

# Situating climate change adaptation within plural worlds: The role of Indigenous and local knowledge in Pentecost Island, Vanuatu

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**Abstract**

Scholars, practitioners, and decision-makers are increasingly recognising that Indigenous knowledge can play a significant role in facilitating adaptation to climate change. Yet, adaptation theorising and practises remain overwhelmingly situated within Euromodern ontologies, and there remains limited space, at present, for plural ontologies or alternative ways of being and knowing. In this paper, and using the Pacific as our case study, we present an argument for the inclusion of multiple ontologies within adaptation policymaking. Pacific adaptation policies and interventions frequently privilege Western scientific knowledge and focus on addressing individual climate risks through technical fixes directed by foreign experts and funding agencies. They are also rooted in a policy architecture that is an artefact of colonisation in the region. Despite these obstacles, Pacific Islander responses to climate change are dynamic, and inclusive of the multiple and competing ontologies they work within, offering insights into how Euromodern and Pacific islander world

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views could coalesce to build adaptive capacity and consolidate community resilience into the future. Highlights • Indigenous Knowledge plays a critical role in enabling resilience and facilitating climate change adaptation in some parts of Vanuatu • Ni-Vanuatu people employ dynamic responses to climate risks incorporating multiple knowledge systems and practises • Co-existence of different knowledge systems provide insights into factors that enable adaptive capacity and consolidate community resilience • Diverse worldviews, knowledge systems and practises with Pacific Island cultures highlights the importance of thinking about ontological pluralism within adaptation • Climate adaptation is principally founded on Western ontologies, but there is a need consider non-Western ontologies and epistemologies.

### **Keywords**

indigenous knowledge, worldviews, ontological pluralism, climate change adaptation, island cultures, resilience

## **Introduction**

There is growing consensus amongst scholars and decision-makers that Indigenous Knowledge (IK), Traditional Ecological Knowledge (TEK), and Local Environmental Knowledge (LEK) systems play a critical role in enabling resilience and facilitating adaptation to climate change (Ford et al., 2016; Nalau et al., 2019). For this paper, we elect to use the term Indigenous and Local Knowledge (ILK), as employed by the Intergovernmental Panel on Climate Change (IPCC). Within the academic scholarship, ILK is often positioned as a critical resource to be integrated with scientific knowledge to improve our understanding of a diversity of topics including ecosystem functioning, environmental health, and the impacts of climate change. Organisations such as the IPCC are calling for such knowledge to be recognised as a core knowledge base that can enable more locally appropriate and empirically-based climate adaptation strategies. Others call for diverse knowledge and approaches to be deployed to address climate-related uncertainties (Mehta et al., 2019a, 2019b). Uncertainty itself may emanate from incomplete knowledge systems (Mehta et al., 2019a) or ignorance as Lyons et al. (2019: 1599) term it. Lyons et al. (2019) identify how different types of uncertainty can co-exist. These include uncertainties those based on: a deficit of knowledge (ignorance) due to incomplete information about system dynamics which generate diverse probabilities for possible future climate scenarios; surprise due to properties of complex systems that demonstrate emergent phenomena and shifts that cross thresholds; and volition-based uncertainties due to the roles of human actors as well as human institutions whose future actions are yet to be made. Lyons et al. (2019) argue that an understanding of the contexts (place- and values-based) and drivers of uncertainties is needed to ensure that Indigenous climate change adaptation planning and practises is socially just and sustainable. Further, political attention is also increasingly being directed at the experiences and concerns of Indigenous peoples within international climate governance through platforms including the United Nations Permanent Forum on Indigenous Issues and the United Nations Framework Convention on Climate Change Indigenous People's Platform. Despite this growing recognition of ILK amongst scholars and decision-makers, climate adaptation continues to be primarily framed through the language and practises of scientific knowledge and Euromodern ontologies, with little space given to plural ontologies and alternative ways of life within the various adaptation policies and strategies (Belfer et al., 2017, 2019; Roosvall and Tegelberg, 2015).

Despite growing recognition of the value of ILK, throughout the Small Island Developing States (SIDS) of the Pacific<sup>1</sup> adaptation policies and interventions frequently privilege Western scientific

knowledge and focus on addressing individual climate risks through technical fixes directed by foreign experts and funding agencies. Researchers' highlight how current climate adaptation policies and agents of adaptation often (re)produce imaginative geographies of Pacific SIDS as inherently vulnerable places and populations with no reference to the socio-political, economic, and cultural contextual factors that underpin patterns of vulnerability (Campbell, 2009; Farbotko, 2010; McNamara and Farbotko, 2017; Parsons and Nalau, 2019). Moreover, the dominant vulnerability discourse overlooks local people's resilience and capacities to adapt to social and environmental changes; demonstrated by the long history of managing climate risks through such practises as moving within and between islands, common pooling of resources, diversified livelihoods, and inter-island resource exchanges.

