wiping them clean for the second mapping activity.

In the second activity, participants were asked to draw the locations of resources used to meet their LSOs, such as wells for water security, or mangroves for housing security. They marked these locations on the satellite images using polygons or points and added notes identifying each source type and its LSO purpose. To facilitate this activity, participants were also provided with A3 posters of Western Province, acknowledging that some resources, like markets, may exist outside of the community. Marked-up images representing LSO source locations were photographed upon completion.

Household Surveys

Quantitative data on hazard exposure and vulnerability (comprising sensitivity, adaptive capacity, and source dependence) were obtained from household surveys. Survey questions, provided in Appendix 6, were comprised of Likert-scale, open-ended, and categorical question types. The survey was translated into the local language, Pijin, by the bilingual local research team from ESSI using a back-translation method. It was then piloted with Pijin speaking participants in the provincial capital of Gizo, who were randomly selected from people encountered on the street.

Convenience sampling was used to select households within each community. Community leaders assisted in accessing a diverse representation of households throughout a community's geographic area. Due to time constraints, a minimum quota of 40% of households was established. This resulted in a sample size of 63 (C1), 76 (C2), and 50 (C3), representing 42%, 54%, and 100% of households respectively. Local researchers conducted the surveys via face-to-face interviews at participant's homes in either Pijin or Bilua. Each survey session lasted approximately 40 minutes. Households were initially approached during the daytime. If this timing was inconvenient, local representatives, who helped researchers engage with households, arranged to return at a more suitable time. Surveys alternated as

much as possible between male and female household heads to provide a balanced representation of responses across sexes (Table 3).

Data Analysis

Hazard Exposure

Analysis of the focus group hazard ranking activity was conducted to obtain a mean ranking score for each hazard, combining responses from male and female groups. I acknowledge that the focus group data were sex-disaggregated and note that differences in ranking scores were observed that would be of relevance to a risk profiling exercise that emphasised gender dimensions. However, this level of detail was outside the scope of this chapter, which is intended to give an overview of the LRPF.

After obtaining aggregated ranking scores for individual hazards, I categorised them into thematic groups, including climate change, resource exploitation, environmental, and socioeconomic issues. This allowed for a clearer understanding of the types of broad challenges faced by a community. The themes were derived using logic, grouping hazards based on shared characteristics and underlying drivers. For example, hazards such as sea level rise, increased rainfall, and temperature rise were logically categorised under ‘climate change’, while hazards including commercial logging and declines in wild fish availability were grouped under ‘resource exploitation’. Following this grouping process, I calculated mean scores for each theme by averaging the scores of the underlying hazards, presenting these as ‘levels of concern’ ranging from very low to very high. These levels reflected the perceived impact of each hazard on rural livelihoods.

The hand drawn maps were digitised using QGIS 3.36.0 to create individual vector polygons. These polygons depicted: i) the spatial distribution of high concern hazards exhibiting spatial variation at the community scale, and ii) the locations and descriptions of source types used for LSOs. Source types were categorised as natural ecosystems (e.g., oceans and forests), modified ecosystems (e.g., food gardens and cash crop plantations), and artificial infrastructure (e.g., rainwater tanks). Hazard polygons were then overlaid onto source type polygons to characterise their interactions. These interactions were further defined through the analysis of qualitative data from workshops and opportunistic informal conversations with workshop participants and community members during the fieldwork, offering insights into how different hazards intersect and influence one another. This contributed to a deeper understanding of risk dynamics within the local context.

Finally, I analysed open-ended questions from household surveys to identify the hazards different LSO source types faced, enhancing the understanding of exposure to broader spatial hazards not included in the participatory mapping exercise. This data was summarised at the community level.

Vulnerability

Household survey data on LSO source dependence were analysed to identify the primary source types used to access water, food, housing, energy, and income. The data were summarised at the community level to establish percentage dependence on each source type, which were then categorised as natural ecosystems, modified ecosystems, or artificial infrastructure.

To construct the vulnerability index, I first used raw data from household surveys to calculate the standardised indicators listed in Table 2, following the detailed methods provided in Appendix 4. A multi-criteria evaluation (MCE) analysis using the Analytic Hierarchy Process (AHP) was employed to weight the indicators that comprised the composite indicators (i.e., LSOs and capital asset categories) and subsequently to calculate vulnerability and its components (Saaty 1980; Maanan et al. 2018). AHP is a widely applied method for prioritising and weighting indicators in vulnerability and risk assessments (e.g., Baffoe 2018; Murali et al. 2013) and is valued for its ability to systematically assess and incorporate the relative importance of each indicator into the final index results (Maanan et al. 2018). The weighting values presented in Table 2 reflect the AHP outcomes, where the research team (comprising Australian and Solomon Islander researchers with significant expertise in Pacific Island rural livelihood contexts) assessed the relative importance of indicators, composite indicators, and vulnerability components through pairwise comparisons. To achieve a consensus on the weighting score among experts, the Delphi technique was used, applying a maximum consistency ratio of 10% to ensure consistent logic (Kaynak and Macaulay 1984). This reduced the potential for inconsistency in expert judgement and helped mitigate potential biases based on the disciplinary backgrounds of the research team (Benitez et al. 2011).

Composite indicator scores were calculated in R using the baseR, tidyverse, and scales packages. The following formula was applied: $Aggregated\ Score = w_1 * Score_1 + w_2 * Score_2 + \dots + w_n * Score_n$; where the *Aggregated Score* represents a composite indicator, w_n represents indicator weightings, and $Score_n$ represents indicator values. Composite indicators were standardised to a 0-100 scale and then aggregated to produce values for the vulnerability components (sensitivity and adaptive capacity) using the same formula. These components were also standardised. Given the inverse relationship between adaptive capacity (AC) and sensitivity (S), their aggregation to produce the final vulnerability (V) index followed the formula: $V = f(AC-S)$. This reflects the negative relationship between sensitivity and adaptive capacity, where an increase in adaptive capacity reduces overall vulnerability, while an increase in sensitivity increases vulnerability. In the formula, ' f ' represents the transformation applied to both AC and S, which included applying the relevant weightings to each indicator and standardising the data.

Household-level vulnerability index scores were standardised and combined to obtain a mean value for community vulnerability along with its underlying components and composite indicators. Finally, these

values were classified into ranks: very low (0-20), low (21-40), moderate (41-60), high (61-80), and very high (81-100), with ranks for adaptive capacity and its associated composite indicators occurring in reverse order. The vulnerability index was contextualised through qualitative data analysis, revealing interactions between indicators, LSO source dependence, and hazard exposure.

Risk-Based Decision Support Tools

As mentioned previously, the LRPF does not calculate a single value for risk but integrates qualitative and quantitative data on risk components (Figure 8). This approach offers a comprehensive overview of risk to guide prioritised adaptation initiatives for rural livelihoods. I developed a suite of decision support tools to effectively capture the complex factors contributing to the LRPF. These included: livelihood risk profiles (LRPs), vulnerability index tables, and risk interaction diagrams.

The LRPs provided a baseline overview of risk by summarising data on hazard exposure and vulnerability, inclusive of the vulnerability index and source dependence. These components were visually documented to represent: i) relevant hazards and their level of concern, ii) the exposure of LSO sources to different hazard types, iii) spatial interactions between hazards and LSO sources, iv) local dependence on LSO sources, and v) vulnerability index outputs (e.g., composite indicator summaries of sensitivity and adaptive capacity). Data were presented using a traffic light scale, ranging from red (very high potential for impact), to green (very low potential for impact). The LRPs were supplemented by a vulnerability index table that documented the contribution of individual adaptive capacity and sensitivity indicators to the overall index score. Finally, qualitative data were summarised using risk interaction diagrams adapted from Gill and Malamud's (2016) method to provide a contextual understanding of interactions among risk drivers.

Together, these decision support tools were used to identify priority adaptation initiatives that target the most critical drivers of risk within a community. By analysing the interactions among risk components, I ensured adaptation initiatives accounted for the complexity of these relationships. For example, flooding may be recognised as a high concern hazard due to its magnitude, severity, and historical patterns of exposure to LSO sources. However, if a community has low dependence on these exposed sources to meet their LSOs, their overall vulnerability to flooding may be low. Consequently, adaptation responses to flooding may be deprioritised in favour of addressing high concern hazards that impact LSO sources vital for meeting essential needs like food or water. I identified priority adaptation initiatives alongside the Australian research team, followed by validation from local researchers in Solomon Islands. This approach was shaped by the project's limited timeline, as COVID-19 delays restricted opportunities for follow-up fieldwork to support the co-selection of adaptation initiatives. The results were shared with each community through knowledge sharing workshops, which used communication materials developed with communities to reflect their preferred method for conveying

the results. These materials (presented in Appendix 8) were translated into Solomon Islands Pijin by the local research team.

Results

The results identify a priority adaptation initiative for each community and outline the key risk factors that informed their selection. These initiatives were derived from data presented in the LRPs (Figures 10-12), as well as the vulnerability index tables, and risk interaction diagrams. While all decision support tools contributed to the selection of adaptation priorities, only the LRPs are presented in this chapter as they encapsulate the core outputs of the LPRF. The vulnerability index tables and risk interaction diagrams are provided in Appendix 7.

Community 1: Improved Crop Productivity in Food Gardens

Improved crop productivity in food gardens was identified as the priority adaptation initiative for C1. The C1 LRP (Figure 10) revealed food sources to be exposed to a variety of hazards, including: i) climate-based stressors such as temperature and rainfall variability, ii) resource exploitation including commercial logging and coastal fishing, iii) environmental issues such as wild pigs (considered pest species), and iv) socioeconomic issues including population increase and COVID-19. Exposure to climate change played a primary role in reducing the productivity of kitchen garden crops, which comprised the community's primary source of food and income. This was further exacerbated by indirect commercial logging impacts, with habitat loss driving the translocation of wild pigs into garden areas in search of alternative food sources. Additionally, in areas where food gardens were situated adjacent to logged forest, the impacts of flooding were increased.

Widespread interactions between logging, flooding, and food garden areas were observed in hazard exposure maps. Despite reductions in garden productivity, there had been increased local dependence on this food source. This shift was driven by exposure to population increase, which intensified fishing activities and decreased wild fish availability. Additionally, market fluctuations induced by COVID-19 reduced income and limited the ability to purchase store-bought food. Together, these hazards impacted food insecurity by reducing food sufficiency and access to nutritionally diverse food sources. The presence of moderate levels of food insecurity, combined with a high dependence on gardens as a food source, indicates a high risk of impact in C1 if hazard-induced reductions in kitchen garden productivity persist. Furthermore, limited access to financial resources may worsen the situation, restricting C1's ability to procure food from alternative sources such as markets or shops.

Community 2: Improved Access to Income Generating Opportunities

Improved access to income generating opportunities was identified as the priority adaptation initiative for C2. The C2 LRP (Figure 11) showed that income sources were exposed to various hazards, including climate change, resource exploitation (i.e., coastal fishing), and socioeconomic issues (i.e., population increase and COVID-19). Among these hazards, climate-based challenges were deemed to have the greatest overall impact on livelihoods. Specifically, exposure to climate change resulted in income loss from food gardens due to reduced crop productivity. This was further exacerbated by exposure to coastal fishing, which impacted income by decreasing wild fish availability. In response, many households had shifted to cash crop farming as their primary income source. However, income from cash crops, such as copra and cocoa, had recently declined due to market fluctuations induced by COVID-19. Collectively, these factors contributed to high rates of income insecurity in C2. The community's ability to access alternative income generating activities was largely restricted by their limited access to physical assets, including transport and equipment for conducting livelihood activities.

Community 3: Improved Access to Safe Drinking Water

Improved access to safe drinking water was identified as the priority adaptation initiative for C3. The C3 LRP (Figure 12) showed that decreased rainfall was perceived as the greatest threat to livelihoods. This hazard had impacted the ability of households to access drinking water, which had been further exacerbated by population increase and sea level rise. Hazard exposure maps revealed spatial interactions between the locations of drinking water sources, such as groundwater wells, and rising sea levels, which caused the salinisation of drinking water. As a result, community members had shifted from using groundwater wells to sharing rainwater tanks. High rates of water insecurity were already evident within the community, with underlying indicators revealing low access to drinking water, as well as issues with sufficiency and quality. The community also faced challenges due to low rates of financial capital, which may impede their ability to invest in alternative water sources, such as purchasing additional rainwater tanks. Compounding these difficulties, household income, primarily derived from coastal fishing, had suffered due to population growth which had driven increased fishing pressure in local waters.

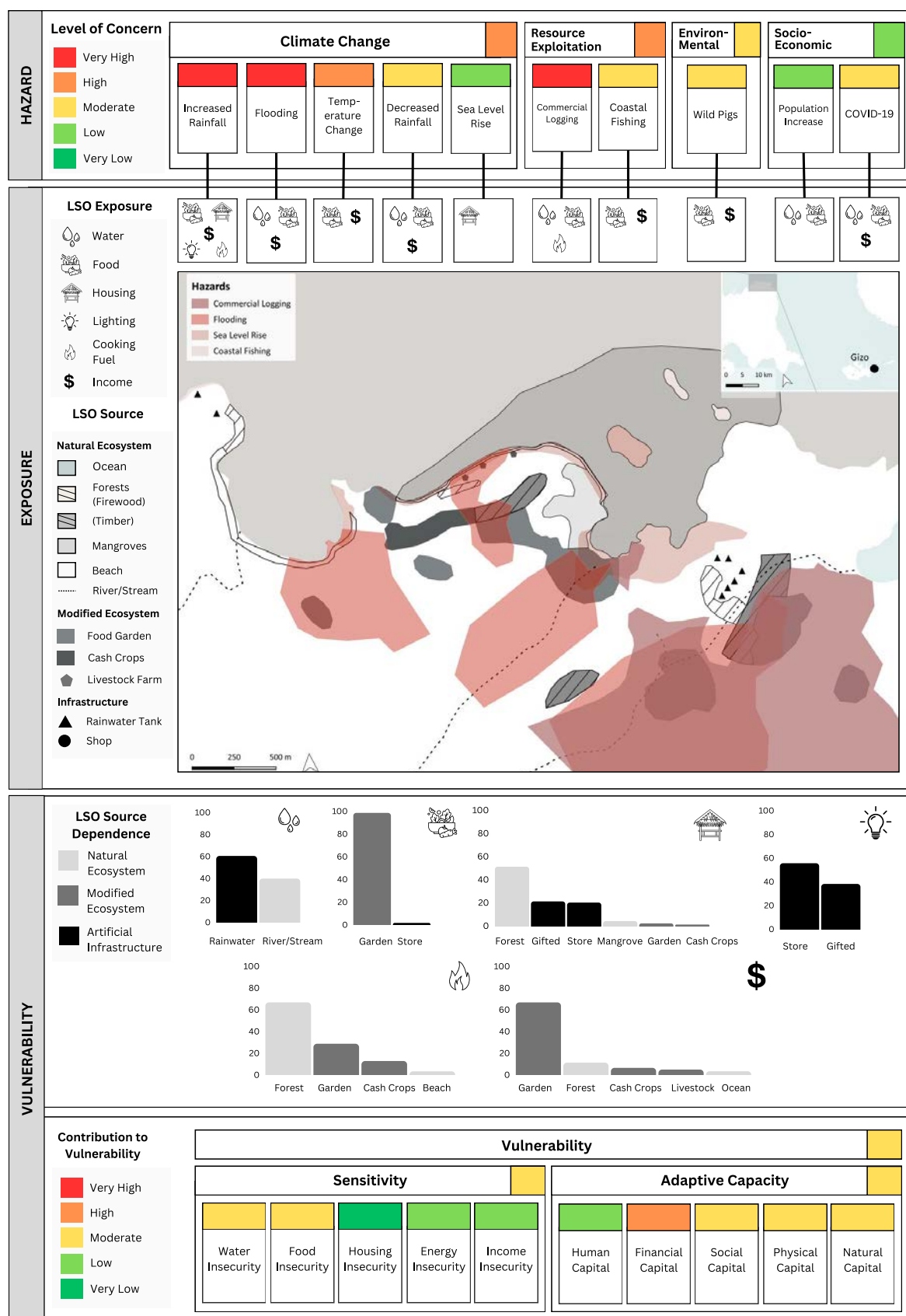


Figure 10: LRP of community 1 (C1) leading to the selection of improved crop productivity in food gardens as a priority adaptation initiative.

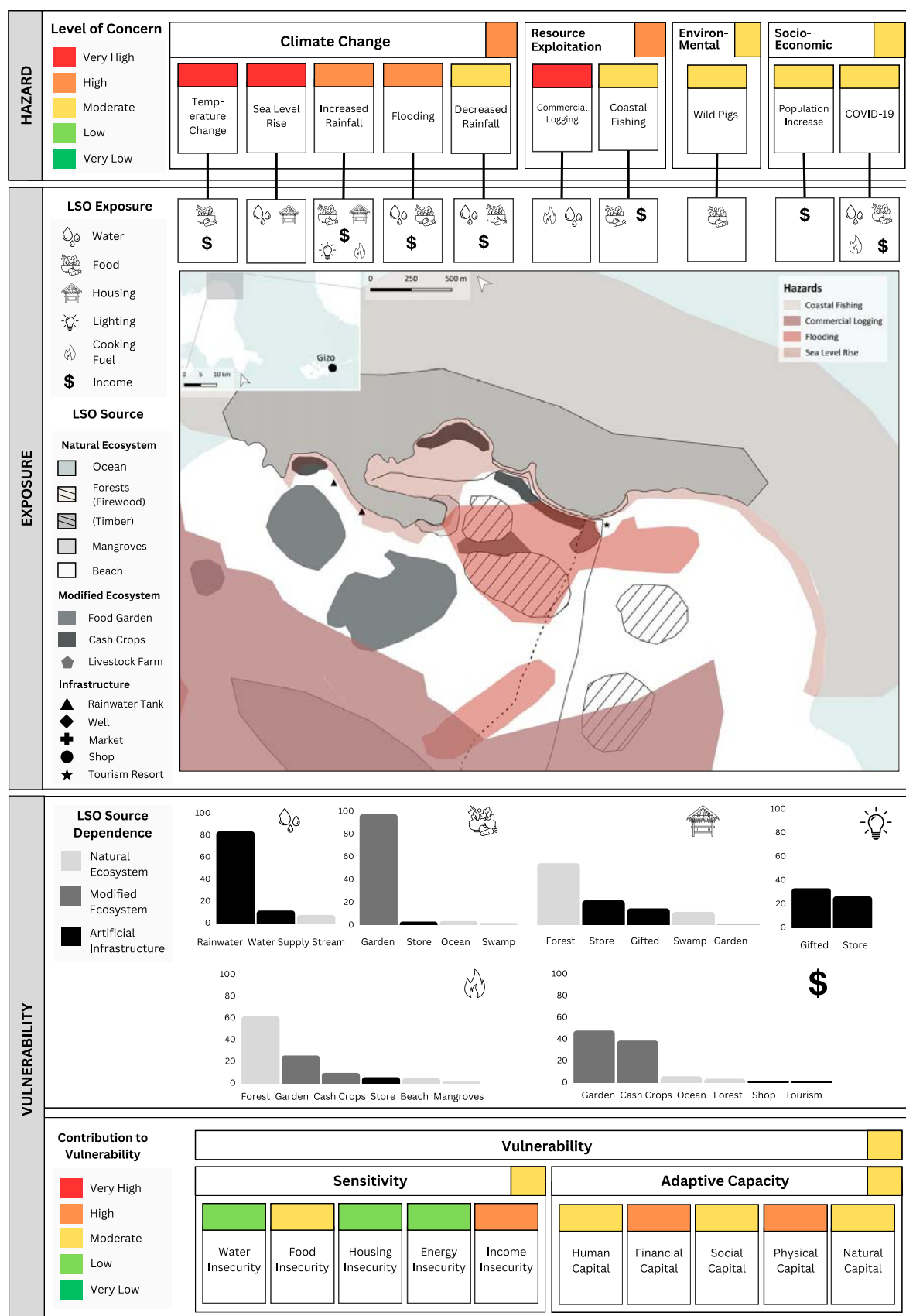


Figure 11: LRP of community 2 (C2) leading to the selection of improved income generating opportunities as a priority adaptation initiative.

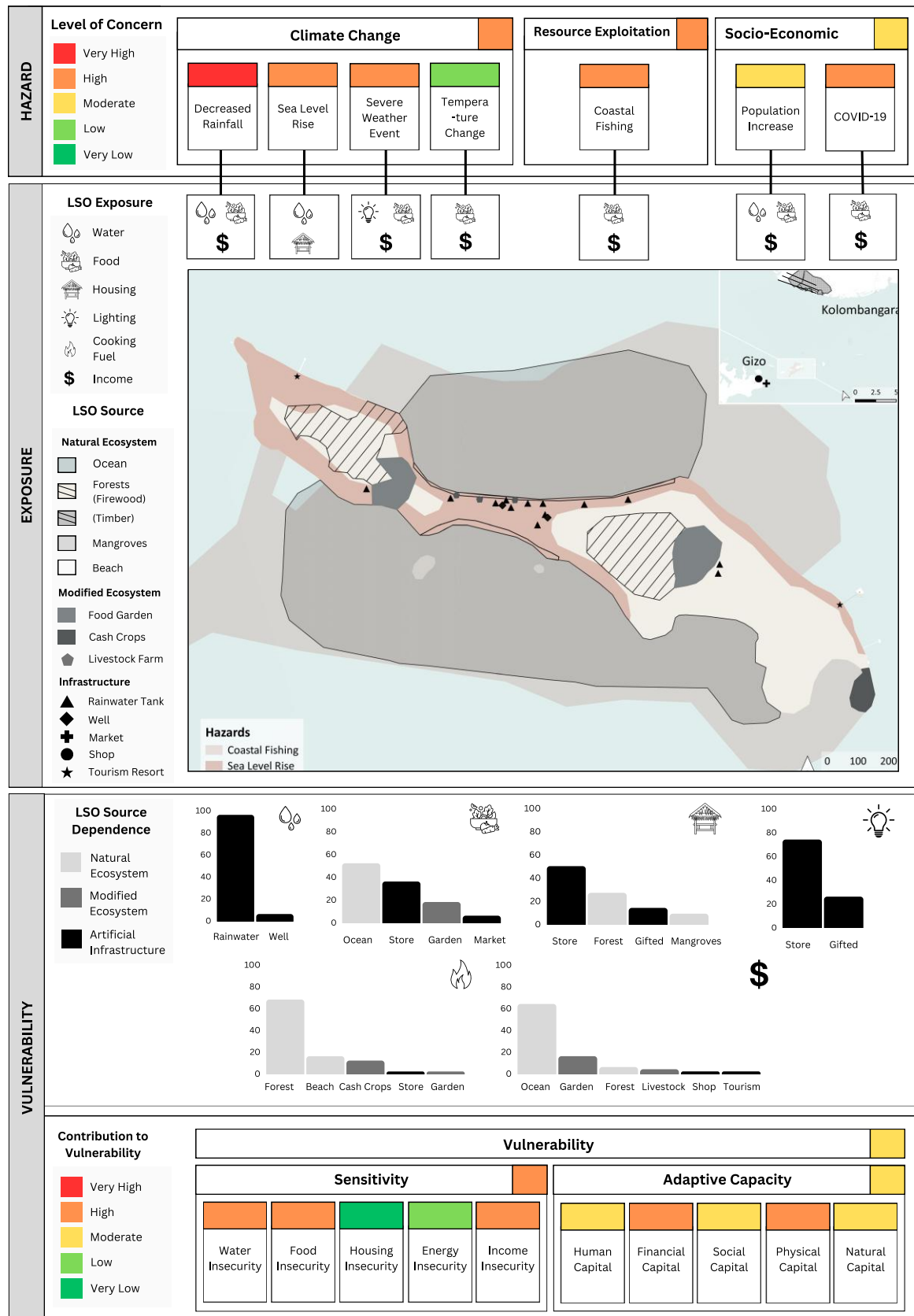


Figure 12: LRP of community 3 (C3) leading to the selection of improved access to safe drinking water as a priority adaptation initiative.

Discussion

I have introduced the LRPF and implemented it in three rural Solomon Islands communities to develop risk-based decision support tools. These tools were used to identify priority initiatives for adaptation. In this discussion, I explore how expansion of the IPCC AR5 Framework (IPCC 2014) contributed to a more robust understanding of risk in the LRPF. Subsequently, I discuss the LRPF's value for guiding more effective and sustainable adaptation planning outcomes. Finally, I outline key future steps and additional analytical capabilities of the LRPF that extend beyond the scope of this chapter, but offer potential to further enhance the framework's contributions.

Evaluating Expansion of the AR5 Framework

The LRPF expanded the AR5 Framework to obtain a holistic understanding of risks to rural community livelihoods. To reiterate, this included: i) incorporating non-climatic hazards, ii) expanding socioeconomic vulnerability indicators, and iii) introducing source dependence. In the following subsections, I evaluate how these expansions shaped the LRPF's interpretation of risk.

Incorporation of Non-Climatic Hazards

By combining quantitative, spatial, and qualitative insights, the LRPF offered a more comprehensive understanding of multi-hazard exposure than the AR5 (Smith and Diedrich 2024). The LRPF decision support tools emphasised the impact of non-climatic hazards on rural livelihoods in Solomon Islands (Filho et al. 2020; Gillet and Tauti 2018; Van der Ploeg et al. 2020a). For example, the prevalence of commercial logging as a 'high concern' hazard confirmed the need for a broader perspective on hazard exposure that goes beyond climate change (McDowell et al. 2016). This is particularly important in Solomon Islands, where commercial logging has impacted a significant proportion of rural populations (Minter et al. 2018). Additionally, there were clear interactions and cumulative impacts occurring between climatic and non-climatic hazard events. Such complex interactions have been widely documented in Solomon Islands (Minter and Van der Ploeg 2023), yet they are rarely addressed in adaptation projects, which tend to exclusively focus on climate change (Van der Ploeg et al. 2020a). This narrow focus has been implicated in ineffective adaptation. For example, coral reef restoration initiatives in response to climate change have been hindered by sedimentation in the marine environment caused by nearby logging activities that were not considered in the planning process (Van der Ploeg et al. 2020b). This underscores the need for holistic approaches, like the LRPF, that can proactively identify the full spectrum of hazards faced by communities.

Expansion of Socioeconomic Vulnerability Indicators

The LRPF incorporated an expanded set of socioeconomic indicators to provide a more holistic assessment of the factors influencing vulnerability. The framing of adaptive capacity indicators around capital asset categories (DFID 1999) made critical factors like social and human capital more explicit within the LRPF and its outputs. This included indicators like trust and collective action, that are commonly excluded from AR4-based studies (Smith and Diedrich 2024), yet have proven crucial for adaptation success (Diedrich et al. 2019; Ha'apio et al. 2019; Malherbe et al. 2020). This was evidenced in C3, where a previous project to enhance drinking water access through communal rainwater tanks faced long-term challenges due to emerging social tensions. Residents cited limited knowledge about fair and sustainable water use and low levels of trust as the cause of disputes about unequal water distribution. These unanticipated consequences further eroded social capital, increasing the community's vulnerability. By including these indicators within the LRPF, such issues are more likely to be recognised and discussed, allowing for the proactive consideration of potential impacts on adaptation efforts (Hagedoorn et al. 2019).

I recognise that the LRPF could be enhanced by the inclusion of other important measures such as the psychological processes that influence adaptive capacity, agency, and knowledge, and their application in addressing risk (Cinner et al. 2018; Torre-Castro et al. 2022). However, the comprehensiveness of the components and measures included in the LRPF necessitated, for the sake of pragmatism, the omission of certain factors typically explored in studies dedicated solely to one risk component, such as adaptive capacity. Shifting from the use of capital assets to more novel framings of adaptive capacity, such as the five domains proposed by Cinner et al. (2018), may offer an alternative pathway to integrate these factors that could be explored in future iterations of the LRPF. I also acknowledge that the LRPF does not account for the community's political influence or ability to mitigate external hazards. This limits its effectiveness in tackling structural drivers of vulnerability, focusing instead on risks communities can manage directly. As a result, adaptation responses may be reactive rather than transformative, highlighting the need for complementary approaches that engage with governance structures, policy change, and external threat mitigation (Thaler et al. 2019).

Across communities, a lack of financial and physical capital emerged as key drivers of vulnerability, posing a significant barrier to adaptation. In Solomon Islands, this has led to reliance on external stakeholders to fund community-based adaptation efforts (Van der Ploeg et al. 2020a). Participatory approaches like the LRPF can help ensure that externally funded responses align with local needs by providing evidence of key risk drivers and empowering communities to communicate their adaptation priorities (Barrowman and Butler 2020).

Framing sensitivity around LSOs enabled the identification of critical community needs that are often overlooked in CBVAs (Smith and Diedrich 2024). Failing to address these factors can result in missed

vulnerabilities and the misallocation of resources for adaptation (Ford et al. 2018). For instance, housing security is frequently disregarded in CBVAs (Smith and Diedrich 2024), yet it plays a crucial role in enabling individuals to engage in livelihood activities (Haddad et al. 2022). By categorising sensitivity into LSOs, the LRPF can more effectively establish adaptation priorities that address the unique challenges faced by each community. For example, while water and food security are critical issues across many rural Solomon Island communities (Basel et al. 2020), the urgency and nature of these challenges can vary significantly from one community to another. This variation underscores the importance of adopting a case-by-case approach to adaptation planning, a process that can be effectively facilitated by frameworks like the LRPF (Barrowman and Butler 2020).

I recognise that despite its expansion, the LRPF's sensitivity analysis remains a basic assessment of the factors influencing a community's ability to meet its basic needs (Frankenberger and McCaston 1998). This reflects the pragmatism necessary for gathering comprehensive data on all risk components, particularly considering factors such as participant fatigue during household surveys (Ambler et al. 2021). The integration of qualitative data in the LRPF was instrumental in bridging these gaps, providing deeper insights into factors contributing to risk that were overlooked in quantitative data collection methods.

Qualitative data additionally provided valuable insights into connections across risk components, revealing critical interactions that shaped how a community experiences risk. This marks a significant advancement of the LRPF over traditional CBVA approaches, which often undervalue qualitative insights (Smith and Diedrich 2024). By incorporating qualitative data, the LRPF can offer a more nuanced understanding of risk that better reflects local contexts, establishes complex interdependencies among factors, and captures temporal dynamics (McDowell et al. 2016; Thiault et al. 2021). This additionally allowed for the incorporation of traditional knowledge, encompassing factors like cultural capital, which were not explicitly included within quantitative data collection methods. Such information is invaluable, given the critical role such factors play in enhancing rural livelihoods resilience in Solomon Islands (Basel et al. 2020).

Introduction of Source Dependence

Source dependence established a direct link between vulnerability and hazard exposure (Marshall 2011), providing insights into hazard specific impacts on rural livelihoods. While absent from most CBVA studies (Smith and Diedrich 2024), this information is vital in guiding adaptation planning. When paired with hazard exposure maps, source dependence allowed for the identification of high impact hotspots and helped prioritise adaptation measures that directly addressed these impacts in relation to the exposed source types (Marshall et al. 2013). This is especially important for communities that depend on a single source type to meet their LSOs. This was observed across LRPF communities, particularly concerning access to food and water. In Solomon Islands, single source dependence has

become increasingly common due to the degradation of traditional source types as a result of resource exploitation activities like commercial logging, highlighting its relevance to CBVA and CBRA studies (Anthonj et al. 2020; Basel et al. 2020).

Qualitative data offered valuable insights into the factors driving long-term shifts in source dependence, further helping to establish priority adaptation initiatives. In many cases, these initiatives involved the introduction of novel source types, which may necessitate investments in infrastructure (e.g., rainwater tanks), or inputs (e.g., novel crop varieties) (Basel et al. 2020). By combining insights on source dependence with vulnerability index outputs, I could further refine adaptation strategies by identifying potential barriers to their implementation. As illustrated in this chapter, for many communities, these barriers are driven by limited access to physical and financial capital (Van der Ploeg et al. 2020a). Providing a mechanism to identify hazard exposure impacts that require urgent attention and linking them to socioeconomic vulnerability demonstrates the critical role of source dependence in understanding and addressing rural livelihoods risk (Marshall 2011).

Using LPRF Outputs to Support Adaptation Planning

By expanding the AR5 to address CBVA limitations in rural livelihood contexts, this chapter facilitates a transition from vulnerability to risk assessment, providing a deeper understanding of the factors impacting rural livelihoods to foster more robust adaptation outcomes (Van Aalst et al. 2008). Given the continued popularity of CBVA approaches (Smith and Diedrich 2024), researchers and practitioners should pay closer attention to the potential benefits of risk-based approaches like the LPRF, as discussed in this chapter (Marin-Puig et al. 2022). From an institutional perspective, transitioning to risk can also better align research outputs with policy, where risk reduction has become a central focus (IPCC 2014; Hugel and Davies 2020). This alignment enhances the practical relevance of research outputs, facilitating their direct application in decision-making contexts (Dubois et al. 2019).

Together, the LPRF decision support tools guided priority adaptation initiatives that address complex interactions among risk drivers. While beneficial, the complexity of these tools may limit their direct use for community-based adaptation. To enhance their value, integrating LPRF tools into adaptation planning methods can make them more accessible and actionable for communities (Barrowman and Butler 2020). This integration can also strengthen adaptation planning by providing a mechanism to explicitly identify, understand, and address key risk drivers within adaptation responses. Many existing planning methods lack this insight, which can limit their capacity to effectively support adaptation (Werners et al. 2021). As such, LPRF decision support tools provide an opportunity to enhance planning methods by incorporating evidence-based insights on local risk drivers. This integration can ensure that adaptation efforts respond to the complex range of factors influencing rural livelihoods risk.

Integrating LRPF outputs into adaptation planning methods also provides an opportunity to account for differences in how adaptive capacity is expressed at the household level, versus how it is mobilised at the community scale. (Mortreux and Barnett 2017). This allows adaptation strategies to be tailored to the unique strengths or needs of households, while also addressing collective requirements, such as coordinated action and resource sharing (Karlsson and Hovelsrud 2015). Communicating LRPF outputs can facilitate this process by fostering active participation and informed decision-making regarding adaptation (Ensor et al. 2018b). By encouraging collective recognition of key risk drivers, the LRPF can facilitate meaningful discussions about adaptation priorities, promoting a sense of collective ownership and responsibility for adaptation efforts (McNamara et al. 2020). Such engagement has been shown to significantly enhance the effectiveness and sustainability of locally led adaptation initiatives (Colloff et al. 2024). This highlights the need for CBRA approaches that go beyond simply assessing risk to effectively communicating findings, empowering communities to take proactive steps towards strengthening their livelihoods (Ensor et al. 2018a).

The LRPF decision support tools can also serve as evidence-based resources to align externally funded adaptation efforts with local priorities. Although this alignment is intended, it often falls short in practice, as funders frequently adopt a ‘one-size-fits-all’ approach that emphasises their organisational goals, which may not necessarily align with local needs (Barrowman and Butler 2020). In Solomon Islands, this disconnect has resulted in numerous cases of misaligned and ineffective adaptation, undermining the potential benefits of external support for adaptation (Eriksson et al. 2020; Harohau et al. 2020; Roscher et al. 2020). Utilising LRPF outputs as a roadmap for designing interventions can help bridge this gap. Growing recognition of the limitations of one-size-fits-all approaches in the literature is fostering an environment where organisations are more likely to consider tailored, community-specific solutions (McNamara et al. 2020).

Stakeholders often rely on quantitative data to assess adaptation needs because it provides a standardised interpretation of risk that can be easily compared across communities (Nguyen et al. 2016). However, this approach overlooks the context specific local factors that critically influence risk (Ford et al. 2018). In this context, the mixed-methods approach of the LRPF is especially valuable, as its qualitative data highlights the unique factors and complex interactions among risk factors that exist within a community.

Future Research Directions

This chapter focused on the development and implementation of the LRPF to support rural livelihoods adaptation. Consequently, several analytical capabilities of the framework were deemed beyond the scope of this research. For instance, by collecting household-level data, the LRPF can be used to analyse intra-community vulnerability, enabling a better understanding of the specific factors driving livelihood impacts across different demographic groups or livelihood activities (Bolt and Bird 2003). This

information is valuable in guiding adaptation efforts, ensuring that initiatives are beneficial and effective for all community members (Eriksen et al. 2021).

Additionally, the LRPF can explicitly inform temporal and spatial components of planning. For example, data on current risks could be used to envision how livelihoods may respond to future hazard predictions through the use of scenario planning methods (Bennett et al. 2016; Colloff et al. 2016). While hazard exposure maps could guide spatially explicit adaptation efforts that focus on reducing place-based risks across interconnected landscapes (Diedrich et al. 2022; Thiault et al. 2018a). Finally, the LRPF could be implemented in contexts beyond Solomon Islands; however, this would require adapting vulnerability indicators to accurately reflect the unique characteristics of rural livelihoods across different locations (Ford et al. 2018).

Conclusions

This chapter introduced and implemented the LRPF as a holistic approach to support rural livelihoods adaptation in Solomon Islands. By addressing the limitations of CBVAs, the LRPF provided a deeper understanding of the factors driving rural livelihood risks. This required considering climatic and non-climatic hazard events, a broader range of socioeconomic vulnerability indicators, and the role of source dependence. Translating LRPF outputs into decision support tools demonstrated the complex multi-hazard risk landscape faced by rural communities, and the diverse socioeconomic factors contributing to their vulnerability. By employing a mixed-methods approach, the LRPF achieved a nuanced understanding of risk, identifying key risk drivers and their interactions to inform targeted priority adaptation initiatives for rural livelihoods. Such information is vital in fostering more effective and sustainable adaptation outcomes in rural areas. At the community scale, LRPF outputs aimed to empower proactive decision making, supporting community members to take ownership over their adaptation responses. At broader scales, LRPF outputs aimed to guide policymakers and external stakeholders in designing context-specific adaptation responses that align with local needs and realities. Ultimately, this chapter demonstrates the importance of transitioning towards holistic risk assessment approaches that address the limitations of CBVAs, supporting more robust adaptation strategies to enhance rural livelihoods resilience.

Chapter Four

From Vulnerability to Risk: Evaluating the Role of Holistic Risk Assessment for Livelihoods Adaptation Planning



Chapter Four: From Vulnerability to Risk: Evaluating the Role of Holistic Risk Assessment for Livelihoods Adaptation Planning

Foreward

In Chapter Three, I introduced and implemented the Livelihoods-Based Risk Profiling Framework (LRPF) as an expanded version of the IPCC AR5 Risk Framework. In developing the LRPF, I specifically aimed to address the limitations of community-based vulnerability assessments (CBVAs), and ensure the LRPF's applicability to rural livelihood contexts. In Chapter Three, I suggested that the LRPF will offer more robust guidance for rural livelihoods adaptation than the AR5 Risk Framework, and its AR4 predecessor. However, this claim was based on assumptions rather than empirical evidence. In this chapter, I evaluate whether these assumptions hold true by comparing the outcomes of the IPCC AR4 and AR5 Frameworks with those of the LRPF. This chapter is in review with *Regional Environmental Change*³.

Abstract

Vulnerability and risk assessments are critical tools for addressing the unique challenges faced by rural livelihoods, providing essential information to guide community-based adaptation. While the Intergovernmental Panel on Climate Change's (IPCC) AR4 Vulnerability Framework has been widely implemented in rural contexts, it has several theoretical limitations, including: i) a narrow focus on climate change, ii) insufficient consideration of the socioeconomic factors driving vulnerability, and iii) neglect of spatial and temporal dynamics. In response, the IPCC introduced the AR5 Risk Framework to address these limitations; however, it has seen limited uptake and lacks operational guidelines for effective implementation. To address these shortcomings, I developed and implemented the Livelihoods-Based Risk Profiling Framework (LRPF) in Chapter Three, offering a holistic risk assessment approach tailored for rural livelihoods. The LRPF incorporates non-climatic hazards, expands vulnerability indicators, and analyses source dependence, providing a comprehensive understanding of the factors influencing risk. This chapter conducts a comparative analysis of the AR4, AR5, and LRPF implemented in a rural community in Western Province, Solomon Islands. The outputs include vulnerability (AR4) and risk (AR5, LRPF) profiles that summarise each frameworks results.

³Smith, B., Duce, S. and Diedrich, A. *In Review*. From vulnerability to risk: Evaluating the role of holistic risk assessment for livelihoods adaptation planning. *Regional Environmental Change*.

These profiles revealed that the LRPf identifies critical factors influencing vulnerability and risk in rural livelihoods that were overlooked in the AR4 and AR5. Specifically, the LRPf highlighted the role of non-climatic hazards, such as resource exploitation, socioeconomic factors like financial capital, and community dependence on exposed food and water sources, as factors impacting rural livelihoods. Overall, the LRPf provided more specific guidance for adaptation than the IPCC frameworks, demonstrating the value of holistic approaches in guiding tailored adaptation responses to address the complex factors driving rural livelihood impacts. Such information is vital in supporting more effective and sustainable adaptation outcomes in the face of global change.

Introduction

Vulnerability and risk assessments are pivotal tools for understanding and addressing the unique challenges faced by rural livelihoods (Thiault et al. 2021; Van Aalst et al. 2008). Both types of assessments provide a systematic approach to understanding how rural livelihoods are exposed to global change and the socioeconomic factors that influence the extent of associated impacts (Begum et al. 2014).

When applied at the community scale, these assessments serve dual purposes. First, they provide critical insights and data for external decision-makers and practitioners, guiding policy directions and funding for community-based adaptation (Birkmann 2007; Fussel and Klein 2006). By understanding rural livelihood contexts, decisions can be informed by local realities, ensuring effective resource distribution for adaptation efforts (Barrowman and Butler 2020; Werners et al. 2021). Second, assessments provide a consolidated understanding of the factors driving vulnerability or risk. When this information is shared with communities, it can empower them to take the lead in their adaptation efforts (McLeod et al. 2015; Werners et al. 2021). This helps create adaptation strategies that adequately address local complexity and supports communities in achieving them by identifying and mitigating potential barriers to implementation (Butler et al. 2016a; 2016b).

Based on these purposes, vulnerability and risk assessments are essential tools for informed decision-making, supporting both high level strategic planning and local-scale adaptation efforts (Birkmann 2007). However, when applied in the context of rural livelihoods, these approaches vary significantly depending on the research field they originate from (Singh et al. 2017). Community-based vulnerability assessments (CBVAs) are commonly used in the climate change adaptation (CCA) or livelihoods and development (from here on referred to as livelihoods) fields (Smith and Diedrich 2024). These fields have different aims and focal areas. CCA studies prioritise understanding biophysical changes and basic socioeconomic conditions to adapt to climate change (Adger 2006), while livelihoods studies conduct a detailed analysis of socioeconomic conditions and critical livelihood assets to alleviate poverty (Sen 1983; Scoones 1998). In contrast, risk assessments, rooted in disaster risk management, evaluate the

likelihood and potential impact of natural hazards, taking socioeconomic vulnerability into account (Burton et al. 1978).

These distinctions have led vulnerability and risk assessment methods to be tailored to achieve specific goals (Alwang 2001). However, recent discussions have explored whether these methods should remain separate or be combined to address the diverse array of factors influencing vulnerability and risk (Fuchs et al. 2012; Wolf 2012). Advocates for integration propose that combining approaches can overcome limitations associated with a preferential focus on biophysical or socioeconomic factors, both of which are essential for understanding global change impacts on rural livelihoods (Begum et al. 2014; Ford et al. 2018). This integration is crucial, as excluding key factors from assessments has led to inadequate, ineffective, or even maladaptive adaptation outcomes (Magnan et al. 2016). By combining research perspectives, methods, and knowledge into a holistic approach, assessments can provide a more comprehensive understanding of rural livelihood challenges, leading to more effective and sustainable adaptation outcomes (Ford et al. 2018).

In rural livelihoods research, the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report (AR4) Framework (IPCC 2007) is the dominant approach for vulnerability assessments (Smith and Diedrich 2024). Originally designed to evaluate climate-induced hazards and their impacts on human systems, the AR4 primarily aims to guide national and international policy decisions on climate change adaptation (Victor 2016). However, its widespread application in the context of rural livelihoods has revealed certain limitations. These include: the AR4's narrow focus on climate change as the sole threat to communities (McDowell et al. 2016), limited consideration of the socioeconomic factors contributing to vulnerability (Ford et al. 2018), and neglect of spatial and temporal dynamics (Jurgilevich et al. 2017). These limitations, arising from the AR4's foundations in CCA, have contributed, in some instances, to ineffective and unsustainable adaptation efforts (Ford et al. 2018).

In response, the IPCC introduced a risk-based framework in their Fifth Assessment Report (AR5), which aimed to combine research perspectives to better predict climate change impacts (IPCC 2014). By equally prioritising biophysical and socioeconomic factors, the AR5 provided a holistic approach that addressed a more comprehensive range of factors influencing rural livelihoods risk. This shift from vulnerability to risk also aligned with evolving policy frameworks and funding mechanisms which have recently emphasised risk management, increasing opportunities for the AR5's implementation (Buchtman et al. 2022). However, despite its potential benefits, the AR5 has seen limited use, especially in rural livelihoods contexts (Smith and Diedrich 2024). This has been attributed to a lack of awareness of the framework and insufficient operational guidelines for its implementation (Estoque et al. 2023). In studies that do utilise the AR5 (e.g., Alam et al. 2022; Bera et al. 2022), ongoing limitations

from the AR4 highlight the need for clearer support in implementing the framework (Ishtiaque et al. 2022).

In Chapter Three, I developed the Livelihoods-Based Risk Profiling Framework (LRPF), which provides an operational method for implementing the AR5 in rural livelihoods contexts, directly addressing these challenges. The LRPF expands the AR5 to tackle persistent limitations in IPCC-based vulnerability and risk assessments when implemented in rural settings, as summarised in Table 4. This holistic framework aims to support robust decision making for community based adaptation. To achieve this aim, I implemented the LRPF in three rural communities in Solomon Islands.

Across Solomon Islands, vulnerability and risk assessments have become indispensable tools for understanding and responding to unique livelihood challenges (Gonzalez 2015). The country's rural population depends heavily on natural resources, making them especially vulnerable to hazards that impact resource availability and quality (Maharjan and Joshi 2013). Additionally, Solomon Islands is located in a region prone to climate-induced hazards, increasing the overall exposure of rural livelihoods to climate change (Dasgupta et al. 2009a; 2009b). Compounding these challenges, many rural areas are exposed to resource exploitation through commercial logging and fishing, placing additional pressure on livelihoods (Gillet and Tauti 2018; Van der Ploeg et al. 2020a). Given the wide range of challenges affecting rural Solomon Islanders' livelihoods, holistic approaches that capture these complexities are essential for developing effective and sustainable adaptation responses (Ford et al. 2018).

This chapter conducts a comparative analysis of the AR4, AR5 and LRPF to evaluate how each framework captures the factors impacting rural livelihoods in Solomon Islands and their effectiveness in guiding adaptation. I begin by outlining the differences between these frameworks and their components used to assess vulnerability (AR4) and risk (AR5, LRPF). I then apply each framework to a rural community in Solomon Islands, using data gathered in Chapter Three. The outputs of each framework are presented as a profile that summarises data on vulnerability and risk. These profiles serve as a comparative tool for evaluating the AR4, AR5, and LRPF. In the discussion, I explore and contrast how each framework contributes to guiding community-based adaptation and outline the impacts of their respective limitations (Table 4). In doing so, I demonstrate how holistic approaches, like the LRPF, provide a more comprehensive and nuanced understanding of the complex challenges faced by rural livelihoods, thereby offering more detailed information to guide adaptation planning. This analysis aligns with the broader research objective of this chapter, which aims to critically evaluate how a framework like the LRPF can contribute to more effective and sustainable outcomes for rural livelihoods adaptation.

Table 4: Evolution of the AR4 (IPCC 2007), AR5 (IPCC 2014), and LRPF applied by Smith et al. 2025 in addressing key limitations to community-based vulnerability assessments (CBVAs). Trends in the conceptual framework and implementation of the IPCC frameworks were informed by Chapter Two (Smith and Diedrich 2024).

Limitations	Framework		
	AR4 (IPCC 2007)	AR5 (IPCC 2014)	LRPF
Limitation 1: Assessments adopt a narrow perspective of climate change as the only threat to rural livelihoods.	Conceptual Framework: Exclusive focus on vulnerability to climate change. Implementation: Studies focus on vulnerability to a single climate-induced hazard event (e.g., sea level rise).	Conceptual Framework: Introduces the need to address climatic and non-climatic hazards. Implementation: Studies applied in the livelihoods context continue to focus on climate-based hazard events.	Conceptual Framework: Explicitly addresses exposure to both climatic and non-climatic hazards Implementation: Focuses on climatic and non-climatic hazards.
Limitation 2: Assessments adopt a narrow perspective on the types of socioeconomic factors that contribute to rural livelihoods' vulnerability.	Conceptual Framework: Limited consideration of socioeconomic factors. Implementation: Most studies cover only a few socioeconomic factors, unless they utilise indices like the Livelihood Vulnerability Index (LVI) (Hahn et al. 2009), which expands the socioeconomic factors included in the AR4.	Conceptual Framework: Emphasises the need to expand socioeconomic factors but does not provide suggestions on the types of factors to include. Implementation: Studies have not expanded on the types of socioeconomic factors applied in AR4 studies.	Conceptual Framework: Includes additional socioeconomic factors via the development of a novel vulnerability index. Implementation: Encompasses a broader range of socioeconomic factors.
Limitation 3: Assessments overlook the influence of spatial and temporal dynamics on rural livelihoods' vulnerability.	Conceptual Framework: Temporal dynamics address the frequency of past hazard exposure. Implementation: Studies measure the frequency of past hazards to predict future hazard impacts.	Conceptual Framework: Reconceptualises hazard exposure as a spatial concept, and addresses temporal dynamics by measuring past hazard frequency. Implementation: Studies examine the spatial distribution of hazard exposure, and the past frequency of hazard events.	Conceptual Framework: Adopts the AR5 theory of temporal and spatial dynamics and expands this to include spatial analysis of climatic and non-climatic hazard exposures. Implementation: Examines the spatial distribution of hazard exposure, spatial interactions among hazards, and past temporal dynamics of risk.

Framework Comparison

The components that shape vulnerability (AR4) and risk (AR5, LRPF) are presented in Figure 13. I have adapted the AR4 and AR5 component definitions to fit the context of rural livelihoods, while keeping their core meanings intact. By ‘core meanings’ I refer to the fact that the original IPCC definitions were not specifically intended to assess rural livelihoods vulnerability. I have therefore modified these definitions to reflect the specific focus of this thesis on rural livelihoods. Despite these modifications, the fundamental concept of each component remains the same. For example, in AR5 the definition of sensitivity was modified from ‘the degree to which a system or species is affected’, to ‘the degree to which rural livelihoods are affected’. Figure 8 defines the risk components used in the LRPF, while a comparison of component definitions across frameworks is provided in Appendix 9. Below, I summarise key differences between the AR4, AR5, and LRPF with respect to how each framework assesses vulnerability and risk.

IPCC AR4 Vulnerability Framework

The AR4 Framework (IPCC 2007) evaluates vulnerability by examining three components: exposure, sensitivity, and adaptive capacity. Exposure assesses the degree to which rural livelihoods experience climate change. Sensitivity assesses how susceptible rural livelihoods are to impact from climate change, while adaptive capacity assesses the ability of livelihoods to adjust to these impacts. These components have typically been assessed using quantitative indicators (Smith and Diedrich 2024). This numerical approach allows for a structured assessment of vulnerability, facilitating comparisons across different communities (IPCC 2007).

IPCC AR5 Risk Framework

The AR5 Framework (IPCC 2014) represents a significant shift from the AR4 in how vulnerability and risk are conceptualised. The AR5 comprises three primary components: hazard, exposure, and vulnerability, with vulnerability informed by sensitivity and adaptive capacity. This restructuring introduced hazard as a distinct component of risk and removed exposure as a sub-component of vulnerability.

Hazard in the AR5 is defined as the likelihood and severity of a climate-based event occurring at a specific location. This definition led to a re-conceptualisation of exposure from the AR4, which assessed the degree of impact from hazard events using indicators like ‘the number of times a household experiences climate-based hazards’. Instead, exposure in the AR5 is place-based, representing the location of key system assets within the local landscape that may interact with hazard events.

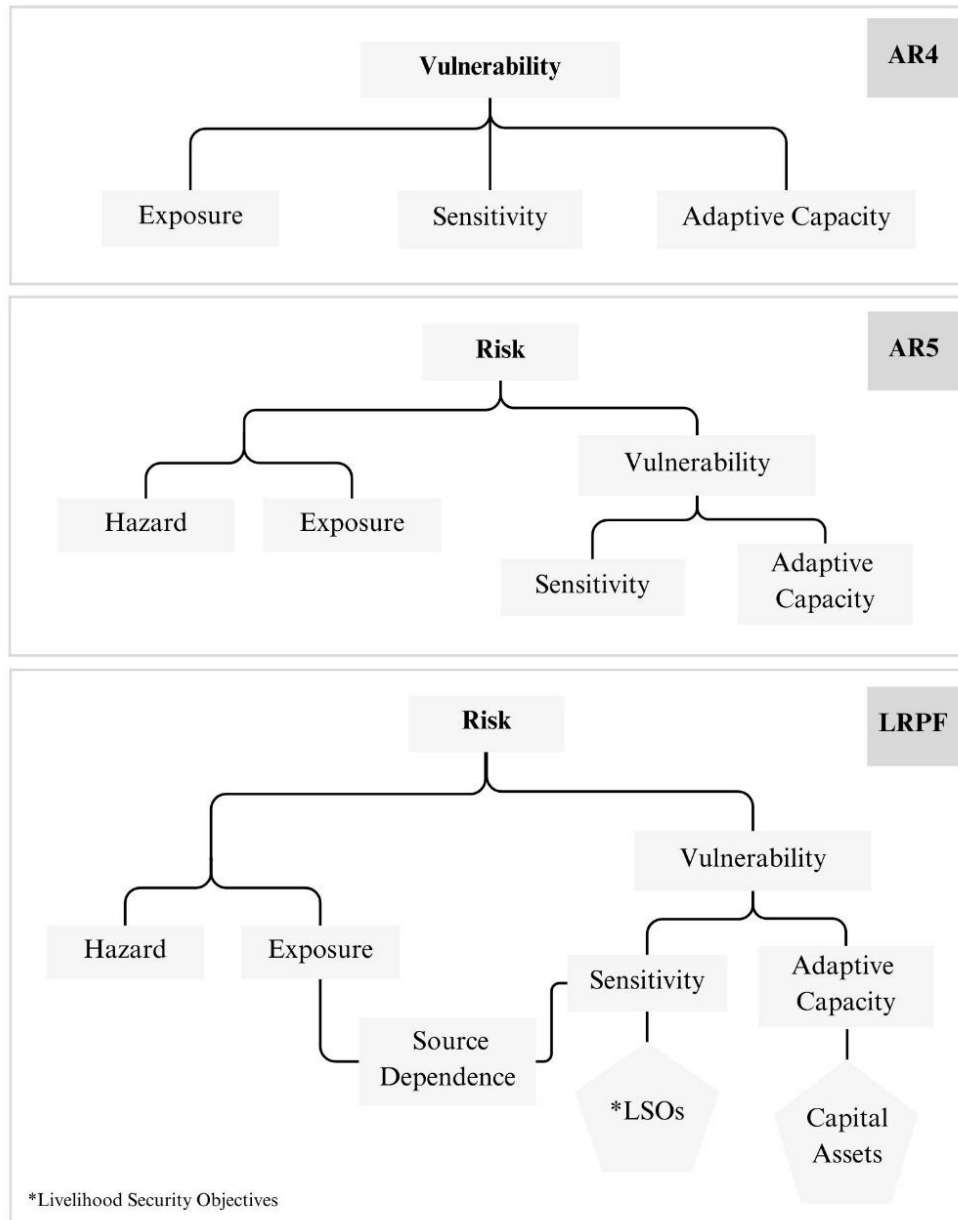


Figure 13: Comparison of the IPCC AR4 Vulnerability Framework (IPCC 2007), AR5 Risk Framework (IPCC 2014), and Livelihoods-Based Risk Profiling Framework (LRPF) introduced in Chapter Three.

This shift emphasises the importance of spatial dynamics in assessing and responding to climate change impacts (Cutter et al. 2008). Under this new framing, exposure evaluates the likelihood that physical assets, such as ecosystems, natural resources, or artificial infrastructure, exist in the same location as hazard events. Hazard exposure is evaluated through spatial analysis and mapping techniques, providing a comprehensive understanding of how hazards interact with these physical assets. For instance, if a rural community prone to flooding has critical infrastructure located in floodplain areas, their risk of impact under the AR5 is higher than that of communities where such infrastructure is situated on higher ground.

To understand the potential impact of hazard exposure on rural livelihoods, these components are assessed in the context of vulnerability. In the AR5, vulnerability is viewed as a pre-existing condition, shaped by the socioeconomic factors that influence rural livelihoods, irrespective of hazard exposure. For example, communities with sufficient resource access, and strong social networks are less likely to be susceptible to and more likely to recover from hazard exposure, minimising their overall impacts (Birkmann et al. 2013). In the AR5, vulnerability continues to be assessed using quantifiable indicators that are combined with spatial analyses of hazard exposure to provide a more comprehensive understanding of the factors impacting rural livelihoods compared to the AR4.

Livelihoods-Based Risk Profiling Framework (LRPF)

In Chapter Three I developed the LRPF to assess rural livelihoods risk, expanding the AR5 to specifically address ongoing limitations in IPCC-based frameworks (Alam et al. 2022; Bera et al. 2022). The LRPF retained the core components of the AR5 while introducing several modifications (Figure 13). For example, I broadened the AR5 definition of hazards to explicitly include both climatic and non-climatic events. This change addressed the need to consider various types of hazard exposure in risk assessments (McDowell et al. 2016), particularly in complex contexts like Solomon Islands (Van der Ploeg et al. 2020a).

I also introduced source dependence as a sub-component of vulnerability. This evaluated the extent to which rural livelihoods depend on exposed assets, establishing a direct link between hazard exposure and vulnerability that was lacking in the AR5. For example, if food gardens vital for food security are located in flood-prone areas, rural livelihoods become more vulnerable to flooding, as their dependence on these gardens for sustenance increases the impact of hazard exposure (Marshall et al. 2013). To better align with the context of rural livelihoods, I framed source dependence around five essential livelihood security objectives (LSOs) in Solomon Islands: water, food, housing, energy, and income (SPC 2016).

In the LRPF, the range of socioeconomic indicators used to assess adaptive capacity and sensitivity were expanded (Smith and Diedrich 2024). This included integrating capital asset composite indicators for adaptive capacity (DFID 1999), and LSO composite indicators for sensitivity (SPC 2016). This expansion led to the development of an LRPF vulnerability index, utilising socioeconomic vulnerability indicators from previous CBVA studies in the fields of CCA or livelihoods. By combining these research perspectives, the LRPF established a more comprehensive list of indicators that influence rural livelihoods. Local experts tailored these indicators to the context of Solomon Islands where the LRPF was implemented. The resulting index comprised nineteen adaptive capacity and ten sensitivity indicators (Table 2). Source dependence was evaluated separately to provide insights into hazard-specific vulnerability, contrasting to the more generalised indicators included in the index.

Methods

This chapter focuses on the comparative analysis of the AR4, AR5 and LRPF in relation to a rural livelihoods case study in Solomon Islands. To conduct this analysis, I used data from Chapter Three where the LRPF was introduced and implemented. Here, I provide a brief overview of the LRPF method, before detailing how I applied the LRPF data to the AR4 and AR5 Frameworks.

Study Community

In this chapter, I focus on a single community (C1) located in Western Province, Solomon Islands, where the LRPF was implemented (Figure 9). This focus enables a more in-depth comparison of the outputs from each framework. Given the complexity of assessing multiple communities, this approach was a pragmatic decision to enhance the coherence of the chapter. C1 is situated on the island of Vella La Vella and comprises approximately 150 households. The community is characterised by its rural coastal setting and relies on subsistence livelihoods that predominately centre around small-scale farming. Its remote location presents significant challenges, limiting access to essential services such as healthcare, markets, shops, and financial institutions, all of which are situated in the provincial capital of Gizo, approximately 50km away.

Data Collection

In Chapter Three, I developed a mixed-methods approach to implement the LRPF in the context of rural livelihoods. The following summary outlines the data collection method as it relates to this chapter. Data on hazards were collected through a focus group mapping workshop comprising twelve participants, who listed and ranked hazard types based on their perceived level of concern in terms of livelihood impacts. Participants also created hand-drawn maps indicating the primary locations where a hazard occurred in the landscape and the location of key livelihood assets used by a community to meet their LSOs. These data were combined to obtain a spatial understanding of hazard exposure.

Vulnerability data were collected through a household survey, inclusive of source dependence, adaptive capacity, and sensitivity. Additional data on hazard exposure were also gathered for hazards that varied across broader spatial scales and could not be mapped at the community level. The survey was conducted using convenience sampling and reached 43% (n=63) of households. All research activities were conducted in Solomon Island Pijin and Bilua, the Vella La Vella dialect, and were facilitated by local researchers from Ecological Solutions Solomon Islands, who brought a combination of scientific expertise and community-based conservation and resource management experience. Data collection occurred from March to September 2022 under James Cook University's human ethics protocol H8497

ensuring adherence to all relevant ethical considerations, including informed consent and confidentiality.

Data Application

I used the analysed data from Chapter Three to develop an AR4 vulnerability profile, an AR5 risk profile and an LRPF risk profile, reflecting the components specific to each framework (Figure 14). I applied the data differently to each framework, capturing the expansions made in the LRPF that addressed the limitations of the AR4 and AR5 frameworks. To reiterate, these limitations include: i) a narrow focus on climate change exposure, ii) limited consideration of socioeconomic factors, and iii) a lack of attention to spatial and temporal dynamics. The methods used to analyse LRPF data on hazard exposure and vulnerability are described in Chapter Three and, therefore, are not reiterated here. However, several analytical distinctions exist between the LRPF data analysis process and the one presented in this chapter. I outline these distinctions below and describe how the data were applied to each framework.

To reflect IPCC framework limitations, I excluded data related to non-climatic hazard exposure from the AR4 and AR5 profiles. I also created a unique vulnerability index for the AR4 and AR5. To do so, I used the results from Chapter Two to identify the types of socioeconomic vulnerability indicators that were consistently applied in more than 25% of the reviewed studies (n=101). Indicators that met this criterion were incorporated into the vulnerability index for the AR4 and AR5, resulting in the selection of five adaptive capacity and five sensitivity indicators for the IPCC frameworks. Additionally, I used the results from Chapter Two to select perception-based indicators for assessing exposure in the AR4 vulnerability index. These indicators evaluated the extent to which households perceived they had been exposed to a range of locally relevant climate change hazards, including: sea level rise, flooding, increased rainfall, decreased rainfall, and temperature change (Table 5).

In Chapter Three, I assigned unique weightings to the vulnerability index indicators, composite indicators, and components, reflecting differences in their relative importance for rural livelihoods. However, in this chapter, I took a different approach, applying equal weighting to all elements of the LRPF, AR4 and AR5 vulnerability indices. This ensured that each indicator, composite indicator and component of vulnerability received equal consideration across the frameworks. By doing so, I ensured that no single indicator disproportionately influenced the vulnerability index outputs beyond their inclusion or exclusion, thereby supporting comparisons across index outputs. This approach enabled a clear, objective comparison of the different frameworks, focusing on the types of indicators used and their importance in addressing rural livelihoods vulnerability. While this approach differs from the practical application of the LRPF (where weightings are used to reflect the relative importance of each indicator), its purpose in this chapter was to enable a direct comparison of the frameworks without introducing bias from various indicator weightings.

Table 5: The types of components, composite indicators, and indicators used to create vulnerability indices in the LRPF, AR4 and AR5 frameworks.

Vulnerability Index	Inclusion		
	LRPF	AR5	AR4
Adaptive Capacity	X	X	X
Human Capital	X	X	X
Dependency Ratio	X	X	X
Health Condition	X		
Access to Healthcare	X		
Livelihood Diversity Index	X	X	X
Extent of Coping Strategies	X		
Financial Capital	X	X	X
Household Savings	X		
Household Income	X		
Household Expenditure	X		
Income Satisfaction	X		
Access to Financial Services	X	X	X
Social Capital	X	X	X
Social Networks	X		
Inclusion in Decision Making	X		
Local Institutional Memberships	X	X	X
Satisfaction with Leadership	X		
Trust	X		
Collective Action	X		
Perceptions of Fair Access to Livelihood Opportunities	X		
Physical Capital	X	X	X
Access to Livelihoods-Based Assets	X	X	X
Natural Capital	X		
Perceptions of Fair Access to Natural Resources	X		
Sensitivity	X	X	X
Water Insecurity	X	X	X
Access to Drinking Water	X	X	X
Water Sufficiency	X	X	X
Water Quality	X	X	X
Access to Sanitation	X		
Food Insecurity	X	X	X
Food Sufficiency	X	X	X
Food Consumption Score	X		
Housing Insecurity	X	X	X
Housing Condition	X	X	X
Energy Insecurity	X		
Cooking Fuel Sufficiency	X		
Lighting Sufficiency	X		
Income Insecurity	X		
Income Stability	X		
Exposure			X
Sea Level Rise			X

Chapter Four

Flooding	x
Increased Rainfall	x
Decreased Rainfall	x
Temperature Change	x

For each framework, I combined data to generate vulnerability (AR4), and risk (AR5 and LRPf) profiles, providing a visual summary of their components (Figure 14). For the AR4, I applied household survey data to calculate a vulnerability index combining exposure, sensitivity, and adaptive capacity indicators (Table 5). For the AR5, I applied the focus group mapping workshop and household survey data to evaluate hazard exposure and combined this with a vulnerability index that incorporated sensitivity and adaptive capacity. For the LRPf, I followed the methods outlined in Chapter Three. The LRPf expanded the AR5 by applying household survey data to evaluate source dependence and developing a broader socioeconomic vulnerability index. I excluded qualitative data obtained from informal conversations in the LRPf from the results of this chapter, as AR4 and AR5-based studies typically do not incorporate this type of data (Smith and Diedrich 2024). By excluding qualitative data, I maintained consistency with the methods commonly used in AR4 and AR5 based studies, ensuring a fair comparison across frameworks. However, the LRPf recognises that qualitative data provides valuable insights on vulnerability that may not be captured through quantitative indicators alone. While this chapter focuses on quantitative comparison, I reflect on the value of qualitative data in the discussion.

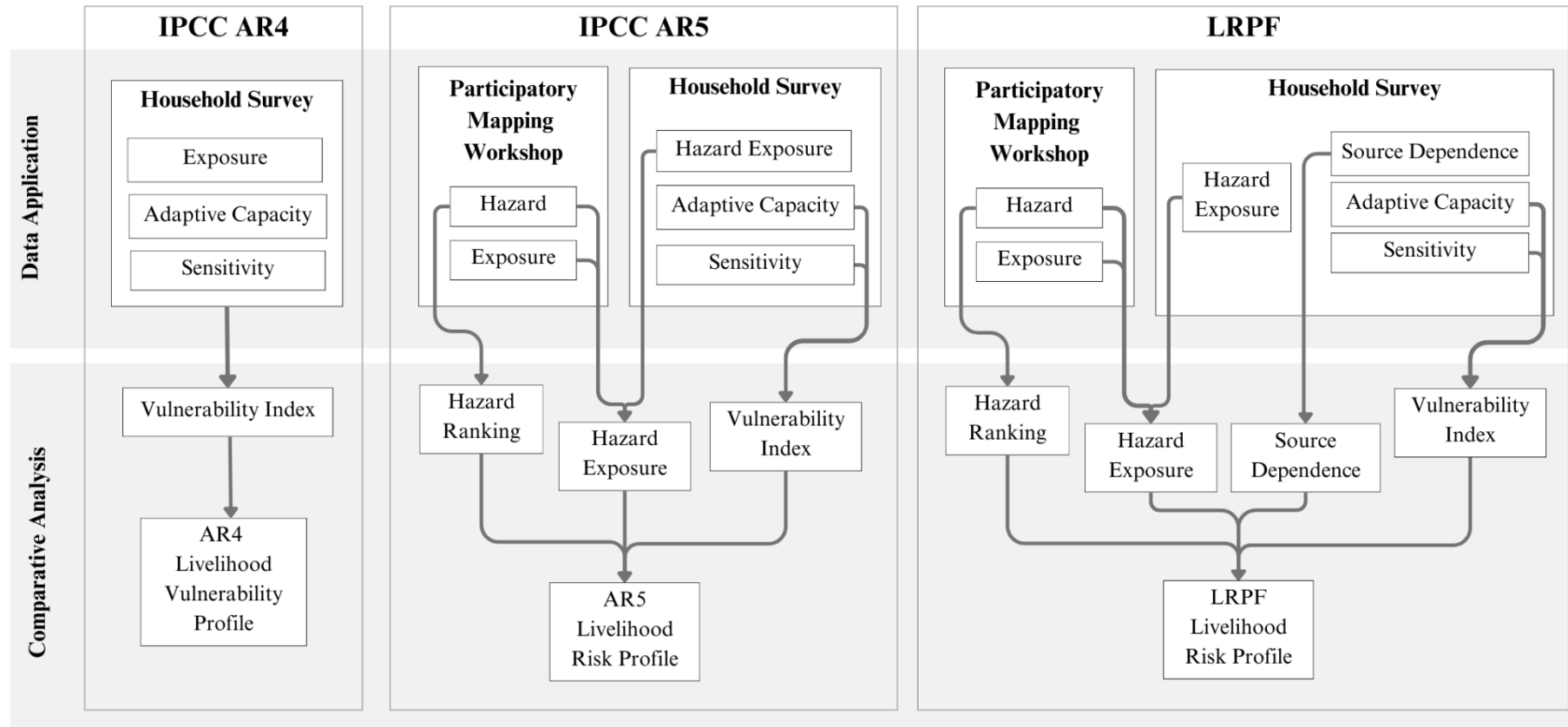


Figure 14: Application of the data to produce the comparative AR4 vulnerability profile, AR5 risk profile, and LRPF risk profile based on the respective components of each framework.

Results

The results showcase differences in the information provided by the AR4 vulnerability profile (Figure 15a), AR5 risk profile (Figure 15b), and LRPF risk profile (Figure 15c). Each profile is discussed individually, summarising the key factors identified to contribute to livelihoods vulnerability or risk. Individual indicator scores for each index are available in Appendix 10.

The AR4 Vulnerability Profile

The AR4 vulnerability profile (Figure 15a) identified the community as most vulnerable to decreased rainfall, assigning a ‘very high’ perceived exposure to this hazard. However, the community also faced ‘high’ exposure to all other climate-based hazards. In terms of sensitivity, the community was most sensitive to food and water insecurity, with greater likelihood of impact from hazards that may interact with these LSOs. Impacts were likely to be most prevalent for hazards that would disrupt food availability, or access to sufficient quantities of good quality drinking water. Despite having a ‘moderate’ rank for adaptive capacity, the community might face challenges in responding to climate change. For example, a ‘moderate’ score for accessing human, social, and physical capital may establish a foundation for adaptation efforts, however, the community’s ‘very low’ financial capital (driven by limited access to financial services) could hinder investments in those adaptation strategies.

The AR5 Risk Profile

The AR5 risk profile (Figure 15b) identified increased rainfall and flooding as the hazards of most concern for the community, while sea level rise posed the lowest concern. Sources used to meet all LSOs were exposed to these hazards; however, food and income sources were additionally exposed to decreased rainfall and temperature change. Hazard exposure maps indicated areas where gardens, used to access both food and income, were exposed to flooding and sea level rise. Flooding was also found to interact with land used for drinking water (rivers and streams), other income sources (cash crop plantation, forests, livestock farms, and the ocean), and to obtain cooking fuel (forests).

The community demonstrated an overall ‘low’ sensitivity to hazard exposure; however, they were ‘moderately’ sensitive to food and water insecurity. Given the extensive exposure of food sources to climate-based hazards, impacts on the community’s ability to meet this LSO may be substantial. The community may wish to leverage strengths in human, social, and physical capital to support adaptation efforts, which achieved a ‘moderate’ score in terms of adaptive capacity. However, these efforts may be hindered by the community’s ‘very low’ financial capital. This financial challenge will likely worsen given the exposure of income-generating sources to climate change.

The LRPF Risk Profile

The LRPF risk profile (Figure 15c) identified the community's 'very high' concern in relation to climate-based hazards, including increased rainfall and flooding, and resource exploitation through commercial logging. Sources used to meet all LSOs were exposed to these hazards. However, food sources faced the greatest extent of multi-hazard exposure, followed by income and water sources. Hazard exposure maps depicted instances of combined exposure to climate change and resource exploitation, such as areas where logging and flooding overlapped with food gardens and drinking water sources. Food gardens encountered pressures from additional hazards, including wild pigs (considered pest species), population growth, temperature change, and decreased rainfall. Water sources were also exposed to population growth and increased rainfall, in addition to long-term impacts from COVID-19. This related to the upstream migration of households during the pandemic who used rivers for sanitation purposes, impacting the quality of downstream drinking water.

The community's dependence on food gardens as their primary food source highlighted a critical vulnerability to hazard-specific impacts. This vulnerability was compounded by the community's 'moderate' level of food insecurity, driven by food insufficiency and limited dietary diversity. Since about half of the community also depended on gardens for income, hazard-specific impacts would not only impact food security, but also strain financial resources. Although rainwater tanks were the community's primary drinking water source, households depending on rivers and streams were more likely to experience hazard exposure impacts, increasing their risk of water insecurity. In terms of adaptive capacity, the community's 'low' access to financial capital may limit their ability to secure alternative food and water sources in response to hazard exposure. However, the community's 'moderate' levels of human and social capital could be leveraged to promote collective action, such as pooling resources for communal food and water source access or purchase.

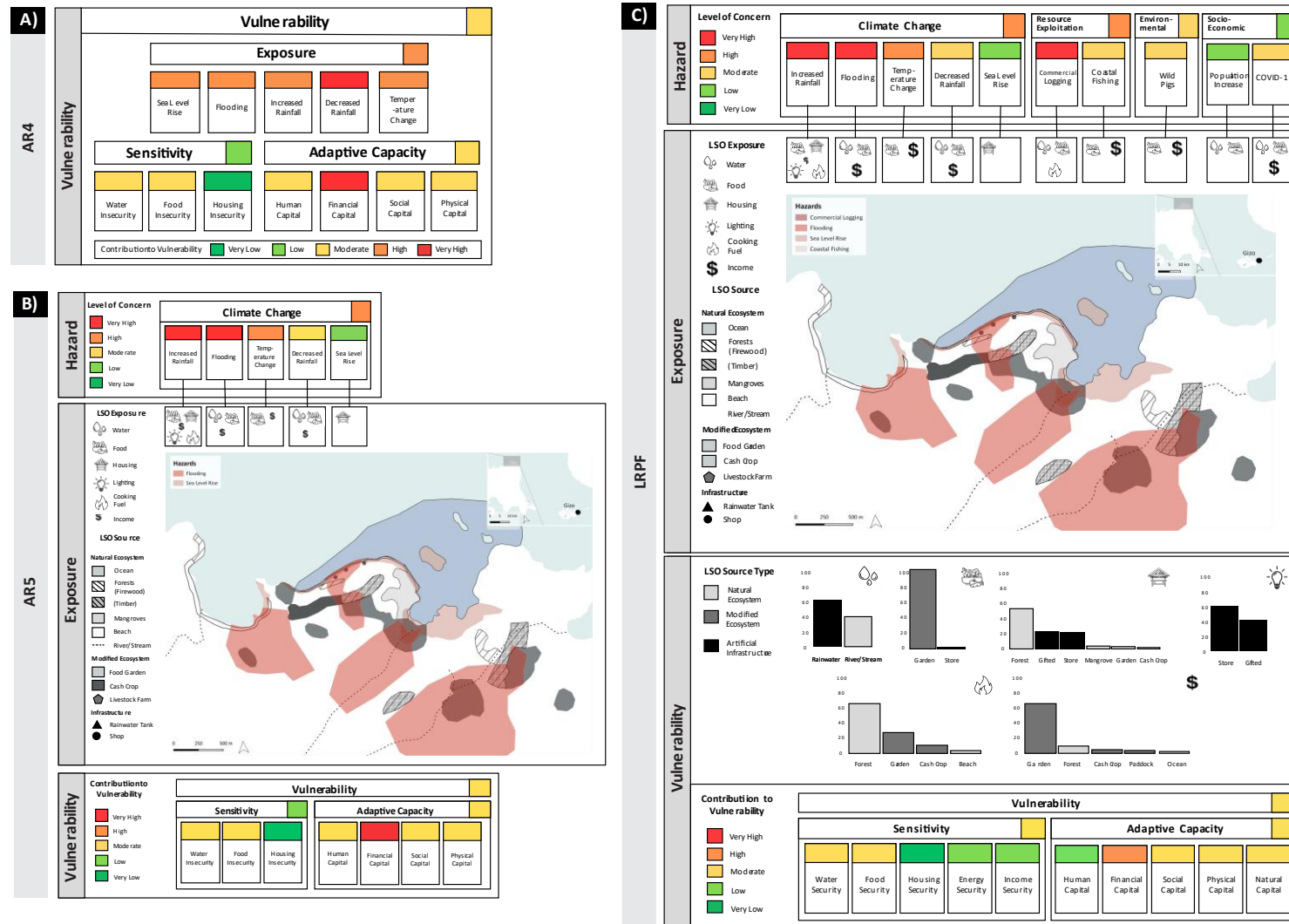


Figure 15: Livelihood profiles summarising results of the: a) IPCC AR4 Vulnerability Framework (IPCC 2007), b) IPCC AR5 Risk Framework (IPCC 2014) and, c) Livelihoods Based Risk Profiling Framework (LRPF).

Discussion

In the previous section, I presented and interpreted vulnerability and risk profiles that summarise outputs of the AR4 vulnerability framework (IPCC 2007), AR5 risk framework (IPCC 2014), and Livelihoods-Based Risk Profiling Framework (LRPF). In this section, I compare these profiles with respect to how established limitations of the AR4 and AR5 frameworks influence their ability to identify key vulnerability and risk drivers and how the LRPF addressed these gaps. Specifically, these limitations include: i) a narrow focus on exposure to climate change (McDowell et al. 2016), ii) limited consideration of the socioeconomic factors driving vulnerability (Ford et al. 2018), and iii) neglect of spatial and temporal dynamics (Jurgilevich et al. 2017). In particular, I reflect on how differences in the depth of information produced by each framework could lead to varying strategies for community-based adaptation in the context of Solomon Islands rural livelihoods. Finally, I propose additional steps to enhance the LRPF as a holistic tool for supporting rural livelihoods adaptation.

Narrow Focus on Climate Change Exposure

The IPCC's focus on climate change adaptation has led to the exclusion of non-climatic hazards from studies applying the AR4 and AR5 frameworks (Smith and Diedrich 2024). The LRPF's inclusion and comparative evaluation of non-climatic hazards revealed their considerable impact on rural livelihoods, with hazards like commercial logging surpassing several climate-based hazards in impact. The LRPF also demonstrated how spatial interactions between climatic and non-climatic hazards can drive cumulative impacts. This reveals the inadequacy of narrow perspectives on the types of hazards impacting livelihoods. By focusing solely on climate change, the IPCC frameworks overlook the complex, interconnected challenges rural livelihoods face, where diverse and interacting hazards play a critical role in shaping vulnerability and risk (McDowell et al. 2016).

In Solomon Islands, externally funded adaptation initiatives have predominantly focused on climate change, particularly sea level rise (Van der Ploeg et al. 2020b), while overlooking other critical challenges such as resource exploitation (Minter and Van der Ploeg 2023). By applying holistic frameworks like the LRPF, which assess diverse hazard contexts, the impacts of non-climatic hazards can be emphasised.

The LRPF provides evidence to advocate for the inclusion of non-climatic hazards in adaptation funding, helping to better align externally led interventions with local realities (Thiault et al. 2021). By supporting contextually relevant adaptation measures, holistic approaches like the LRPF can also help prevent the diversion of resources away from pressing local concerns, such as commercial logging (Nunn and Kumar 2019). The narrow perspective of the AR4 and AR5 frameworks results in the loss

of this information, reinforcing a climate-centric focus in externally funded adaptation efforts that, while essential, should not be the sole emphasis of adaptation (Cinner et al. 2018; Van der Ploeg et al. 2020a).

At the local scale, rural communities' deep connection with their environment often fosters a profound understanding of the hazards impacting their livelihoods (Ensor et al. 2018a). This includes awareness of projected climate change impacts, which have been reinforced by educational campaigns in Solomon Islands, helping communities to better understand long-term changes in local conditions (McNamara 2013). As such, vulnerability and risk profiles may consolidate existing information rather than introduce new insights to communities; however, they can play a crucial role in guiding the prioritisation of adaptation strategies.

From the LRPF profile, prioritised adaptation strategies are likely to involve holistic multi-hazard responses that consider both climatic and non-climatic challenges. In contrast, the AR4 and AR5 profiles are likely to guide climate-focused efforts, which, while important, may overlook other critical hazards like commercial logging. These overlooked hazards can exacerbate existing vulnerabilities (McNamara et al. 2020). For instance, ongoing logging activities could degrade ecosystems and worsen food and water insecurity, further increasing local vulnerability despite efforts to reduce climate change impacts (Minter and Van der Ploeg 2023).

The LRPF method, as outlined in Chapter Three, further supports adaptation prioritisation by incorporating qualitative data which helps clarify how different risk factors interact. This allows for the integration of lived experiences, perceptions, and local knowledge in terms of the dynamic and unique ways risk manifests at the local scale (Kettle et al. 2014). Such insights are specific to a community and are unlikely to emerge from purely quantitative approaches like those found in AR4 and AR5-based studies (Ahmed and Kelman 2018; Smith and Diedrich 2024). While quantitative approaches are valuable for guiding externally funded adaptation by providing standardised data to determine risk drivers across communities, they overlook the nuanced, context-specific realities that shape a community's adaptation requirements (Van Aalst et al. 2008). The inclusion of qualitative data within the LRPF therefore adds critical depth, facilitating a more comprehensive understanding of risk. This information is essential for developing more effective and sustainable adaptation strategies that are tailored to the specific needs of rural communities (Ahmed and Kelman 2018).

Limited Consideration of Socioeconomic Factors

The AR4 and AR5 have faced criticism for their limited analysis of the socioeconomic factors contributing to vulnerability (Ford et al. 2018). While the LRPF's expansion of socioeconomic indicators resulted in minimal changes to vulnerability index ranks, it did provide valuable context to the LRPF risk profile that can support more targeted adaptation efforts.

Expanding sensitivity indicators revealed previously overlooked challenges, such as inadequate access to sanitation. Traditionally considered a development issue (Anthonj et al. 2020), insufficient access to critical infrastructure, like sanitation, can amplify hazard exposure impacts. This highlights the intrinsic connection between hazard-based adaptation and rural development, particularly in locations like Solomon Islands, where the impacts of climate change and development issues often intersect (Butler et al. 2024; McEvoy et al. 2020). Recognition of this intersection has led to increased calls for adaptation strategies that promote ‘hazard-resilient development’, simultaneously responding to hazards and tackling development-based issues (Butler et al. 2016b). This aligns with broader literature on disaster risk reduction and climate adaptation, which highlights the need to integrate resilience-building measures into development planning rather than treating adaptation as a separate or reactive process (Ireland 2011; Kelman and Mercer 2015). Scholars also caution that development projects can inadvertently increase risk and vulnerability when they prioritise short-term gains over long-term sustainability (Schipper 2011; Schipper et al. 2016). For example, infrastructure development in hazard-prone areas, such as coastal zones exposed to sea-level rise, can exacerbate rather than reduce risk (Adshead et al. 2024). By incorporating perspectives from the livelihoods field, which emphasises the importance of strengthening rural development and reducing vulnerability (Scoones 1998; Sen 1981; Sen 1983), the LRPf is uniquely positioned to inform hazard-resilient development.

Expanding adaptive capacity indicators related to human and social capital provided critical insights for adaptation that were lacking in the AR4 and AR5 profiles (Diedrich et al. 2016b, 2019; Petzold and Rattler 2015). This related to the importance of factors like social cohesion, collective action, and trust, which are known to influence the long-term success of adaptation efforts (Suhaeb et al. 2024). While the AR4, AR5, and LRPf profiles emphasised financial capital as a barrier to adaptation, focusing solely on increasing access to financial resources may hinder adaptation success (Wuepper et al. 2017). Evidence from Solomon Islands demonstrates this issue, where financial support for infrastructural development that overlooked the role of social capital led to unfair resource distribution, social tension, and a lack of community-buy in for adaptation initiatives. This, in turn, eroded local adaptive capacity (Ha’apio et al. 2019).

Prior AR4 and AR5-based studies have also fallen short in their analysis of financial capital by focusing primarily on access to services, while neglecting other critical aspects of financial well-being, such as income, expenditure, and savings (Bruggen et al. 2017; Vlaev and Elliot 2014). The LRPf adopts a more comprehensive evaluation of financial capital by exploring these factors. This is crucial in contexts like Solomon Islands where income levels, spending habits, and savings are more valuable in terms of understanding and responding to rural livelihood risks (Malherbe et al. 2020).

Introducing source dependence as a risk component in the LRPf provided crucial insights into the interactions between vulnerability and hazard exposure (Marshall 2011). This bridged the gap between

overly generalised assessments, which lack hazard-specific details and highly specific assessments, which overlook broader vulnerability factors (O'Brien et al. 2007). In Solomon Islands, where rural livelihoods are heavily reliant on natural resources (Maharjan and Joshi 2013), identifying which sources are most likely to undergo hazard exposure can help prioritise adaptation efforts. This is particularly important in communities dependent on a single source to meet their LSOs, such as gardens for food. In such cases, responding to hazards that impact food gardens may become an adaptation priority, especially where an absence of alternative food sources is observed (Marshall et al. 2013). By omitting source dependence from their frameworks, the AR4 and AR5 lack critical detail needed to guide more targeted, hazard-specific adaptation responses that can play a key role in supporting rural livelihoods resilience (Marshall 2011).

Adopting a spatial approach to analyse hazard exposure within the AR5 and LRPF further contextualised vulnerability by establishing interactions between different hazard and source types, enhancing the precision and relevance of adaptation strategies (Preston et al. 2011). In contrast, the AR4's conceptualisation of exposure provided less actionable information, lacking a direct connection to the socioeconomic factors that influence local impacts. The frequency-based indicators used to quantify exposure in AR4-based studies (Smith and Diedrich 2024) may also underestimate the extent of local impacts (Caldera and Wirasinghe 2022). For example, frequent but low severity drought periods may be manageable for communities, whereas sporadic yet severe events, such as cyclones, may have devastating consequences for livelihoods (Niji and Balgah 2019). Both the AR5 and LRPF profiles highlighted this issue by employing hazard ranking methods that considered a broader range of characteristics, including magnitude, severity, and frequency, enabling a more nuanced assessment of hazard events. As a result, rankings of 'high concern' for various climate-based hazards differed from those in the AR4 profile. Triangulating these results with direct community feedback would have strengthened the confidence in the LRPF's ability to capture local risk perceptions and lived experiences (Warren and White 2020). However, due to logistical constraints (including COVID-19 imposed delays) this was not possible.

Neglect of Spatial and Temporal Dynamics

By depicting hazard exposure spatially, the AR5 and LRPF provided a more nuanced understanding of where hazard impacts occur. This supports the development of place-based adaptation strategies tailored to the unique geographical context of a community (Sullivan-Wiley et al. 2019). For external stakeholders, community-based hazard exposure mapping can serve as a tool to ground-truth national scale hazard models, which are often too coarse to capture local conditions accurately (Sadd et al. 2014). In Solomon Islands, this could benefit government ministries, local authorities, and NGOs. Such data is particularly valuable as the national government transitions towards spatial planning and prioritises more localised, evidence-based decision making to support rural livelihoods (Solomon Islands

Government 2018; Solomon Islands Ministry of Fisheries and Marine Resources 2019; Solomon Islands Ministry of Environment 2023).

This localised mapping can support external decision-makers in understanding fine scale spatial variations in hazard exposure, counteracting the ‘one-size-fits-all’ perspective observed when stakeholders consider hazard impacts to occur homogeneously across a landscape (Van Aalst et al. 2008). At the community scale, these maps can serve as valuable planning tools (Sullivan-Wiley et al. 2019). For example, they can guide the placement of infrastructure in less hazard-prone areas (Vajhala 2005), or, by depicting multi-hazard interactions in the landscape, they can help pinpoint land areas that warrant prioritisation in adaptation responses (Carver et al. 2009).

Temporal dynamics were represented in both the AR5 and LRPF hazard exposure maps, which reflected past hazard occurrences. However, in Chapter Three, the LRPF provided an expanded understanding of temporal interactions by incorporating qualitative data from informal conversations with community members. This approach provided valuable insights into the long-term impacts of hazards and their influence on vulnerability over time. Such data were essential for understanding interactions among framework components, which supported the development of more robust adaptation strategies, capable of addressing these complex dynamics. Such interactions were not captured through the qualitative methods applied in this chapter, further emphasising the value of adopting a mixed-methods approach to assess vulnerability and risk.

Next Steps for Holistic Risk Assessment

The LRPF has made significant strides towards a more holistic risk assessment approach, laying a foundation for future research. A key area for expansion is the analysis of temporal dynamics, particularly by incorporating projections for future hazard exposure and vulnerability (Butler et al. 2020a). Methods like scenario-planning can be particularly valuable as they provide a mechanism to anticipate future conditions (Butler et al. 2020b). This, in turn, informs the proactive development of adaptation strategies that are more likely to remain effective under evolving and uncertain conditions (Flynn et al. 2018). Other approaches, such as trend-based forecasting (which extrapolate historical data to project future risk) (Reilly et al. 2017) and back-casting (which works backwards from a desired future state) (Dreborg 1996) can also provide valuable insights (Faldi and Macchi 2017). However, each method has limitations that must be carefully considered within the study context. For instance, scenario-planning can focus too narrowly on plausible futures and downplay extreme scenarios (Birkmann et al. 2015; Butler et al. 2020b), trend-based forecasting can assume future patterns will reflect the past, which may be unsuitable in rapidly changing contexts (Garnier 2019) and back-casting can lack grounding in current trends or realistic pathways (Faldi and Macchi 2017). Selecting the most

appropriate method for each context is essential, along with explicit acknowledgment of the uncertainties inherent in projections (Fekete et al. 2010).

In terms of spatial dynamics, hazard exposure maps may benefit from expansion beyond a community's immediate land area, allowing for an examination of landscape level interactions that influence risk (Bilali et al. 2017). This expansion could include an in-depth exploration of inter-community interactions and 'ridge-to-reef' dynamics, both of which are known to influence rural livelihoods (Fache and Pauwels 2022; Diedrich et al. 2022). By incorporating these forward-looking methods and considering broader ecological and social interactions, the LRPF can enhance its relevance for communities facing dynamic risks, ultimately leading to more tailored and effective adaptation strategies.

While the LRPF has made progress in addressing AR4 and AR5 limitations, these efforts will have little impact unless framework users are aware of their shortcomings. While numerous studies have highlighted these limitations (e.g., Guerrero et al. 2018; Singh et al. 2017; Thiault et al. 2021), they continue to persist during the application of IPCC frameworks (Smith and Diedrich 2024). Greater attention is therefore needed to explore pathways for overcoming them. The IPCC itself has recognised this need (IPCC 2023); however, recognition alone is insufficient. Notably, the AR5 has been criticised for its confusing layout and lack of clear implementation guidelines, which may contribute to the continued presence of AR4 limitations (Ishtiaque et al. 2022; Fuchs et al. 2024). Addressing this requires not only refinement of the framework but also practical guidance for its implementation. In its AR6 report, the IPCC has also acknowledged the importance of community-based data in improving our understanding of climate change, land use pressures, and associated impacts, as well as establishing effective adaptation responses (Calvin et al. 2023; IPCC 2022). The LRPF provides a potential mechanism to support this shift by offering a practical approach for applying the AR5 at the local scale.

Application of Study Findings

Several methodological choices that shaped the results should be acknowledged when applying the study findings. First, to enable comparisons across frameworks, I applied equal weighting to the vulnerability indices in this chapter. This approach assumed that each index element contributed equally to vulnerability; however, this may not accurately reflect the actual influence of each indicator on rural livelihoods (Garriga and Foguet 2010; Saisana et al. 2005). To address this limitation, methods like the Analytic Hierarchy Process (AHP), as applied in Chapter Three, allow indicators to be weighted based on their relative importance (Saaty 1980). Second, I used categorical binning to classify vulnerability index outputs (e.g., very low: 0-20, low: 21-40 etc.). While this approach allowed data to be presented in clear, comparable categories that aid interpretation and decision-making, it may obscure subtle variations in vulnerability that can influence adaptation requirements (Thekdi and Aven 2021). To

mitigate this, framework outputs should be compared with qualitative data that may capture nuances not reflected in the vulnerability and risk profiles presented in this chapter (Downs 2014).

Finally, the findings of this chapter offer valuable insights for practitioners conducting community-based vulnerability and risk assessments by highlighting the limitations of IPCC frameworks and proposing actionable steps to address them through the LRPF. In Solomon Islands, these insights can support ongoing efforts to establish and implement risk-based community resource management (e.g., Solomon Islands Ministry of Climate Change, Environment, Disaster Management and Meteorology 2024). This includes applying a risk-based perspective to the Integrated Vulnerability Assessment Framework (IVA) (SPC 2016), which is presently being implemented in Solomon Islands. The IVA tool has been applied in numerous Pacific Island Countries (including Tuvalu, Kiribati and Fiji) by the Pacific Community (SPC) and the Secretariat of the Pacific Regional Environmental Programme (SPREP) to assess vulnerability and propose adaptation strategies in rural communities (SPC 2016; NAP Global Network 2020). Frameworks like the LRPF may provide an opportunity to expand this framework to more explicitly consider risk, aligning with regional policies that are shifting towards the use of this concept (e.g., SPC 2017; World Bank 2017).

Conclusions

This chapter demonstrated the importance of adopting a holistic approach to risk assessments that address key limitations of the IPCC AR4 and AR5 frameworks. The LRPF lays the groundwork for such assessments by identifying critical factors influencing rural livelihoods that have been overlooked in prior AR4 and AR5-based studies. These insights are essential for developing targeted adaptation responses that are more likely to achieve effective and sustainable outcomes, ultimately enhancing the resilience of rural livelihoods.

Specifically, the LRPF highlighted the need to address non-climatic hazard exposure, expand socioeconomic vulnerability indicators, and consider source dependence within assessments. Including these factors illuminated pressing livelihood challenges in Solomon Islands, such as resource exploitation from commercial logging, that were overlooked in the climate focused AR4 and AR5. Additionally, a broader examination of socioeconomic vulnerability enabled the exploration of factors, like social capital, that are crucial for effective adaptation in rural contexts. Finally, source dependence revealed critical interactions between hazards and local access to food and water, offering vital insights for adaptation that the AR4 and AR5 could not establish.

Together, these factors enabled the LRPF to provide more targeted guidance for adaptation. At the community level, this can help ensure adaptation efforts better address complex local risk drivers. At a broader scale, this can support a transition beyond the ‘one-size-fits-all’ approach that is often observed

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in externally funded community-based adaptation projects. By demonstrating the value of holistic risk assessment approaches, this chapter calls on researchers involved in vulnerability and risk-based studies to move beyond established limitations of the AR4 and AR5 and conduct more robust analyses to guide adaptation.

Chapter Five

Building Stronger Futures: Combining Risk Assessments and Adaptation Pathway Approaches for Rural Livelihoods Resilience in Solomon Islands



Chapter Five: Building Stronger Futures: Combining Risk Assessments and Adaptation Pathway Approaches for Rural Livelihoods Resilience in Solomon Islands

Foreward

In this chapter, I implement the Community Adaptation Pathway Solomon Islands (CAPSI) approach (Butler et al. 2015), as a method for deriving community-led adaptation priorities focused on climate resilient development. The authors of this approach have recognised the potential benefits of combining the CAPSI with a risk assessment framework to enhance decision-making for adaptation. Given the successful implementation of the LRPF in Solomon Islands, where the CAPSI was developed, a unique opportunity was presented to combine these approaches. In this chapter, I present the results of the CAPSI and then apply the knowledge obtained via the LRPF retrospectively to explore how a deeper understanding of risk can support more effective and sustainable adaptation outcomes for rural livelihoods. Ideally, I would have completed the LRPF first and then used the results from Chapter Three to apply the adapted CAPSI with each community. However, travel delays due to COVID-19 delayed my timeline, preventing me from implementing these methods in the intended sequence. Looking ahead, the Australian Centre for International Agricultural Research (ACIAR) plans to build on this work through the FIS-2023-111 project and a combined LRPF-CAPSI approach will be a part of this. To support this process, I include a reflection at the end of this chapter on next steps for transitioning from the retrospective application of the LRPF to the CAPSI, to developing a practical method for their combined implementation. This chapter is presently being prepared for publication in *Climate and Development*⁴.

Abstract

Community-led adaptation pathway approaches support communities to identify, plan, and implement priority adaptation responses tailored to their unique needs and circumstances. However, the effectiveness of these approaches can be hindered by failing to robustly evaluate the underlying drivers of risk that may impact adaptation efforts. For rural communities in Solomon Islands, effective adaptation is crucial for ensuring livelihoods resilience amid increasing uncertainties brought about by climate change and other factors. In response to these challenges, Butler et al. (2015) developed the Community Adaptation Pathways Solomon Islands (CAPSI) approach in Western Province to support the development of ‘no-regrets’ priority adaptation strategies that are beneficial across a range of future scenarios. While the CAPSI approach has proven effective in supporting communities to identify and prioritise adaptation strategies, the authors acknowledge that a more explicit consideration of risk could

enhance decision-making. This can be accomplished by combining the CAPSI with the Livelihoods-Based Risk Profiling Framework (LRPF), as presented in Chapter Three, which conducts a comprehensive evaluation of the factors driving rural livelihoods risk. In this chapter, I propose that a combined LRPF-CAPSI approach can enhance decision-making and strengthen the ‘no-regrets’ status of adaptation initiatives. To evaluate this, I retrospectively apply the LRPF to the CAPSI using data from a rural community in Western Province where the LRPF and CAPSI have been implemented. This analysis employs a dual learning cycle that poses specific questions to guide risk-informed adaptation. The first learning cycle applies CAPSI data to establish priority no-regrets adaptation strategies based on: i) current hazard exposures, ii) visions for livelihoods, and iii) future hazard scenarios. While the second learning cycle applies LRPF data to evaluate how these priority adaptation strategies might interact with local hazard exposures, community sensitivity, and adaptive capacity. The LRPF identified numerous instances where CAPSI adaptation strategies may be impacted by underlying risk drivers. This included locally relevant hazards that were overlooked in the CAPSI process, potential trade-offs between adaptation efforts and other resource requirements, and a lack of local capacity to implement the proposed strategies. By identifying these challenges, the LRPF-CAPSI approach can support their mitigation during the planning stages of adaptation. Ultimately, this can enhance the effectiveness and sustainability of adaptation efforts to better support the resilience of rural livelihoods.

Introduction

Planning for the future amid the complexity and uncertainty of global change demands innovative methodological approaches (Wise et al. 2014). One promising approach comprises community-led adaptation pathways, from here on referred to as pathway approaches, which facilitate decision-making in the face of uncertain future conditions (Bosomworth et al. 2017; Haasnoot et al. 2013). This offers a proactive and participatory method to respond to global-scale challenges, like climate change, at the local level (Fazey et al. 2016).

By directly involving community members in identifying, planning, and implementing priority adaptation responses, pathway approaches leverage local knowledge and resources in the adaptation process (Kirkby et al. 2018). This enables adaptation responses to address global change in ways that are best suited to local contexts (Schipper et al. 2014). As a result, the long-term effectiveness and sustainability of these adaptation efforts are significantly enhanced. This contrasts to externally derived adaptation responses, which often lack local input, resulting in strategies that may not align with the specific needs of a community (Butler et al. 2016a).

Pathway approaches have been deemed particularly beneficial in low-income rural contexts, where people’s livelihoods depend on natural resources (Maru et al. 2018). In these settings, adaptation is often intertwined with broader development challenges faced by communities (Sparkes et al. 2024; Wise et al. 2014). For example, while climate change directly impacts the natural resources communities depend

on to meet their basic needs, the local socioeconomic context limits access to alternative source types (Scoones et al. 2020). This situation exacerbates existing vulnerabilities, like food and water insecurity. Consequently, adaptation strategies must be developed that address the impacts of climate change (e.g., the degradation of natural resources), alongside long-term development goals (e.g., improving access to alternative food and water sources) (Fazey et al. 2010). In Solomon Islands, numerous studies have highlighted how limited access to economic alternatives, such as formal employment or diversified income sources, leaves communities reliant on climate-sensitive natural resources (Rasmussen et al. 2009; Schwarz et al. 2011). This dependence heightens vulnerability, making adaptation challenging, as evidenced in cases where households are forced to remain in hazard-prone areas due to the absence of financial support for relocation (Ha'apio et al. 2019).

Recognising the interplay between climate change and development, many pathway approaches have integrated these goals to support socioeconomic transformations that build long-term resilience to global change (Gorrdard et al. 2016). In this context, resilience is defined as a system's ability to absorb shock and stressor events (such as climate change), while retaining its basic function, structure, and identity, as outlined by Holling (1973). This definition encompasses not only the capacity of livelihoods to adapt to hazard events, but also, where necessary, the ability to transform in order to sustain and maintain their livelihoods through time (Engle et al. 2014; Lin et al. 2017).

In recent years, these 'transformation-oriented' pathway approaches have gained popularity (Dodman and Mitlin 2013; Werners et al. 2021). By employing methods such as future visioning, back-casting, and scenario planning, these approaches can navigate complex adaptation contexts, addressing present hazards, broader development issues, and future uncertainties (e.g., Butler et al. 2016a; Colloff et al. 2016; Lavorel et al. 2019). In doing so, they promote the development of 'no-regrets' adaptation, defined as strategies that are beneficial across a range of future scenarios and can avoid unanticipated or negative consequences (Colloff et al. 2021; Heltberg et al. 2009). This is exemplified by Butler et al.'s (2015) Community Adaptation Pathways in Solomon Islands (CAPSI) approach which creates a learning cycle for climate-resilient development pathways through four major steps: i) identifying locally relevant drivers of change, ii) developing aspirational community visions, iii) envisaging future change scenarios, and iv) back-casting to identify priority 'no-regrets' adaptation strategies.

The CAPSI approach has been implemented in several communities across Western Province and Guadalcanal Province in Solomon Islands (Butler et al. 2018; Colloff et al. 2024), addressing the urgent need to scale out climate change adaptation in remote rural areas, where over 80% of the population resides (Solomon Islands National Statistics Office 2020). These subsistence-based communities primarily depend on natural resources to meet their essential needs, such as accessing food and water (Maharjan and Joshi 2013). In many areas, climate change impacts are already being felt, with rising sea levels and shifting rainfall and temperature patterns impacting access to drinking water and reducing

food production (Fazey et al. 2011; Leal-Filho et al. 2021). While resource exploitation activities like commercial logging and fishing have increased water and food insecurity by diminishing the ability of ecosystems to provide these essential resources (Gillett and Tauti 2018; Van der Ploeg et al. 2020a).

Although the national government is working to address these challenges, the dispersed and isolated nature of Solomon Islands' rural communities complicates the delivery and scaling of adaptation efforts (Basel et al. 2020). The CAPSI approach helps bridge this implementation gap by providing targeted adaptation support at the local level (Butler et al. 2015; 2020b). While broader drivers of change, such as governance structures and sociopolitical dynamics, influence both the types of adaptation required at the local scale and the implementation of adaptation efforts (Birchall et al. 2023), this chapter focuses specifically on how the CAPSI is applied in identifying local adaptation priorities. Structural dynamics are acknowledged as part of the broader risk context within Solomon Islands and tied to relevant CAPSI outputs in the discussion section.

Despite the widespread implementation of pathway approaches, their effectiveness has not been extensively evaluated. In response, Werners et al. (2021) conducted a systematic review to assess their utility and recommend future research directions. This review aimed to identify, compare, and contrast different adaptation pathway approaches by analysing 47 applied studies conducted from 2010 onwards. The review found that adaptation outcomes were most successful when they addressed and accounted for a community's underlying vulnerability. However, many approaches, like the CAPSI, lack a structured analysis of these factors. This suggests that to build resilience, adaptation strategies must be informed by a deep understanding of the factors driving livelihood impacts (Ngoma et al. 2023). Pathway approaches that fail to address these factors may inadvertently deepen vulnerability (Maru et al. 2014). Indeed, Werners et al. (2021) found that when vulnerability drivers were overlooked, adaptation was more likely to be ineffective, or even maladaptive, inadvertently exacerbating existing challenges or creating new ones. This led the authors to ask: 'What diagnostic questions can effectively identify the drivers of vulnerability within pathway approaches?'

Community-based vulnerability assessments (CBVAs) have been widely implemented in rural contexts to analyse the factors driving livelihood impacts (Adger 2006). As such, CBVA outputs can help meet Werner's call to explicitly consider vulnerability drivers within adaptation pathway approaches (Werners et al. 2021). By providing a detailed understanding of the factors driving vulnerability, CBVAs offer insights that can support better decision making for adaptation. For example, CBVAs allow for an extended evaluation of the 'no-regrets' potential of proposed strategies by assessing their interactions with other vulnerability drivers that could impact the success of adaptation efforts (Adger 2006; Smit and Wandel 2006; Thomas et al. 2018). By proactively identifying these interactions, communities can adjust their strategies to ensure adaptation remains 'no-regrets' (Eriksen et al. 2021). This reduces the potential for maladaptation, which erodes resilience over time (Gallopín 2006).

Despite their value, CBVAs face several limitations that hinder their ability to fully capture vulnerability drivers. These limitations include: a narrow focus on climate change as the primary challenge for livelihoods, limited analysis of the socioeconomic factors contributing to vulnerability, and neglect of spatial and temporal dynamics (Ford et al. 2018; Jurgilevich et al. 2017; McDowell et al. 2016). As a result, there has been a shift towards risk-based approaches (e.g., IPCC 2014) that aim to address these shortcomings and provide a more robust understanding of the factors influencing rural livelihood impacts (Buchtman et al. 2022).

In Chapter Three, I developed the Livelihoods-Based Risk Profiling Framework (LRPF) to address CBVA limitations and implemented the framework to assess rural livelihoods risk in Solomon Islands. This chapter builds on that work by developing an approach to apply LRPF outputs within the CAPSI approach. By combining these two approaches, I respond to Werner et al.'s (2021) learning question, providing a mechanism to explicitly consider risk drivers within adaptation pathway approaches. This aims to enhance decision making for adaptation efforts by providing additional information to strengthen the 'no-regrets' status of CAPSI-based adaptation priorities, which can contribute towards livelihoods resilience. In this chapter, I retrospectively apply the LRPF to interpret the results of the CAPSI using data collected in a rural community in Western Province, Solomon Islands, where both methods had been implemented. In doing so, I demonstrate the value of risk-informed pathway approaches in contributing to 'no-regrets' adaptation strategies, achieving more effective and sustainable outcomes for rural livelihoods. I conclude this chapter by outlining next steps for moving from the retrospective application of the LRPF to the CAPSI, to the development of practical methods for the implementation of a combined LRPF-CAPSI approach.

Methods

Learning Cycles for Risk-Informed Adaptation Pathways

Developed by Butler et al. (2015), the CAPSI approach empowers communities to create and implement their desired adaptation strategies through a 'decision-into-practice' learning cycle. Drawing on Brown's (2008) learning cycle framework, the CAPSI fosters collaborative decision making and the development of adaptive solutions through a series of cyclical steps. Butler et al. (2015; 2016a) structured the CAPSI learning cycle to support communities in establishing priority 'no-regrets' adaptation strategies and created a corresponding workshop for its implementation (Butler et al. 2018).

The CAPSI learning cycle comprises four steps, each guided by a corresponding diagnostic question (Figure 16). These steps are: (step 1) 'What is?' – examining the current adaptation context based on the main drivers of change impacting community livelihoods, (step 2) 'What should be?' – exploring the community's desired vision for future livelihoods, (step 3) 'What could be?' – considering potential livelihood scenarios based on a range of possible futures, and (step 4), 'What can be?' – identifying

priority ‘no-regrets’ adaptation strategies. Together, these steps help communities conceptualise their current adaptation needs, set future development goals, and navigate future uncertainties to select priority ‘no-regrets’ adaptation strategies for climate resilient development.

To apply the CAPSI learning cycle, I modified step 1 (‘What is?’) by shifting the focus from ‘drivers of change’ to ‘hazards’. This change aligns more effectively with the LRPF, which assesses the risks posed by specific events or conditions with immediate impacts (i.e., hazards) (IPCC 2014), rather than broader, long-term factors that drive systemic shifts in a system (i.e., drivers of change) (Kelman 2017).

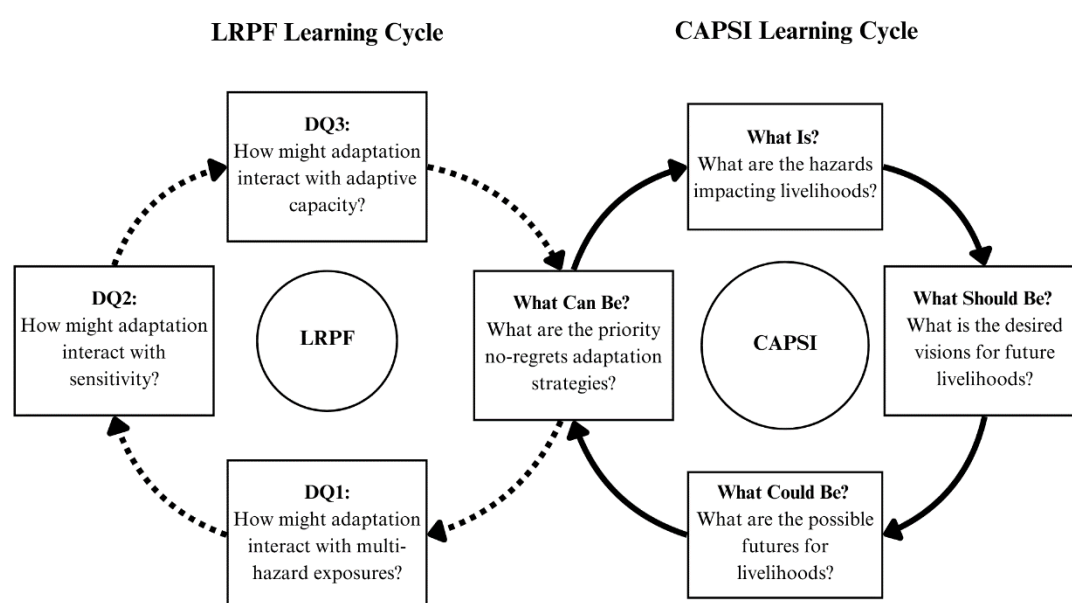


Figure 16: The dual learning cycles for the risk-informed adaptation pathways approach, which combines the CAPSI learning cycle (Butler et al. 2015), with a risk-based learning cycle developed to reflect LRPF components (Figure 8).

To develop a risk-informed pathways approach, I applied outputs of the LRPF, as outlined in Chapter Three, to the results of the CAPSI learning cycle. The LRPF is a holistic community-based risk assessment (CBRA) approach that addresses the limitations of CBVAs and provides a tailored method for assessing risk in rural livelihoods context. By doing so, this framework enhances our understanding of the factors driving rural livelihood impacts. In Chapter Three, I communicated LRPF outputs through a series of decision support tools designed to translate complex information into actionable insights at the community scale. In particular, a risk profile was produced that summarised key components of the LRPF, including hazard exposure and the underlying socioeconomic vulnerabilities that shape livelihood impacts.

I developed a secondary learning cycle grounded in the LRPf components of risk (Figure 8) to enhance decision-making for adaptation. This cycle evaluates how underlying risk drivers can influence the ‘no-regrets’ status of CAPSI adaptation strategies. It does this by examining potential interactions between LRPf components and the proposed strategies. By identifying these interactions, the LRPf learning cycle can reveal possible unanticipated consequences of adaptation, enabling proactive adjustments to strengthen their ‘no-regrets’ status.

The LRPf learning cycle includes three risk-based diagnostic questions applied to the priority adaptation strategies identified in step 4 of the CAPSI process (Figure 16). These questions focus on the LRPf components of risk (Figure 8) including hazard exposure, sensitivity, and adaptive capacity. Table 6 provides definitions and diagnostic questions for each LRPf component. In the LRPf, hazard exposure encompasses both climatic and non-climatic hazards that threaten the sources necessary for achieving livelihood security objectives (LSOs) including access to water, food, housing, energy, and income. Sensitivity examines the characteristics of LSOs that influence the extent of hazard impacts. This includes source dependence, which measures a community’s dependence on LSO source types. Finally, adaptive capacity evaluates the socioeconomic characteristics that influence a community’s ability to access assets, such as social, human, financial, physical, and natural capital that aid in responding to hazard exposure.

Table 6: The LRPf learning cycle questions and their corresponding framework components and definitions.

Learning Question	Component	Component Definition
DQ1) How might adaptation interact with multi-hazard exposures?	<i>Hazard</i>	The potential occurrence of a shock or stressor event that may impact rural livelihoods.
	<i>Exposure</i>	The presence of rural livelihoods in a location that may be adversely impacted by the occurrence of a hazard.
DQ2) How might adaptation interact with sensitivity?	<i>Sensitivity</i>	The degree to which rural livelihoods may be impacted by hazard exposure.
	<i>Source Dependence</i>	The degree to which rural livelihoods depend on source types that may be impacted by hazard exposure.
DQ3) How might adaptation interact with adaptive capacity?	<i>Adaptive Capacity</i>	The ability for communities engaged in rural livelihoods to respond to potential impacts, take advantage of opportunities, or respond to consequences.

Case Study

The CAPSI and LRPf learning cycles were applied retrospectively after both approaches were implemented in a small-scale fishing community (C1) on the island of Vella La Vella in Western Province, Solomon Islands (Figure 9). This community was characterised by its coastal setting and dependence on natural resources for livelihoods. Its remote location presented challenges, including

limited access to essential facilities such as healthcare, markets, shops, and financial institutions. The community was managed by a tribal association, with decisions made collaboratively among households. The LRPF was implemented in September 2022, with detailed methods described in Chapter Three. The CAPSI was implemented in March 2023, with the data collection and analysis methods outlined below.

CAPSI Data Collection

The CAPSI was implemented through a one-day participatory workshop. Participants were selected with the support of community leaders and comprised twelve individuals, including six males and females, four youth, adults, and elders, and representatives from a range of livelihood activities such as fishing, gardening, handicrafts, carpentry, and teaching. The selection was considered appropriate by the community and no concerns were raised about demographic representation. The workshop took place in a community gathering space and participants were divided into four groups of three, each containing representatives from the demographic categories mentioned above. The workshop covered steps 1-3 of the CAPSI learning cycle, while step 4 comprised a data analysis process following the conclusion of the workshop. Three local researchers facilitated the workshop activities which were conducted in the local languages of Solomon Island Pijin, and Bilua, the Vella La Vella dialect. These researchers provided clear instructions for each activity, circulated the room to provide assistance and encourage group discussions, and guided feedback sessions to ensure they ran in a timely manner.

Below I detail the methods used to collect data and outline any modifications from Butler et al.'s (2015) approach.

Step 1: What Is?

To establish the current hazards impacting livelihoods, participants were supplied with butcher paper and coloured pens and asked to list the main hazards they perceived to affect the community. Afterwards, they identified priority adaptation responses for each hazard. Each group was allocated 45 minutes to complete this task before nominating a representative to present their findings to the larger group.

Step 2: What Should Be?

To gather participant's desired visions for future livelihoods, I asked them to imagine what they would like their community to look like by the year 2040. This timeframe was intentionally selected to contrast with Butler et al.'s (2015) longer-term focus of 2090, as it was deemed more accessible for the community to visualise their aspirations within a shorter timeframe. During the activity, each group was supplied with butcher paper and coloured pens, allowing them to creatively depict their visions through writing, drawing, or mapping. This enabled participants to express their ideas in a manner that best

suited their individual skills and preferences. They were given 45 minutes to complete the task and were asked to select their top three visions for the future before presenting their results to the larger group. Local researchers took detailed notes during these presentations to ensure that drawings and maps could be effectively translated into actionable goals for community development.

Step 3: What Could Be?

To help participants envision future hazard exposure scenarios, I created a scenario planning matrix. This matrix reflected the ‘drivers of change’ identified as most concerning for livelihoods, using the types of hazards listed during step 1. For the community, this included climate change and resource exploitation. The matrix (Figure 17) positions these themes at opposite ends of two arrows, representing a spectrum from ‘bad’ to ‘good’ futures. This generates four distinct scenarios: best-case (A) with ‘slow’ climate change and ‘sustainable’ resource exploitation, worst-case (C) with ‘fast’ climate change and ‘unsustainable’ resource exploitation, and two intermediate scenarios (B and D).

Facilitators encouraged participants to envision how these scenarios could impact their livelihoods by the year 2040. To enhance participants understanding, facilitators provided specific examples of characteristics that could define ‘good’ and ‘bad’ for each scenario. For example, a ‘good’ climate change scenario might involve gradual shifts in temperature and rainfall patterns, whereas a ‘bad’ scenario might entail abrupt changes, leading to a sudden increase in extreme events such as flooding and drought. These examples helped participants understand the exercise’s objectives, enriching their contributions. Each group was assigned one of the four scenarios (A, B, C, or D) and tasked with writing or illustrating their perception of the future under that scenario. Focus was given to documenting the types of impacts future hazard exposure might have on livelihoods. Participants were given 45 minutes to complete this activity before presenting their insights to the larger group. Facilitators took detailed notes during these presentations to capture the key ideas shared by participants.

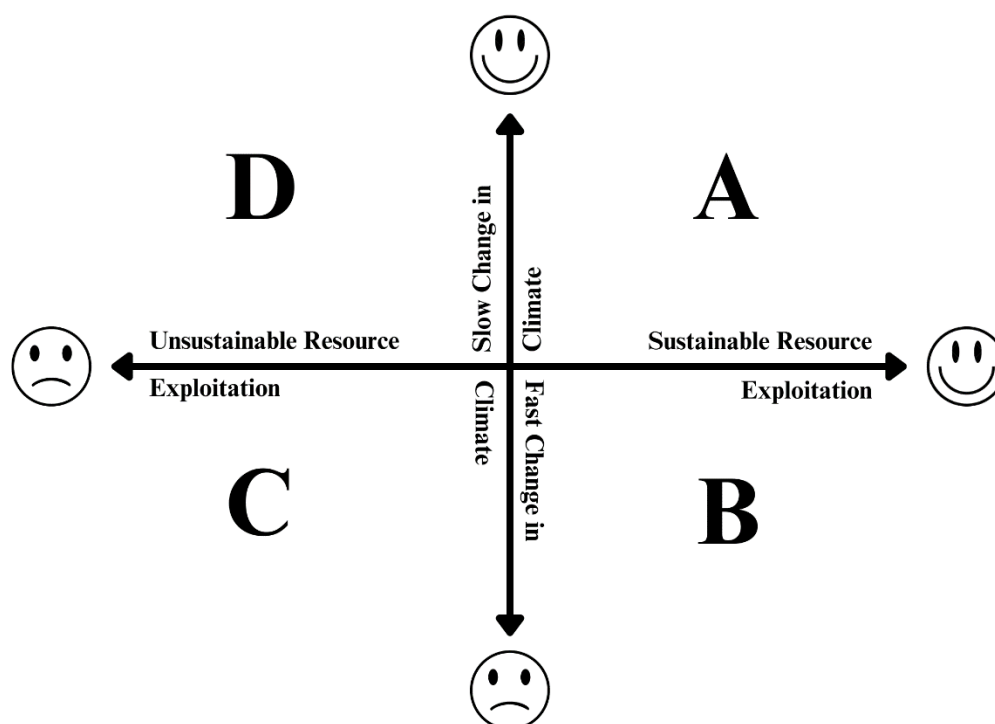


Figure 17: The scenario planning matrix used during the 'what if' step of the CAPSI approach.

CAPSI Data Analysis

Step 4: What Can Be?

Step 4 of the CAPSI was implemented retrospectively, utilising outputs from the CAPSI workshop to identify priority no-regrets adaptation strategies for the community. These strategies collectively addressed: current hazard exposures (step 1), visions for livelihoods (step 2), and future hazard scenarios (step 3).

This approach differed from Butler et al. (2015), who employed a back-casting method during the workshop, starting with the identification of priority adaptation responses based on the community's future visions (step 2), followed by an exploration of how these strategies might interact with both current and future hazard exposures. While this method encourages communities to consider the steps needed to achieve their development goals in a hazard-resilient manner, it overlooks the immediate hazards that communities face. If left unaddressed, these hazards can increase vulnerability and create additional long-term development challenges (Adger 2006). By retrospectively establishing priority adaptation strategies that respond to both hazard exposures and community visions, I aimed to create a balanced approach that effectively addresses present-day risk drivers while also pursuing future development goals.

To determine priority adaptation strategies, I compiled the responses from steps 1-3 across each workshop group and categorised them based on the hazards they addressed (steps 1 and 3), or thematic vision they related to (step 2). After completing this categorisation, I analysed the responses within each hazard type or vision theme for key similarities. This analysis identified the adaptation strategies that most frequently arose across groups in response to current hazards (step 1), visions for livelihoods (step 2), and future hazard scenarios (step 3). This resulted in a list of nine priority adaptation strategies, which I then grouped according to the broader adaptation themes they corresponded to.

Applying the LRPF Learning Cycle

The data from the community's risk profile, presented in Chapter Three (Figure 10) was used to apply the LRPF learning cycle questions to the priority adaptation strategies. Chapter Three details the data collection method used to implement the LRPF and produce the community's risk profile, which includes a summary of key risk drivers (i.e., the individual factors that were considered to contribute to risk in the LRPF) based on local hazard exposures, sensitivity, and adaptive capacity as defined in Table 6. To evaluate how underlying risk drivers might influence the 'no-regrets' status of the priority adaptation strategies, I developed a checklist that included each component, sub-component, composite indicator and indicator of hazard exposure, sensitivity, and adaptive capacity in the LRPF risk profile (Figure 10). This checklist enabled a systematic evaluation of how these components etc., may interact with CAPSI priority adaptation strategies, helping to establish potential unintended consequences.

Using a systematic approach, I first identified potential interactions between LRPF risk components etc., and priority adaptation strategies, cross-referencing these assumed relationships with evidence from the broader scientific literature. This initial evaluation was based on my personal judgement, informed by my understanding of LRPF components. This interpretation was then validated through a targeted review of journal articles that examine the links between risk drivers and adaptation outcomes. This literature review not only strengthened my initial assessment with empirical and theoretical support but also helped establish additional interactions that I may not have identified.

Next, I reviewed the community's LRPF profile to assess whether the potential interactions between LRPF components etc., and proposed adaptation strategies were relevant to the local context. For example, after determining that infrastructural development might be constrained by financial capital, I cross-referenced this with the community's risk profile to confirm whether financial capital was a key risk driver in the local context. This step ensured that the analysis was not only based on broader insights of potential interactions between LRPF components and adaptation strategies but also reflected local conditions, allowing for a more rigorous evaluation of how underlying risk drivers might influence the 'no-regrets' status of the proposed adaptation strategies.

Results & Discussion

In this section, I outline the priority adaptation themes and underlying strategies identified through the CAPSI learning cycle (step 4) and explain how they align with participants' desired responses to: current hazard exposures (step 1), visions for livelihoods (step 2), and future hazard scenarios (step 3). I reflect on how these strategies relate to climate-resilient development and broader adaptation trends in Solomon Islands. I then explore outputs of the LRPf learning cycle, describing how a deeper understanding of risk can improve decision-making for adaptation. This centres on possible interactions between CAPSI adaptation priorities and the community's hazard exposure, sensitivity, and adaptive capacity, as outlined in their risk profile (Figure 10). I recommend actions to address these interactions that can help strengthen the 'no-regrets' status of adaptation. Finally, I reflect on the contributions of this combined approach for supporting rural livelihoods and propose next steps for evolving from a retrospective analysis to a participatory method for LRPf-CAPSI implementation.

CAPSI Learning Cycle Outputs:

Identifying Priority Adaptation Strategies

Three broad adaptation themes emerged from the CAPSI learning cycle. These were: i) development of integrated water management solutions, ii) implementation of resilient agricultural practices, and iii) strengthening of community resource management. In Table 7, I outline the priority adaptation strategies associated with each theme. Although participants identified additional strategies, a discussion of these was deemed beyond the scope of this chapter.

The CAPSI priority adaptation strategies primarily addressed the current and anticipated impacts of climate change, particularly increased rainfall, flooding, and sea level rise. Proposed strategies included relocating households to higher grounds to reduce the risk of inundation, provision of rainwater tanks for all households, and introducing diversified, climate-resilient crop varieties. These strategies align with national adaptation goals for rural livelihoods in Solomon Islands (Solomon Islands Ministry of Environment 2023). However, participants also emphasised the need to address the impacts of commercial logging, which is overlooked in several national policies that promote logging as an essential activity for economic growth (CBSI 2020; IMF 2020). This demonstrates the value of community-based approaches, like the CAPSI, in identifying rural livelihood challenges that may be excluded from externally funded adaptation initiatives (Ensor et al. 2018a).

The growing interest in and implementation of reforestation initiatives among rural communities in Solomon Islands, as noted by workshop participants, reflects a widespread desire to address the negative impacts of commercial logging (Lyons et al. 2016; Minter and Van der Ploeg 2023). This emphasises the need for broader acknowledgment and support from adaptation funders, ensuring that local

aspirations are more explicitly included within funding opportunities (Van der Ploeg et al. 2020a; Schipper et al. 2014).

Table 7: Priority adaptation strategies (and overarching adaptation themes) emerging from the CAPSI learning cycle. These strategies are linked to the CAPSI step they originated from reflecting: (1) current hazard exposures, (2) visions for livelihoods, and (3) future hazard scenarios.

Adaptation Theme	Priority Adaptation Strategy	CAPSI Step	Hazard/ Vision Theme
1 Development of integrated water management solutions.	1 Obtain rainwater tanks for all households.	(1), (2), (3)	    
	2 Obtain sanitation for all households.	(1), (3)	 
	3 Relocate households to higher ground	(1), (2)	 
2 Implementation of resilient agricultural practices.	1 Introduce diversified crop types.	(1), (3)	  
	2 Implement training for resilient farming.	(1), (2), (3)	  
	3 Introduce sustainable management and harvest practices.	(2), (3)	 
3 Strengthening of community resource management.	1 Implement forest replanting scheme.	(1), (3)	
	2 Implement educational campaign on logging impacts and alternate livelihood opportunities.	(1), (2), (3)	  
	3 Develop community spaces (e.g., village hall).	(1), (2), (3)	  

Hazards:  Increased Rainfall  Flooding  Logging  Sea Level Rise

Vision Theme:  Resource Access  Sustainable Natural Resource Use

The participants expressed a desire for adaptation strategies that prioritised education and training, recognising the pivotal role these factors play in navigating global change. By emphasising education, participants acknowledged its potential to enhance local awareness and understanding of hazards and equip community members with the skills required for effective adaptation (Ha'apio et al. 2019). In Solomon Islands, education-based adaptation has emerged as a successful strategy for building resilience and laying the foundations for transformational change (Ha'apio et al. 2018a). This reflects a forward-thinking perspective, emphasising that adaptation is not just about managing current impacts, but also about empowering communities to create a more resilient and sustainable future (Ensor et al. 2018a). For instance, incorporating climate change awareness into school curricula prepares future generations for environmental uncertainties, strengthens decision-making, and promotes local leadership (Feinstein and Mach 2019; Liu et al. 2020; Lundholm et al. 2010). As a result, education-

based adaptation not only addresses present-day vulnerabilities, but can also strengthen resilience by equipping communities with knowledge to navigate future climate change (Poole et al. 2013).

Hazard-based adaptation strategies were closely aligned with the participants' visions for livelihoods. These visions focused on improving access to resources, many of which had been degraded due to previous hazard exposures. This reflects how ongoing challenges, such as resource depletion, shape community goals, particularly in contexts where natural resources are essential for livelihoods (Wise et al. 2014). For example, the impacts of hazards on water availability and quality prompted the prioritisation of access to rainwater tanks throughout the CAPSI learning cycle steps. Additionally, the community expressed a strong desire for the sustainable management of forests. This centred around future protection from commercial logging activities through the establishment of protected areas and implementation of traditional management practices, which have a long history of success in Solomon Islands (Cohen et al. 2015).

Participants also emphasised the need for community spaces, where individuals can gather for meetings, events, and cultural activities. While these spaces may not traditionally be viewed as a hazard-based adaptation strategy, they play a crucial role in reducing vulnerability and building resilience (Aldrich and Meyer 2015; Green and Haines 2015). By fostering social interaction and collective action, community spaces can help reduce exposure and sensitivity to hazards by facilitating information exchange, skills training, and coordinated disaster responses (Cannon 2008; McShane and Coffey 2022). At the same time, they can contribute to long-term resilience by strengthening social networks, preserving cultural traditions, and enhancing collective decision-making (Aldrich and Meyer 2014; Berry et al. 2019; Colombi and Smith 2012). By providing a platform for communities to communicate their adaptation needs and desires, the CAPSI can advocate for strategies that external funding bodies might otherwise overlook, ensuring that both immediate vulnerabilities and long-term resilience are addressed (Kiem and Austin 2013).

LRPF Learning Cycle Outputs:

Strengthening 'No-Regrets' Adaptation

Below, I explore outputs of the LRPF learning cycle to identify potential barriers to achieving 'no-regrets' adaptation. I focus on a single adaptation strategy within each theme, these include: i) obtaining rainwater tanks for all households, ii) introducing diversified crop types, and iii) implementing forest replanting schemes.

Strategy 1: Obtaining Rainwater Tanks

A major adaption priority for developing integrated water management solutions involved obtaining access to rainwater tanks for all households. Although both the LRPF and the CAPSI engaged

communities in a hazard listing exercise, the LRPf identified a broader range of hazards. This was likely due to the varied methodological approaches, where the LRPf spent more time and emphasis on understanding hazards and their interactions. As such the community's risk profile (Figure 10) revealed several hazards that were not identified in the CAPSI that could affect the 'no-regrets' status of this adaptation strategy. This included hazards that might impact water sufficiency, such as rising temperatures that increase evaporation, decreased rainfall that limits water collection, and population growth which puts additional strain on water supplies (Haque et al. 2016; Opare 2012). Simple solutions, such as adding covers to tanks, can mitigate issues like evaporation (Elsebaie et al. 2017). While more comprehensive strategies to ensure long-term water sufficiency may involve installing additional tanks, increasing their capacity, or improving infrastructure, such as guttering, to maximise water collection (Kinkade-Levario 2007).

Data on source dependency revealed that switching from polluted natural water sources to rainwater tanks would lead to local reliance on a single source type for accessing drinking water. In other communities, as evidenced in Chapter Three, this has led to disagreements over shared tank usage, resulting in water shortages and conflicts among households. Recognising the potential for such issues can prompt communities to establish clear agreements on tank use before installation, ensuring equitable access for all (Rosegrant et al. 2009; Kirkby et al. 2018). This is particularly important given the predicted impact of hazard exposure on rainwater tanks, which could further reduce water sufficiency if not proactively addressed (Haque et al. 2016). Additionally, while rainwater tanks may typically provide high-quality drinking water, improper maintenance can lead to contamination and health risks (Elsebaie et al. 2017). Acknowledging this risk may encourage households to seek maintenance training, ensuring water from tanks remains safe for consumption (Mandara et al. 2013).

The LRPf risk profile highlights key constraints to obtaining and maintaining rainwater tanks, including financial, physical, and social capital (Mostafavi et al. 2018). For example, the community's limited savings and income, established in their risk profile, may impede tank acquisition and maintenance (Khastagir and Jayasuriya 2011). Additionally, a lack of access to financial services may restrict opportunities for securing loans and funding (Peters 2017), posing a key challenge to obtaining tanks. Physical capital issues, like limited access to tools and equipment, could also obstruct tank installation and maintenance, leading to problems like leaks and reduced water collection (Kinkade-Levario 2007). Addressing these issues is vital for long-term adaptation success; however, it is likely that external funding will be required, which is an ongoing challenge in many rural areas in Solomon Islands (Prizzon 2020). On the social front, moderate levels of collective action may also limit resource pooling for acquiring and maintaining tanks (Esterhuyse 2012). Strengthening collective action through inclusive planning processes, like the CAPSI, could enhance the community's ability to collaborate on adaptation efforts, helping to overcome this barrier (Kirkby et al. 2018).

Strategy 2: Introducing Diversified Crop Types

The introduction of diversified crop types is a major adaptation priority for implementing resilient agricultural practices. While crop diversification is a key response to climate-induced hazards like flooding and sea level rise, other challenges, like temperature increase must also be considered when selecting climate-resilient species (Lu et al. 2013). Additionally, other hazards identified in the community's risk profile may hinder crop diversification success. For example, commercial logging can lead to reduced soil quality, loss of biodiversity, and water course disruptions, all of which negatively impact crop growth (Hamilton and Pearce 2019). While logging may also exacerbate local climate change impacts by removing trees that regulate climate and water cycles (Kreutzweiser et al. 2008). Additionally, wild pigs present a significant threat to crops by consuming and damaging them (VerCauteren et al. 2024). To ensure 'no-regrets' adaptation, diversification efforts must address not only climate resilience, but also the impacts of other local hazards, such as logging and wild pigs.

While crop diversification aims to enhance food security, it may pose challenges for other LSOs, like water access. For example, new crops often require more water, which may strain the community's already insufficient water supply (Feliciano 2019). Consequently, the community may face a trade-off, where water allocated for irrigation reduces availability for essential uses, such as drinking water (Usman and Gerber 2021). Data on source dependence in the community's risk profile can help identify these trade-offs. In this context, it may lead to the introduction of water-saving agricultural technologies, or the selection of less water-intensive crops to ensure continued water sufficiency for all needs (Feliciano 2019).

The community's limited access to financial and physical capital may once again pose a barrier to successful adaptation. Limited financial resources may restrict the community's ability to purchase seeds, equipment, and cover ongoing costs (Khanal and Omobitan 2020). Additionally, inadequate agricultural infrastructure may prevent crop diversification from reaching its full potential (Abdulai and Crole-Rees 2001). While the community may need external support to secure funding for initial crop diversification efforts, this initiative can ultimately generate new income streams to cover ongoing expenses. Introducing value-added processing, such as dried fruit products, could further enhance revenue (Farrell et al. 2023). The risk profile also revealed local concerns about unequal access to new livelihood activities, which could diminish support for crop diversification if some community members are perceived to disproportionately benefit. To mitigate these concerns, actions such as introducing community farming plots could help distribute responsibilities and benefits more fairly among households (Neo and Chua 2017).

Strategy 3: Implementing Forest Replanting Schemes

A major adaptation priority for strengthening community resource management was the implementation of forest replanting schemes. Several hazards identified in the community's risk profile that were overlooked during the CAPSI process may influence the success of these efforts. For example, elevated temperatures may stress newly planted trees, while reduced rainfall may limit water availability (Nolan et al. 2018). Addressing these challenges is essential to ensure long-term climate resilience in reforestation initiatives (Locatelli et al. 2015). The CAPSI process also identified hazards like flooding and sea level rise which are likely to interact with reforestation efforts. The hazard exposure maps in the community's risk profile can help guide better planning by identifying areas prone to flooding and saltwater intrusion, supporting communities in making informed planting decisions (Brown and Kytta 2018).

The risk profile highlighted potential conflicts between reforestation efforts and existing land uses vital for livelihoods. For instance, many food gardens and cash crop plantations, crucial for food and income, are situated in previously logged areas that may overlap with targeted reforestation zones. By identifying these conflicts, the risk profile can help balance reforestation efforts with other land use requirements. One potential solution is the introduction of agroforestry, a common practice in Solomon Islands that integrates food gardens with forest replanting efforts, aligning food security, income, and conservation objectives (Hviding and Bayliss-Smith 2018). Source dependence data also revealed the importance of remnant forest areas for obtaining building materials and cooking fuel. Acknowledging and accommodating these needs during the planning process is likely to enhance local adherence and co-operation for reforestation efforts (Le et al. 2012). This is particularly important given the community's limited perception of fair access to natural resources, which may diminish the willingness of community members to engage in reforestation activities that could limit resource access (Infield and Namara 2001).

Contributions of Risk-Informed Adaptation Pathway Approaches

The risk-informed pathways approach presented in this chapter directly responds to Werner et al.'s (2021) call for a diagnostic method to identify the root causes of vulnerability as a component of adaptation pathway approaches. I chose to shift from vulnerability to risk to obtain a broader understanding of the diverse factors contributing to livelihood impacts (Marin-Puig et al. 2022). This addressed the limitations of prior CBVAs, which have been criticised for overlooking several key factors that influence rural livelihoods (Ford et al. 2018). By integrating risk-based information within the CAPSI approach, a wider range of hazard exposures, sensitivity, and adaptive capacity were considered, enhancing the robustness of decision making.

The combined LRPF-CAPSI approach demonstrates how risk-based information can enhance decision making within adaptation pathway methods. By providing comprehensive insights into the various risks that communities face, this approach strengthens the ‘no-regrets’ status of adaptation priorities. This ensures that adaptation strategies not only address local hazard exposures and community visions but are cognisant of other risk drivers that could hinder adaptation success.

A key strength of this approach lies in its ability to integrate present-day risk factors into adaptation responses. Although the LRPF is oriented around current livelihoods, this does not limit its efficacy for informing adaptation planning. Instead, the LRPF’s emphasis on present-day conditions offers a systematic means to identify constraints and opportunities within local livelihoods that may either facilitate or impede the successful implementation of adaptation strategies. By linking insights with longer-term adaptation objectives, the LRPF-CAPSI approach can ensure that adaptation planning is grounded in current realities while also accounting for future change. Through the LRPF, we can identify specific barriers (such as limited access to financial resources) that may hinder a community’s ability to implement or sustain adaptation. This is valuable because it highlights where additional support is needed to overcome these obstacles. Such information not only aids in community level planning but can guide strategic directions for local governance and NGOs investing in rural livelihoods (Ha’apio et al. 2018a; 2018b). At the same time, the LRPF identifies opportunities within existing community conditions (such as strong social networks) that can be leveraged to support adaptation. This dual focus on barriers and opportunities ensures that adaptation strategies are realistic and achievable, building on local strengths while addressing key constraints (Klein et al. 2015; Oberlack et al. 2017).

LRPF learning cycle questions were instrumental in identifying potential risks linked to adaptation strategies and clarifying the steps needed to achieve ‘no-regrets’ status. Compared to the CAPSI process, the LRPF community risk profiles identified additional locally relevant hazards, offering a more detailed understanding of the factors that could shape adaptation outcomes. This helped uncover potential, often overlooked, interactions between adaptation strategies and hazard events that could be addressed in advance of strategy implementation (Bennett et al. 2016). In some cases, both the LRPF and CAPSI flagged the same hazards, such as logging. These overlaps remain important because if CAPSI-identified adaptation actions do not directly address logging, they still need to account for the associated risks driven by this activity.

Examining the underlying drivers of local sensitivity also revealed potential unintended consequences of the proposed strategies. This was largely due to the central role of natural resources in many aspects of local livelihoods, with adaptation efforts that focus on these resources potentially limiting their availability for other uses (Maharjan and Joshi 2013). Recognising these trade-offs allows adaptation strategies to be refined in ways that minimise their negative impact and improves their overall effectiveness (Suckall et al. 2014).

Finally, evaluating adaptive capacity identified barriers that could limit the successful implementation of adaptation strategies. This information was crucial for determining if proposed strategies were realistic for communities to carry out. In Solomon Islands, as evidenced in this chapter, common barriers include limited access to infrastructure and financial resources (Basel et al. 2020; Ha'apio et al. 2018b). Such constraints pose a challenge for local adaptation efforts, since many strategies require resources that are beyond a community's means (Ha'apio et al. 2018a). As a result, adaptation will often depend on a community's ability to secure funding or technical support from government agencies, non-governmental organisations (NGOs) or international donors (Prizzon 2020).

In remote rural areas of Solomon Islands access to funding remains a challenge, which in turn limits capacity for local adaptation responses (McLoughlin et al. 2022). Many funding opportunities require detailed proposals that articulate specific adaptation needs and resource requirements (Ha'apio et al. 2018a). Yet, these processes often privilege communities with higher levels of formal education, literacy, or external support, leaving many rural communities at a disadvantage (Butler et al. 2016b; Spires et al. 2014). In this context, risk-informed pathway approaches can be valuable, providing communities with clear, evidence-based insights into their priority adaptation responses, strengthening local planning and agency in guiding adaptation efforts. While these approaches offer valuable information, they do not directly address structural barriers to funding. Instead, they provide insights that, when coupled with capacity building support such as developing proposal writing skills and advocacy, can help communities to navigate funding systems more effectively and secure support that genuinely reflects local priorities and contexts (Thiault et al. 2021; Van der Ploeg 2020a).

Next Steps

In this chapter, I retrospectively applied the risk-informed pathways approach to data collected from the LRPf and the CAPSI. This demonstrated the value of combining these approaches to enhance decision-making for adaptation, ultimately strengthening the 'no-regrets' status of the proposed strategies. A critical next step involves developing a participatory method to implement the combined LRPf-CAPSI approach at the community level. This method would directly engage communities in the LRPf learning cycle, utilising the risk profiles generated during the LRPf process, as described in Chapter Three. By actively engaging with these risk profiles, communities can move beyond establishing priority adaptation strategies to identifying barriers that may undermine these efforts. This participatory method can not only empower communities to take ownership of their adaptation pathways but also equip them with the tools and knowledge needed to tackle the complexities of adaptation and manage associated risks (Bednarska-Olejniczak et al. 2021; McNamara et al. 2020).

Conclusions

In this chapter, I introduced the combined LRPf-CASPI approach as a method for risk-informed adaptation planning. This innovative approach aims to support rural communities in making informed decisions about their adaptation needs, helping to ensure that the strategies they implement are effective and sustainable in the long-term. By building on traditional pathway approaches, this chapter retrospectively evaluated how climate-resilient development strategies may be impacted by underlying local risk drivers. This provides communities with a clearer understanding of how factors, such as hazard exposure and socioeconomic conditions, may influence the effectiveness of their adaptation efforts, enabling them to anticipate and address challenges proactively. Ultimately, the LRPf-CASPI approach provides a structured mechanism to develop robust, locally relevant adaptation strategies. By explicitly integrating risk considerations, it increases the likelihood that adaptation actions will remain effective over time, ultimately enhancing the resilience of rural livelihoods.

Chapter Six

General Discussion



Chapter Six: General Discussion

Introduction

In the face of global change, rural communities require effective and sustainable adaptation responses (McNamara et al. 2020). Community-based vulnerability assessments (CBVAs) have gained popularity as a tool for guiding adaptation by evaluating the factors that drive impacts on rural livelihood (Adger 2006; Ensor and Berger 2009). However, CBVAs have faced several limitations that undermine their effectiveness, including a tendency to overlook non-climatic hazards (Bennett et al. 2016), socioeconomic factors (Ford and Pearce 2012), and the spatial and temporal dynamics (Jurgilevich et al. 2017) that shape vulnerability. These limitations have sometimes led to ineffective and maladaptive outcomes where CBVAs have informed adaptation efforts (Castree et al. 2014; Magnan et al. 2016). Consequently, there have been calls for holistic approaches that establish a more robust understanding of vulnerability (Ford et al. 2018) and translate assessment findings into actionable strategies that strengthen the resilience of rural livelihoods (Dubois et al. 2019; McLeod et al. 2015).

My thesis aimed to develop a holistic risk-based framework to support more effective and sustainable adaptation outcomes for rural livelihoods by addressing the limitations of CBVAs. To achieve this, I focused on four research objectives:

1. Evaluate whether CBVAs continue to exhibit their limitations, justifying the need for a holistic risk assessment framework.
2. Develop and implement the Livelihoods-Based Risk Profiling Framework (LRPF) as a holistic approach to address CBVA limitations.
3. Evaluate the capacity of the LRPF to deliver more robust outcomes for adaptation planning compared to prior frameworks.
4. Develop a method to apply LRPF outputs to enhance decision making, supporting more effective and sustainable adaptation planning outcomes.

In this chapter, I summarise the key research findings from each data chapter (Chapters Two – Five) and discuss their implications in relation to rural livelihoods adaptation. I then examine the broader implications of my thesis for theory, practice, and policy. Finally, I outline future research opportunities that could further enhance the contributions of this thesis for supporting rural livelihoods in Solomon Islands and the broader Pacific region.

Summary of Thesis Contributions

Chapter Two: A Systematic Review of Current Progress in Community-Based Vulnerability Assessments

The objective of this chapter was to systematically evaluate whether scholars assessing rural livelihoods vulnerability are effectively addressing CBVA limitations. To achieve this, I conducted a systematic review evaluating if CBVAs applied from the climate change adaptation (CCA) and livelihoods and development fields adequately addressed: i) exposure to climatic and non-climatic hazards, ii) a comprehensive range of socioeconomic indicators, and iii) spatial and temporal dynamics. Given the extensive literature on CBVAs, my review concentrated on studies that implemented the most widely recognised frameworks from each field: the IPCC AR4 Vulnerability Framework (IPCC 2007) for CCA and the Sustainable Livelihoods Framework (SLF) for livelihoods and development (DFID 1999).

Key Research Findings:

This chapter revealed that studies have made modest progress in addressing CBVA limitations, however several critical gaps persist. These include:

- **Neglect of non-climatic hazards:** Many studies failed to address non-climatic hazards, overlooking their impact on rural livelihoods. This reinforces the narrow perspective that climate change is the sole challenge faced by rural communities (Bennett et al. 2016).
- **Limited analysis of certain socioeconomic factors:** Few studies conducted a comprehensive analysis of the socioeconomic factors influencing vulnerability. AR4-based studies frequently neglected aspects of adaptive capacity, like social capital, while SLF-based studies overlooked key aspects of sensitivity, like water security. This reinforces the research perspective of each framework, which prioritises either biophysical or social factors over a more holistic understanding of vulnerability (Ford et al. 2018; O'Brien et al. 2007).
- **Exclusion of spatial and temporal dynamics:** Spatial and temporal dynamics were commonly overlooked in CBVAs. This reinforces the idea that vulnerability is a static process, failing to account for the evolving nature of vulnerability and the interactions among its underlying factors (Jurgilevich et al. 2017; Thiault et al. 2021).

Implications for Adaptation:

Focusing solely on climate change as the main challenge to rural livelihoods overlooks the broader vulnerability context (Ford et al. 2018). Non-climatic hazards can weaken local capacity to respond to climate change and create cumulative impacts when combined with climate-based hazards (Hilson 2016; Rasanen et al. 2016). A clear understanding of exposure to various hazards is crucial for designing

effective interventions (Natarajan et al. 2022). Ignoring these factors can drive ineffective outcomes, particularly where cumulative impacts are neglected (Rasanen et al. 2016). Additionally, in many rural contexts, non-climatic hazards such as resource exploitation have a more immediate and severe impact on livelihoods than climate change (Van der Ploeg et al. 2020a). By failing to address these hazards, adaptation strategies may become misaligned with the realities faced by communities, undermining efforts to enhance their resilience and cope with current and future hazard events (Roscher et al. 2020).

Conducting a limited analysis of socioeconomic factors reduces the ability for CBVAs to understand vulnerability (Ford et al. 2018). As a result, adaptation efforts may not effectively address the key factors driving livelihood impacts, leading to ineffective outcomes (Marin-Puig et al. 2022). For instance, overlooking the role of social capital can undermine the collaborative efforts, social networks, and trust, essential for successful adaptation (Ha'apio et al. 2019; Malherbe et al. 2020). While neglecting critical aspects like water security may result in the prioritisation of less vital adaptation efforts, diverting attention and resources away from a community's most pressing needs (Usman and Gerber 2021). By failing to consider these key socioeconomic factors, adaptation efforts may perpetuate existing vulnerabilities, hindering rather than enhancing the resilience of rural livelihoods (Ford and Pearce 2012).

Excluding spatial and temporal dynamics from CBVAs overlooks how vulnerability evolves and interacts over time and space. This can prevent decision-makers from understanding the complex dynamics that exacerbate vulnerability (Jurgilevich et al. 2017). For instance, shifts in livelihood activities due to past hazard exposures can diminish community resilience by limiting access to essential resources (Ekblom 2012). Alternatively, neglecting spatial dynamics can obscure critical interactions between neighbouring communities, such as how the resource use of one community can adversely impact another (Diedrich et al. 2022). By overlooking these dynamics, adaptation efforts may encounter unanticipated challenges, ultimately compromising their effectiveness (Thiault et al. 2018b).

Overall, this chapter established the persistent limitations of CBVAs, which pose significant challenges for effective adaptation efforts (Ford et al. 2018). My findings underscore a need to shift towards holistic approaches that address these limitations. By integrating non-climatic hazards, a wider range of socioeconomic factors, and spatial and temporal dynamics, adaptation efforts informed by CBVAs can better align with the complex realities faced by rural communities (Fekete et al. 2010; Thiault et al. 2018b). Given the availability of straightforward yet effective methods for incorporating these elements into CBVAs, it is imperative that future studies prioritise their inclusion (e.g., Butler et al. 2015; Naylor et al. 2020). Addressing these limitations will enhance the effectiveness of adaptation initiatives and ultimately improve the livelihoods of rural communities (Ford et al. 2018). Without significant advancements in this area, my thesis indicates that the continued relevance of CBVAs as a tool for adaptation warrants re-evaluation.

Chapter Three: Navigating Risk: A Holistic Framework for Supporting Rural Livelihoods Adaptation in Solomon Islands

The objective of this chapter was to develop and implement the Livelihoods-Based Risk Profiling Framework (LRPF) as a holistic approach to address CBVA limitations. In this chapter, I shifted from a focus on vulnerability, to risk, recognising that risk is informed by a multidisciplinary perspective which supports a more comprehensive analysis of the factors influencing rural livelihoods (Gero et al. 2010; Buchtmann et al. 2022). In the LRPF, I expanded the AR5 Framework (IPCC 2014) to include novel risk components that addressed CBVA limitations. This included the incorporation of non-climatic hazards, expansion of socioeconomic indicators (inclusive of source dependence), and consideration of spatial and temporal dynamics. Employing a mixed-methods approach, I collected and analysed data associated with risk through participatory mapping workshops, household interviews, and informal conversations in three rural communities in Western Province, Solomon Islands. This process yielded a range of decision support tools, which visually communicated risk in an accessible format for decision-makers. These tools guided the identification of priority adaptation initiatives by highlighting the most critical drivers of risk for each community.

Key Research Findings:

The LRPF demonstrated the value of adopting a holistic approach to guide decision making for rural livelihoods adaptation, highlighting several critical, yet overlooked, factors in prior CBVAs. These included:

- **Integration of non-climatic hazards:** Non-climatic hazards, particularly resource exploitation, were identified as key threats to rural livelihoods in Solomon Islands.
- **Expansion of socioeconomic vulnerability:** The LRPF provided a deeper understanding of key vulnerability drivers, such as limited access to financial and physical capital, and issues related to water and food insecurity.
- **Introduction of source dependence:** Rural communities exhibited a critical dependence on natural source types (e.g., food gardens) experiencing hazard exposure.
- **Inclusion of spatial and temporal dynamics:** Visualisation of hazard exposure uncovered impact hotspots, while qualitative data revealed how long-term risk dynamics shape present-day vulnerability.

By incorporating qualitative data obtained from informal conversations, the LRPF uncovered complex interactions that are often missed in purely quantitative studies, providing a more comprehensive understanding of local risk drivers.

Implications for Adaptation:

The LRPF findings have numerous implications for rural livelihoods adaptation. First, they emphasise the need for more nuanced, multi-hazard responses that focus on contextually relevant risk drivers. This is especially critical in locations like Solomon Islands, where rural communities face complex, multi-hazard environments (Minter and Van der Ploeg 2023). Approaching adaptation from a multi-hazard perspective provides a more realistic understanding of the challenges faced by communities (Bennett et al. 2016).

By incorporating locally relevant hazard exposures and their interactions, the LRPF enabled a clearer identification of adaptation priorities. This included instances where non-climatic hazards, such as commercial logging, posed a more immediate threat to livelihoods than climate change. Failing to address these critical issues can leave communities less equipped to handle global change (Katovai et al. 2015; McDowell et al. 2016). This highlights a gap in many current policies and adaptation funding streams in Solomon Islands, which tend to focus on climate change (Van der Ploeg et al. 2020a). By broadening the scope to address non-climatic hazards, the LRPF evidences the need for more flexible funding opportunities, ensuring resources are better aligned with the actual hazards communities face.

The LRPFs expansion of socioeconomic indicators, such as social capital, provided essential insights to support adaptation planning (Ford et al. 2018). While social capital didn't emerge as a key risk driver in the engaged communities, it is a crucial factor in the successful implementation of adaptation initiatives (Diedrich et al. 2019; Ha'apio et al. 2019). In this thesis, lack of access to financial resources was a key barrier to adaptation. Additionally, critical issues like water and food insecurity exacerbated by local dependence on degraded natural resources, suggested the need for costly local interventions such as rainwater tanks. This situation has been evidenced across Solomon Islands, leading to local reliance on external adaptation funding in many rural locations (Nunn and Kumar 2019). Most funding bodies acknowledge this need and aim to facilitate local access to micro-financing and small grants to support communities in implementing adaptation strategies (Basel et al. 2020; Robinson and Dornan 2017; Van der Ploeg et al. 2020a). However, as dependence on external financial support is not sustainable in the long term, mitigating the hazards that drive these impacts is critical (Minter and Van der Ploeg 2022).

Visualising hazard exposure in the LRPF provided valuable insights into the physical impacts faced by communities. The mapping exercise not only identified these impacts, but facilitated important conversations regarding broader interactions among risk drivers. These interactions were often too complex to be captured through quantitative data collection methods (Brown and Kyttä 2018; Diedrich et al. 2022). Through the mapping exercise, communities were able to engage more meaningfully in discussions about complex risk drivers by leveraging place-based information, which helped them conceptualise other risk components. In Solomon Islands, where place-based knowledge is deeply

rooted in the culture and traditions of communities, this technique proved particularly valuable (Piccolella 2013). However, it is important to recognise that the efficacy of mapping techniques may vary across contexts (Sullivan-Wiley et al. 2019).

One of the key findings of this thesis was the value of qualitative data in understanding risk. While qualitative data has been absent or played a minor role in prior CBVAs and CBRAs (Smith and Diedrich 2024), it proved essential for fully conceptualising how risk manifests in the LRPF (Birkmann 2007). Qualitative data uncovered complex interactions among risk drivers that mapping and quantitative data alone could not reveal (Barnett et al. 2008). This, in turn, helped establish robust adaptation initiatives that were socially and culturally appropriate, enhancing the likelihood of their long term success (Ahmed and Kelman 2018). By demonstrating this, my thesis highlights the important role of qualitative research methods in community-based risk and vulnerability assessments.

Chapter Four: From Vulnerability to Risk: Evaluating the Role of Holistic Risk Assessment for Livelihoods Adaptation Planning

The objective of this chapter was to evaluate the capacity of the LRPF to deliver more robust outcomes for adaptation planning compared to the IPCC AR4 (IPCC 2007) and AR5 (IPCC 2014) Frameworks. To achieve this, I first outlined the conceptual differences between the frameworks in assessing vulnerability (AR4) and risk (AR5, LRPF). I then applied each framework to the data collected in Chapter Three for one of the rural communities in Western Province, generating summary vulnerability and risk profiles that highlighted their distinct outputs. These profiles served as a basis for comparing the information obtained from each framework. This comparison focused on differences in the depth of information provided by each profile and how this may influence decision making for rural livelihoods adaptation.

Key Research Findings:

Overall, this chapter provided two critical insights. First, it demonstrated the value of transitioning from a vulnerability (AR4) to a risk-based (AR5) approach. This shift was characterised by the reconceptualization of hazard exposure as a place-based concept in the AR5, which offered deeper insights into potential hazard exposure impacts on communities (IPCC 2014). Second, it demonstrated how the LRPF provides a more comprehensive understanding of the factors influencing rural livelihoods vulnerability and risk compared to the AR4 and AR5 frameworks. This was attributed to:

- **Depth of information:** The LRPF's inclusion of non-climatic hazards, a broader range of socioeconomic indicators, and the spatial and temporal dynamics that influence rural livelihoods risk provided information that is not included in the AR4 and AR5 frameworks.

- **Introduction of novel risk components:** The LRPF's introduction of source dependence served as a crucial link between vulnerability and hazard exposure which is missing from the AR4 and AR5 frameworks.

Implications for Adaptation:

In the previous chapter summaries, I outlined how the LRPF addresses CBVA limitations by incorporating additional components to enhance its understanding of risk and how this can help achieve more effective adaptation outcomes. Therefore, I won't reiterate those points here. Instead, I will focus on the implications of this chapter in demonstrating the value of transitioning from a vulnerability to a risk-based assessment framework.

While many studies have outlined the limitations of CBVAs and their implications for adaptation (Ford et al. 2018; Guerrero et al. 2018; Singh et al. 2017; Thiault et al. 2021), few have demonstrated the increased depth of information that a risk-based approach can provide. Das et al. (2020) provide an exception, using a district-level case study to compare the outcomes of the AR4 and AR5 frameworks in the Indian Bengal. While this study highlights the differences between the frameworks, it does not explore the implications this has for adaptation and is not applicable at the community scale. As such, this chapter offers valuable insights by demonstrating the advantages of applying the AR5 to support community-based adaptation. Researchers and practitioners advocating for a shift to risk-based approaches can leverage this evidence to strengthen their arguments.

As mentioned throughout the thesis, the AR5 framework has not yet been widely implemented at the community scale (Smith and Diedrich 2024). A key reason for this is a lack of operational guidelines, which creates uncertainty around its implementation (Estoque et al. 2023; Ishtiaque et al. 2022). This chapter, along with Chapter Three, helps bridge this gap by advancing guidelines for the AR5's (and LRPF's) implementation. Furthermore, by expanding the AR5 to clearly address CBVA limitations, the LRPF ensures that these issues do not persist when the framework is implemented in rural contexts. For example, introducing source dependence as an additional component of the LRPF established the reliance of rural livelihoods on natural source types that are increasingly exposed to hazards (Basel et al. 2020). This inclusion allowed for the development of targeted adaptation strategies that better address key risk drivers. By demonstrating how the LRPF can achieve more robust adaptation outcomes than the AR4 and AR5, this chapter emphasises the need to transition towards more holistic assessment approaches (Singha et al. 2023).

Chapter Five: Building Stronger Futures: Combining Risk Assessments and Adaptation Pathway Approaches for Rural Livelihoods Resilience in Solomon Islands

The objective of this chapter was to combine the LRPF with the Community Adaptation Pathway Solomon Islands (CAPSI) approach (Butler et al. 2015) to enhance decision-making for climate resilient development. By retrospectively applying the LRPF to the CAPSI, I explored how a deeper understanding of risk could support more effective ‘no-regrets’ adaptation outcomes that were less likely to produce unintended negative consequences. The CAPSI uses a three-stage learning cycle to develop climate resilient development strategies based on: i) current hazard exposure, ii) visions for livelihoods, and iii) future hazard scenarios. A second learning cycle, using the LRPF, assessed how these strategies might interact with a more comprehensive understanding of risk drivers, including local hazard exposure, sensitivity and adaptive capacity. This process revealed potential negative interactions between CAPSI strategies and underlying risk drivers identified through the LRPF. By identifying these risks early, communities can proactively address them during the planning stages of adaptation, increasing the likelihood that their climate resilient development strategies will be ‘no-regrets’.

Key Research Findings:

The LRPF data were applied to evaluate the ‘no-regrets’ status of three climate resilient development strategies: i) obtaining rainwater tanks, ii) introducing diversified crop types, and iii) implementing forest replanting schemes. From this evaluation, several key research findings emerged:

- **Interactions with hazard exposure:** The LRPF identified additional local hazard exposures that were overlooked during the CAPSI process. These hazards were likely to negatively interact with the proposed adaptation strategies (e.g., through wild pigs disturbing crop diversification efforts (VerCauteren et al. 2024)). Addressing these issues can help ensure the long-term success of adaptation efforts.
- **Interactions with sensitivity:** Local dependence on source types required for adaptation revealed potential unanticipated consequences of the proposed strategies (e.g., reducing the availability of water for other uses, such as drinking (Feliciano 2019)). Identifying these trade-offs allows adjustments to be made to minimise negative impacts on livelihoods.
- **Interactions with adaptive capacity:** Limited access to infrastructure and financial resources was identified as a barrier to implementing the proposed strategies (e.g., the capacity to purchase rainwater tanks (Khastagir and Jayasuriya 2011)). External funding and support may be required for adaptation strategies to be implemented.

Implications for Adaptation:

This chapter demonstrated the value of applying LRPf outputs to enhance decision-making for adaptation planning. By combining the LRPf and CAPSI, potential unanticipated consequences arising from adaptation strategies can be identified and proactively managed (Colloff et al. 2024; Werners et al. 2021). This chapter advanced the thesis beyond merely identifying risks and associated priority adaptation responses, demonstrating how the LRPf can support the effective implementation of ‘no-regrets’ climate resilient development strategies.

Climate resilient development is an emerging approach that seeks to integrate adaptation, mitigation, and sustainable development to reduce risks, enhance well-being and build long-term resilience (IPCC 2022; Suckall et al. 2014). However, ongoing debate highlights its shortcomings (Andrijevic et al. 2020; Taylor et al. 2023). A key criticism is that many climate resilient adaptation efforts fail to adequately capture the underlying vulnerabilities of a system, resulting in ineffective outcomes (Rodriguez and Carril 2024). Similarly, climate resilient mitigation efforts often do not align with community priorities, reducing their relevance and effectiveness (Gilmore and Buhaug 2020; Hickel and Slamersak 2022). By providing a more detailed understanding of vulnerability and supporting context-specific, community-driven adaptation, the LRPf offers a way to strengthen climate-resilient development.

Evaluating the ‘no-regrets’ status of adaptation is often overlooked, particularly when adaptation efforts are led by external stakeholders (Butler et al. 2020a; 2024). Numerous instances of failed adaptation highlight the consequences of this oversight. For example, strategies focused solely on exogenous hazards like climate change may overlook local issues, reducing their effectiveness (Van der Ploeg et al. 2020a). Similarly, initiatives that fail to consider existing social dynamics can lead to increased inequality or create social tensions (Dow 2006). While strategies that overlook long-term access to essential resources can undermine the sustainability of initially successful initiatives (Walker et al. 2013). This has been evidenced in Solomon Islands where freezers, introduced to improve food security by storing fish, often break down and cannot be repaired, undermining their intended benefits (Batololo et al. 2024).

Given the importance of assessing the ‘no-regrets’ status of adaptation efforts, it is crucial to transition from the retrospective application of LRPf data to CAPSI, to a combined LRPf-CASPI approach. Developing a participatory method to implement the LRPf-CAPSI alongside communities could strengthen local capacity to evaluate, design, and implement effective ‘no-regrets’ adaptation strategies (Colloff et al. 2024). By ensuring these strategies are actionable, sustainable, and capable of delivering tangible benefits, community members are more likely to feel empowered to take ownership over their adaptation outcomes, further improving the likelihood of adaptation success (Ensor et al. 2018a; McLeod et al. 2015). As noted, the transition to a combined LRPf-CAPSI approach will be supported

through a follow-on project in Solomon Islands (FIS-2023-111) funded by the Australian Centre for International Agricultural Research (ACIAR).

Broader Implications of Thesis Findings

Below, I reflect on the broader theoretical, practical, and policy implications of my research findings. These implications include advancements in theoretical frameworks on vulnerability and risk, as well as contributions of this research to rural livelihoods adaptation in Solomon Islands at both the local and national scale.

Theoretical Implications

As previously discussed, this thesis addressed the limitations of CBVAs by developing a holistic risk assessment framework tailored to the context of rural livelihoods. This framework incorporated non-climatic hazard exposure (Bennett et al. 2016), a broader range of socioeconomic factors (Ford et al. 2018), and spatial and temporal dynamics (Jurgilevich et al. 2017). Throughout this thesis, I have demonstrated the critical role these factors play in influencing rural livelihoods risk and emphasised their need for inclusion within vulnerability and risk assessments.

From a theoretical perspective, these findings provide compelling evidence for the need to transition to holistic approaches that yield robust information for adaptation planning (Ford et al. 2018). As CBVAs continue to gain popularity as a method for addressing the adaptation needs of rural livelihoods (Smith and Diedrich 2024) it is essential to develop, promote, and facilitate the broader uptake of such frameworks. This is critical given the complex and increasing challenges rural livelihoods face (Preston et al. 2011), especially in locations like Solomon Islands (Kumar 2020; Van der Ploeg 2020a). In these contexts, effectively addressing CBVA's limitations can help communities navigate unprecedented challenges (McNamara et al. 2020). The LPRF provides a valuable mechanism to achieve this not only in Solomon Islands but across the Pacific Islands where many rural communities face similar challenges (McNamara et al. 2020). While many countries in the region have previously engaged with vulnerability assessments (e.g., Shiiba et al. 2023; Weatherill 2023; Wolf et al. 2021), a transition is now occurring towards risk-based approaches (Westoby et al. 2022). The LPRF can support this transition by providing a comprehensive, context-specific methodology to support the adoption of risk-based approaches across the Pacific region.

By combining qualitative and quantitative data to understand risk, this thesis enhanced both the depth and breadth of risk analysis, offering a more comprehensive understanding of the complex and nuanced factors that impact rural livelihoods (Ahmed and Kelman 2018; Konig et al. 2017). The quantitative data identified key drivers of risk that were deemed important across the study area (Nguyen et al. 2016), while the qualitative data captured local knowledge, perspectives, and experiences on risk that

are often overlooked in quantitative approaches (Vojinovic et al. 2015). In particular, the qualitative data provided crucial insights into the interactions between vulnerability and risk drivers, revealing how these interactions drove cumulative impacts on rural livelihoods. Such interactions are often excluded from vulnerability and risk-based studies (Bennett et al. 2016) but proved integral to a comprehensive understanding of risk in the thesis.

While qualitative data is effective for understanding and communicating risk at the community scale, the inclusion of quantitative data can make the LRPf more valuable in supporting communities to secure funding for adaptation (Fekete 2019; Massman and Wehrhahn 2014; Torok 2018). Quantitative outputs are often better understood and more readily communicated at broader governance levels, enhancing their usefulness for decision-making (Mustafa et al. 2010). Additionally, quantitative data more readily enables the comparison of risk drivers across the communities where the LRPf was applied, facilitating a broader understanding of adaptation needs and how they may vary across and within government jurisdictions (Beauchamp et al. 2019).

Despite the strengths of a mixed-methods approach, several limitations in both qualitative and quantitative data may affect the LRPf's ability to fully capture risk. Quantitative indicators, for example, may not always be the most appropriate measure for complex factors such as food security (Birkmann 2007). Context-specific validation is essential to ensure indicators accurately reflect what they intend to measure (Tonmoy et al. 2014). While all indicators used in this thesis were validated for rural livelihoods (see supplementary information), few were explicitly validated within Solomon Islands, presenting an opportunity for further research. Aggregating indicators into a single index can also obscure nuances and introduce biases in identifying the factors driving risk (Fekete 2019). To address this, I applied the AHP to weight indicators based on local conditions; however, the subjectivity of the experts involved in weighting may have influenced results (Benitez et al. 2011).

Subjectivity and bias may also have affected qualitative data. Participants might have withheld information due to trust concerns, topic sensitivity, or recall limitations (Madill and Jordan 2010; Maxwell 2018). Researcher bias may have further shaped findings through selective attention to data that aligned with preconceived notions of the factors driving local risk (Thogersen 2011). To mitigate this, I worked with local researchers during qualitative data collection, remained reflexive about my positionality, and validated qualitative data interpretations with local researchers.

Practical Implications

Beyond addressing CBVA's limitations, this thesis also responds to the practical application gap in effectively communicating assessment outputs to community members (Arteaga et al. 2023; Kumar 2020). In this way, the findings have direct practical relevance for the communities where the LRPf was implemented.

The practical component of this thesis emerged from Chapter Three. In this chapter, I conveyed LRPF outputs through various decision support tools which led to the identification of priority adaptation initiatives for each community. While these tools aim to support informed decision-making (Ensor et al. 2018a), their complexity may limit their usability at the local level (Westoby et al. 2019). Recognising this, I developed additional communication tools, translated into Solomon Island Pijin, as shown in Appendix 8. These tools were created in collaboration with local researchers and community members to ensure that LRPF outputs were accessible and interpretable by the communities.

In May 2024, the ESSI team and I made a final visit to each community to disseminate the research findings. During this visit, I co-facilitated knowledge sharing workshops that supported the use of the LRPF communication tools by community members and shared each community's priority 'no-regrets' adaptation strategies based on the LRPF and CAPSI outputs. While community members expressed that the workshops were valuable for understanding their adaptation priorities and felt empowered to take actionable steps, they also recognised barriers to doing so. This primarily involved the need for financial resources to implement adaptation that exceeded local capacity.

Anticipating this challenge, I collaborated with local researchers to support communities in using the LRPF decision support tools to access locally available funding for adaptation. This focused on the Provincial Capacity Development Fund, which provides rural communities in Solomon Islands with funding for adaptation initiatives (Solomon Islands Government 2024a). Accessing this fund requires communities to submit a proposal, a process that privileges those with greater education, technical skills, or external support, leaving many communities disadvantaged. The LRPF decision support tools aim to help address this barrier by providing the necessary information for funding proposals. During my final field visit, local researchers explained the fund to each community and demonstrated how the LRPF outputs could support their applications. These researchers continue to provide support to each community throughout the application process.

Beyond Solomon Islands, this research has practical implications for risk-informed adaptation planning across the Pacific Islands and globally. The development of locally tailored decision support tools and their integration into adaptation planning provides a model for effectively translating risk and vulnerability assessments into actionable strategies (Nay et al. 2014). In countries such as Vanuatu and Fiji, where rural communities face similar threats (Wolf et al. 2021), the LRPF could be adapted and applied to support local adaptation. More broadly, this research contributes to global community-based risk assessments by providing a flexible framework that can be tailored to diverse socioeconomic and environmental contexts.

Policy Implications

By communicating the factors driving risk at the community level, LRPF outputs can help shift adaptation funding mechanisms away from a ‘one-size-fits-all’ approach that often overlooks the unique needs of communities (Barrowman and Butler 2020; Roscher et al. 2020). The communities engaged in this thesis illustrate the diverse risks faced by rural populations, even within a relatively small geographic area. Acknowledging these differences can encourage external decision-makers including governments, NGOs, and international donors to tailor adaptation efforts to local needs, resulting in more effective and sustainable outcomes (Barrowman and Butler 2020). Such context-specific responses are essential for addressing the diverse range of hazards impacting rural livelihoods (McNamara et al. 2020).

The LRPF offers an opportunity to tailor adaptation support in Solomon Islands, ensuring it aligns with the unique context of each community. The Solomon Islands government has committed to addressing key livelihood vulnerabilities to strengthen adaptation and resilience through its 2023-2032 climate change adaptation policy (Solomon Islands Government 2023). Disaster risk management has become a central focus of climate resilience efforts within this and other national policies (Solomon Islands Government 2022). As part of this shift, the country is developing a risk-informed integrated planning tool (Solomon Islands Government 2024b), presenting an opportunity to apply insights from this thesis to support its design and implementation. Embedding the LRPF into this tool could enhance its capacity to identify community-specific risks and vulnerabilities, improving its effectiveness for local adaptation planning.

The Solomon Islands’ shift towards risk reduction is further supported by international partnerships, such as Australia’s ‘Governance for Resilient Development in the Pacific’ (Gov4Res) project, which aims to strengthen decision-making and governance (United Nations 2025), and the ‘Disaster READY’ programme (Australian Humanitarian Partnership 2025), which aims to support community and government-led resilience building efforts. The alignment between the thesis outputs and these initiatives strengthens their relevance for policymakers and practitioners seeking to implement locally grounded, risk-responsive adaptation strategies.

Opportunities for Further Research

While this thesis demonstrated the LRPF’s value in supporting rural livelihoods adaptation in Solomon Islands, several opportunities for further research exist that could enhance its outputs.

First, in Chapter Two, I evaluated whether contemporary CBVAs address their theoretical limitations. This review identified several frameworks aiming to overcome these issues (e.g., Berrouet et al. 2018; Birkmann et al. 2013; Cinner et al. 2013; Naylor et al. 2020), yet their adoption has been limited.

Examining the reasons for this limited uptake could provide important insights into the barriers to implementing holistic CBVA approaches. Understanding these barriers could help improve the scalability and practical application of frameworks like the LRPF.

Second, in Chapter Three I presented the LRPF as a holistic risk assessment approach for rural communities in Solomon Islands. While the framework addressed CBVA limitations, there are opportunities to further enhance its analysis of spatial and temporal dynamics. For example, the LRPF currently lacks a future-oriented risk analysis, which limits its ability to anticipate emerging threats to livelihoods and the development of proactive strategies to mitigate these challenges (Jurgilevich et al. 2017; Flynn et al. 2018). Incorporating future dynamics through methods like scenario planning, as described in Chapter Five, could further enhance the LRPFs utility for adaptation decision-making (Butler et al. 2015).

Third, the LRPF's spatial analysis was limited to the land and sea areas directly governed by a community. However, risk extends beyond these boundaries, with environmental, social and economic factors in adjacent areas also influencing community livelihoods (Jurgilevich et al. 2018). By focusing solely on immediate surroundings, the LRPF overlooks these broader scale interactions (Thiault et al. 2021). Expanding the spatial analysis to incorporate neighbouring areas would therefore enhance the LRPFs ability to capture the full range of risks influencing rural livelihoods (Diedrich et al. 2022).

Fourth, because risk is dynamic, achieving effective adaptation outcomes may require repeated application of the LRPF (Jurgilevich et al. 2017). Replication allows communities to capture evolving risk drivers and make necessary adjustments to their adaptation strategies (Fawcett et al. 2017). Additionally, replication of the approach provides a mechanism to monitor and evaluate the effectiveness of adaptation efforts, enabling communities to assess their success in reducing risk over time (Archer et al. 2017).

Fifth, I acknowledge that the labour intensive nature of implementing the LRPF may limit its replicability (Dubois et al. 2019). To address this, a streamlined data collection method may be needed, one that retains a holistic understanding of risk while reducing the resources required (Chambers 1981; Schutt et al. 2015). Such an approach could facilitate the LRPF's application across diverse contexts, including regions beyond Solomon Islands (Rossing et al. 2014). If scaled in this way, additional adaptations would be required to ensure that LRPF components aligned with local risk characteristics which may differ from those observed in Solomon Islands (Birkmann 2007).

Sixth, while the LRPF provided valuable insights into community-level risk, it did not capture intra-community variations and overlooked differences in risk drivers between demographic groups such as gender, age, or livelihood activities. Understanding these differences is crucial for developing inclusive adaptation strategies that benefit all community members (Araos et al. 2021; Dow et al. 2006). Although a detailed intra-community risk analysis was beyond the scope of this thesis, the household-level

vulnerability data described in Chapter Three presents an opportunity to explore these factors further. This data could be used to develop more targeted adaptation recommendations. For example, women often face heightened vulnerabilities to hazard exposure (Arora-Johnson 2011; Abbott and Porter 2012; Kuran et al. 2020). Applying a gender-sensitive lens to future LRPF applications could help identify specific risks faced by women and support the design of targeted adaptation strategies.

Seventh, as previously mentioned, combining the LRPF with the CAPSI approach can yield valuable insights for ‘no-regrets’ adaptation. However, since this approach was applied retrospectively, I could not explore its contributions to this process in real-time. Developing a participatory method for implementing the LRPF-CAPSI that actively engages communities in knowledge brokering processes would be highly valuable (Butler et al. 2024; Cvitanovic et al. 2015). Such an approach should extend beyond implementation to establish effective channels for communicating and applying outputs, thereby supporting better decision-making processes (Tran and Rodela 2019).

Finally, this thesis could be expanded by further exploring the concept of resilience. While resilience was introduced, its full potential in the context of rural livelihoods adaptation has not been thoroughly examined. A more in-depth analysis could focus on the interactions between resilience, risk, and vulnerability, exploring how these concepts can be addressed together to develop a more comprehensive framework for adaptation planning (Graveline and Germain 2022; Lei et al. 2014). Specifically, this could involve examining how these concepts contribute across different dimensions of adaptation, from immediate vulnerability reduction to supporting long-term transformative change (Joakim et al. 2021; Maru et al. 2014).

Conclusions

This thesis has explored the complex relationship between rural livelihoods and risk in Solomon Islands. It has demonstrated the urgent need for a shift in how we assess vulnerability and risk, advocating for holistic approaches that address the complex, interconnected factors impacting rural livelihoods. Through the development, implementation, and comparative evaluation of the Livelihoods Based Risk Profiling Framework (LRPF) this thesis has called to attention the critical importance of incorporating non-climatic hazards, broader socioeconomic factors, and spatial and temporal dynamics within assessments. By addressing these elements holistically, the thesis identified priority adaptation initiatives that reflect the multi-faceted risks faced by rural communities.

Beyond highlighting community realities, this approach underscores the importance of tailoring adaptation strategies to meet local needs. By developing practical tools for applying LRPF results, the research provided a pathway for communities to engage with and respond to local risk drivers, empowering them to build resilient futures. The implications of this work extend beyond Solomon Islands, providing valuable insights for researchers, practitioners, and policymakers working in diverse

Chapter Six

adaptation contexts. Through continued collaboration and commitment to holistic, context-specific methods, adaptation practices can become more effective, sustainable, and truly responsive to the needs and realities of rural communities.

Appendix



Chapter One

Appendix 1: Summary table of previous systematic reviews (n=22) assessed during the scoping stage of Chapter One to confirm the novel contribution of the review.

#	Reference
1	Fatemi, F., Ardalan, A., Aguirre, B., Mansouri, N. and Mohammadfam, I. 2017. Social vulnerability indicators in disasters: Findings from a systematic review. <i>International Journal of Disaster Risk Reduction</i> . 22. 219-227.
2	Shukla, R., Sachdeva, K. and Joshi, P.K. 2018. Demystifying vulnerability assessment of agriculture communities in the Himalayas: a systematic review. <i>Natural Hazards</i> . 91(1). 409-429.
3	Singh, C., Deshpande, T. and Basu, R. 2017. How do we assess vulnerability to climate change in India? A systematic review of literature. <i>Regional Environmental Change</i> . 17(2). 527-538.
4	Nor Diana, M.I., Muhamad, N., Taha, M.R., Osman, A. and Alam, M. 2021. Social Vulnerability Assessment for Landslide Hazards in Malaysia: A Systematic Review Study. <i>Land</i> . 10(3). 315-323.
5	Asadzadeh, A., Kötter, T., Salehi, P. and Birkmann, J. 2017. Operationalizing a concept: The systematic review of composite indicator building for measuring community disaster resilience. <i>International Journal of Disaster Risk Reduction</i> . 25. 147-162.
6	Moreira, L.L., de Brito, M.M. and Kobiyama, M. 2021. A systematic review and future prospects of flood vulnerability indices. <i>Natural Hazards and Earth System Sciences</i> . 21(5). 1513-1530.
7	Salehi, S., Ardalan, A., Garmaroudi, G., Ostadtaghizadeh, A., Rahimiforoushani, A. and Zareiyan, A. 2019. Climate change adaptation: a systematic review on domains and indicators. <i>Natural Hazards</i> . 96(1). 521-550.
8	Smith, E.F., Keys, N., Lieske, S.N. and Smith, T.F. 2015. Assessing Socio-Economic Vulnerability to Climate Change Impacts and Environmental Hazards in New South Wales and Queensland, Australia. <i>Geographical Research</i> . 53(4). 451-465.
9	Yu, J., Castellani, K., Forsysinski, K., Gustafson, P., Lu, J., Peterson, E., Tran, M., Yao, A., Zhao, J. and Brauer, M. 2021. Geospatial indicators of exposure, sensitivity, and adaptive capacity to assess neighbourhood variation in vulnerability to climate change-related health hazards. <i>Environmental Health</i> . 20(1). 1-20.
10	Hagenlocher, M., Meza, I., Anderson, C.C., Min, A., Renaud, F.G., Walz, Y., Siebert, S. and Sebesvari, Z. 2019. Drought vulnerability and risk assessments: state of the art, persistent gaps, and research agenda. <i>Environmental Research Letters</i> . 14(8). 083002.
11	Reyes-García, V., Fernández-Llamazares, Á., Guèze, M., Garcés, A., Mallo, M., Vila-Gómez, M. and Vilaseca, M. 2016. Local indicators of climate change: the potential contribution of local knowledge to climate research. <i>Wiley Interdisciplinary Reviews: Climate Change</i> . 7(1). 109-124.
12	Kwazu, G. and Chang-Richards, A.Y. 2020. A metric of indicators and factors for assessing livelihood preparedness: A systematic review. <i>International Journal of Disaster Risk Reduction</i> . 52. 101966.
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Appendix 2: Systematic search strategy applied in Chapter One comprising i) search string selection, ii) inclusion and exclusion criteria, and iii) questions applied to conduct content analysis.

i) Search String Selection Method

Table i) The different search strings applied to the SLF and AR4 Framework in the Web of Science (Core Collection), Scopus and Google Search Engine.

Framework	Database	Search String
SLF	Web of Science/ Scopus	sustainab* AND livelihood* OR ("sustainable livelihood*" OR "SLF") AND (analys* OR framework OR assess*) AND (poverty OR poor OR vulnerability OR "socioeconomic level" OR "socioeconomic status" OR "low income" OR "inequality" OR "inequity") AND (communit* OR household*) AND rural
	Google	("sustainable livelihoods framework" OR "SLF" OR sustainable AND livelihoods) AND "vulnerability assessment"
AR4	Web of Science/ Scopus	vulnerab* AND (assess* OR framework OR ind*) AND (climat* OR "climat* change" OR "climat* variability") AND (communit* OR household*) AND rural
	Google	("IPCC" AND "AR3" OR "AR4") AND "vulnerability assessment"

ii) Inclusion and Exclusion Criteria

Table ii) The various components evaluated in the inclusion and exclusion criteria, along with the rationale for each.

Component	Criteria	Rationale
Timeframe	2014-2023	The publication of the IPCC AR5 framework in 2014 (IPCC 2014) marked a transitional period to the use of a more holistic framework.
Study Type	Peer-review papers and conference papers	The chapter was limited to peer reviewed articles and conference papers to allow for a certain level of 'robustness' in screening results
Application	Framework applied in its original context and is unmodified.	Studies are only considered if they apply a given framework in a largely unmodified manner, (for example adding an additional capital asset category would be accepted, however integrating three different pre-existing frameworks', and presenting this as a 'novel framework' is not considered).
Context	Frameworks are applied in the context of rural livelihoods, excluding any studies applied in built urban environments.	This chapter is centred around CBVAs applied within a rural context. This ensured a level of comparability between the indicators applied across frameworks, with a different group of indicators often applied within rural versus urban settings.
Scale	Frameworks applied at the community scale (aggregation to broader spatial scales included if the analysis is centred around community scale case studies).	This chapter is focused on community level vulnerability assessments.

Location	UN developing country categories 2022: least developed countries (LDC); landlocked developing countries (LLDC) and small island developing states (SIDS).	This chapter is centred around CBVAs applied within a low-income context. This ensured a level of comparability between the indicators applied across frameworks, with a different group of indicators often applied within low versus high income settings.
Analysis	Quantitative indicator-based	Studies that include purely qualitative information have been excluded from the analysis, focusing on the quantitative analysis of vulnerability using indicator-based studies. This is most common within studies applying the IPCC AR4 and SLF and better allowed for the examination of vulnerabilities limitations.

iii) Content Analysis Questions

Table iii) The questions applied to content analysis.

#	Question
1	How are popular CBVA frameworks distributed across time (e.g., year of publication)?
1a	What year was the article published?
2	Are there any methodological trends in CBVAs applied from the livelihoods and development and climate change adaptation fields?
2a	What is the sample size of the study (i.e., number of communities and number of households)?
2b	Did the study use a quantitative, qualitative or mixed methods analysis of vulnerability?
2c	What methods were used to determine the indicators applied to assess vulnerability?
2d	What methods were used for data collection purposes?
2e	Was a pilot study undertaken?
2f	What indicators were applied to quantify vulnerability within assessments?
2g	What methods of data analysis were undertaken?
3	Do SLF-based studies address framework limitations?
3a	How was vulnerability framed within CBVAs (i.e., was vulnerability based on internal socioeconomic conditions or exposure to external shocks and stressors)?
3b	Was exposure addressed as an empirical component within CBVAs?
3c	What indicators were used to assess exposure within CBVAs?
3d	Do CBVAs assess spatial scale as an empirical component of vulnerability (e.g., do studies include indicators representing i) higher levels institutions and governance; ii) interactions with the broader ecological landscape)?
3e	Do CBVAs assess temporal scale as an empirical component of vulnerability (e.g., do studies include analysis of historical conditions and future projections of vulnerability)?
4	Do AR4-based studies address framework limitations?
4a	Do CBVAs address both socioeconomic and biophysical factors within their analysis that correspond to key components of the SLF and IPCC AR4 framework (table 5)?
4b	Do CBVAs include a temporal analysis of socioeconomic vulnerability factors as an empirical component of vulnerability (e.g., do studies include analysis of historical conditions and future projections of vulnerability)?
4c	Do studies frame CBVAs around exposure to multiple drivers of change (e.g., exposure to multiple different shocks and stressors)?
4d	Do CBVAs include an empirical analysis of exposure to multiple drivers of change?

Appendix 3: Reference list of studies reviewed in Chapter One that implemented the Sustainable Livelihoods Framework (DFID 1999) (n=73), and the IPCC AR4 Vulnerability Framework (IPCC 2007) (n=101).

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Chapter Three

Appendix 4: Livelihoods-Based Risk Profiling Framework (LRPF) vulnerability guide comprising i) adaptive capacity and ii) sensitivity indicators

i) Adaptive Capacity Indicators

Human Capital

HC1: Dependency Ratio

Indicator Summary	
Indicator: The ratio of dependent (i.e., non-working) to non-dependent household members (i.e., working).	
Indicator Description: The number of household members that do not contribute to livelihood activities compared to the number of household members that contribute to livelihood activities.	
Measuring Unit: Ratio of dependent to non-dependent household members.	
Contribution to Adaptive Capacity	
Summary: A household with a higher dependency ratio will have a reduced capacity to adapt to hazard exposure.	
Justification: The dependency ratio highlights the potential responsibility that will be placed on economically active members of a household by dependents (i.e., children, the elderly and additional non-working household members). In the context of this approach, a higher dependency ratio represents lower adaptive capacity reflecting instances where economically active household members face a greater responsibility to support and provide for children and older or non-working household members (United Nations 2007). Households with a high dependency ratio are considered to be more vulnerable to hazards given that the young, elderly and non-working are more at risk of impact from exposure, and that a smaller proportion of the household is responsible in acquiring the necessary resources to provide for livelihood requirements (Mulyana et al. 2013).	
Indicator Method	
Indicator Origin & Adaptations	
Origins: This indicator calculates the dependency ratio within a household (non-working individuals/working individuals*100) rather than the more widely applied technique which calculates dependency ratios across populations (e.g., UN 2007). The household ratio method was applied to enable differences in adaptive capacity to be observed from within sub-groups of a community. By applying the household ratio method, this indicator can identify specific households that have a limited number of working adults to support dependents. Household level dependency ratios have been utilised in numerous livelihoods-based studies (Fang 2022; Hadley et al. 2011). These indicators typically calculate the number of working age (i.e., aged 15-64) to non-working age household members (i.e., children and the elderly).	
Adaptations: The method applied in this approach considered instances where working age adults did not contribute to a household, or non-working aged adults did. This information was obtained via data on the main livelihood activities conducted by each household member, with individuals conducting 'no activities' considered as dependents. By calculating dependency ratio based on contribution to livelihood activities, a more accurate representation for each household was obtained. This enabled factors such as disability, physical and mental health issues, engagement in education, etc., to be represented as a component of the dependency ratio. If a household did not contain any non-dependent members (i.e., no individuals conducted livelihood activities), then a high dependency ratio was assigned (e.g., 4:1 or 400%) and the household was assumed to have very low adaptive capacity in relation to this indicator. This assumed (validated during participant observation in Solomon Islands) that non-working households rely on family or community members for support.	
Data Collection Instrument	
Household Survey Question(s): What is the main livelihood activity conducted by each household member?	
Processing Steps	
Data Type	Integer/Continuous
1. Classify responses into dependents (1) those who are not contributing to livelihood activities, irrespective of age and non-dependents (2) those who are contributing to livelihood activities irrespective of age.	

Appendix 4

- Calculate the dependency ratio using the formula (number of non-working household members/number of working household members)*100). - Assign dependency ratio data ranks using below categories (based on equal interval binning from dependency ratio data range).			
Indicator Rankings			
Rank		Definition	Description
1	Very Low	321-400%	Very High Dependency Ratio
2	Low	241-320%	High Dependency Ratio
3	Medium	161-240%	Mid-Level Dependency Ratio
4	High	81-160%	Low Dependency Ratio
5	Very High	0-80%	Very Low Dependency Ratio
Key References			
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HC2: Health Condition

Indicator Summary
Indicator: The number of times in the last year household members missed their livelihood responsibilities due to being sick, ill or injured. Indicator Description: The amount of time household members were not able to go to work, attend the garden, collect food (e.g., fish or forage), go to school, etc., due to being sick, ill or injured. This proxy for health condition was measured on a scale reflecting where (1) livelihood activities have never been missed, to where (5) livelihood activities are missed all the time. A proxy measure of health condition was utilised given data limitations in household survey questions that attempted to obtain a more detailed understanding of the physical and mental health status of household members. Where such questions were asked (i.e., ‘how many members of your household suffer from a long-term health condition or disability’, and ‘would you mind sharing these conditions or disabilities’) data response bias was observed. This is likely attributed to the overly intimate nature of health associated questions in the rural communities where the LRP was operationalised. Measuring Unit: Number of time livelihood activities were missed in the last year (5-point Likert Scale: (1) never missed – (5) always missed).
Contribution to Adaptive Capacity
Summary: As the duration of time household members miss their livelihood responsibilities increases, their capacity to adapt to hazard exposure decreases. Justification: The use of ‘missed school or work’ (i.e., livelihood responsibilities) as a proxy measure for health condition is an indicator that has been widely applied in prior vulnerability assessments (Smith & Diedrich 2024). Mitchell & Bates (2011) and Marmot et al. (1995) evidenced this indicator to deliver an accurate representation of health status, finding a direct relationship between ill health and productivity loss (i.e., reduced amount and quality of labour). The significant negative relationship between poor health condition and an individual’s ability to contribute to livelihood responsibilities highlights the critical importance of this indicator as a component of adaptive capacity (Bleakley 2010). In the context of hazard exposure, households with high levels of ill health are assumed to be less capable of contributing to and participating in activities that may support households in adapting to or overcoming impacts from hazard exposure (Smith 2008).
Indicator Method
Indicator Origin & Adaptations
Origins: Measuring health security using the amount a household has missed ‘work or school’ due to ill health has been used as an indicator in many prior community based vulnerability assessments (e.g., Oo et al. 2018; Owusu et al, 2021; Panthi et al. 2016). In these assessments, this indicator is worded as ‘the amount of times household members missed school or work due to sickness, illness or injury’.

Adaptations: A minimal change in question wording was applied to cover the range of livelihood responsibilities that are conducted by rural households. By rephrasing ‘school or work’ as ‘livelihood responsibilities’ and providing a range of examples (e.g., not able to go to work, attend the garden, collect food (e.g., fish and forage), go to school, etc.,), the LRP approach aims to reduce confusion by survey respondents in relation to what constitutes ‘work’.			
Data Collection Instrument			
Household Survey Question: Were there any times in the past year that members of your household missed their livelihood responsibilities due to being sick, ill or injured? (5) no times; (4) a few times; (3) several times; (2) many times; (1) all the time. (e.g., not able to go to work, attend the garden, collect food (e.g., fish and forage), go to school, etc.,).			
Data Type		Ordinal	
1. Input survey data based on the 1-5 scale whereby high adaptive capacity = (5 - household members missed their livelihood responsibilities no times), and low adaptive capacity = (1 - household members missed their livelihood responsibilities all the time).			
Indicator Rankings			
Rank		Definition	Description
1	Very Low	All the time	Household missed their responsibilities all the time due to ill health.
2	Low	Many times	Household missed their responsibilities many times due to ill health.
3	Medium	Several times	Household missed their responsibilities several times due to ill health.
4	High	A few times	Household missed their responsibilities a few times due to ill health.
5	Very High	No times	Household never missed their responsibilities due to ill health.
Key References			
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HC3: Access to Healthcare

Indicator Summary	
Indicator: The amount of time a household can access healthcare in times of need.	
Indicator Description: The amount of time a household is capable of accessing healthcare in times of need ranging from (5) never; (4) rarely; (3) occasionally; (2) frequently and (1) all the time.	
Measuring Unit: Access to healthcare (amount of time) (5-Point Likert Scale: 1 (all the time) to 5 (never)).	
Contribution to Adaptive Capacity	
Summary: Households that struggle to access healthcare in times of need will have less capacity to adapt to hazard exposure.	
Justification: Access to healthcare is essential to build the resilience of a population and protect communities from a wide range of health issues. However, limited access to healthcare can reduce the ability of a household to detect, respond and reduce impact from health issues (Peters et al. 2008). Without healthcare access, treatable issues can become life threatening, and result in higher levels of morbidity within a community (Nugent 2008). Limited access to healthcare can additionally increase hazard exposure impacts, especially when a hazard has direct health implications. Where healthcare access is limited, hazard induced health issues can fail to receive essential and timely medical attention, treatment and rehabilitation (Ebi & Bowen 2016). Failure to receive preventative healthcare (e.g., vaccinations) can also increase the risk of transmissible diseases within a community (Kein 2008).	

Indicator Development			
Indicator Origin & Adaptations			
Origins: This indicator was developed in alignment with the World Health Organisation and United Nations access to essential health services (UN 2020a). The specific indicator utilised for this assessment comprised the amount of time a household lacks access to healthcare. This indicator has been utilised in numerous CBVAs as a metric of health security (e.g., Ahmad & Afzel 2022; Amevenku 2019; Phan 2019).			
Adaptations: A 5-point Likert scale was developed to represent the amount of time healthcare was not accessible for a household. This question type was selected for simplicity and ease of use, and to help prevent respondent fatigue given the number of indicators included in the LRP approach.			
Sampling Method			
Household Survey Question: In the past year, were there ever times when you or members of your household couldn't access healthcare? (5) never; (4) rarely; (3) occasionally; (2) frequently; (1) all the time.			
Data Type		Ordinal	
1. Input household survey data ranging from (1) household never has issues accessing healthcare (very low sensitivity) to (5) always has issues accessing healthcare (very high sensitivity) into standardised indicator rankings.			
Indicator Rankings			
Rank		Definition	Description
1	Very Low	All the Time	Household can never access healthcare.
2	Low	Frequently	Household frequently cannot access healthcare.
3	Medium	Occasionally	Household occasionally cannot access healthcare.
4	High	Rarely	Household rarely cannot access healthcare.
5	Very High	Never	Household always has access to healthcare.
Key References			
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HC4: Livelihood Diversity Index

Indicator Summary
Indicator: The number of unique livelihood activities that members of a household are engaged in.
Indicator Description: The number of unique livelihood activities (e.g., fishing, agriculture, tourism) that members of a household participate in.
Measuring Unit: Number of livelihood activities.
Contribution to Adaptive Capacity
Summary: The greater the number of livelihood activities a household engages in, the more capacity they have to adapt to hazard exposure.
Justification: Livelihood diversification is defined as the 'process by which rural families construct a diverse portfolio of activities and social support capabilities in order to survive and improve their standard of living' (Ellis 1998). A widespread number of studies report that livelihood diversification is beneficial for reducing livelihood risks and vulnerability (Liao & Fei 2017; Zhang et al. 2019), improving livelihood resilience and sustainability (Ifejika et al. 2014) relieving pressure on the environment (Hao et al. 2015), and alleviating poverty (Igwe 2013). Zhang et al. (2019) found a limited livelihood portfolio to be the most important driver

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of vulnerability in relation to climate change, highlighting the importance of this variable as a metric for use in vulnerability index.

Indicator Method

Indicator Origin & Adaptations

Origins: The index method used in this approach is representative of ‘household occupational diversity index’, which assesses the variety of unique occupations or activities pursued by household members throughout a given year. The method was replicated from Hahn et al. (2009), who use ‘number of livelihood activities reported by a household’ to measure agricultural livelihood diversity. In this method, the diversification index is represented as an inverse number, reflecting that an increase in livelihood activities decreases vulnerability.

Adaptations: The Hahn et al. (2009) indicator measures agricultural livelihood diversity, while the LRP addresses livelihood activities as any ‘action, task or endeavour that a household engages in to secure their means of living and sustain their livelihood’ (DFID 1999). The use of an inverse measure (as seen in Hahn et al. 2009) was not applied during the calculation of this indicator. This is due to the classification of livelihood diversity as a component of adaptive capacity. In this context, an increase in the number of activities conducted by a household will result in a direct increase in adaptive capacity, voiding the requirement for an inverse calculation.

Data Collection Instrument

Household Survey Question(s): What is the primary livelihood activity conducted by each household member? What other livelihood activities does each household member (including yourself) participate in?

Data Type Integer

1. List the types of primary livelihood activities and additional livelihood activities conducted within a household.
2. Sum the number of UNIQUE livelihood activities conducted by household members, to calculate the final livelihood diversity score.
3. Assign ranking scores based on the data range.

Indicator Rankings

Rank	Definition	Description
1	Very Low	0-1 Activities
2	Low	2-3 Activities
3	Medium	4-5 Activities
4	High	6-7 Activities
5	Very High	8-9 Activities

Key References

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- Liao, C. and Fei, D. 2017. Sedentarization as constrained adaptation: Evidence from pastoral regions in far north-western China. *Human Ecology*. 45. 23-35.
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HC5: Extent of Coping Strategies

Indicator Summary

Indicator: The extent to which a household perceives they can cope with locally relevant hazard exposure.

Indicator Description: This indicator determines the extent to which a household believes they are capable of coping with exposure to a range of locally relevant shock and stressor events (i.e., commercial logging, reductions in wild fish availability, sea level rise, flooding, increased rainfall, reduced rainfall, and

temperature increase). Coping strategies were measured on a 5-point Likert scale ranging from (1) strongly disagree (i.e., a household believes they have no strategies to cope with hazard exposure), to (5) strongly agree (i.e., a household believes they have a lot of strategies to cope with hazard exposure). The relative importance of a given shock or stressor to community members was used to weight, and combine the overall extent of coping strategies in a household. For example, coping strategies related to sea level rise were given a higher weighting in communities experiencing significant exposure to this stressor compared to other events (e.g., commercial logging). By incorporating these weightings inter-community variation in hazard exposure can be recognised, reflected in the relative importance assigned to coping strategies. Weighting scores for each community were obtained during focus group workshops where participants ranked the relative importance of locally relevant shock and stressor events.			
Measuring Unit: Extent of coping strategies (five-point Likert Scale: (1) none to (5) a lot of coping strategies)			
Contribution to Adaptive Capacity			
Summary: A household perceived to have a greater number of coping strategies to locally relevant shock and stressor events will have greater capacity to adapt to hazard exposure in the long-term.			
Justification: Short-term coping capacity has become increasingly important as a measure to protect communities from hazard exposure (Tanner et al. 2015). Defined by the IPCC (2014) as ‘the ability of a community or individual to address, manage, and overcome adverse conditions in the short to medium term’, coping capacity represents the strategies available to meet immediate needs and manage the impacts of hazard exposure. The short-term nature of coping is differentiated from longer-term adaptive capacity, which focuses on the ability of a community or individual to adjust, learn and evolve in the face of hazard exposure (Whitney et al. 2017). Despite these differences, there is correlation between the two terms, with strong coping capacity shown to positively contribute to adaptive capacity (Smit & Wandel 2006). This correlation is due to shared attributes that support both coping and adaption to hazard events (Yohe & Tol 2002). As such, households with a greater number of coping strategies will be more likely to both recover quickly and adapt to hazard events in the short-term and long-term (Smit & Wandel 2006).			
Indicator Method			
Indicator Origin & Adaptations			
Origins: Coping strategies are included in a minimal number of CBVAs, and commonly relate to a pre-dictated list of strategies related to a single shock or stressor event (e.g., Maikhuri et al. 2017). However, Likert scale questions have also been utilised to measure individual perceptions of coping capacity (e.g., Perlaviciute 2021). The range of clear responses in a Likert scale question, commonly ranging from ‘bad’ to ‘good’ enables participants to reflect upon and indicate the extent of their coping strategies in a manner that can be compared across households (Batterton & Hale 2017).			
Adaptations: Given the range of shock and stressor events addressed in the LRP, coping strategies were determined using a perception based measure. To do so, a Likert scale question was developed that enabled easy reflection on the extent of coping strategies held within a household based on a 5-point response.			
Data Collection Instrument			
Household Survey Question: Does your household have ways of coping with these problems? (1) strongly disagree; (2) disagree; (3) neither agree nor disagree; (4) agree; (5) strongly agree.			
Data Type		Ordinal	
1. Determine focus group outputs ranking hazards based on perceived impacts to local livelihoods. 2. Input survey responses onto a 1-4 scale (from (0) strongly disagree (i.e., household has no coping strategies), to (4) strongly agree (i.e., household has a lot of knowledge of coping strategies)), to obtain an overall understanding of the extent of household coping strategies for each type of hazard. 3. Multiply coping strategy scores by the rank of a given hazard. 4. Add coping strategy types together to calculate household scores, transformed into a % of the maximum possible score of combined ranks. 5. Rank household coping strategies using the following ranking categories.			
Indicator Rankings			
Rank		Definition	Description
1	Very Low	0-20%	Household has no strategies to cope with hazard exposure.
2	Low	21-40%	Household has very few strategies to cope with hazard exposure.
3	Medium	41-60%	Household has some strategies to cope with hazard exposure.
4	High	61-80%	Household has many strategies to cope with hazard exposure.
5	Very High	81-100%	Household has a lot of strategies to cope with hazard exposure.
Key References			
• Batterton, A.K. and Hale, N.K. 2017. The Likert Scale, what is it and when to use it. <i>Phalanx</i>. 50(2). 32-39			

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- Yohe, G. and Tol, J.S.R. 2002. Indicators for social and economic coping capacity – moving toward a working definition of adaptive capacity. *Global Environmental Change*. 12(1). 25-40.

Financial Capital

FC1: Household Savings

Indicator Summary

Indicator: The total amount of savings accumulated by a household.

Indicator Description: The total amount of savings in Solomon Islands Dollar (SI\$) that has been accumulated by a household based on the following categories (1) none; (2) less than \$250; (3) \$250-500; (4) \$500-1000; (5) more than \$1000.

Measuring Unit: Solomon Island Dollars (five-point Likert Scale: None – More than SI\$1000).

Contribution to Adaptive Capacity

Summary: The greater the amount of savings accumulated by a household, the greater their capacity to adapt to hazard exposure.

Justification: Low amounts of household savings can negatively impact adaptive capacity by reducing the availability of a financial cushion to absorb shocks and stressor events (Daramola et al. 2016). By holding savings, household are provided with a safety net that can be used to proactively adapt to challenges that exist within the local environment (Susilo et al. 2021). Low savings have also been shown to interact with limited resource access in relation to healthcare, education and other basic services, and can perpetuate a cycle of limited adaptive capacity across generations in situations where access to these resources is monetary dependent (Jones et al. 2022). The link between low savings and adaptive capacity has been empirically justified by Daramola et al. (2016) who found households without personal savings experience a 13.87x greater impact from hazard exposure than households with savings.

Indicator Method

Indicator Origin & Adaptations

Origins: Amount of household savings is a standardised indicator used to understand a households' accumulated funds and is applied by many agencies including the WorldBank (2020) and United Nations (2005) in addition to many published CBVAs (Smith & Diedrich 2024).

Adaptations: The savings categories (and associated values) for this indicator were developed in coordination with local experts and represent suitable income levels for rural communities in Solomon Islands. All savings-related questions were asked in the local currency of Solomon Island Dollars.

Data Collection Instrument

Household Survey Question: Approximately how much money does your household hold in savings? (1) none; (2) less than \$250; (3) \$250-500; (4) \$500-1000; (5) more than 1000; (0) don't know; (00) refuse to answer.

Data Type	Ordinal
1. Input household survey data relating to household savings. 2. Identify instances where households responded with 'don't know' or 'refuse to answer' and use average data imputation to replace this response. Average data imputation was identified as an appropriate mechanism to replace missing data given significant comparability across households in a community in relation to savings and the low rate of missing data (i.e., <5%) across the sample. 3. Rank household savings on a scale reflecting adaptive capacity (see below) ranging from very low (no savings) to very high (more than SI\$1000 savings).	

Indicator Rankings

Rank	Definition	Description
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1	Very Low	None	Household has no savings.
2	Low	Less than \$250	Household has savings valued at less than SI\$250.
3	Medium	\$251-500	Household has savings valued between SI\$251-500.
4	High	\$501-1000	Household has savings valued between SI\$501-1000.
5	Very High	More than \$1000	Household has savings valued at more than SI\$1000.

Key References

- Daramola, Y.A., Oni, T.O., Ogundele, O. and Adesanya, A. 2016. Adaptive capacity and coping response strategies to natural disasters. A study in Nigeria. *International Journal of Disaster Risk Reduction*. 15. 132-147.
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- United Nations. 2005. *Household sample surveys in developing and transition countries*. Department of Economic and Social Affairs, Statistics Division. United Nations, New York. 1-655.
- WorldBank. 2012. *Living standards measurement survey*. WorldBank, Washington DC. 1-17.

FC2: Household Income

Indicator Summary

Indicator: The amount of income a household acquires in a one-month period.

Indicator Description: The amount of income (in Solomon Island Dollars) a household makes from livelihood activities in a one-month period based on the following income categories 1) less than \$250; 2); \$250-500 3); \$500-1000 4) \$1-2000; 5) more than \$2000.

Measuring Unit: Solomon Island Dollars (five-point Likert Scale: None – More than SI\$2000).

Contribution to Adaptive Capacity

Summary: The greater a household's total monthly income, the greater their capacity to adapt to hazard exposure.

Justification: Low levels of income can negatively impact a household's ability to adapt to hazard exposure (Jin et al. 2016). This occurs through a number of mechanisms, including i) limited resource access; ii) high dependence on existing local resources; and iii) restricted access to infrastructure and services (Jones et al. 2022; Susilo et al. 2021). For example, households with low-income will have fewer available finances to invest in adaptive measures (i.e., resources) that can reduce potential impact from hazard exposure (Jones et al. 2022). This may also occur in instances where local natural resources (that households depend on for basic needs) are eroded (Susilo et al. 2021). In such instances, low-income households may not be capable of investing in alternate monetary-based resources that are available within or outside of the community (Jones et al. 2022). Finally, low-income households often have lower access to healthcare, education, sanitation, electricity etc., that contribute to adaptive capacity (Susilo et al. 2021).

Indicator Method

Indicator Origin & Adaptations

Origins: Average monthly income is a standardised indicator used to understand household income rates. This indicator is utilised by many agencies including the WorldBank (2020) and United Nations (2005) and within prior CBVA studies (Smith & Diedrich 2024).

Adaptations: The income categories (and associated values) for this indicator were developed in coordination with local experts and represent suitable income levels for rural communities in Solomon Islands. All income-related questions were asked in the local currency of Solomon Island Dollars.

Data Collection Instrument

Household Survey Question: How much money does your household make on average in one month? (1) less than \$250; (2); \$250-500 (3) \$500-1000; (4) \$1-2000; (5) more than \$2000; (0) Don't know; (00) Refused to answer.

Data Type Ordinal

1. Input household survey data relating to monthly income rates.
2. Identify instances where households responded with 'don't know' or 'refuse to answer' and use average data imputation to replace this response. Average data imputation was identified as an appropriate mechanism to replace missing data given significant comparability across households in relation to income level, and the low rate of missing data (i.e., <5%) across the sample.
3. Rank monthly income on a scale reflecting adaptive capacity (see below) ranging from very low (less than SI\$250) to very high (more than SI\$2000).

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Indicator Rankings			
Rank		Definition	Description
1	Very Low	Less than \$250	Household has a monthly income less than SI\$250
2	Low	\$251-500	Household has a monthly income between SI\$251-500
3	Medium	\$501-1000	Household has a monthly income between SI\$501-1000
4	High	\$1001-2000	Household has a monthly income between SI\$1001-2000
5	Very High	More than \$2000	Household has a monthly income of more than SI\$2000
Key References			
- Jin, J., Wang, W. and Wang, X. 2016. Adapting agriculture to the drought hazard in rural China: household strategies and determinants. <i>Natural Hazards</i>. 82. 1609-1619. - Jones, L.H.B., Unsworth, F.K.R., Nordlund, M.L., Elkof, S.J., Ambo-Rappe, R., Carly, F., Jiddawi, S.N., Nafie, A.Y., Udagedara, S. and Cullen-Unsworth. 2022. Dependence on seagrass fisheries governed by household income and adaptive capacity. <i>Ocean & Coastal Management</i>. 225. 106-126. - Smith, B. and Diedrich, A., 2024. A systematic review of current progress in community based vulnerability assessments. <i>Regional Environmental Change</i>, 24(1). 1-17. - Susilo, E., Purwanti, P., Fattah, M., Qurrata, A.V. and Namaditya, S.B. 2021. Adaptive coping strategies towards seasonal change impacts: Indonesian small-scale fisherman household. <i>Heliyon</i>. 7. 681-692. - United Nations. 2005. <i>Household sample surveys in developing and transition countries</i>. Department of Economic and Social Affairs, Statistics Division. United Nations, New York. 1-655. - WorldBank. 2012. <i>Living standards measurement survey</i>. WorldBank, Washington DC. 1-17.			

FC3: Household Expenditure

Indicator Summary	
Indicator: Household monthly expenditure on basic needs (e.g., food, water, housing, energy and healthcare).	
Indicator Description: The approximate amount a household spends per month on key basic needs including food, water, housing, energy and healthcare. Expenditure is based on the following categories: (1) none; (2) less than \$250; (3) \$250-500; (4) \$500-1000; (5) more than \$1000.	
Measuring Unit: Solomon Island Dollars (5-point Likert Scale: None – More than SI\$1000).	
Contribution to Adaptive Capacity	
Summary: The greater a household's monthly expenditure, the greater their capacity to adapt to hazard exposure.	
Justification: Expenditure has been used as a proxy indicator for wealth by Cinner et al. (2015) when evaluating adaptive capacity. In this context, higher expenditure reflects greater overall wealth, and thus greater adaptive capacity. This correlation has been empirically validated in numerous other studies; where increased expenditure was attributed to greater capacity for involvement in the formal economy, and increased ability to purchase resources required to achieve livelihood security (e.g., food, water, energy and healthcare) (Defiesta & Rapera 2014; Thathsarani & Gunaratne 2018).	
Indicator Method	
Indicator Origin & Adaptations	
Origins: Household expenditure is a commonly utilised indicator applied in prior CBVA studies (Smith & Diedrich 2024), and household expenditure per annum is the official indicator adopted by the Solomon Islands National Statistics Office within national surveys (SINS 2012). Expenditure-based questions commonly revolve around a household's total fortnightly (e.g., Cinner et al. 2015), or monthly, expenditure (e.g., Sekhampu & Niyimbanira 2013) across all livelihood outcome categories (e.g., food, water, housing, energy, healthcare).	
Adaptations: Monthly expenditure was selected as an indicator for this approach to best capture potential fluctuations, trends, and variation in expenses through time. The expenditure categories (and associated values) for this indicator were developed in coordination with local experts and represent suitable income levels for rural communities in Solomon Islands. All expenditure-related questions were asked in the local currency of Solomon Island Dollars.	
Data Collection Instrument	
Household Survey Question: Approximately how much money does your household spend in one month? (1) no expenditure; (2); less than \$250 (3) \$250-500; (4) \$500-1000; (5) more than \$1000; (0) Don't know; (00) Refused to answer.	
Data Type	Ordinal
1. Input household survey data relating to monthly expenditure.	

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2. Identify instances where households responded with ‘don’t know’ or ‘refuse to answer’ and use average data imputation to replace this response. Average data imputation was identified as an appropriate mechanism to replace missing data given significant comparability across households in relation to expenditure, and the low rate of missing data (i.e., <5%) across the sample.
3. Rank monthly expenditure on a scale reflecting adaptive capacity (see below) ranging from very low (no expenditure) to very high (monthly expenditure more than SI\$1000).

Indicator Rankings

Rank	Definition	Description
1	Very Low	No Expenditure
2	Low	Less than \$250
3	Medium	\$251-500
4	High	\$501-1000
5	Very High	More than \$1000

Key References

- Cinner, E.J., Huchery, C., Hicks, C.C., Daw, M.T., Marshall, N., Wamukota, A. and Allison, H.E. 2015. Changes in adaptive capacity of Kenyan fishing communities. *Nature Climate Change*. 5. 872-876.
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FC4: Income Satisfaction

Indicator Summary

Indicator: The extent to which a household is satisfied with their ability to purchase basic goods.

Indicator Description: Household income satisfaction level based on their ability to purchase basic goods required for survival (e.g., food, water, healthcare, energy and housing). Income satisfaction was measured on a scale ranging from (1) very dissatisfied; (2) somewhat dissatisfied; (3) neither satisfied or dissatisfied; (4) somewhat satisfied; (5) very satisfied.

Measuring Unit: Level of satisfaction (5-point Likert Scale: 1) very dissatisfied – 5) very satisfied).

Contribution to Sensitivity

Summary: The higher a household’s overall satisfaction with income, the greater their capacity to adapt to hazard exposure.

Justification: Objective income measures (e.g., FS2) assume a linear relationship between a greater level of income and a household’s ability to purchase basic goods and satisfy essential needs (e.g., purchase food, water, healthcare etc.) (Rojas 2008). Despite the importance of this metric, Camfield & Guillen-Royo (2009) have demonstrated that subjective income metrics (i.e., income satisfaction) can be of greater value in determining a household’s overall sense of well-being and equality based on income. This is associated to variation in the amount of income required to acquire basic goods across different contexts (Ahmad et al. 2016; Fafchamps & Shilip 2008). Subjective income measures have therefore been argued to provide greater clarity in relation to evaluation the overall ability for household income to support access to basic goods (Camfield & Guillen-Royo 2009).

Indicator Method

Indicator Origin & Adaptations

Origins: Satisfaction with income is a key indicator applied in the Canterbury Wellbeing Index as a component of overall life satisfaction. The indicator is collected via a household survey question that asks respondents ‘how well their household income supports them in meeting their everyday needs’ (Canterbury Wellbeing Index 2023). Income satisfaction has been recognised as a key indicator of well-being in numerous studies and has become a commonly utilised indicator in relation to income security and life satisfaction (Kubiszewski et al. 2018).

Adaptations: The wording of the household survey question reflecting income satisfaction was adapted during pilot testing to enhance clarity in the local context. Responses were separated into a 5-point Likert Scale ranging from 1) very dissatisfied to 5) very satisfied, reflecting the 5-point scale utilised in other

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financial capital LRP indicators. This also supported question simplicity, ease of use helped prevent respondent fatigue given the overall length of the household survey.			
Data Collection Instrument			
Household Survey Question: How satisfied are you with your ability to purchase the items your household needs to survive (e.g., food, water, healthcare, etc.,)?			
Data Type		Ordinal	
1. Input data reflecting household satisfaction within income ranging on a scale from (1) very dissatisfied (low adaptive capacity) to (5) very satisfied (high adaptive capacity).			
Indicator Rankings			
Rank		Definition	Description
1	Very Low	Very dissatisfied	Household is very dissatisfied with their income.
2	Low	Somewhat dissatisfied	Household is somewhat dissatisfied with their income.
3	Medium	Neither satisfied nor dissatisfied	Household is neither satisfied nor dissatisfied with their income.
4	High	Somewhat satisfied	Household is somewhat satisfied with their income.
5	Very High	Very satisfied	Household is very satisfied with their income.
Key References			
• Ahmad, F.N., Mansor, M. and Paim, L. 2016. Income poverty and well-being among vulnerable households: A study in Malaysia. <i>Asian Journal of Social Sciences</i>. 12(2). 1911-2023. • Camfield, L. and Guillen-Royo, M. 2001. Wants, needs and satisfaction: A comparative study in Thailand and Bangladesh. <i>Social Indicators Research</i>. 96. 183-203. • Canterbury Wellbeing Index. 2023. <i>Satisfaction with Income</i>. Canterbury Wellbeing Index. New Zealand. 1-7. • Fafchamps, M., and Shilpi, F. 2008. Subjective welfare, isolation, and relative consumption. <i>Journal of Development Economics</i>. 86. 43-60. • Kubiszewski, I., Zakariyya, N. and Costanza, R. 2018. Objective and subjective indicators of life satisfaction in Australia: How well do people perceive what supports a good life? <i>Ecological Economics</i>. 154. 361-372. • Rojas, M. 2008. Experienced Poverty and Income Poverty in Mexico: A Subjective Well-Being Approach. <i>World Development</i>. 36(6). 1078-1093. • Susilo, E., Purwanti, P., Fattah, M., Qurrata, A.V. and Namaditya, S.B. 2021. Adaptive coping strategies towards seasonal change impacts: Indonesian small-scale fisherman household. <i>Helivon</i>. 7. 681-692.			

FC5: Access to Financial Services

Indicator Summary	
Indicator: Household access to key financial services including bank accounts, pensions and loans.	
Indicator Description: Household utilisation of financial services comprising (1) bank accounts (e.g., daily accounts, and savings accounts), (2) pensions (and associated accounts) and (3) loans.	
Measuring Unit: The number of financial services accessed by a household (e.g., how many of the following does a household presently utilise; 1) bank accounts; 2) pensions and 3) loans?).	
Contribution to Adaptive Capacity	
Summary: Household's with access to a range of financial services will have a greater capacity to adapt to hazard exposure.	
Justification: Financial exclusion (i.e., lack of access to financial services including bank accounts, credit, pensions or loans) has been evidenced to reduce adaptive capacity by aggravating poverty and driving financial isolation (Kamran & Uusitalo 2016). When a household experiences financial exclusion, their ability to respond to hazard exposure is significantly reduced through a number of mechanisms. These include: i) limited ability to build and maintain a financial safety net through savings, access to loans etc., which can be used to recover from shocks or stressors or in times emergency (e.g., healthcare costs or repairs) (Christian et al. 2019); ii) limited ability to invest in opportunities that require money including education and skills development that may increase adaptive capacity (Messy & Monticone 2016) and; iii) limited ability to invest in adaptive planning mechanisms that may reduce the potential impact of hazard exposure in the long-term (Kamran & Uusitalo 2016).	
Indicator Method	
Indicator Origin & Adaptations	
Origins: Access to financial services is applied as an indicator in many CBVA studies (Smith & Diedrich 2024). These studies measure access to a variety of services including bank accounts, pensions, loans, credit, insurance and extension services. Access is most commonly measured based on a household's present utilisation of these services (e.g., Aguilar 2021; Ho 2021).	

Adaptations: The types of financial services assessed in this approach were selected based on discussions with local experts (i.e., in-country civil society organisations). This led to the identification of i) bank accounts; ii) pensions and iii) loans as the most important types of services in the local context. To create a consolidated indicator for access to financial services, a 4-point scale was developed whereby no access = very low adaptive capacity, and access to all three service types = very high adaptive capacity.			
Data Collection Instrument			
Household Survey Question: Does your household currently use any of the following services: 1) bank accounts; ii) pensions (and associated accounts) or; iii) loans?			
Data Type		Integer	
1. Input household access to financial service types (e.g., 1) bank accounts; 2) pensions; 3) loans).			
2. Rank access to financial services based on the following scores, whereby no access = (1) very low adaptive capacity and full access = (4) very high adaptive capacity.			
Indicator Rankings			
Rank		Definition	Description
1	Very Low	No Access	Household does not have access to any financial services
2	Low	Single Access	Household has access to a single financial service.
3	Medium	Dual Access	Household has access to two financial services.
4	High	Full Access	Household has access to all three financial services.
Key References			
• Aguilar, M.H.C., Altoveros, N.C., Borromeo, H.T., Dayo, F.H.M. and Koohafkan, P. 2021. Traditional rice-based agroecosystem in Kiangnan, Ifugao, Philippines: drivers of change, resilience and potential trajectories. <i>Agroecology and Sustainable Food Systems</i>. 45(2). 296-316. • Christian, P., Kandpal, E., Palaniswamy, N. and Rao, V. 2019. Safety nets and natural disaster mitigation: evidence from cyclone Phailin in Odisha. <i>Climatic Change</i>. 153. 141-164. • Ho, T.D., Kuwornu, J.K. and Tsusaka, T.W. 2021. Factors influencing smallholder rice farmers vulnerability to climate change and variability in the Mekong Delta region of Vietnam. <i>The European Journal of Development Research</i>. 1-31. • Kamran, S. and Uusitalo, O. 2016. Vulnerability of the unbanked: evidence from a developing country. <i>International Journal of Consumer Studies</i>. 40. 400-409. • Messy, A.F. and Monticone, C. 2016. Financial education policies in Asia and the Pacific. <i>OECD Working Paper on Finance, Insurance and Private Pensions</i>. No. 40. OECD Publishing. 1-66.			

Social Capital

SC1: Social Networks

Indicator Summary
Indicator: The number of social relationships a household can turn to for support in times of need.
Indicator Description: The number of individuals that a household can turn to for support if they need access to basic livelihood outcomes such as food, water, shelter, energy or healthcare.
Measuring Unit: Number of individuals within a households social network.
Contribution to Adaptive Capacity
Summary: The greater the number of individuals a household can turn to for support in times of need, the greater their capacity to adapt to hazard exposure.
Justification: The informal and formal social relationships (i.e., social networks) held by a household are a key component of adaptive capacity (Cinner et al. 2018). Well-connected households are capable of accessing their social relationships to obtain information, resources, support and opportunities to enhance their adaptive potential (Barnes et al. 2017). For example, information and knowledge related to hazard exposure is commonly shared across social networks, increasing the ability for a household to make appropriate adaptive decisions (Fazey et al. 2014). Social networks are also known to facilitate resource sharing and support in times of need, with individuals with strong social relationships more likely to share food, physical assets, money etc., (Islam & Nguyen 2018). Communities with strong social networks are also more likely to engage in collaborative adaptation actions, which often act as the best adaptive method when shocks and stressors are homogenous across the local environment (Nunan et al. 2018). Involvement in community-based actions can additionally enhance wellbeing by increasing a household's sense of belonging and cohesion with neighbours (Lai et al. 2021), whilst providing greater access to community-based opportunities such as livelihood activities and market access (Nunan et al. 2018).
Indicator Method
Indicator Origin & Adaptations

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Origins: Information on the number of social relationships a household relies on for support has been evidenced to provide basic empirical insight into social network responses, and correspondingly adaptive capacity (Misra et al. 2017). Counting the number of social relationships has been used as an indicator in many CBVA studies (Smith & Diedrich 2024). Evidence suggests that most households have a social network of close friends and family numbering between 5-12 individuals (Dunbar & Spoors 1995). As such, this was deemed an appropriate question metric for the LRP social network indicator.			
Adaptations: n/a			
Data Collection Instrument			
Household Survey Question: If you suddenly needed access to water, food, shelter, energy or healthcare, how many people that are not members of your household could you turn to for help? 1) no one; 2) 1-2 people; 3) 3-4 people; 4) >5 people; 5) >10 people.			
Data Type		Ordinal	
1. Input responses from the household survey reflecting the number of social relationships held by a household.			
2. Rank the number of social relationships according to the following ranking categories, whereby 1) no social relationships = (1) very low adaptive capacity and 5) >10 social relationships = (5) very high adaptive capacity.			
Indicator Rankings			
Rank		Definition	Description
1	Very Low	No One	A household has no one to turn to in times of need.
2	Low	1-2 People	A household has 1-2 people to turn to in times of need.
3	Medium	3-4 People	A household has 3-4 people to turn to in times of need.
4	High	>5 People	A household has >5 people to turn to in times of need.
5	Very High	>10 People	A household has >10 people to turn to in times of need.
Key References			
• Barnes, L.M., Wang, P., Cinner, E.J., Graham, A.J.N., Guerrero, M.A., Jasny, L., Lau, J., Sutcliffe, R.S. and Zamborain-Masno, J. 2020. Social determinants of adaptive and transformative responses to climate change. <i>Nature Climate Change</i>. 10. 823-828. • Cinner, E.J. and Barnes, L.M. 2019. Social dimensions of resilience in social-ecological systems. <i>One Earth</i>. 1. 51-56. • Dunbar, M.I.R. and Spoors, M. 1995. Social networks, support cliques and kinship. <i>Human Nature</i>. 6. 273-290. • Fazey, J., Bunse, L., Msika, J., Pinke, M., Preedy, K., Evely, C.A., Lambert, E., Hastings, E., Morris, S. and Reed, S.M. 2014. Evaluating knowledge exchange in interdisciplinary and multi-stakeholder research. <i>Global Environmental Change</i>. 25. 204-220. • Islam, A. & Nguyen, C. 2018. Do networks matter after a natural disaster? A study of resource sharing within an informal network after Cyclone Aila. <i>Journal of Environmental Economics and Management</i>. 90. 249-268. • Lai, S., Zhou, Y. & Yuan, Y. 2021. Associations between community cohesion and subjective wellbeing of the elderly in Guangzhou China – A cross sectional study based on the structural equation model. <i>International Journal of Environmental Research and Public Health</i>. 18. 953-960. • Misra, S., Goswami, R., Mondal, T. and Jana, R. 2017. Social networks in the context of community response to disaster: Study of a cyclone affected community in Coastal West Bengal, India. <i>International Journal of Disaster Risk Reduction</i>. 22. 28-296. • Nunan, F., Cepic, D., Mbilingi, B., Odongkara, K., Yongo, E., Owili, M., Salehe, M., Mlahagaw, E. and Onyango, P. 2018. Community cohesion: Social and economic ties in the personal networks of fisherfolk. <i>Society & Natural Resources</i>. 31(3). 306-319.			

SC2: Inclusion in Decision Making

Indicator Summary
Indicator: The extent of household satisfaction with its inclusion in community level decision making.
Indicator Description: The extent to which a household is satisfied with their role in community level decision making, varying from i) strongly disagree; ii) disagree; iii) neither agree nor disagree; iv) agree; v) strongly agree.
Measuring Unit: Extent of satisfaction with decision making capacity. (5-point Likert Scale: Strongly Disagree – Strongly Agree).
Contribution to Adaptive Capacity
Summary: Households with higher levels of satisfaction with their inclusion in community decision making will have a greater capacity to adapt to hazard exposure.
Justification: Household ability to be involved in local scale decision making has been shown to have an overall positive influence on social capital and adaptive capacity (Ensor et al. 2009). This relationship occurs through a number of mechanisms, whereby involvement in decision making causes individuals with limited

capacity to implement adaptive actions, or make decisions for themselves, to experience increased opportunity to benefit from applied management actions when involved in decision making activities (Smit & Wandel 2006). Involvement in decision making also supports the development of 'fair adaptation' that provides equal benefit to community members with different socioeconomic characteristics (Paavola & Adger 2006); and increases the likelihood these adaptation strategies will be adopted, given their increased reflection of local desires, wants, and aspirations (Patterson et al. 2009). Finally, inclusion in decision making has been shown to drive an increase in trust of community members and leaders, further contributing to social capital and adaptive capacity (Ensor et al. 2015).

Indicator Method

Indicator Origin & Adaptations

Origins: Decision making capacity is a commonly utilised indicator in studies applying the Sustainable Livelihoods Framework (SLF) (Smith & Diedrich 2024), measured via Likert scale questions that obtain information on a household's perceived level of involvement (e.g., Arthur et al. 2020; Bisseleua et al. 2018; Freduah et al. 2018; Lin et al. 2019).

Adaptations: n/a

Data Collection Instrument

Household Survey Question: Are you happy with your level of involvement with decisions that are made in your community? 1) strongly disagree; 2) disagree; 3) neither agree nor disagree; 4) agree; 5) strongly agree.

Data Type Ordinal

1. Input responses from household survey regarding perceived levels of satisfaction with involvement in community decision making where 1) strongly disagree = (1) a household is very dissatisfied with their level of involvement in decision making equates to very low adaptive capacity and, to 5) strongly agree = (5) household is very satisfied with their level of involvement in decision making equates to very high adaptive capacity.

Indicator Rankings

Rank	Definition	Description
1	Very Low	Very Dissatisfied
2	Low	Somewhat Dissatisfied
3	Medium	Neither Satisfied Nor Dissatisfied
4	High	Somewhat Satisfied
5	Very High	Very Satisfied

Key References

- Arthur, L.J., Murray, G., Rollins, R., Dearden, R. and Stahl, A. 2020. Differential impacts of dam construction on livelihoods in Ghana. *African Geographical Review*. 39(3). 267-281.
- Bisseleua, B.H.D., Idrissou, L., Olurotimi, P., Ogunniyi, A., Mignouna, D. and Bamire, A.S. Multi-stakeholder process strengthens agricultural innovations and sustainable livelihoods of farmers in Southern Nigeria. *The Journal of Agricultural Education and Extension*. 24(1). 29-49.
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- Smith, B. and Diedrich, A., 2024. A systematic review of current progress in community based vulnerability assessments. *Regional Environmental Change*. 24(1). 1-17.

SC3: Local Institutional Membership

Indicator Summary

Indicator: Household membership in local institutions (e.g., groups, organisations and associations).

Indicator Description: The number of local institutional (e.g., groups, organisations and associations) memberships held by a household. During household surveys, community members were asked to list their institutional memberships. These were later cross-checked against a complete list of community-based institutions obtained during key informant interviews with community leaders. A full list of institutional types was developed for each community, and the number of memberships per household summed. This number was then used to reflect adaptive capacity, whereby 0 memberships = low adaptive capacity and >5 memberships = high adaptive capacity.			
Measuring Unit: The number of local groups, organisations and associations a household is a member of.			
Contribution to Adaptive Capacity			
Summary: The greater the number of institutions a household is a member of, the greater their capacity to adapt to hazard exposure.			
Justification: In the context of the Sustainable Livelihoods Framework institutional access refers to the organisations, associations and groups that exist to govern local processes, and reflect systems of rules, regulations and norms (DFID 1999). Yaro et al. (2014) provide evidence to support the positive association between institutional membership and adaptive capacity. This highlights the role institutions play in influencing social interactions between members (through the legitimisation of rules, norms and practices), whilst also enhancing members ability to access shared resources to enhance adaptive capacity, including natural resources and knowledge (Agrawal et al 2008; Yaro et al. 2014). Positive interactions have also been seen between institutional membership and a household’s ability to contribute to local scale decision making, assessed as an additional component of social capital in this approach (Malakar 2013).			
Indicator Method			
Indicator Origin & Adaptations			
Origins: Membership to local organisations, associations and groups is a common indicator applied within CBVAs to assess household involvement in local-scale institutions (Smith & Diedrich 2024). Within these studies, membership is normally measured by i) obtaining an understanding of the institutions a household is member of based on an open-ended response question; or ii) listing all available local institutions and asking a household to check off those they are member to (e.g., Gai 2018; Kuuwill et al. 2022; Mallick 2020; Pour 2018). For this indicator the first approach was utilised, with households asked to free list their institutional memberships.			
Adaptations: The ranking categories for this indicator were developed following data collection. This was based on significant contextual variation in the number of institutions households are a member of. In the context of this approach, no household was member to more than 4 groups, organisations or associations, as such, a 0-4 range was dictated for the adaptive capacity ranking scale.			
Data Collection Instrument			
Household Survey Question: Please list any community-based (i.e., local) groups, organisations, or associations that your household belongs to.			
Data Type		Text	
1. List the total number of local institutions available within a community based on qualitative information obtained from key informant interviews, cross-checked with a full list of institutions obtained during household surveys.			
2. Sum the number of institutions a household is a member of within a community (and cross-check this list against the full list of available institutions developed in step 1).			
3. Rank household membership to local institutions where very low membership (and adaptive capacity) = 0 institutions, and very high membership (and adaptive capacity) = >5 institutions.			
Indicator Rankings			
Rank		Definition	Description
1	Very Low	0 Memberships	Household is not member to local institutions.
2	Low	1 Membership	Household is member to a single local institutions.
3	Medium	2 Memberships	Household is member to several local institutions.
4	High	3 Memberships	Household is member to a few local institutions.
5	Very High	4 Memberships	Household is member to many local institutions.
Key References			
• Agrawal, A., Chhatre, A. and Hardin, R. 2008. Changing governance of the world’s forests. <i>Science</i>. 320. 1460-1472. • DFID. 1999. <i>Sustainable Livelihood Guidance Sheets</i>. Department for International Development. London, United Kingdom. 1-150. • Gai, A.M., Soewarni, I. and Sir, M.M. 2018. <i>The concept of community poverty reduction in coastal area of Surabaya based on sustainable livelihood approach</i>. In. IOP Conference series: Earth and Environmental Science. 137(1). 120-129. • Kuuwill, A., Kimensgi, N.J. and Campion, B.B. 2022. Pandemic induced shocks and shifts in forest based livelihoods			

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- Yaro, A.J., Teye, J. & Bawakyillenuo, S. 2015. Local institutions and adaptive capacity to climate change/variability in the northern savannah of Ghana. *Climate and Development*. 7(3). 235-245.

SC4: Satisfaction with Leadership

Indicator Summary

Indicator: The extent to which a household is satisfied with the leadership in their community.

Indicator Description: The extent to which household members are satisfied with the leadership in their community, ranging from (1) strongly disagree; (2) disagree; (3) neither agree nor disagree; (4) agree; (5) strongly agree.

Measuring Unit: Satisfaction with leadership. (5-point Likert Scale: Strongly Disagree – Strongly Agree).

Contribution to Adaptive Capacity

Summary: The greater a household's satisfaction with community leadership, the greater their capacity to adapt to hazard exposure.

Justification: Diedrich et al. (2019) found satisfaction with leadership to be the most influential aspect of social capital in relation to small scale fishing communities in Papua New Guinea. This was attributed to the role leadership plays in achieving positive success in natural resource management (Diedrich et al. 2017). Leadership satisfaction has also been found to have a direct correlation with the equitable distribution of economic benefits linked to natural resource use, and general access to resources (Banks 2008). In association to adaptive capacity, higher income levels and access to natural resources increase a household's ability to respond to hazard exposure (Jin et al. 2016). When community members are more satisfied with leadership, they have also been found to increase their support of community-level adaptation (Gutierrez et al. 2011).

Indicator Method

Indicator Origin & Adaptations

Origins: Satisfaction with leadership has been applied in many CBVAs as a component of social capital (e.g., Diedrich et al. 2019; Islam et al. 2019; Rampengan et al. 2016). Studies generally utilise a basic household survey question comprising 'are you satisfied with the leadership in your village' to measure this indicator.

Adaptations: The household survey question used the word 'happy' to assess satisfaction with leadership. This decision was based on local expert knowledge and survey pilot testing, with 'happy' deemed more interpretable in the local context.

Data Collection Instrument

Household Survey Question: How much do you agree with the following statement? I am happy with the leadership in my community. (1) Strongly disagree; (2) Disagree; (3) Neither Agree nor Disagree; (4) Agree; (5) Strongly Agree.

Data Type Ordinal

1. Input responses from household survey reflecting if a household is satisfied with the leadership in their community varying from (1) strongly disagree (very low adaptive capacity) to (5) strongly agree (very high adaptive capacity).

Indicator Rankings

Rank	Definition	Description
1	Very Low	Very Dissatisfied
2	Low	Somewhat Dissatisfied
3	Medium	Neither Satisfied nor Dissatisfied
4	High	Somewhat Satisfied
5	Very High	Very Satisfied

Key References

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- Banks, G. 2008. Understanding ‘resource’ conflicts in Papua New Guinea. *Asia-Pacific Viewpoint*. 49. 23-34.
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SC5: Trust

Indicator Summary

Indicator: The level of trust a household has in community members.

Indicator Description: The extent to which household members trust the people in their community, ranging from (1) strongly disagree; (2) disagree; (3) neither agree nor disagree; (4) agree; (5) strongly agree.

Measuring Unit: Extent of trust (5-point Likert Scale: Strongly Disagree – Strongly Agree).

Contribution to Adaptive Capacity

Summary: The greater a household’s level of trust towards fellow community members, the greater their capacity to adapt to hazard exposure.

Justification: Trust in community members is an important component of adaptive capacity (Folke et al. 2005). High levels of trust are evidenced to increase resource exchange between community members, stimulate innovative thinking, and increase the overall success of community-based governance activities (Pelling & Hugh 2005). These benefits are attributed to the role trust plays in encouraging community members to work together to achieve shared objectives and feel accountability in relation to the management of a community and its resources (Agrawal & Chhatre 2006).

Indicator Method

Indicator Origin & Adaptations

Origins: Trust is a complex concept, which if assessed comprehensively encompasses a broad range of indicators spanning trust in individuals, place, leadership etc., (Di Napoli et al. 2019). In the context of this approach, a comprehensive assessment of trust was unfeasible given potential respondent fatigue and time-availability in relation to household survey questions. As such, a common indicator to assess trust applied within CBVAs was selected, which primarily related to household trust in community members (Smith, B. & Diedrich, A. 2023). Using a statement-based question to assess trust is a common household survey technique. In this context, respondents are asked to respond to a statement such as ‘I trust the members of my community’ using a Likert-scale response system ranging from strongly agree to strongly disagree (Yamagishi & Yamagishi 1994). This technique was used to assess trust in the LRP index approach.

Adaptations: n/a

Data Collection Instrument

Household Survey Question: How much do you agree with the following statement? I trust the people in my community. (1) strongly disagree; (2) disagree; (3) neither agree nor disagree; (4) agree; (5) strongly agree.

Data Type Ordinal

1. Input responses from household survey reflecting if a household trusts the people in their community varying from (1) strongly disagree (very low adaptive capacity) to (5) strongly agree (very high adaptive capacity).

Indicator Rankings

Rank	Definition	Description
1	Very Low	Strongly Disagree
2	Low	Disagree
3	Medium	Neither Agree nor Disagree
		Household strongly disagrees with the statement ‘I trust the people in my community’.
		Household disagrees with the statement ‘I trust the people in my community’.
		Household neither agrees nor disagrees with the statement ‘I trust the people in my community’.

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4	High	Agree	Household agrees with the statement ‘I trust the people in my community’.
5	Very High	Strongly Agrees	Household strongly agrees with the statement ‘I trust the people in my community’.
Key References			
• Agrawal, A. and Chhatre, A. 2006. Explaining success on the commons: Community Forest governance in the Indian Himalaya. <i>World Development</i>. 34(1). 149-166. • Di Napoli, I., Dolce, P. and Arcidiacono, C. 2019. Community Trust: A social indicator related to community engagement. <i>Social Indicators Research</i>. 145(1). 551-579. • Folke, C., Hahn, T., Olssen, P. and Norberg, J. 2005. Adaptive governance of social-ecological systems. <i>Annual Review of Environmental Resources</i>. 30. 441-473. • Smith, B. and Diedrich, A., 2024. A systematic review of current progress in community based vulnerability assessments. <i>Regional Environmental Change</i>, 24(1). 1-17. • Pelling, M. and Hugh, C. 2005. Understanding adaptation: what can social capital offer assessments of adaptive capacity? <i>Global Environmental Change</i>. 15(4). 308-319. • Yamagishi, T. & Yamagishi, M. 1994. Trust and commitment in the United States and Japan. <i>Motivation and Emotion</i>. 18. 129-166.			

SC6: Collective Action

Indicator Summary			
Indicator: The extent of household participation in community-based activities.			
Indicator Description: The extent to which a household participates in community-based activities ranging from; 1) never; 2) rarely; 3) sometimes; 4) frequently and 5) all the time.			
Measuring Unit: The extent (e.g., rated amount of time) a household participates in community activities. (5-point Likert Scale: (1) Never – (5) All the time).			
Contribution to Adaptive Capacity			
Summary: Households that exhibit greater involvement in community-based activities will have a greater capacity to adapt to hazard exposure.			
Justification: Collective action refers to the steps taken by a group of people (e.g., a community) that have chosen to engage in a common action or activity in pursuit of a shared goal or interest (Matta & Alavalpati 2006). Collective action has been shown to positively contribute to adaptive capacity by i) supporting the establishment and strengthening of social networks, ii) improving access to local financial resources, iii) supporting individual and collective empowerment and, iv) offering a forum for community members to communicate and resolve problems (Adger 2003; Ireland & Thomella 2011).			
Indicator Method			
Indicator Origin & Adaptations			
Origins: At the household level, collective action is commonly represented by the extent of a household’s involvement in community-based activities (Meinzen-Dick et al. 2004). The use of Likert-based measures for this indicator provides households with a structured self-assessment of their level of participation in community-based activities, in a manner that is straightforward and easy to understand. Measurement of household participation using a Likert Scale has been used to assess collective action in many previous vulnerability assessments (e.g., Brown 2018; Kaskoya 2017; Phan 2019).			
Adaptations: n/a			
Data Collection Instrument			
Household Survey Question: In the past year, did anyone in your household participate in any community activities? (1) never; (2) rarely; (3) sometimes; (4) frequently; (5) all the time.			
Data Type		Ordinal	
1. Input responses from household survey question onto the standardised indicator ranking scale whereby (1) never = very low adaptive capacity and (5) all the time = very high adaptive capacity.			
Indicator Rankings			
Rank		Definition	Description
1	Very Low	Never	Household members never participate in community activities.
2	Low	Rarely	Household members rarely participate in community activities.
3	Medium	Sometimes	Household members sometimes participate in community activities.
4	High	Frequently	Household members frequently participate in community activities.
5	Very High	All the Time	Household members always participate in community activities.
Key References			

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SC7: Fair Access to Livelihood Opportunities

Indicator Summary

Indicator: Household perception of fair access to livelihood opportunities within their community.

Indicator Description: The extent to which a household believes there is fair access to new economic opportunities within their community, ranging from (1) strongly disagree; (2) disagree; (3) neither agree nor disagree; (4) agree and (5) strongly agree.

Measuring Unit: Perception of fair access (5-point Likert Scale: Strongly Disagree – Strongly Agree).

Contribution to Adaptive Capacity

Summary: The more a household believes there is fair access to new economic opportunities within their community, the greater their capacity to adapt to hazard exposure.

Justification: Fair access to resources has been deemed an important component of adaptive capacity, supporting a household's ability to build preparedness and develop adaptation strategies to overcome hazard exposure (Cafer et al. 2019). Fairness-based indicators provide an understanding of marginalisation within a community, where access to resources (such as income) may be limited (Williamson et al. 2012). Research has found perceptions of fairness to be representative of resource access, with low perceptions (i.e., limited fair access) reflective of corruption, marginalisation, and poor community relationships (Bennett et al. 2014). Unfair access to income can reduce household adaptive capacity by i) limiting resource access, ii) increasing dependence on existing resources that may be degraded, and iii) restricting access to infrastructure and services required to achieve livelihood outcomes (e.g., food, water, housing, energy, income and healthcare security) (Jones et al. 2022; Susilo et al. 2021). Whilst there is no one measure of fairness, access to income making opportunities (e.g., livelihood activities) was selected for this approach to reflect the importance of alternate livelihood activities as a component of adaptive capacity. This stems from the major adaptive opportunity access to alternative livelihoods has played in many rural environments, supporting local development and reducing impacts from hazard exposure (e.g., Cinner et al. 2018; Thulstrup 2015).

Indicator Method

Indicator Origin & Adaptations

Origins: Fairness based indicators are not a common component of CBVAs (Smith & Diedrich 2024). However, there is significant evidence to support their value for inclusion as a component of adaptive capacity (Cafer et al. 2019; Williamson et al. 2012). Where measures of fairness are included in household surveys, they are commonly related to perceived levels of resource access (e.g., Braun et al. 2008; Howley et al. 2008; Sharkey et al. 2010). This justified the use of a perception-based metric to quantify fairness within the LRP index.

Adaptations: This indicator was developed based on previous household survey questions that measure fairness based on Likert scale responses (e.g., Braun et al. 2008; Howley et al. 2008; Sharkey et al. 2010). Adaptations were made to suit the specific information required for this indicator, with the phrase 'access to new economic opportunities' selected following discussions with local experts.

Data Collection Instrument

Household Survey Question: How much do you agree with the following statement? Access to new economic opportunities within my community is fair. (1) strongly disagree; (2) disagree; (3) neither agree nor disagree; (4) agree; (5) strongly agree.

Data Type	Ordinal
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Appendix 4

1. Input responses from household survey whereby (1) strongly disagree that access to new economic opportunities is fair = very low adaptive capacity, to (5) strongly agree that access to new economic opportunities is fair = very high adaptive capacity.			
Indicator Rankings			
Rank		Definition	Description
1	Very Low	Strongly Disagree	Household strongly disagrees that resource access is fair.
2	Low	Disagree	Household disagrees that resource access is fair.
3	Medium	Neither Agree nor Disagree	Household neither agrees nor disagrees that resource access is fair.
4	High	Agree	Household agrees that resource access is fair.
5	Very High	Strongly Agree	Household strongly agrees that resource access is fair.
Key References			
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Physical Capital

PC1: Access to Livelihood Assets

Indicator Summary
Indicator: Household access to key assets required to support livelihoods.
Indicator Description: Household access to key goods and infrastructural assets that are required to support local livelihoods. The asset types included in this indicator were developed in coordination with a local civil society organisation in Solomon Islands and comprise: i) generator; ii) fridge or freezer; iii) boat, canoe, OBM, or other forms of transport; iv) communication devices including mobile phones or radios, v) the internet; vi) land for gardening and vii) access to equipment types required for agriculture/gardening, fishing and livestock rearing. This indicator reflects the percentage access a household has to different assets based on their relative importance to livelihoods. For example, access to assets of higher relative importance will give households a higher overall indicator score, compared to households that only have access to assets deemed of relatively low importance.
Measuring Unit: Number of assets owned by a household.
Contribution to Adaptive Capacity
Summary: Household's with greater access to livelihoods-based assets will have greater capacity to adapt to hazard exposure.
Justification: Access to livelihoods-based goods and infrastructure plays a key role in influencing adaptive capacity, directly influencing a household's ability to conduct livelihood activities and respond to shock and stressor events. For example, a household that lacks access to transport may be incapable of accessing resources and services such as healthcare, food markets, etc., (Daramola et al. 2016). A similar interaction

occurs in relation to household access to communication devices, which can support resource and service access, whilst additionally acting as an early warning system to advise households of upcoming hazard events (Thatsarani & Gunaratne 2018). Access to generators, fridges and gardening land have a direct role in a household's ability to produce and store food in the short and long-term (Daramola et al. 2016). Access to livelihoods-based equipment ensure a steady supply of resources, whilst also enabling households to adapt to cope with periods of environmental/resource instability (Blakie & Wisner 2014). Access to livelihood equipment can also support income stability, by reducing dependence on externally sourced equipment (Li et al. 2020).

Indicator Method

Indicator Origin & Adaptations

Origins: Access to goods and infrastructure required to support livelihoods is a widely applied indicator in many CBVAs (Smith & Diedrich 2024). These studies generally assess if a household has access (based on a yes or no response) to infrastructure (e.g., transport, communication devices etc., (e.g., Becker 2017; Fischer 2021; Rampengan 2016)) and goods (e.g., agricultural (e.g., Azami & Shanazi 2020) and fisheries (e.g., Brown 2018) based equipment).

Adaptations: The LRP assessed household access to key infrastructure and goods deemed important to livelihoods in the local context of Solomon Islands. This was based on expert knowledge from a local civil society organisation. For livelihoods-based equipment, activity types followed the major activities occurring within partner communities (i.e., farming, kitchen gardening, fishing and livestock production). The LRP index used an open-ended question format to enable households to free list the equipment and tools owned, ensuring the full range of items were captured within responses.

Data Collection Instrument

Household Survey Question: Does your household have access to any of the following items? i) generator; ii) fridge or freezer; iii) boat, canoe, OBM or other forms of transport; iv) communication devices including mobile phones or radios, v) the internet; vi) land for gardening, vii) fishing equipment (please specify); viii) farming equipment (please specify); ix) livestock (please specify).

Data Type Integer

1. Input access to asset types (Y/N), for livelihoods equipment, including the full list of available equipment types. (This process led to the identification of n=21 asset types important to support livelihoods in the local context; (1) generator; (2) fridge/freezer; (3) boat/canoe; (4) OBM; (5) other transport types; (6) communication devices; (7) internet; (8) land for gardening; (9) fishing line; (10) fishing hook; (11) fishing bolt; (12) diving gun; (13) diving spear; (14) net; (15) knife; (16) hoe; (17) axe; (18) bow; (19) spade; (20) pitchfork; (21) pig; (22) chicken).
2. Conduct Principal Component Analysis (PCA) using R package 'prcomp' to assign relative importance weightings to each asset type. Calculate rotation loadings for each PCA component and use % variance explanations (75.00%) to calculate the weighting of each livelihood-based asset. Sum asset types using the following equation where: $Resource\ Access = (Resource_1 * Weight_1) + (Resource_2 * Weight_2)$ etc., to obtain a final output for resource access. Normalise final indicator outputs onto a 0-1 scale to allow for comparability across the sample.
3. Categorise into indicator rankings where low access = very low adaptive capacity, and high access = very high adaptive capacity.

Indicator Rankings

Rank	Definition	Description
1	Very Low	0-20% Access
2	Low	21-40% Access
3	Medium	41-60% Access
4	High	61-80% Access
5	Very High	81-100% Access

Key References

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Natural Capital

NC1: Fair Access to Natural Resources

Indicator Summary

Indicator: Household perception of fair access to natural resources within their community.

Indicator Description: The extent to which a household believes there is fair access to natural resources within their community, ranging from (1) strongly disagree; (2) disagree; (3) neither agree nor disagree; (4) agree and (5) strongly agree.

Measuring Unit: Perception of equitable access (5-point Likert Scale: Strongly Disagree – Strongly Agree).

Contribution to Adaptive Capacity

Summary: The more a household believes there is fair access to natural resources within their community, the greater their capacity to adapt to hazard exposure.

Justification: Fair access to resources has been deemed an important component of adaptive capacity, supporting a household's ability to build preparedness and develop adaptation strategies to overcome hazard exposure (Cafer et al. 2019). Fairness based indicators provide an understanding of marginalisation within a community, where access to natural resources may be limited (Williamson et al. 2012). Research has found perceptions of fairness are representative of resource access, with low perceptions (i.e., limited equitable access) reflective of corruption, marginalisation, and poor community relationships (Bennett et al. 2014). Unfair access to natural resources can reduce household adaptive capacity by i) limiting access to food, water, housing, energy or income; and ii) increasing dependence on degrading or depleting resource types (Jones et al. 2022; Susilo et al. 2021). Fair access to natural resources is essential in rural communities that heavily depend on the environment to access basic goods (Jones et al. 2022). Fair access to natural resources additionally enables households to access services that support adaptation, including land for gardening, access to food stocks, and protection from hazard exposure through natural buffers such as mangroves and coastal wetlands (DFID 1999).

Indicator Method

Indicator Origin & Adaptations

Origins: Natural capital indicators are not a common within CBVAs (Smith & Diedrich 2024). However, there is significant evidence to support their value for inclusion as a component of adaptive capacity (Cafer et al. 2019; Williamson et al. 2012). Where natural capital has been assessed studies commonly use perceptions of resource access, rather than a direct measurement of the availability of natural resource stocks (Chepkoech et al. 2020; Nawrotzki et al. 2012). This finding justified the use of a perception-based metric to quantify fair access to natural resources within the LRP vulnerability index.

Adaptations: n/a

Data Collection Instrument

Household Survey Question: How much do you agree with the following statement? Access to natural resources in my community is fair: (1) strongly disagree; (2) disagree; (3) neither disagree nor agree; (4) agree; (5) strongly agree.

Data Type Ordinal

1. Input responses from household survey whereby (1) strongly disagree that access to new economic opportunities is fair = very low adaptive capacity, to (5) strongly agree that access to new economic opportunities is fair = very high adaptive capacity.

Indicator Rankings

Appendix 4

Rank		Definition	Description
1	Very Low	Strongly Disagree	Household strongly disagrees that resource access is fair.
2	Low	Disagree	Household disagrees that resource access is fair.
3	Medium	Neither Agree nor Disagree	Household neither agrees nor disagrees that resource access is fair.
4	High	Agree	Household agrees that resource access is fair.
5	Very High	Strongly Agree	Household strongly agrees that resource access is fair.
Key References			
- Bennett, J.N., Dearden, P., Murray, G. and Kadfak, A. 2014 The capacity to adapt? Communities in a changing climate, environment, and economy on the northern Andaman coast of Thailand. <i>Ecology & Society</i>. 19(2). 1-21. - Cafer, A., Green, J. and Goreham, G. 2019. A community resilience framework for community development practitioners building equity and adaptive capacity. <i>Community Development</i>. 50. 201-216. - Chepkoech, W., Mungai, W.N., Stober, S. and Lotze-Campen, H. 2020. Understanding adaptive capacity of smallholder African indigenous vegetable farmers to climate change in Kenya. <i>Climate Risk Management</i>. 27. 100-123. - Jones, L.H.B., Unsworth, F.K.R., Nordlund, M.L., Elkof, S.J., Ambo-Rappe, R., Carly, F., Jiddawi, S.N., Nafie, A.Y., Udagedara, S. and Cullen-Unsworth. 2022. Dependence on seagrass fisheries governed by household income and adaptive capacity. <i>Ocean & Coastal Management</i>. 225. 106-126. - Nawrotzki, J.R., Hunter, M.L. and Dickinson, W.T. 2014. Rural livelihoods and access to natural capital: Differences between migrants and non-migrants in Madagascar. <i>Demographic Research</i>. 26(10). 123-129. - Susilo, E., Purwanti, P., Fattah, M., Qurrata, A.V. and Namaditya, S.B. 2021. Adaptive coping strategies towards seasonal change impacts: Indonesian small-scale fisherman household. <i>Heliyon</i>. 7. 681-692. - Smith, B. and Diedrich, A., 2024. A systematic review of current progress in community based vulnerability assessments. <i>Regional Environmental Change</i>, 24(1). 1-17. - Williamson, T., Hessel, H. and Johnston, M. 2012. Adaptive capacity deficits and adaptive capacity of economic systems in climate change vulnerability assessment. <i>Forest Policy and Economics</i>. 1. 160-166.			

ii) Sensitivity Indicators

Water Insecurity

WS1: Access to Drinking Water

Indicator Summary
Indicator: Household has access to improved sources of drinking water within a 30-minute return distance.
Indicator Description: Household has access to an improved source of drinking water as defined by the World Health Organisation (i.e., piped water, borehole, tube well, protected dug well, protected spring, packaged water, and rainwater) within a 30-minute return distance from the household. Whereby: - Very low sensitivity = drinking water is obtained from an improved source within the home. - Low sensitivity = drinking water is obtained from an improved source within 30 minutes from home. - Moderate sensitivity = drinking water is obtained from an improved source >30 minutes from home. - Drinking water is obtained from an unimproved water source (e.g., dug well or unprotected stream). - Drinking water is obtained from an unimproved water source (e.g., surface water comprising rivers, dams, lakes, ponds, streams, canals or irrigation channels).
Measuring Unit: i) Drinking water source and ii) distance of source from household.
Contribution to Sensitivity
Summary: Households with access to an improved source of drinking water close to home are considered to be less sensitive to water insecurity following hazard exposure.
Justification: Access to unimproved water sources is linked to the transmission of diseases such as cholera, diarrhoea, dysentery, hepatitis A, typhoid, and polio and has been shown to be a leading cause of morbidity and mortality, especially among children (Fowad et al 2021). Households with access to unimproved water sources are more likely to be impacted by these health conditions, reducing their overall livelihood security and their ability to respond to hazard exposure. Consumption of contaminated water also has economic implications associated to medical costs. In relation to distance from household, when water sources are located further from the home they take more time and physical effort to access, reducing time spent on productive activities, and limiting accessibility for less able individuals (WHO 2022).
Indicator Method
Indicator Origin & Adaptations

Appendix 4

Origins: This indicator was developed by the World Health Organisation and UNICEFs joint water monitoring programme (JMP) to support accurate information on drinking-water access. The indicator utilises household water source as a proxy for whether a household has access to improved (i.e., safe) drinking water (WHO 2006). The indicator requires information on the primary source of drinking water utilised by a household and separates this into i) improved and ii) unimproved sources. Where improved drinking water sources include piped water, boreholes, tube well, protected dug well, protected spring, packaged water and rainwater; and unimproved sources include unprotected dug wells, springs and surface water (WHO 2006). Water source is then paired with the total number of minutes it takes to obtain drinking water. The JMP transformed this information into a 5-point drinking water ladder, reflecting household access to safely managed water sources. This scale was directly utilised to generate indicator rankings.			
Adaptations: n/a			
Data Collection Instrument			
Household Survey Question(s): What source(s) of water do you use for drinking in your household? Which of these sources is most important? Approximately how long does it take you to obtain drinking water from these sources (return time)?			
Data Type		Text, Integer	
1. Identify the most important drinking water source used by a household and categorise response into (1) improved sources of drinking water (e.g., piped water, boreholes, tube well, protected dug wells, protected springs, packaged water, rainwater), (2) unimproved water sources (e.g., unprotected dug well, spring) and (3) surface water (e.g., river, dam, lake, pond, stream, canal, irrigation channel) as designated by the World Health Organisation.			
2. Categorise distance responses into (1) 0 minutes – in/around shelter; (2) <30 minutes; (3) <30 minutes.			
3. Rank responses using the following ranking categories based on the JMP ladder classifications for household drinking water services.			
Indicator Rankings			
Rank		Definition	Description
1	Very Low	Improved Access	Drinking water obtained from an improved drinking water source located within/next to a homestead.
2	Low	Basic Access	Drinking water obtained from an improved water source with a collection time of less than 30 minutes.
3	Medium	Limited Access	Drinking water obtained from an improved water source where collection time exceeds 30 minutes.
4	High	Unimproved Access	Drinking water obtained from an unprotected dug well or unprotected stream.
5	Very High	Surface Water	Drinking water collected from surface water (e.g., river, dam, lake, pond, stream, canal, irrigation channel).
Key References			
• Fowad, M., Mahvish, M., Tajammal, M. and Javaria, A. 2021. Water and sanitation risk exposure in children under-five in Pakistan. <i>Journal of Family and Community Medicine</i>. 28(2). 103-109. • WHO. 2006. <i>Core Questions on Drinking-Water and Sanitation for Household Surveys</i>. World Health Organisation and UNICEF. Geneva, Switzerland. 1-24. • WHO. 2022. <i>Guidelines for drinking-water quality: Fourth edition, incorporating the first and second addenda</i>. World Health Organisation. • JMP. 2023. Drinking Water. World Health Organisation. Available from: https://washdata.org/monitoring/ drinking water			

WS2: Water Sufficiency

Indicator Summary	
Indicator: Household has access to sufficient quantities of water to meet basic needs.	
Indicator Description: The amount of time a household lacks access to the quantity of water required to meet basic needs ranging from 1) never; 2) rarely; 3) occasionally; 4) frequently; 5) all the time.	
Measuring Unit: Amount of time (5-point Likert scale: 1) never to 5) all the time).	
Contribution to Sensitivity	
Summary: The more time a household lacks access to sufficient volumes of water, the more sensitive they are to water insecurity following hazard exposure.	
Justification: Water sufficiency evaluates the ability of a household to obtain sufficient quantities of water to meet basic needs. The indicator has been shown to be particularly important in rural contexts, where water sufficiency is impacted by seasonal and topographical changes, and accessibility can be hampered based on	

transport availability (Calow et al. 2010; Dickson et al. 2016). In relation to sensitivity, households with limited water sufficiency will be more likely to be impacted by external shock and stressor events that influence water access (e.g., droughts) (Khastagir & Jayasuriya 2010). This is particularly prevalent in relation to climate change and natural resource extraction activities such as logging which can result in water source contamination associated to chemical use and sedimentation (Kumar et al. 2020; Minter & Van der Ploeg 2023).

Indicator Method

Indicator Origin & Adaptations

Origins: Drinking water sufficiency is utilised as an indicator within the SIIVA as a component of water security (SPC 2016). The LRP index attempts to closely align sensitivity indicators with the SIVA approach where households are asked if their 'water supply meets household needs', with Likert-scale response categories comprising 1) never; 2) rarely; 3) sometimes and 4) all the time.

Adaptations: Household survey responses were extended to cover a 5-point Likert scale ranging from 1) never to 5) all the time. This adaptation occurred to allow for comparability with other water-security based indicators that are represented on a 5-point scale, whilst also supporting further differentiation between instances of water insufficiency.

Data Collection Instrument

Household Survey Question(s): Over the past year, how often have you NOT been able to access a sufficient volume of water to meet household requirements, on a scale from (1) never to (5) all the time.

Data Type Ordinal

1. Input responses from survey question whereby: low sensitivity (1) = household never lacks access to sufficient quantities of water, and high sensitivity (5) = household lacks access to sufficient quantities of water all the time.

Indicator Rankings

Rank	Definition	Description
1	Very Low	Never
2	Low	Rarely
3	Medium	Occasionally
4	High	Frequently
5	Very High	All the Time

Key References

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WS3: Water Quality

Indicator Summary

Indicator: The extent to which a household is satisfied with the quality of their drinking water.

Indicator Description: The extent to which a household is satisfied with their drinking water quality ranging on a scale from 1) very satisfied; 2) somewhat satisfied; 3) neither satisfied nor unsatisfied; 4) somewhat unsatisfied and 5) very unsatisfied.

Measuring Unit: Household satisfaction (5-point Likert Scale: 1) very satisfied to 5) very unsatisfied).

Contribution to Sensitivity

Summary: Household's with higher levels of water quality dissatisfaction will be more sensitive to water insecurity following hazard exposure.

Justification: Poor water quality makes water unsafe for use by households, thereby reducing water availability and imposing multiple health implications and environmental impacts (Mishra et al. 2021). Water quality is heavily influenced by global change pressures including climatological factors such as drought, in

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addition to pollution via the intensification of human populations and activities (Lese et al. 2021). Results from several studies have shown that satisfaction with water quality can be linked to the presence of contaminants etc., within a water source (Delpa et al. 2020; Lee & Lee 2015).

Indicator Method

Indicator Origin & Adaptations

Origins: Drinking water quality is utilised as an indicator within the SIIVA as a component of water security (SPC 2016). The LRP index attempts to closely align sensitivity indicators with this approach given its application in Solomon Islands. Within the SIIVA water quality is measured by asking a household if they believe their drinking water supply is safe for consumption, with responses varying from 1) almost all of the time to 4) never.

Adaptations: Water quality was measured by extent of satisfaction rather than the amount of time a household believes their water supply is safe (SPC 2016). This adaptation was selected due to the ability for satisfaction to capture not only the objective aspects of water quality (i.e., chemical and biological composition), but also the subjective experience of the individuals consuming the water. This considers the needs and preferences of households and their willingness to consume different types of water sources (Denantes & Donoso 2021).

Data Collection Instrument

Household Survey Question: How happy are you with the quality of your drinking water? 1) very satisfied; 2) somewhat satisfied; 3) neither satisfied nor unsatisfied; 4) somewhat unsatisfied; 5) very unsatisfied.

Data Type Ordinal

1. Input household survey responses whereby 1) very satisfied (very low sensitivity) and 5) very unsatisfied (very high sensitivity).

Indicator Rankings

Rank	Definition	Description
1	Very Low	Very Satisfied
2	Low	Somewhat Satisfied
3	Medium	Neither Satisfied nor Unsatisfied
4	High	Somewhat Unsatisfied
5	Very High	Very Unsatisfied

Key References

- Delpa, I., Legay, C., Proulx, F. and Rodriguez, J.M. 2020. Perception of tap water quality: Assessment of the factors modifying the links between satisfaction and water consumption behaviour. *Science of the Total Environment*. 722. 136-145.
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WS4: Access to Sanitation

Indicator Summary

Indicator: Household has access to an improved form of sanitation.

Indicator Description: Household has access to an improved form of sanitation (i.e., household does not practice open defecation), that is utilised by a single family (i.e., private).

Measuring Unit: i) Type of sanitation (e.g., most improved (slab toilet with flush), improved (slab toilet with pour) and unimproved (open defecation) and ii) number of households utilising sanitation type (e.g., private or shared).

Contribution to Adaptive Capacity

Summary: Household's that lack access to a private and improved form of sanitation will be more sensitive to water insecurity following hazard exposure.

Justification: Access to improved sanitation is a key contributor to health, wellbeing and water security. Unimproved sanitation practices (e.g., open defecation) have a range of impacts, including public health

issues, child mortality and reductions in ecosystem quality (Giribabu et al. 2019). Open defecation has been implicated in high rates of infectious disease transmission and is a major driver of ill health in the areas where it is practiced (Freeman et al. 2017). Open defecation is of particular concern in areas that utilise groundwater and natural water sources for drinking, with consumption associated to high rates of waterborne diseases (Giribabu et al. 2019). To enhance water security, slab toilets have been introduced in rural areas, comprising slab pours (e.g., a toilet flushed with a bucket of water) or flush pours (e.g., a toilet with a mechanical flushing device). Of the two types, slab flush toilets are generally considered better in terms of healthcare. This is attributed to reduced contact with human waste and pathogens, and the effective removal of waste from mechanical flushing which further reduces the spread of waterborne diseases (Meili et al. 2021).

Indicator Method

Indicator Origin & Adaptations

Origins: Access to sanitation is an indicator that has been developed by the World Health Organisation, whereby households are asked the type of toilet facility that they utilise. The World Health Organisation classifies unimproved sanitation types as i) open defecation, and ii) slab toilets with pour, and improved sanitation as i) slab toilets with flush (WHO 2006). Additional sanitation practices are listed by the World Health Organisation however these were not relevant in the context of Solomon Islands where the LRP was applied.

Adaptations: This indicator differentiates slab toilets with pour as an ‘improved’ sanitation type, elevating slab toilet with flush to ‘most improved’. This variation from the WHO indicator has taken place given significant differences in incidences of mortality and disease transmission between these type of sanitation practices (Giribabu et al. 2019). Differences in disease transmission have also been observed between households utilising shared versus private toilets, with shared toilets more likely to harbour pathogens (Meili et al. 2021). This has led to the development of shared versus private toilet type as an additional sanitation-based indicator within a number of studies (e.g., Evans et al. 2017; Meili et al. 2021), and was thus integrated as a component within the LRP indicator.

Data Collection Instrument

Household Survey Question: What is the main type of toilet facility used by your household? Do you share this facility with any other households?

Data Type

Ordinal

1. Input household survey data categorising type of toilet facility responses into 1) most improved (e.g., slab toilet with flush); 2) improved (e.g., slab toilet with pour) and 3) unimproved (e.g., open defecation).
2. Input household survey data categorising the number of households using a sanitation type into 1) shared or 2) private.
3. Combine type of toilet facility and number of households using a toilet facility and classify into the following ranking categories.

Indicator Rankings

Rank	Definition	Description
1	Very Low	Most improved
2	Low	Improved (private)
3	Medium	Improved (shared)
4	High	Unimproved (private)
5	Very High	Unimproved (shared)

Key References

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Food Insecurity

FS1: Food Sufficiency

Indicator Summary		
Indicator: Household has uninterrupted access to sufficient volumes of food to meet household requirements.		
Indicator Description: Household has access to food at all times at a rate that meets household requirements.		
Measuring Unit: Extent of food sufficiency (5-point Likert scale: 1 – never lack access to sufficient volumes of food to meet household requirements; to 5 – always lack access to sufficient volumes of food to meet household requirements).		
Contribution to Sensitivity		
Summary: A household with uninterrupted access to sufficient volumes of food to meet requirements will be less sensitive to food insecurity following hazard exposure.		
Justification: Food sufficiency refers to instances where a household has enough food to meet their basic dietary needs (Coates et al. 2007). If a household has enough food, it is considered food sufficient. Food sufficiency is a fundamental component of food security. When a household cannot access enough food, they may begin to suffer from undernutrition, malnutrition and micronutrient deficiencies (Siddiqui et al. 2020). In time, this lack of food can lead to long term health issues including stunted growth, impaired cognitive development and increased risk of disease (Siefert et al. 2004). Food insufficiency can also drive economic and social impacts within a household. This is commonly observed when households attempt to combat food insufficiency by lending or selling assets, increasing a household's risk of poverty (Siddiqui et al. 2020). Food insufficiency can be further compounded by hazard exposure (Wheeler & Von Braun 2013). This is of particular relevance in rural environments that depend on self-production (i.e., gardening and fishing) for their food intake (Schwarz et al. 2013). Significant evidence has documented the negative impacts of natural hazards (such as climate change), and human activities (such as land use change), on the productivity of home-grown and caught food products, with flow on implications for food sufficiency (Thanichanon et al. 2018; Wheeler & Von Braun 2013).		
Indicator Method		
Indicator Origin & Adaptations		
Origins: The Household Food Insecurity Access Scale (HFIAS) developed by Coates et al. (2007) is a widely applied indicator representing food sufficiency. The indicator works by addressing 9 food occurrence related questions measuring access to sufficient volumes of food to meet household requirements. Households are asked to reflect on instances where they lacked sufficient food access in the previous four weeks, with responses recorded on a 4-point Likert scale comprising lack of access occurring 1) never; 2) rare, 3) sometimes and 4) often.		
Adaptations: The HFIAS indicator was not applied in its entirety in the LRP. Instead, the most essential question related to food sufficiency was extracted from the HFIAS (i.e., 'how often did your household does not have enough food') and applied as a standalone metric of food sufficiency. This basic measure has been utilised within a number of previous vulnerability assessments (e.g., Busse 2017; Pham et al. 2020), and has been evidenced to provide a quick, accurate, direct and culturally sensitive metric of food sufficiency (Webb et al. 2022). This adaptation was made given the extensive nature of the LRP household survey, with a streamlined food sufficiency indicator helping prevent participant fatigue. Likert-scale responses were additionally extended to a 5-Point scale given the use of this range across the majority of indicators within the LRP index.		
Data Collection Instrument		
Household Survey Question(s): In the past four weeks, how many times has the following question statement applied: your household did not have enough food? Respond on a scale from (1) never; (2) rarely; (3) sometimes; (4) often; (5) always		
Data Type		Ordinal
1. Input household survey responses into ranking categories whereby (1) very low sensitivity = household never lacked access to sufficient volumes of food, and (5) very high sensitivity = household lacked access to sufficient volumes of food all the time.		
Indicator Rankings		
Rank	Definition	Description

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1	Very Low	Never	Household never lacked access to sufficient volumes of food.
2	Low	Rarely	Household rarely lacked access to sufficient volumes of food.
3	Medium	Sometimes	Household sometimes lacked access to sufficient volumes of food.
4	High	Often	Household often lacked access to sufficient volumes of food.
5	Very High	All the time	Household lacked access to sufficient volumes of food all the time.
Key References			
- Busse, A.H., Jogo, W., Fofanah, M., Tesfay, H., Hadush, M., Kiflom, E. and Schulz, S. 2017. Participatory assessment of factors influencing nutrition and livelihoods in rural Ethiopia: Implications for measuring impacts of multisector nutrition programmes. <i>Food and Nutrition Bulletin</i>. 38(4). 468-484. - Coates, J., Swindale, A. and Bilinsky, P. 2007. <i>Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide (v3)</i>. Food and Nutrition Technical Assistance Project, Academy for Educational Development. Washington, US. 1-36. - Pham, T.T.N., Nong, D., Sathyan, R.A. and Garschagen, M. 2020. Vulnerability assessment of households to flash floods and landslides in the poor upland regions in Vietnam. <i>Climate Risk Management</i>. 28. 121-135. - Schwarz, M.A., Bene, C., Bennett, G., Boso, D., Hilly, Z., Paul, C., Posala, R., Sibiti, S. and Andrew, N. 2011. Vulnerability and resilience of remote rural communities to shocks and global changes: Empirical analysis from Solomon Islands. <i>Global Environmental Change</i>. 21(3). 1128-1140. - Siddiqui, F., Salam, A.R., Lassi, Z.S. and Das, K.J. 2020. The intertwined relationship between malnutrition and poverty. <i>Frontiers in Public Health</i>. 8. 453-464. - Siefert, K., Heflin, M.C. and Williams, R.D. 2004. Food insufficiency and physical and mental health in a longitudinal survey of welfare recipients. <i>Journal of Health and Social Behaviour</i>. 45(2). 204-218. - Thanichanon, P., Schmidt-Vogt, D., Epprecht, M., Henimann, A. and Wiesmann, U. 2018. Balancing cash and food: The impacts of agrarian change on rural land use and wellbeing in Northern Laos. <i>PLOS One</i>. 13(12). 166-189. - Webb, P., Coates, J. and Houser, R. 2002. Allocative responses to scarcity: Self-reported assessments of hunger compared with conventional measures of poverty and malnutrition in Bangladesh. <i>Food Policy and Applied Nutrition</i>. 20(13). 1-41. - Wheeler, T. and Von Braun, J. 2013. Climate change impacts on global food security. <i>Science</i>. 341(6415). 508-513.			

FS2: Food Diversity

Indicator Summary

Indicator: The frequency of consumption of different food groups during the previous 7 days.

Indicator Description: Proxy measurement for dietary diversity representing the number of days a household has consumed different types of food groups in the previous week (i.e., 7 days), multiplied by a food groups nutritional value. Food groups include i) main staples (e.g., rice, flour, roots and tubers), ii) pulses (e.g., grains and nuts); iii) vegetables; iv) fruits; v) meat; vi) fish; vii) dairy; viii) sugar and ix) oil.

Measuring Unit: Number of days a household has consumed different food groups.

Contribution to Sensitivity

Summary: The larger a household's food consumption score (i.e., the greater the amount of nutritionally rich food groups a household consumed in the previous 7-day period) the lower a household's sensitivity to food insecurity following hazard exposure.

Justification: Consuming a range of diverse food types that are rich in nutrients (e.g., minerals, proteins and vitamins) is a vital component of food security (World Food Programme 2015). A household that consumes a range of nutritionally rich food sources on a daily basis will be less at risk of malnutrition and associated health related issues. In contrast, a household that relies on a narrow range of nutritionally limited food sources may develop nutritional deficiencies (Verger et al. 2021). Households with limited dietary diversity may also be more at risk of impact from hazard exposure where hazards restrict access to nutritionally diverse food types. In these instances, household food security will be heavily compromised if alternate food sources are not available (Niles et al. 2021).

Indicator Method

Indicator Origin & Adaptations

Origins: The Food Consumption Score (FCS) was developed by the World Food Programme (2015). The FCS measures household dietary diversity by determining a 7-day day recall of the types of food groups a household has consumed and the frequency of consumption, which is then compared against each food groups nutritional value (Sileshi et al. 2012). The FCS indicator was selected to represent dietary diversity in the LRP over the Dietary Diversity Index Score developed by the Fanta II Project (Kennedy et al. 2011). This decision reflects the improved ability of the FCS to incorporate the nutritional value of food types as a component of dietary diversity. In this way, the FCS reflects not only the variety of food types a household has consumed, but also overall energy intake and nutritional value (Kennedy et al. 2010). The data collection and indicator calculation method for the FCS has been outlined below.

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Adaptations: Indicator Rankings were developed based on the range of FCS scores across all case study communities, allowing for the development of a 5-point indicator scale.

Data Collection Instrument

Household Survey Question: How many times has your household eaten these different types of food in the past week (7 days)? i) main staples (e.g., rice, flour, roots and tubers), ii) pulses (e.g., grains and nuts); iii) vegetables; iv) fruits; v) meat; vi) fish; vii) dairy; viii) sugar and ix) oil.

Data Type	Integer
1. List the number of days each food group was consumed by a household.	
2. Multiply the number of days each food group was consumed by a household based on the nutritional value designated by WFP (2015). i.e., days consumed x nutritional weight = weighted value.	

Food Group	1) Days Consumed	Nutritional Weight	2) Weighted Value
Main Staples	6	2	12
Pulses	1	3	3
Vegetables	6	1	6
Fruit	3	1	3
Meat & Fish	4	4	16
Dairy	1	4	4
Sugar	1	0.5	0.5
Oil	1	0.5	0.5

3. Sum the values of each food group to obtain a food consumption score.

$$\text{FCS} = 12 + 3 + 6 + 3 + 16 + 4 + 0.5 + 0.5$$

4. Use the indicator rankings listed below to designate a sensitivity rank for food consumption scores based on the total range of FCS across partner communities. Whereby very low sensitivity (1) = very high food consumption score (i.e., household has consumed a large amount of nutritional foods over the previous 7 days), and very high sensitivity (5) = very low food consumption score (i.e., household has consumed a small amount of nutritional foods over the previous 7 days).

Indicator Rankings

Rank	Definition	Description	
1	Very Low	89.7 – 112.00	Household has a very high food consumption score.
2	Low	67.3 – 89.6	Household has a high food consumption score.
3	Medium	44.9 – 67.2	Household has a moderate food consumption score.
4	High	22.5 – 44.8	Household has a low food consumption score.
5	Very High	0.00 - 22.4	Household has a very low food consumption score.

Key References

- Kennedy, G., Berardo, A., Papavero, C., Horjus, P., Ballard, T., Dop, M.C., Delbaere, J. and Brouwer, D.I. 2010. Proxy measures of household for food security assessment and surveillance: comparison of the household dietary diversity and food consumption scores. *Public Health Nutrition*. 13(12). 2010-2018
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Housing Insecurity

HS1: Housing Condition

Indicator Summary

Indicator: The type of material used for the roof, flooring and walls of a household's shelter.

Indicator Description: The walls, floor and roof of a household’s shelter are comprised of strong materials (e.g., iron, timber and concrete) that will be capable of withstanding shock and stressor events.			
Measuring Unit: Type of material (i.e., solid or weak).			
Contribution to Sensitivity			
Summary: Household’s with solid shelters (i.e., the walls, floor and roof are made of strong housing materials) will be less sensitive to housing insecurity following hazard exposure.			
Justification: Poor housing condition (i.e., structures comprised of weak materials) increases the sensitivity of a household to impact from exposure to physical shock and stressor events such as flooding, cyclones, and storm surges (Ajibade & McBean 2014). Households with shelters comprised of weak materials are also more likely to be impacted by seasonal weather events such as monsoonal rainfall (Haddad et al. 2022). Poor housing condition can create a cycle of additional physical and psychological challenges, with negative impacts on health and wellbeing (Bonnefoy 2007). Costs of maintenance and repair can also increase a household’s financial sensitivity and reduce adaptive capacity by forcing a household to spend their time and resources on improving housing condition (Barnett 2010).			
Indicator Method			
Indicator Origin & Adaptations			
Origins: Housing condition is addressed in many CBVAs based on the types of material used for the roofs, walls, and flooring of a shelter (Smith & Diedrich 2024). Housing condition has also been utilised as an SDG indicator, with the structural quality and durability of housing materials a key component of ‘adequate or inadequate’ housing (UN 2021). In this indicator, strong housing materials comprise high strength, durability and resistance to environmental factors (e.g., iron, timber and concrete), contrasting to weak housing materials (e.g., bush materials such as Sago palm) which are more likely to degrade over time (UN 2021).			
Adaptations: This indicator combined the strength of roof, wall, and flooring materials into a single measure of housing condition. Equal importance was given to each component given the UN requirement for component to be solid and in good condition (UN 2021).			
Data Collection Instrument			
Household Survey Question: What material is the i) roof; ii) floor; iii) walls of your shelter made from?			
Data Type		Text	
1. Input household survey responses documenting the type of material used for a household’s i) roof; ii) floor and iii) walls.			
2. Classify each type of material as strong (i.e., iron, timber and concrete) or weak (i.e., sago palm).			
3. Sum the total number of strong housing materials within a shelter.			
4. Classify housing condition using the following rankings where very low sensitivity = strong housing condition (e.g., the floor, roof and walls of a shelter are made from strong materials), and high sensitivity = weak housing condition (e.g., the floor, roof and walls of a shelter are made from weak materials).			
Indicator Rankings			
Rank		Definition	Description
1	Very Low	Excellent Housing Condition	The roof, floor, and walls of a shelter are comprised of strong housing materials.
2	Low	Good Housing Condition	Two components of a shelter (e.g., roof and floor) are comprised of strong housing materials.
3	High	Fair Housing Condition	One component of a shelter (e.g., roof) is comprised of strong housing materials.
4	Very High	Poor Housing Condition	No components of a shelter are comprised of strong housing materials.
Key References			
• Ajibade, I. and McBean, G. 2014. Climate extremes and housing rights: A political ecology of impacts, early warning and adaptation constraints in Lagos slum communities. <i>Geoforum</i> . 55. 76-86.			
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• Smith, B. and Diedrich, A. 2024. A systematic review of current progress in community based vulnerability assessments. <i>Regional Environmental Change</i> , 24(1). 1-17.			

Energy Insecurity

ES1: Cooking Fuel Sufficiency

Indicator Summary			
Indicator: The amount of time a household has problems accessing cooking fuel.			
Indicator Description: The amount of time a household reports that they have problems accessing cooking fuel. This is a self-reported measure of cooking fuel access based on a 5-point Likert Scale reflecting the amount of time a household lacks access, ranging from 1) never to 5) all the time.			
Measuring Unit: Access to cooking fuel (5-point Likert scale: (1) never; (5) all the time).			
Contribution to Sensitivity			
Summary: The greater the amount of time a household struggles to access cooking fuel, the more sensitive they are to energy insecurity following hazard exposure.			
Justification: Sufficient access to cooking fuel (in particular from modern fuel sources such as electricity) has been shown to drastically improve well-being and quality of life (Gonzalez-Eguino 2015). While lack of cooking fuel is associated to negative socioeconomic impacts, particularly in low-income rural areas (Kanagawa & Nakata 2008). These impacts mainly relate to reductions in time availability and increased energy expenditure for household members that acquire fuel (e.g., firewood) (Guta 2014; Schat & Gilbert 2014). Additional negative health impacts have also been observed for households that use open fires, including respiratory and cardiovascular problems (Prunedo-Alvarez et al. 2012). Households that depend on natural resources for cooking (i.e., firewood, coconut husks etc.), may also experience greater impact following hazard exposure (Rajesh et al. 2014). This is of particular prevalence in relation to human activities such as logging and mining that result in deforestation (Minter & Van der Ploeg 2023).			
Indicator Method			
Indicator Origin & Adaptations			
Origins: The International Energy Agency classify ‘household access to a minimum level of energy’ as a key indicator of energy security (IEA 2007). Household access to energy has been utilised in previous CBVAs as an indicator of sensitivity, where the utilisation of self-reporting methods are common (Begg 2021). Self-reporting has been validated as an accurate measure of energy access by Warriner et al. (1984).			
Adaptations: This indicator utilised a 5-Point Likert scale to reflect the amount of time a household lacks access to cooking fuel where (1) never; (2) rarely; (3) frequently; (4) sometimes; (5) all the time.			
Data Collection Instrument			
Household Survey Question: In the past year, were there times when you didn’t have any access to cooking fuel? If yes, how many times did this take place? I) never; ii) rarely; iii) occasionally; iv) frequently; v) all the time.			
Data Type		Ordinal	
1. Input household survey data reflecting household access to cooking fuel whereby i) household never has problems accessing cooking fuel represents (1) low sensitivity, and v) household always has problems accessing cooking fuel represents (5) high sensitivity.			
Indicator Rankings			
Rank		Definition	Description
1	Very Low	Never	Household never has problems accessing cooking fuel.
2	Low	Rarely	Household rarely has problems accessing cooking fuel.
3	Medium	Occasionally	Household occasionally has problems accessing cooking fuel.
4	High	Frequently	Household frequently has problems accessing cooking fuel.
5	Very High	All the Time	Household has problems accessing cooking fuel all the time.
Key References			
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E2: Lighting Sufficiency

Indicator Summary

Indicator: The amount of time a household has problems accessing lighting.

Indicator Description: The amount of time a household reports that they have problems accessing lighting. This is a self-reported measure of lighting access based on a 5-point Likert Scale reflecting the amount of time a household lacks access, ranging from 1) never to 5) all the time.

Measuring Unit: Access to lighting (5-point Likert scale: (1) never; (5) all the time).

Contribution to Sensitivity

Summary: The greater the amount of time a household struggles to access lighting, the more sensitive they are to energy insecurity following hazard exposure.

Justification: Sufficient access to lighting (in particular from modern fuel sources such as electricity) has been shown to drastically improve well-being and quality of life (Gonzalez-Eguino 2015). This is attributed to the role lighting plays in enabling daily activities to be conducted, such as reading, cooking, studying and socialising (Sharma et al. 2019). Lighting also increases the ability for households to conduct livelihood-based activities during night-time (Kanagawa & Nakata 2008). Lighting has also been shown to increase safety within a community, reducing the risk of accidents and falls in unlit conditions, and increasing an individual's sense of security when moving around (Shahsavari & Akbari 2018). Households that have limited access to lighting and depend on natural resources (i.e., firewood) as their energy source, may additionally experience greater risk of energy insecurity following hazard exposure where these resources have been depleted, or can't be readily accessed (Rajesh et al. 2014).

Indicator Method

Indicator Origin & Adaptations

Origins: The International Energy Agency classify 'household access to a minimum level of energy' as a key indicator of energy security (IEA 2007). Household access to energy has been utilised in previous CBVAs as an indicator of sensitivity, where the utilisation of self-reporting methods are common (Begg 2021). Self-reporting has been validated as an accurate measure of energy access by Warriner et al. (1984).

Adaptations: This indicator utilised a 5-Point Likert scale to reflect the amount of time a household lacks access to lighting where (1) never; (2) rarely; (3) frequently; (4) sometimes; (5) all the time.

Data Collection Instrument

Household Survey Question: In the past year, were there times when you didn't have any access to lighting? If yes, how many times did this take place? I) never; ii) rarely; iii) occasionally; iv) frequently; v) all the time.

Data Type Ordinal

1. Input household survey data reflecting household access to lighting whereby i) household never has problems accessing lighting represents (1) low sensitivity, and v) household always has problems accessing cooking fuel represents (5) high sensitivity.

Indicator Rankings

Rank	Definition	Description
1	Very Low	Never
2	Low	Rarely
3	Medium	Occasionally
4	High	Frequently
5	Very High	All the Time

Key References

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Income Insecurity

IS1: Income Stability

Indicator Summary

Indicator: The extent to which household income has fluctuated over the previous 12 months.

Indicator Description: Household measure of changes in overall income rates from one year to the next reflecting an increase, decrease, or no change.

Measuring Unit: Perception of change in household income.

Contribution to Sensitivity

Summary: Household's with stable or increasing income will be less sensitive to income insecurity following hazard exposure than household's with declining income.

Justification: Income security is acknowledged as a key aspect of financial security, with financial instability reducing a household's ability to meet daily life expenses and reducing their capacity to respond to hazard exposure (Lee & Sabri 2017). Abubakar et al. (2018) and Mian et al. (2017) have empirically demonstrated this relationship, with a direct correlation between financial stability and household debt. As such, household's demonstrating less financial instability in relation to household income are more likely to exhibit long-term financial security (Lee & Sabri 2017).

Indicator Method

Indicator Origin & Adaptations

Origins: Perception of change in household income from one year compared to the previous year has been used as a metric of financial insecurity in a range of vulnerability assessments (e.g., Hoffmann & McNair 2019; Lee & Sabri 2017; Noerhidajatai et al. 2021;), including the IVA approach (SPC 2016). Likert-scales are a common method used to assess income changes from one year to the next.

Adaptations: n/a

Data Collection Instrument

Household Survey Question: Was your household's income this year higher, lower, or about the same as last year?

Data Type Ordinal

1. Input household survey data reflecting income stability where households income i) remained the same; ii) was higher; iii) was lower than the previous year, where higher income = low sensitivity and lower income = high sensitivity.

Indicator Rankings

Rank	Definition	Description
1	Low	Higher income
2	Medium	Stable income
3	High	Lower income

Key References

- Abubakar, A., Astuti, R. and Oktapiani, R. 2018. The analysis of risk profile and financial vulnerability of households in Indonesia. *Bulleting Economic*. 20(4). 443-474.
- Hoffmann, I.O.A. and McNair, J.S. 2019. How does consumers' financial vulnerability relate to positive and negative financial outcomes? The mediating role of individual psychological characteristics. *The Journal of Consumer Affairs*. 53(4). 1630-1673.
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Appendix 5: Abridged version of the Livelihoods-Based Risk Profile (LRPF) user manual



Australian Government
Australian Centre for
International Agricultural Research

The Livelihoods-Based Risk Profiling Framework

User Manual

July 2024

Produced by Bethany Smith
on behalf of the SRA FIS 2020/111 team



Authors

Bethany Smith

PhD Candidate at James Cook University

Associate Professor Amy Diedrich

Director of the Centre for Sustainable Tropical Fisheries and Aquaculture, Associate Professor and leader of the Livelihoods Lab at James Cook University

Dr Stephanie Duce

Lecturer in spatial science at James Cook University

Dr Nicholas Murray

Senior research fellow in conservation science at James Cook University

Dr Katie Sievers

Postdoctoral researcher at James Cook University

Hensllyn Boseto

Project manager at Ecological Solutions Solomon Islands

David Boseto

Co-Director at Ecological Solutions Solomon Islands

Aubrey Vavu

Research Assistant at Ecological Solutions Solomon Islands

Relna Peter

Research Assistant at Ecological Solutions Solomon Islands

Claire Holland

Senior Lecturer of Conflict Management and Resolution at James Cook University

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All photographs included in this manual were taken by Bethany Smith.

Introduction

This user guide provides practical guidance for implementing the Livelihoods-Based Risk Profiling Framework (LRPF) as a community-based tool to support adaptation planning for rural livelihoods. The guide aims to equip practitioners, community leaders, and stakeholders with the necessary knowledge and tools to successfully implement the LRPF. The LRPF itself is intended to guide rural communities in identifying, assessing, and understanding risks to their livelihoods, facilitating the development of tailored adaptation strategies that can enhance local resilience to future challenges.

In this guide you will find detailed explanations and instructions on how to apply the LRPF to your community's specific context. This includes:

- **Overview of the LRPF:** An introduction to the framework's components and objectives.
- **Implementation of the LRPF:** A step-by-step guide to implementing the LRPF within rural communities
- **LRPF Integration with Adaptation Planning Approaches:** A guide to the Community-Based Adaptation Planning approach (CAPSI) and how to integrate LRPF outputs for risk-informed adaptation.

Each section of the guide is designed to build upon the previous, providing a comprehensive approach to risk profiling and adaptation planning. We hope this guide can support the effective implementation of the LRPF in your community, contributing to more resilient and adaptive livelihoods in the face of future challenges.

Part 1: Developing the Livelihoods-Based Risk Profiling Framework

Part 1: Developing the Livelihoods-Based Risk Profiling Framework

1.1. Framework Overview

The Livelihoods-Based Risk Profiling Framework (LRPF) was developed to support rural communities in understanding and responding to the factors that influence their likelihood of impact from global change.

The LRPF expands the Intergovernmental Panel on Climate Change's (IPCC) AR5 Risk Assessment Framework (IPCC 2014), addressing identified limitations of the AR5 (Smith et al. 2024), and developing a specific methodology for its implementation in the context of rural livelihoods.

Specifically, the LRPF assesses how rural livelihoods are at risk of impact from exposure to various hazards, and how underlying community vulnerabilities influence the extent of these impacts and the local capacity for response.

1.2. Framework Components

To assess risk, the LRPF conducts a mixed method-analysis of its underlying factors.

These include (Figure 1):

Hazard Exposure:

- **Hazard:** The potential occurrence of a shock or stressor event that may impact rural livelihoods.
- **Exposure:** The presence of rural livelihoods in a location that may be adversely impacted by the occurrence of a hazard.

Vulnerability:

- **Sensitivity:** The degree to which rural livelihoods may be impacted by hazard exposure.
- **Adaptive Capacity:** The ability for communities engaged in rural livelihoods to respond to potential impacts, take advantage of opportunities, or respond to consequences.
- **Source Dependence:** The degree to which rural livelihoods depend on source types that may be impacted by hazard exposure.

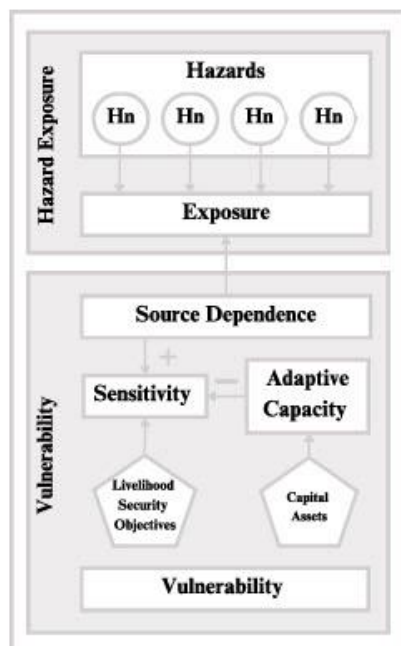


Figure 1: The structure of the Livelihoods-Based Risk Profiling Framework (LRPF).

1.3. LRPV Vulnerability Index

A vulnerability index was developed within the LRPV to conduct a quantitative assessment of adaptive capacity and sensitivity in the context of rural livelihoods.

Indicators were determined through a systematic review of prior risk and vulnerability assessments applied to rural livelihoods (Smith and Diedrich 2024). These indicators were refined to the local context of Western Province, Solomon Islands by local experts.

A series of composite indicators guide the analysis of sensitivity and adaptive capacity.

These include:

Sensitivity

- **Water Security:** Access to adequate quantities of acceptable quality water for sustaining livelihoods and ensuring protection against water borne diseases.
- **Food Security:** Access to sufficient, safe, and nutritious foods to maintain a healthy and active lifestyle.
- **Housing Security:** Access to adequate housing.
- **Income Security:** Access to reliable and stable income that can meet basic needs.
- **Energy Security:** Access to uninterrupted energy sources.

Adaptive Capacity

- **Human Capital:** The skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives.
- **Financial Capital:** The financial resources that people use to achieve their livelihood objectives.
- **Social Capital:** The social resources upon which people draw

in pursuit of their livelihood objectives.

- **Physical Capital:** The basic infrastructure and goods needed to support livelihoods.
- **Natural Capital:** Fair access of households to stocks of natural resources that are important for livelihoods.

Within these composite indicators, 10 individual indicators of sensitivity, and 19 of adaptive capacity were selected for inclusion within the LPRF vulnerability index (Table 1).

Table 1: The components, composite indicators, and individual indicators that comprise the LPRF vulnerability index.

Indicator	Definition
Adaptive Capacity	
Human Capital	
Dependency Ratio	The ratio of dependent (i.e., non-working adults) to non-dependent household members (i.e., working adults).
Health Condition	The number of times in the last year household members missed their livelihood responsibilities due to being sick, ill or injured.
Access to Healthcare	The amount of time a household can access healthcare in times of need.
Livelihood Diversity Index	The number of unique livelihood activities that members of a household are engaged in.

Extent of Coping Strategies

The extent to which a household believes they can cope with locally relevant hazard exposure.

Financial Capital

Household Savings	The total amount of savings accumulated by a household.
Household Income	The amount of income a household acquires in a one-month period.
Household Expenditure	Household monthly expenditure on basic needs (e.g., food, water, housing, energy and healthcare).
Income Satisfaction	The extent to which a household is satisfied with their ability to purchase basic goods.
Access to Financial Services	Household access to key financial services including bank accounts, pensions, and loans.

Social Capital

Social Networks	The number of social relationships a household can turn to for support in times of need.
Inclusion in Decision Making	The extent of household satisfaction with their inclusion in community decision making.
Local Institutional Memberships	Household membership in local institutions (e.g., groups, organisations and associations).
Satisfaction with Leadership	The extent to which a household is satisfied with the leadership in their community.
Trust	The level of trust a household has in community members and leaders.
Collective Action	The extent to which a household participates in community-based activities.

Perceptions of Fair Access to Livelihood Opportunities	Household perception of fair access to livelihood opportunities within their community.	Lighting Sufficiency	The amount of time a household has problems accessing lighting.
Physical Capital		Income Security	
Access to Livelihoods-Based Assets	Household access to key assets required to support livelihoods.	Income Stability	The extent to which household income has fluctuated over the previous 12 months.
Natural Capital			
Perceptions of Fair Access to Natural Resources	Household perception of fair access to natural resources within their community.		
Sensitivity			
Water Security			
Access to Drinking Water	Household has access to improved sources of drinking water within a 30-minute return distance.		
Water Sufficiency	Household has access to sufficient quantities of water to meet basic needs.		
Water Quality	The extent to which a household is satisfied with the quality of their drinking water.		
Access to Sanitation	Household has access to an improved form of sanitation.		
Food Security			
Food Sufficiency	Household has uninterrupted access to sufficient volumes of food to meet household requirements.		
Food Consumption Score	The frequency of consumption of different food groups during the previous 7 days.		
Housing Security			
Housing Condition	The type of material used for the roof, flooring, and walls of a household's shelter.		
Energy Security			
Cooking Sufficiency	The amount of time a household has problems accessing cooking fuel.		

Part 2: Implementing the Livelihoods-Based Risk Profiling Framework

Part 2: Implementing the Livelihoods-Based Risk Profiling Framework

The following section details steps to implement the LRPF. The LRPF was trialled in three rural communities in Western Province, Solomon Islands.

The LRPF uses a mixed methods approach to assess risk, comprising **focus group mapping workshops** and **household surveys**. The mapping workshops are used to collect data on hazard exposure, while the household surveys are used to collect data on vulnerability.

2.1. Data Collection

2.1.2. Focus Group Mapping Workshop

Sampling Method

The mapping workshop requires a minimum of twelve individuals selected by community leaders. Participants should comprise an equal number of:

- Males and females.
- Youth, adults, and elders.
- Representatives from different livelihood activities.

The workshop should be held in a community gathering space. Participants should be divided into demographic groups that are most suited to the social dynamics

within a community, such as by sex or age to encourage equal participation during the sessions.

Several workshop facilitators should be present to support the implementation of activities in the local language.

The workshop is comprised of two activities:

- **Hazard Ranking:** Used to determine the hazards that pose the greatest concern to local livelihoods.
- **Hazard Exposure Mapping:** Used to establish where hazards occur and interact with sources used to meet essential needs.

Activity 1: Hazard Ranking

The hazard ranking activity allows participants to identify and prioritise the major hazards impacting their livelihoods.

In this activity, participants will be provided flashcards depicting hazards deemed 'high concern' within the landscape. These hazards should be selected by local experts

and represent broad issues such as climate change. Participants will rank these hazards based on their perceived impact on livelihoods. If a hazard is not deemed relevant to the local context, it should be removed from the ranking activity.

Participants will also receive blank flashcards to list any additional hazards not identified by local experts and include these in the ranking process.

Participants will have 45 minutes to complete the ranking activity. Workshop facilitators should encourage discussions and negotiation to help each group reach a consensus on the ranking scores.

Step by Step Guide:

Required Materials:

- Marker pens
- Flashcards

Steps:

- Ask participants to breakout into designated groups.
- Provide participants with a pre-identified list of locally relevant hazards.

In the context of Western Province, pre-identified hazards included: commercial logging, coastal fishing, sea level rise, flooding, increased rainfall, decreased rainfall, and temperature increase.

- Provide participants with marker pens and additional flashcards and ask them to list any additional hazards they perceive as a concern for local livelihoods.

- Ask participants to rank all flashcards from high to low in terms of their impact on livelihoods.



Hazard ranking results, showing both pre-identified and locally identified hazards, ordered from highest to lowest perceived impact on livelihoods.

Activity 2: Hazard Exposure Mapping

The hazard exposure mapping activity identifies where hazards occur in the local landscape and how these locations interact with sources used to meet essential needs.

Participants will receive laminated A0-sized satellite images (e.g., Google Maps or Bing) of the land and marine areas used by the community. The extent of these areas should be determined with community leaders before the workshop. Prepare a broader scale map (e.g., district or province

level) to allow for mapping which may involve documenting locations outside the community's land area.

Satellite Image Preparation:

Satellite images and marked up maps will be digitised during the data analysis process. This requires several pre-processing steps:

- Determine the extent of the community's land and sea areas through discussions with community leaders.
- Download satellite imagery of these areas (e.g. from Bing or Google Maps). **Check multiple sources to find the clearest available images for the community.*
- Place Ground Control Points (GCPs) on the satellite images using tools like Google Earth or GIS. This helps to ensure accurate alignment of photographed maps from the activity during digitisation.

Step by step guide for placing GCP points: <https://help.inflights.com/en/articles/6495854-ground-control-points-tutorial>.



Satellite image preparation using GCP

Before the activity commences, workshop facilitators should help orient participants by pointing out key landmarks on the images.

The activity will then be divided into two sessions each lasting 45 minutes. After each session the maps should be photographed from directly above to enable digitisation, before being wiped clean for the next session. Workshop facilitators should take detailed notes during the activities to help interpret maps.

Session 1: Map the locations where the high ranking hazards (identified in the previous activity) occur.

**Hazards with broad-scale spatial variation that are uniform across the community (e.g., temperature change) will not be included in the mapping process.*

Session 2: Map the locations of sources critical for essential needs including:

- Building materials
- Cooking fuel
- Lighting
- Income

Ask participants to either outline or pinpoint the locations of these sources on the map. They should also note what each source is and its specific use. Where relevant,

provide broader scale maps to document the location of sources (such as markets) which may be located remote from the community.

Step by Step Guide:

Required Materials:

- Satellite images
- Marker pens
- Marker pen remover
- Digital camera

Session 1 – Steps:

- Introduce participants to the satellite images and help orient them.
- Re-confirm high ranking hazards from exercise one and determine which of these vary at the community scale.
- Ask participants to draw the locations where these hazards occur within their community.
- Photograph the marked up images before wiping clean for the next session.



Workshop facilitator supports participants in orienting maps, and determining the location of hazards.

Session 2 – Steps:

- Ask participants to map the location of the main sources used by community members to access water, food, building materials, cooking fuel, lighting and income.

Prompts for this activity include:

- Where on the map has this hazard occurred?
- Is there an area where the impacts are the worst?



Workshop facilitator supports participants in mapping the location of sources that meet essential needs.

2.2. Household Survey

The LRPf household survey collects data on community vulnerability. It includes a variety of open ended, categorical, and Likert Scale questions that reflect the indicators of sensitivity and adaptive capacity in Table 1, as well as information on source dependence.

A final section on hazard exposure is included to capture any additional context missed during the focus group workshop.

While the LRPf focuses on community level risk analysis, the survey collects household demographic data, enabling researchers to perform intra-community analysis of vulnerability and identify differences based on characteristics such as livelihood activities.

Sampling Method

Convenience sampling can be used to obtain data from a diverse representation of households within a community. A minimum quota of 40% of households has been established for the LRPf.

Surveys should be conducted in local language through face-to-face interviews at participants homes. Surveys should alternate as much as possible between male and female household heads to obtain a balanced representation of responses across sexes.



Researchers conduct the LRPf household survey with the female head of a household.

The household survey was translated into Solomon Island Pijin prior to its implementation. Each survey should last approximately 40 minutes. The following sections present the household survey questions used within the LRPf.

Section A: Demographic Information

Participant Information

Q1	Sex of participant (Household head)
Male	☐
Female	☐
Q2	How old are you?
Q3	What are your main livelihood activities?

2.2. Data Analysis

The following section details the steps required to develop livelihood risk profiles from LRP data.

2.2.1. Hazard Exposure

Hazard Ranking

- Combine the ranking scores across breakout groups to calculate a mean ranking score for each hazard within a community.
- Once you have a mean score for each hazard, categorise hazards into thematic groups such as climate change, resource exploitation etc.,
- For each thematic group calculate the mean score by averaging the scores of the individual hazards within that category.
- Present mean scores as 'levels of concern' ranging from very low to very high, reflecting the perceived impact on rural livelihoods.

Hazard Exposure Mapping

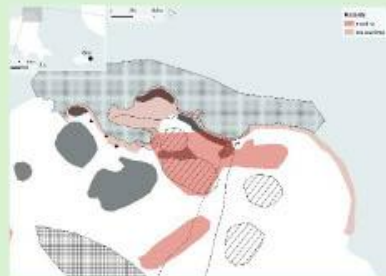
- Take the hand drawn maps provided by focus groups and digitise them in QGIS including:
 - Polygons of hazard impact areas.
 - Polygons of source types used to access water, food, housing materials, cooking fuel, lighting, and income.

- Categorise source types into natural ecosystems (e.g., oceans, forests), modified ecosystems (e.g., food gardens, cash crop plantations), and artificial infrastructure (e.g., rainwater tanks).
- Overlay the hazard polygons with the source type polygons to obtain a map of hazard exposure.

Hazard Exposure Map Digitisation



Example of a hand drawn map representing hazard locations.



Digitised version of hazard locations in QGIS.

*The full protocol for digitisation is provided in appendix 3.

Hazard Exposure Survey Outputs

- Review responses from open-ended questions in household surveys to

identify the different hazards that source types are exposed to.

- Summarise this data at the community level to provide a clear picture of the specific hazards impacting source types.

2.2.2. Vulnerability

2.2.2.1. Source Dependence

- Calculate the percentage of households that rely on different source types to access water, food, housing materials, cooking fuel, lighting and income.

2.2.2.2. Vulnerability Index

Indicator Development

- Use raw data from household surveys to compute the standardised indicators listed in Table 1.
- A full list of the methods used to develop LRPF indicators has been provided in appendix 3 of this manual.

Index Development

Step 1: Weight Indicators

- Use the Analytic Hierarchy Process (AHP) to weight the indicators within the Index (Saaty 1980; Maanan et al. 2018).
- This method compares each indicator with every other indicator to determine their relative importance and assign them weights within the index.
- Identify key local experts to conduct this process within your study area.

- Apply the Delphi technique to reach consensus on the weighting scores amongst experts (Linstone 1985).

Step 2: Calculate Composite Indicators

- Calculate composite indicator scores by combining the indicators within a given sub-component of the index using the formula:

Composite indicator score = $w_1 \times \text{Score}_1 + w_2 \times \text{Score}_2 + \dots$. Where w = indicator weighting value, and Score = indicator value.

- Standardise each composite indicator to a 0-100 scale.

Step 3: Calculate Component Scores

- Combine composite indicators using the same formula to calculate adaptive capacity and sensitivity where:

Adaptive Capacity (AC) = human capital + financial capital + social capital + physical capital + natural capital.

Sensitivity (S) = water security + food security + housing security + energy security + income security

- Standardise component scores to a 0-100 scale.

Step 4: Calculate Final Vulnerability Index

- Combine components to obtain a final index value for vulnerability using the formula:

$$V = f(AC - S)$$

- Adaptive capacity is subtracted from sensitivity due to their inverse relationship.
- Standardise vulnerability index scores to a 0-100 scale.

Step 5: Classify Vulnerability

- Use the standardised household scores for vulnerability, its components and sub-components to obtain a mean value across the community.
- Classify the final values into ranks including:
 - Very low (0-20)
 - Low (21-40)
 - Moderate (41-60)
 - High (61-80)
 - Very high (81-100)

*Adaptive capacity (and composite indicator ranks) will occur in reverse order.

2.2.3. Livelihood Risk Profile

Data representing each risk component will be combined to create a summarised livelihood risk profile for a community (Figure 2).

This includes:

- Hazard concern ranks
- Hazard exposure household survey and mapping data
- Source dependence scores
- Vulnerability index scores

Livelihood risk profiles present data using a traffic light scale where:

- Red = very high risk of impact
- Orange = high risk of impact
- Yellow = moderate risk of impact
- Dark Green = low risk of impact
- Light Green = very low risk of impact

Indicator scores within each sub-component of vulnerability are not presented in livelihood risk profiles. This information should be provided in a separate table (e.g., Table 2).

Table 2: Example of indicator scores from the LRPV vulnerability index.

Indicator	C1	C2	C3
Adaptive Capacity			
Human Capital			
HC1: Dependence Ratio			
HC2: Health Conditions			
HC3: Access to Healthcare			
HC4: Livelihood Diversity Index			
HC5: Extent of Coping Strategies			
Financial Capital			
FC1: Household Savings			
FC2: Household Income			
FC3: Household Expenditure			
FC4: Income Satisfaction			
FC5: Access to Financial Services			
Social Capital			
SC1: Social Networks			
SC2: Inclusion in Decision Making			
SC3: Local Institutional Membership			
SC4: Satisfaction with Leadership			
SC5: Trust			
SC6: Collective Action			
SC7: Fair Access to Livelihood Opportunities			
Physical Capital			
PC1: Access to Livelihood-Based Assets			
Natural Capital			
NC1: Fair Access to Natural Resources			
Sensitivity			
Water Security			
WS1: Access to Drinking Water			
WS2: Water Efficiency			
WS3: Water Quality			
WS4: Access to Sanitation			
Food Security			
FS1: Food Sufficiency			
FS2: Food Consumption Score			
Housing Security			
HS1: Housing Conditions			
Energy Security			
ES1: Cooking Fuel Sufficiency			
ES2: Lighting Sufficiency			
Income Security			
IS1: Income Stability			

Part 3: Applying the Livelihoods-Based Risk Profiling Framework

Part 3: Applying the Livelihoods-Based Risk Profiling Framework

3.1. Risk Profiles for Decision Support

The LRPF risk profiles are a tool designed to guide adaptation planning by highlighting key risk drivers across a community.

This can be done by:

- Reviewing the profiles to understand specific hazards and vulnerabilities faced by a community.
- Using hazard exposure maps to pinpoint areas most susceptible to hazard impacts.
- Examining dependencies on high risk resources (e.g., water sources) that are critical to livelihoods.
- Analysing strengths and weaknesses associated with sensitivity and adaptive capacity.

By following these steps, the LRPF risk profiles can help communities to develop effective, targeted adaptation plans to enhance livelihoods resilience to future challenges.

3.2. Risk-Informed Adaptation Planning

While livelihood risk profiles allow for a specific response to local risk drivers, they

do not consider the adaptation desires of a community. By integrating the LRPF with community input and aspirations for the adaptation process, researchers can ensure that adaptation is not only effective, but also aligns with the community's vision for the future (Butler et al. 2016).

The Community-Led Adaptation Pathways Approach (CAPSI) was developed by Butler et al. (2015) to provide a mechanism to identify, plan, and implement communities priorities for adaptation within rural communities in Solomon Islands.

The following section outlines the steps to implement the CAPSI approach and explains how to incorporate LRPF profiles to incorporate risk within the planning approach. The CAPSI has been adapted to integrate with LRPF outputs (Smith et al. *In Prep*).

3.2.1. The CAPSI Process

The adapted CAPSI is comprised of four major steps (Figure 3):

- Identifying key drivers of change that might impact a community.
- Developing an agreed future vision for community livelihoods.

- Visualising potential futures based on a range of 'drivers of change scenarios'.
- Making collective decisions on potential 'no regrets' adaptation and development strategies that will enable a community to achieve their desired future and adapt to drivers of change.

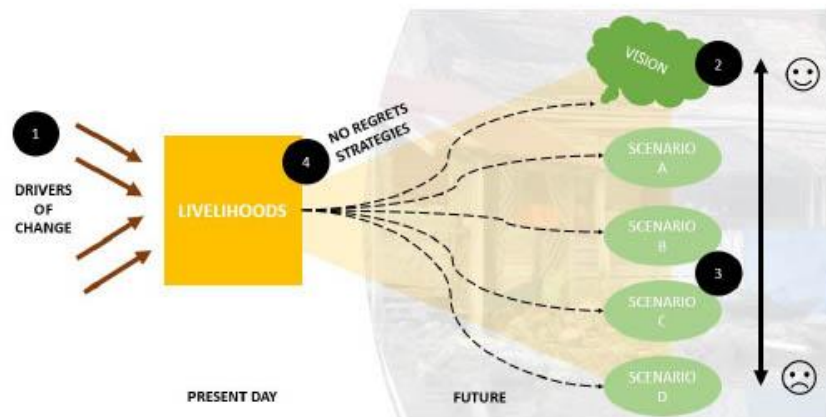


Figure 3: Steps to implement the CAPSI process adapted from Butler et al. (2015) to support integration with livelihood risk profiles.

Data Collection

The CAPSI workshop requires a minimum of twelve individuals selected by community leaders. Participants should comprise an equal number of:

- Males and females.
- Youth, adults, and elders.
- Representatives from different livelihood activities.

The workshop should be held in a community gathering space. Participants should be divided into demographic groups that are most suited to the social dynamics within a community, such as by sex or age

to encourage equal participation during the sessions. Participants should be divided into four equal sized breakout groups.

Several workshop facilitators should be present to support the implementation of activities in the local language.

The two-day workshop will be divided into four main activities, reflecting each step of the adapted CAPSI approach.

Workshop Day 1 (Activities 1-3)

1. Drivers of Change:

The drivers of change activity asks participants to confirm the high-priority

hazards identified in their livelihood risk profiles.

In this activity, participants will be presented the hazards ranked 'high concern for livelihoods' in their risk profile.

Workshop facilitators will guide participants to review and confirm the ranking scores of hazards to determine which ones are priorities for adaptation. If participants agree on the importance of hazards not included within their risk profile, these can be included in the CAPSI process.

After confirming high priority hazards, participants will have 45 minutes to discuss their current adaptation responses to these hazards and suggest future adaptation

measures to reduce their impact on livelihoods.

Desired responses for adaptation in the future.

- Ask each group to present their ideas to the room.



Participants write down their desired adaptation to hazards ranked high concern for livelihoods.

Step by Step Guide:

Required Materials:

- Paper
- Marker Pens

Steps:

- Present the hazards ranked high concern within the communities risk profile.
- Ask participants to discuss their importance within breakout groups, before reporting back to the room.
- Develop a final list of high concern hazards.
- Distribute paper and marker pens and ask breakout groups to list the main adaptation responses to these hazards used by the community, and

2. Future Visions:

The future visions activity asks participants to envisage what they would like their community to look like by the year 2040.

During the activity, each group will receive butcher paper and coloured pens to document their vision through writing, drawing, or mapping. This creative approach allows participants to express their ideas in the way they feel most confident.

Each group will have 45 minutes to complete the activity before presenting back to the room. Workshop facilitators should take detailed notes on these

presentations to ensure illustrated visions are accurately interpreted.

Step by Step Guide:

Required Materials:

- Butcher Paper
- Marker Pens

Steps:

- Provide groups with butcher paper and pens.
- Ask participants to imagine how they would like their community to look by the year 2040.
- Support participants in translating these visions into a written or illustrated format.
- Ask each group to present their visions to the room.



Participants present their vision for the community.

3. Scenario Planning:

The scenario planning activity asks participants to imagine how hazards might evolve by 2040, considering both worst-case and best-case scenarios.

Before this activity commences, a scenario matrix should be developed that addresses

the two major thematic hazards that impact community livelihoods in their risk profile (e.g., climate change and resource exploitation).

The matrix (Figure 4) should place these themes at opposite ends of two intersecting arrows, representing 'best' and 'worst' case scenarios for the future.

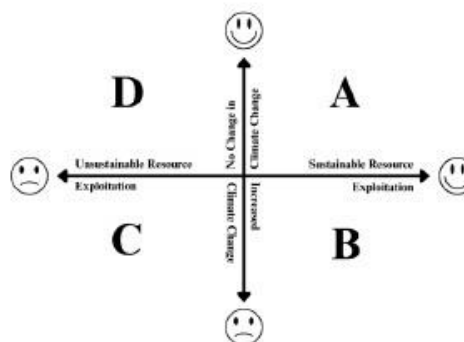


Figure 4: Example scenario planning matrix for worst and best case scenarios of climate change and resource exploitation.

The matrix will generate four distinct scenarios. Using climate change and resource exploitation as an example where climate change is on the y axis and resource exploitation on the x axis, these scenarios would include:

- (A) Best case scenario (i.e., slow climate change and sustainable resource exploitation).
- (B) Intermediate scenario (i.e., fast climate change and sustainable resource exploitation)
- (C) Intermediate scenario (i.e., slow climate change and unsustainable resource exploitation)

(D) Worst case scenario (i.e., fast climate change and unsustainable resource exploitation).

Present the scenario matrix to participants, and assign one scenario to each breakout group. Provide examples of best and worst-case scenarios for each thematic hazard. Each group will then be given 45 minutes to write or illustrate the potential impacts they believe their assigned scenario on livelihoods by the year 2040.

Upon completion of the activity, each group will present their findings to the room.

Step by Step Guide:

Required Materials:

- Butcher Paper
- Marker Pens

Steps:

- Provide groups with butcher paper and pens and assign each group a future scenario.
- Ask participants to imagine what the impacts of this scenario would be on their livelihoods by the year 2040.
- Provide several examples of what a 'best' or 'worst' case scenario could look like for each thematic hazard
- Support participants in translating their ideas into a written or illustrated format.
- Ask each group to present their visions to the room.



Participant presents their vision of the potential impacts of future climate change and resource exploitation on livelihoods.

Workshop Day 2 (Activity 4)

4. No Regrets Adaptation:

The no-regrets adaptation activity asks participants to identify priority adaptation strategies for the future based on the outcomes of activities 1-3.

Present the results of day 1 back to participants, summarising the main adaptation strategies emerging from:

- Desired adaptation to hazards
- Desired community visions
- Potential impacts on livelihoods from future hazard exposure.

Discuss these strategies with the community and explain how they have emerged as local priorities.

3.2.2. Using Livelihood Profiles for Risk Informed Adaptation

Livelihood risk profiles can be used to inform the development of no-regrets adaptation.

The following diagnostic questions were developed to guide the approach:

- How might adaptation intersect with multi-hazard exposure?
- How might adaptation be affected by local sensitivity?
- How might adaptation be affected by local adaptive capacity?

Information from livelihood profiles can be used to answer these questions, and evaluate the no-regrets status of adaptation.

Additionally, this process can help identify strengths and barriers to implementing adaptation. Addressing these barriers and leveraging strengths can enhance the likelihood of successful and sustainable adaptation.

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Appendix 6: Household survey applied to collect data on vulnerability through the Livelihoods-Based Risk Profiling Framework.

Survey Number				
Interviewer Name				
Date of Interview				
Time of Interview				
Have you marked the location of the household on the community map?				
Yes ☐				
No ☐				
If not, why?				
Q1	Sex of participant (Household head)			
Male ☐				
Female ☐				
Other ☐				
Q2	How old are you?			
Q3	What are your main livelihood activities?			
1				
2				
3				
4				
5				
Q4	Are you originally from this community?			
Yes ☐ (If YES, go to Q8)				
No ☐				
Q5	If NO, where are you originally from?			
Q6	If NO, how did you come to live in this community?			
Q7	If NO, how long have you lived within this community?			
Q8	How many children live in your household?			
Q9	Q10	Q11		Q12
What other adults live in your household?	How old is each household member?	What sex is each household member?		What is the main livelihood activity conducted by each household member?
		Male	Female	
		☐	☐	
		☐	☐	
		☐	☐	
☐	☐			

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		☐	☐	
		☐	☐	
		☐	☐	
		☐	☐	
		☐	☐	
		☐	☐	

Q13 What is the most important livelihood activity within your household?

Q14 What is second most important?

Q15 What is third most important?

Q16 How much of the food that your household catches & grows did you sell in the last year?

Almost None	Some	About Half	Most	Almost All
1	2	3	4	5

Q17 How important is **access** to the following resources within your household?

	Unimportant	Somewhat Unimportant	Neither Important nor Unimportant	Somewhat Important	Important
Drinking Water	1	2	3	4	5
Food	1	2	3	4	5
Lighting	1	2	3	4	5
Fuel for Cooking	1	2	3	4	5
Building Materials	1	2	3	4	5
Healthcare	1	2	3	4	5
Income	1	2	3	4	5

Q18

Q19

Q20

What sources of water do you use for drinking?	How long does it take you to get to this drinking water?	How do you get there?

Q21 Which water source is most important for your household?

Q22 Which is the second most important?

Q23 Which is the third most important?

Q24 Does it ever cost you money to access water?

Never	Rarely	Sometimes	Frequently	All the Time
1	2	3	4	5

Q25 How often does your household pay for bottled water?

Never	Rarely	Sometimes	Frequently	All the Time
1	2	3	4	5

Q26 (If 2-5) Approximately how much do you spend getting water in a month?

SI\$:

Q27 Does the amount of water that you get meet the needs of your household?

Yes ☐ (If YES, go to Q29)

No ☐

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Q28 IF NO, how often does your household not have enough water?						
Rarely		Occasionally		Frequently		All the Time
☐		☐		☐		☐

Q29 How happy are you with the quality of your drinking water?				
Very Unsatisfied	Somewhat Unsatisfied	Neither Satisfied or Unsatisfied	Somewhat Satisfied	Very Satisfied
1	2	3	4	5

Q30 (IF 1-4) What is affecting the quality of your drinking water?						

Q31 In the past year has anything affected your ability to access water?						
Yes ☐						
No ☐ (If NO, go to Q34)						

Q32		Q33				
If YES, what is the name of the problem?		If YES, how often have you experienced these problems?				
		Very Rarely	Rarely	Occasionally	Frequently	All the Time
A		1	2	3	4	5
B		1	2	3	4	5
C		1	2	3	4	5
D		1	2	3	4	5
E		1	2	3	4	5

Q34 What is the main type of toilet facility used by your household (e.g., mangroves, bush, slab toilet with pour, slab toilet with flush)?						

Q35 Do you share this toilet facility with any other households?						
Yes						
No						

Q36 How happy are you with sanitation within your household/community?						
Very Unsatisfied	Somewhat Unsatisfied	Neither Satisfied or Unsatisfied	Somewhat Satisfied	Very Satisfied		
1	2	3	4	5		

Q37 If 1-4, why aren't you satisfied with sanitation within your household/community?						

Q38 Where does the food in your household come from?						

Q39 Which food source is most important?						

Q40 Which is the second most important?						

Q41 Which is the third most important?						

Q42 How often does your household pay for food?						
Never	Rarely	Occasionally	Frequently	All the Time		
1	2	3	4	5		

Q43 Approximately how much do you spend on food in a month?						
SI\$:						

Q44 In the past month, how many times were the following true?						
	Never	Rarely	Sometimes	Often	Always	
You couldn't eat the kinds of foods you prefer?	1	2	3	4	5	

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Your household did not have enough food?	1	2	3	4	5
--	---	---	---	---	---

Q45 How many times has your household eaten these food types in the past week?						
						Number of Times Eaten in Past Week
Rice (and other grains)						
Flour						
Roots & Tubers (potato, taro etc.,)						
Nuts (cashew nuts, peanuts etc.,)						
Milk & Other Dairy Products (i.e., cheese)						
Canned Meat (Corned Beef, Luncheon Meat/Chicken, Duck Meat)						
Fresh Meat (Chicken wings, pork, beef etc)						
Canned Fish (Taiyo, Besta, Mariko etc)						
Marine Fish/Shellfish						
Freshwater Fish/Shellfish						
Eggs						
Vegetables & Leaves						
Fruits (pawpaw, ripe banana, melon, pineapple, pomolo etc)						
Oil, Fat, Butter						
Sugar or Sweets (lolly, ice cream, ice block etc.,)						

Q46 In the past year has anything affected your ability to access food?						
Yes ☐						
No ☐ (If NO, go to Q45)						

Q47		Q48				
If YES, what is the name of the problem?		If YES, how often have you experienced these problems?				
		Very Rarely	Rarely	Occasionally	Frequently	All the Time
A		1	2	3	4	5
B		1	2	3	4	5
C		1	2	3	4	5
D		1	2	3	4	5
E		1	2	3	4	5

Q49 What material is the roof of your house made from?						

Q50 Where do you get this material?						

Q51 What material are the walls of your house made from?						

Q52 Where did you get this material from?						

Q53 What material is the floor of your house made from?						

Q54 Where did you get this material?						

Q55 How often do you pay for building materials?				
Never	Rarely	Occasionally	Frequently	All the Time
1	2	3	4	5

Q56 Approximately how much do you spend on building materials in a year?						
SI\$:						

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Q57 In the past year have any problems affected your house?									
Yes ☐									
No ☐ (If NO, go to Q56)									
Q58				Q59					
If YES, what is the name of the problem?				If YES, how often have you experienced these problems?					
				Very Rarely	Rarely	Occasionally	Frequently	All the Time	
A				1	2	3	4	5	
B				1	2	3	4	5	
C				1	2	3	4	5	
D				1	2	3	4	5	
Q60 What do you use for lighting?				Q61 Where do you get this from?					
1									
2									
3									
Q62 Which source of lighting is most important?									
Q63 Which is second most important?									
Q64 Which is third most important?									
Q65 How often do you pay for lighting?									
Never		Rarely		Occasionally		Frequently		All the Time	
1		2		3		4		5	
Q66 Approximately how much do you spend on lighting in a month?									
SI\$:									
Q67 In the past year, were there times when you didn't have access to lighting?									
Yes ☐									
No ☐ (If NO, go to Q65)									
Q68 IF YES, how often did this take place?									
Rarely		Occasionally		Frequently		All the Time			
☐		☐		☐		☐			
Q69 In the past year has anything affected your ability to access lighting?									
Yes ☐									
No ☐ (If NO, go to Q68)									
Q70				Q71					
If YES, what is the name of the problem?				If YES, how often have you experienced these problems?					
				Very Rarely	Rarely	Occasionally	Frequently	All the Time	
A				1	2	3	4	5	
B				1	2	3	4	5	
C				1	2	3	4	5	
D				1	2	3	4	5	
Q72 What sources of fuel do you use for cooking?				Q73 Where do you get this fuel from?					
Q74 Which is the most important source of cooking fuel?									
Q75 Which is second most important?									

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Q76 Which is third most important?							
Q77 How often do you pay for fuel for cooking?							
Never	Rarely	Occasionally	Frequently	All the Time			
1	2	3	4	5			
Q78 Approximately how much do you spend on fuel (gas, firewood etc) in a month?							
SI\$:							
Q79 In the past year, were there time when fuel for cooking was not available?							
Yes ☐							
No ☐ (If NO, go to Q75)							
Q80 IF YES, how often did this take place?							
Rarely	Occasionally	Frequently	All the Time				
☐	☐	☐	☐				
Q81 In the past year has anything affected your ability to access fuel for cooking?							
Yes ☐							
No ☐ (If NO, go to Q78)							
Q82			Q83				
If YES, what is the name of the problem?			If YES, how often have you experienced these problems?				
			Very Rarely	Rarely	Occasionally	Frequently	All the Time
A			1	2	3	4	5
B			1	2	3	4	5
C			1	2	3	4	5
D			1	2	3	4	5
E			1	2	3	4	5
Q84 How many members of your household suffer from a long term health condition or disability?							
Q85 Who within your household is suffering from this?							
Q86 Would you mind sharing what these health conditions or disabilities are? (i.e., physical, mental, socio-physical)							
Q87 Were there any times in the past year that any member of your household missed their livelihood responsibilities due to being sick, ill or injured?							
None	Few	Some	Many	All the Time			
1	2	3	4	5			
Q88 How often do you pay for medicine or other health related items?							
Never	Rarely	Occasionally	Frequently	All the Time			
1	2	3	4	5			
Q89 Approximately how much do you spend in a year?							
SI\$:							
Q90 In the past year, were there ever times when you or members of your household couldn't access healthcare?							
Yes ☐							
No ☐ (If NO, go to Q86)							
Q91 IF YES, how often did this take place?							

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Rarely	Occasionally	Frequently	All the Time
☐	☐	☐	☐

Q92		Q93				
If YES, what is the name of the problem?		If YES, how often have you experienced these problems?				
		Very Rarely	Rarely	Occasionally	Frequently	All the Time
A		1	2	3	4	5
B		1	2	3	4	5
C		1	2	3	4	5
D		1	2	3	4	5
E		1	2	3	4	5

Q94 Does your household have access to any of the following items?		
Household Asset	Items Accessed	
	Yes	No
Generator	☐	☐
Fridge/Freezer	☐	☐
Boat/canoe	☐	☐
Boat with motor/OBM	☐	☐
Other transport (specify):	☐	☐
Communication device (i.e., mobile phone or radio)	☐	☐
Internet	☐	☐
Recreational (e.g., musical instruments)	☐	☐
Access to land for gardening	☐	☐
Fishing equipment (specify):	☐	☐
Farming equipment (specify):	☐	☐
Livestock (specify):	☐	☐
Other equipment for accessing natural resources (specify):	☐	☐

Q95 If you suddenly needed access to food, water, fuel (for cooking & transportation) or healthcare how many people that aren't household members could you turn to who would help?				
No One	1-2 People	3-4 People	>5 People	>10 People
1	2	3	4	5

Q96 How much do you agree with the following?					
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I trust the people in my community	1	2	3	4	5
I am happy with the leadership in my community	1	2	3	4	5
Access to natural resources in my community is fair	1	2	3	4	5
Access to new economic opportunities in my community is fair	1	2	3	4	5

Q97 Are you happy with your level of involvement with decisions that are made within your community?				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Q98 In the past year did anyone in your household participate in community activities?				
Never	Rarely	Sometimes	Frequently	All the Time
1	3	4	5	5

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Q99		Q100					
Please list the groups, organisations or associations that your household belongs to?		Does any member of your household have a leadership role in these organisations?					
1							
2							
3							
Q101 How much money does your household make on average in one month?							
Less than \$250		\$250-500	\$500-1000	\$1000-2000	More than \$2000		
☐		☐	☐	☐	☐		
Q102 How satisfied are you with your ability to purchase the items your household needs to survive (e.g., food, water, healthcare etc.,)?							
Very Dissatisfied		Somewhat Dissatisfied	Neither Satisfied or Dissatisfied	Somewhat Satisfied	Very Satisfied		
1		2	3	4	5		
Q103 Was your household's income this year higher, lower or about the same as last year?							
☐ Higher							
☐ Lower							
☐ About the same							
Q104 IF Higher or Lower, why do you believe your income changed?							
Q105 Approximately how much money does your household have in savings?							
None		Less than \$250	\$250-500	\$500-1000	\$1000-2000	More than \$2000	
☐		☐	☐	☐	☐	☐	
Q106 Approximately how much money does your household spend in one month?							
None		Less than \$250	\$250-500	\$500-1000	\$1000-2000	More than \$2000	
☐		☐	☐	☐	☐	☐	
Q107a			Q107b				
Do you currently use any of the following ?			If YES, what type was this/where did you obtain this from?				
Bank Accounts (BSP, ANZ, Bred Bank, POB, Womens Saving Club)			Yes ☐	No ☐			
Pension Accounts (NPF, You Save)			Yes ☐	No ☐			
Loans (BSP, ANZ, Bred Bank, POB, Womens Savings Club, National Finance etc.,)			Yes ☐	No ☐			
Q108 In the past year, has anything affected your access to income?							
Yes ☐							
No ☐ (If NO, go to Q107)							
Q109			Q110				
If YES, what is the name of the problem?			If YES, how often have you experienced these problems?				
			Very Rarely	Rarely	Sometimes	Frequently	All the Time
A			1	2	3	4	5
B			1	2	3	4	5
C			1	2	3	4	5
D			1	2	3	4	5
E			1	2	3	4	5

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Q111 Have these problems effected your household?					
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Logging	1	2	3	4	5
Changes in Wild Fish Availability	1	2	3	4	5
Sea Level Rise	1	2	3	4	5
Flooding	1	2	3	4	5
Increased Rainfall	1	2	3	4	5
Reduced Rainfall	1	2	3	4	5
Increased Temperature	1	2	3	4	5
Covid-19	1	2	3	4	5
Other (specify below):					
	1	2	3	4	5
	1	2	3	4	5

Q112 Does your household have some knowledge of these problems?					
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Logging	1	2	3	4	5
Changes in Wild Fish Availability	1	2	3	4	5
Sea Level Rise	1	2	3	4	5
Flooding	1	2	3	4	5
Increased Rainfall	1	2	3	4	5
Reduced Rainfall	1	2	3	4	5
Increased Temperature	1	2	3	4	5
Covid-19	1	2	3	4	5
Other (specify below):					
	1	2	3	4	5
	1	2	3	4	5

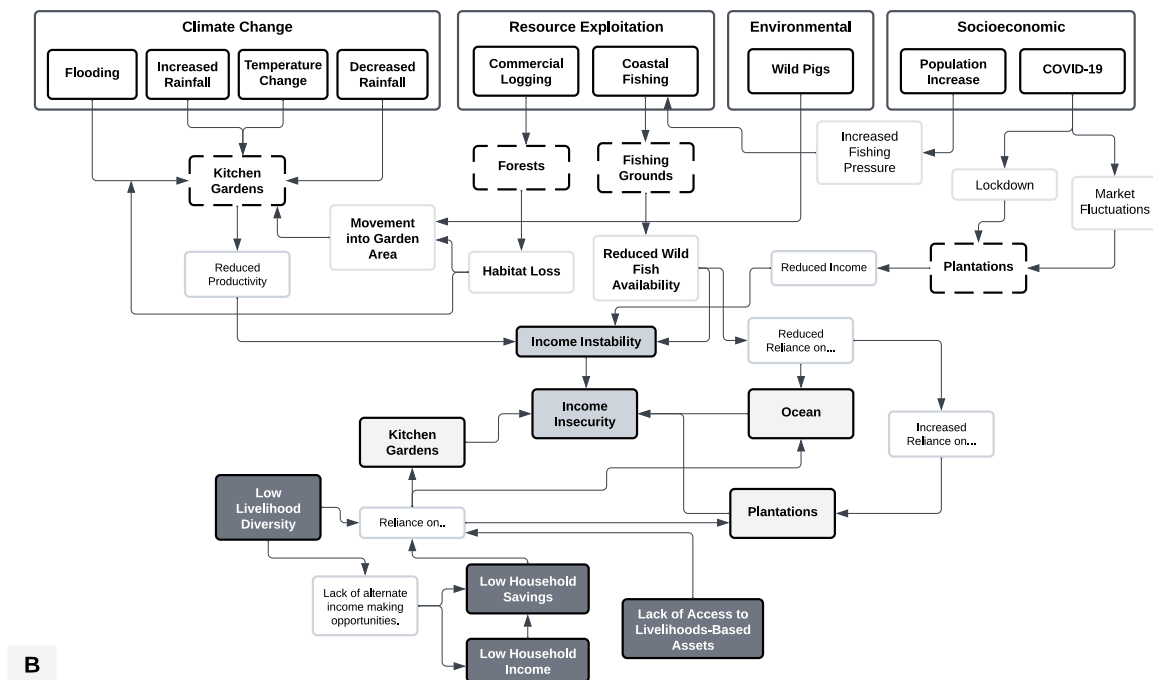
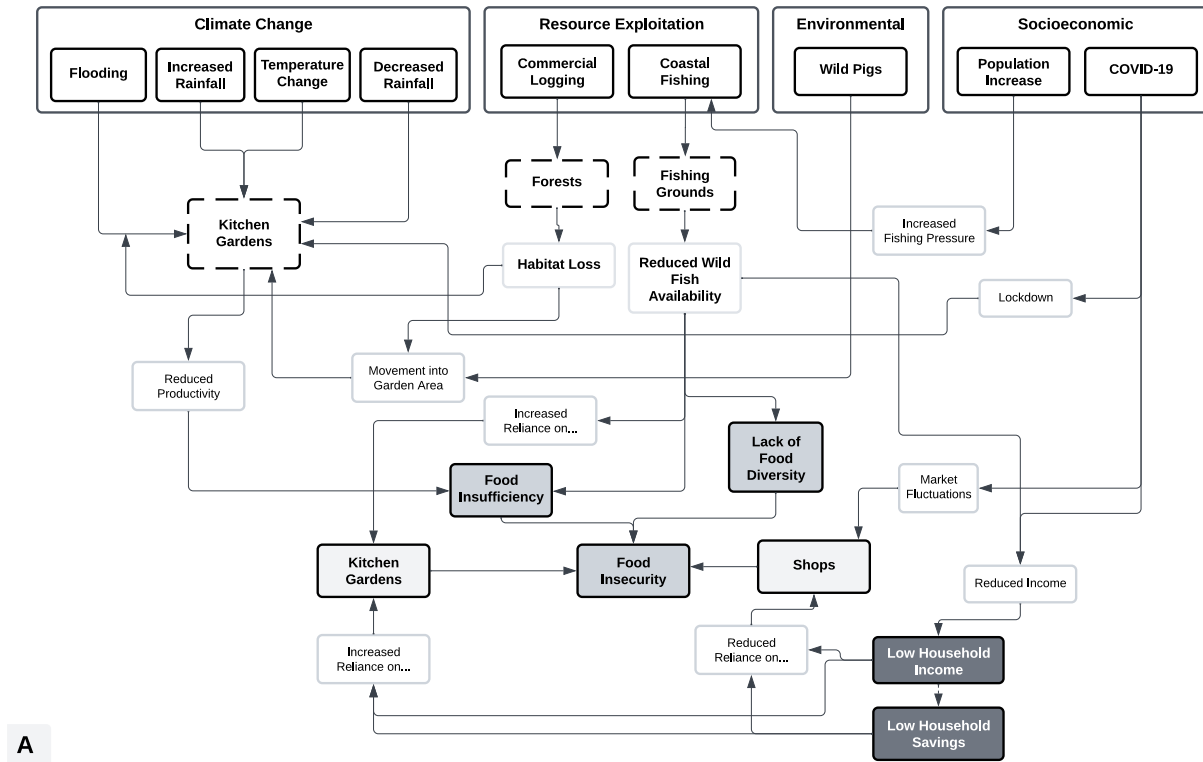
Q113 Does your household have ways of coping with these problems?					
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Logging	1	2	3	4	5
Changes in Wild Fish Availability	1	2	3	4	5
Sea Level Rise	1	2	3	4	5
Flooding	1	2	3	4	5
Increased Rainfall	1	2	3	4	5
Reduced Rainfall	1	2	3	4	5
Increased Temperature	1	2	3	4	5
Covid-19	1	2	3	4	5
Other (specify below):					
	1	2	3	4	5
	1	2	3	4	5

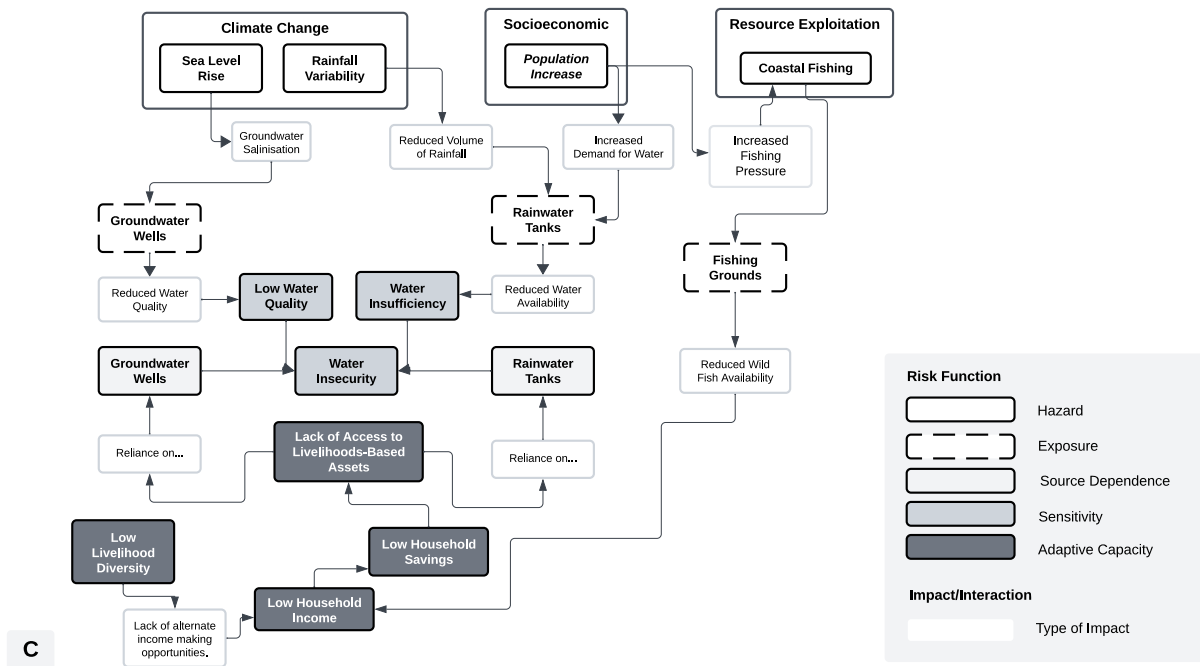
Appendix 7: Additional decision support tools used to interpret LRPf outputs

- i) Vulnerability index table showing the outputs of adaptive capacity and sensitivity indicators ranging from very low (light green) to very high (red) for each community.

Indicator		C1	C2	C3
Adaptive Capacity				
Human Capital		L	M	M
HC1	Dependency Ratio	M	M	L
HC2	Health Condition	L	L	L
HC3	Access to Healthcare	M	M	M
HC4	Livelihood Diversity Index	M	M	H
HC5	Extent of Coping Strategies	L	M	L
Financial Capital		H	H	H
FC1	Household Savings	H	H	H
FC2	Household Income	H	H	M
FC3	Household Expenditure	M	M	M
FC4	Income Satisfaction	M	M	M
FC5	Access to Financial Services	VH	H	M
Social Capital		M	M	M
SC1	Social Networks	M	M	M
SC2	Inclusion in Decision Making	M	M	M
SC3	Local Institutional Membership	M	H	H
SC4	Satisfaction with Leadership	M	M	M
SC5	Trust	M	M	M
SC6	Collective Action	M	M	M
SC6	Fair Access to Livelihood Opportunities	M	M	M
Physical Capital		M	H	H
PC1	Access to Livelihoods-Based Assets	M	H	H
Natural Capital		M	M	M
NC1	Fair Access to Natural Resources	M	M	M
Sensitivity				
Water Security		M	L	H
WS1	Access to Drinking Water	M	L	VL
WS2	Water Sufficiency	M	L	H
WS3	Water Quality	M	M	H
WS4	Access to Sanitation	VH	H	H
Food Security		M	M	H
FS1	Food Sufficiency	M	M	H
FS2	Food Consumption Score	M	M	M
Housing Security		VL	L	VL
HS1	Housing Condition	VL	L	VL
Energy Security		L	L	L
ES1	Cooking Fuel Sufficiency	L	L	L
ES2	Lighting Sufficiency	M	M	M
Income Security		L	H	H
IS1	Income Stability	L	H	H
Contribution to Vulnerability: Very Low (VL) Low (L) Moderate (M) High (H) Very High (VH)				

- ii) Risk interaction diagrams illustrating connections between LRPf risk components and their underlying factors, which informed the establishment of priority adaptation initiatives for a) C1, b) C2, and c) C3.

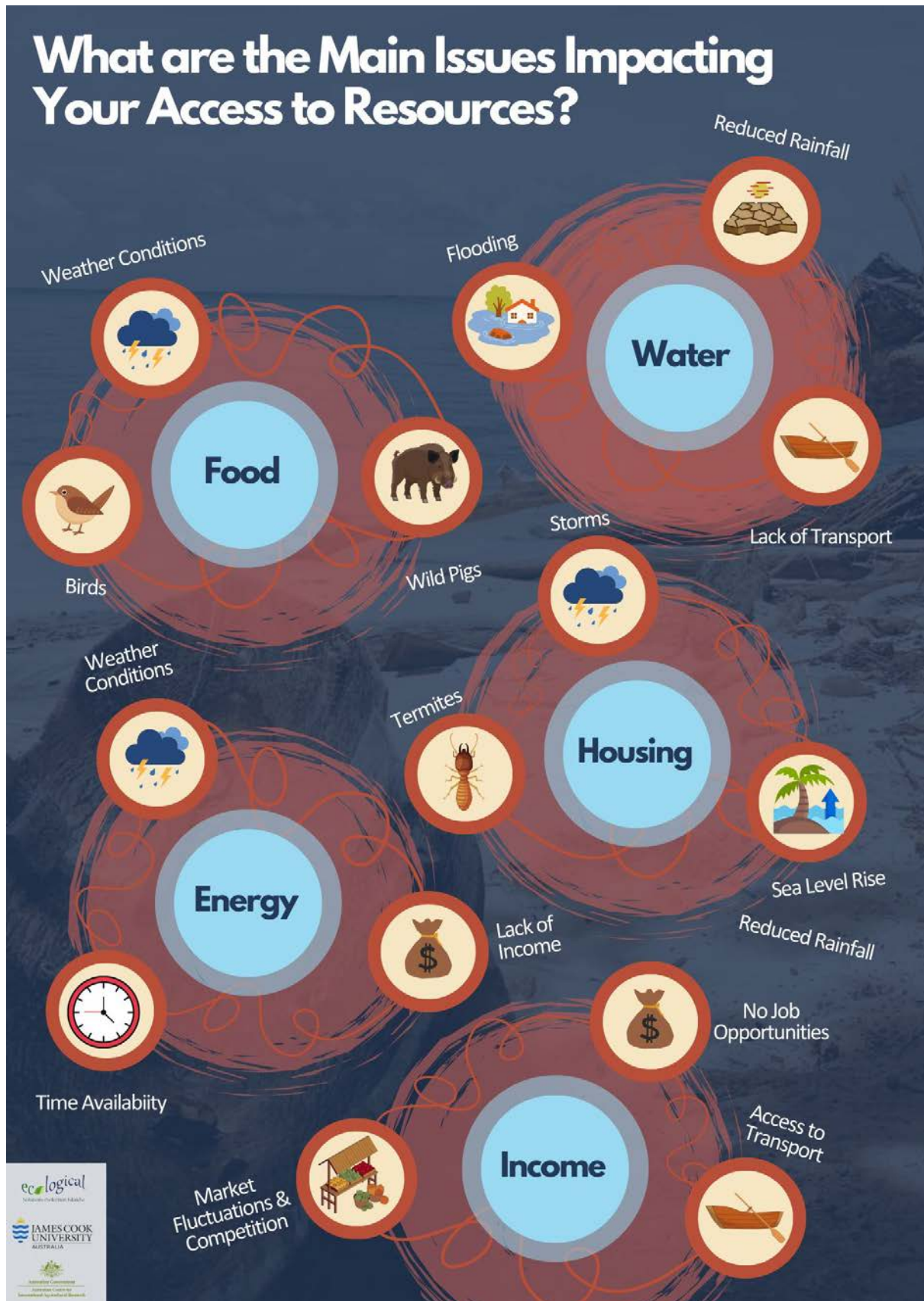




Appendix 8: Example of the LRPF knowledge sharing outputs disseminated to support their use in community-based adaptation planning processes











Chapter Three

Appendix 9: The different definitions applied to assess rural livelihoods vulnerability in the AR4 Framework, and risk in the AR5 Framework versus the LRPF.

AR4 (IPCC 2007)	AR5 (IPCC 2014)	LRP (Smith et al. 2024)
<pre> graph TD Vulnerability --> PotentialImpact[Potential Impact] Vulnerability --> AdaptiveCapacity[Adaptive Capacity] PotentialImpact --> Exposure PotentialImpact --> Sensitivity </pre>	<pre> graph TD Risk --> PotentialImpact[Potential Impact] Risk --> Vulnerability PotentialImpact --> Exposure PotentialImpact --> Hazard Vulnerability --> Sensitivity Vulnerability --> AdaptiveCapacity </pre>	<pre> graph TD Risk --> PotentialImpact[Potential Impact] Risk --> Vulnerability PotentialImpact --> Exposure PotentialImpact --> Hazard Vulnerability --> Sensitivity Vulnerability --> AdaptiveCapacity AdaptiveCapacity --- CapitalAssets[Capital Assets] Sensitivity --- LivelihoodObjectives[Livelihood Objectives] </pre>
Risk: n/a Vulnerability: The degree to which a system is susceptible to, and unable to cope with adverse effects of climate change. Adaptive Capacity: The ability of a system to adjust to exposure to shocks and stressors, moderate potential damage, take advantage of opportunities, and cope with consequences. Capital Assets: n/a Sensitivity: The degree to which a system is affected by exposure to shocks and stressors. Livelihood Objectives: n/a Resource Dependence: n/a Hazard: n/a Exposure: The nature and degree to which a system is exposed to significant climate variation.	Risk: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognising the diversity of values. Vulnerability: The propensity or predisposition to be adversely affected. Adaptive Capacity: The ability of systems, institutions, humans and other organisms to adjust to potential damage, take advantage of opportunities, or respond to consequences. Capital Assets: n/a Sensitivity: The degree to which a system or species is affected, either adversely or beneficially by climate variability or change. Livelihood Objectives: n/a Resource Dependence: n/a Hazard: The potential occurrence of a natural or human-induced physical event, or trend, or physical impact that may cause loss of life, injury, or other impacts. Exposure: The presence of people, livelihoods, species, or ecosystems, environmental functions, services, resources, infrastructure, or economic, social or cultural assets in places and settings that could be adversely affected.	Risk: The potential for consequences where community livelihoods are at stake, and the outcome is uncertain. Vulnerability: The degree to which a community is susceptible to, or unable to adapt to the adverse impacts of hazard exposure. Adaptive Capacity: The socioeconomic characteristics that influence the ability of a community to respond to potential impacts, take advantage of opportunities, or respond to consequences. Capital Assets: The resources and assets that communities utilise to pursue and maintain sustainable livelihoods. Sensitivity: The degree to which a community may be impacted by hazard exposure. Livelihood Objectives: Objectives that support communities in meeting their basic needs and achieving sustainable livelihoods. Resource Dependence: The dependence of a community on resource types that may be impacted by hazard exposure. Hazard: The potential occurrence of a shock or stressor event that may impact local livelihoods. Exposure: The presence of a community in a location that may be adversely impacted by hazard event occurrence.

Appendix 10: Vulnerability index outputs for the AR4, AR5 (IPCC 2014) and LRPF.

Scores are represented according to the contribution of an indicator, composite indicator, or component to vulnerability, with the following colour codes: dark green = very low (VL); light green = low (L), yellow = moderate (M), orange = high (H), and red = very high (VH). If an element was not included in a framework's vulnerability index, it is indicated as n/a.

Vulnerability Index	Inclusion		
	LRPF	AR5	AR4
Adaptive Capacity	M	M	M
Human Capital	L	L	L
Dependency Ratio	M	M	M
Health Condition	L		
Access to Healthcare	M		
Livelihood Diversity Index	M	M	M
Extent of Coping Strategies	L		
Financial Capital	H	H	H
Household Savings	H		
Household Income	H		
Household Expenditure	M		
Income Satisfaction	M		
Access to Financial Services	VH	VH	VH
Social Capital	M	M	M
Social Networks	M		
Inclusion in Decision Making	M		
Local Institutional Memberships	M	M	M
Satisfaction with Leadership	M		
Trust	M		
Collective Action	M		
Perceptions of Fair Access to Livelihood Opportunities	M		
Physical Capital	M	M	M
Access to Livelihoods-Based Assets	M	M	M
Natural Capital	M		
Perceptions of Fair Access to Natural Resources	M		
Sensitivity	M	M	M
Water Insecurity	M	M	M
Access to Drinking Water	M	M	M
Water Sufficiency	M	M	M
Water Quality	M	M	M
Access to Sanitation	VH		
Food Insecurity	M	M	M
Food Sufficiency	M	M	M
Food Consumption Score	M		
Housing Insecurity	VL	VL	VL
Housing Condition	VL	VL	VL
Energy Insecurity	L		
Cooking Fuel Sufficiency	L		
Lighting Sufficiency	M		

Appendix 10

Income Insecurity	L	
Income Stability	L	
Exposure		H
Sea Level Rise		H
Flooding		H
Increased Rainfall		H
Decreased Rainfall		VH
Temperature Change		H

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