Pacific SIDS communities are commonly positioned by international aid agencies, development and adaptation "experts", journalists, NGOs, and certain academics as highly vulnerable populations, as climate change victims, and as prime examples of the global climate change crisis. The emergence of these narratives through interlinked channels involves climate change experts and advocates making wide ranging claims about Pacific SIDS. Just as in earlier generations the colonisers (be they colonial government officials, missionaries, traders) imagined the islands of the Pacific as "spaces outside continental and mainland modernity" (Farbotko, 2010: 52) so too do many contemporary narratives about the Pacific SIDS, particularly those emphasising ideas of "sinking islands", in a way that resembles Edward Said's previous identification of Western knowledge about the Middle East (the East) as ideologically built on unequal power relations between the 'West' and the 'East'. De Loughrey (2013), for instance, highlights the development of climate change documentary films that position Pacific SIDS as remote, isolated, vulnerable, endangered and pre-modern spaces, with images of local children on a beach playing and adults fishing contrasting with images of climate-induced hazards (inundation events, tropical cyclones, coastal erosion). Small Islands, once again (paralleling colonial period), are problematically imagined through Western discourses as spaces (dichotomously opposed to continents), which provide analogues for climate change without requiring audiences to discuss and actively engage with climate change as a product of modernity (Pacific islands as innocent victims) (De Loughrey, 2013; Farbotko, 2010: 52).

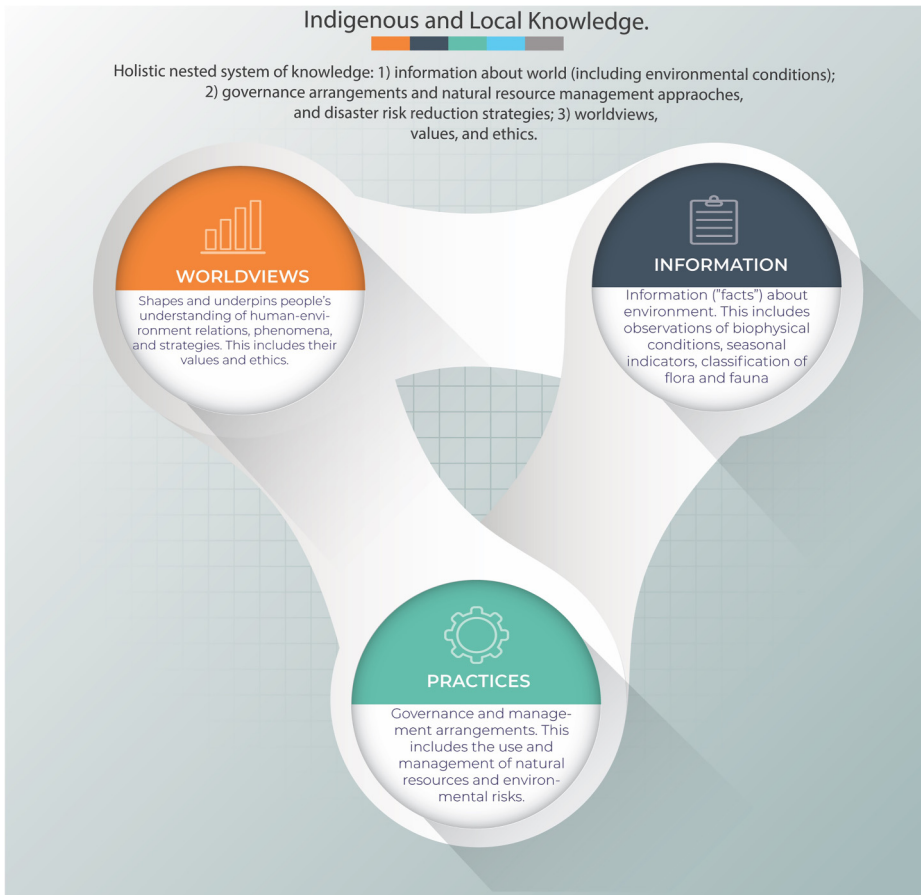
The populations of Pacific SIDS are represented as living on small isolated islands that are exposed to numerous natural hazards with constrained access to financial, technological, and natural resources with limited recognition given to their resilience and capacities to adapt (as critiqued by Barnett and Campbell, 2010; Parsons and Nalau, 2019). Experts and funding bodies, informed by this discourse of islands-as-inherently-vulnerable, frequently focus on the construction of hard (engineered) adaptation works, such as sea walls and other coastal defences to address the risks of coastal erosion, inundation events, and sea-level rise (Kench et al., 2018; McLean and Kench, 2015); strategies that are underpinned by Western scientific knowledge and associated ontologies and epistemologies (dubbed 'outside' knowledge by many Pacific communities, which contrasts with 'inside' knowledge or ILK) (Hetzel and Pascht, 2017; Hofmann, 2017). In this way, scholars and practitioners are primarily framing adaptation through a techno-centric (Western modernising) lens that mask the values held in other forms of knowledge (Barnett and Campbell, 2010). The broad application of technical, one-size-fits-all approaches also fails to account for nuanced understandings of climate change as well as the diverse adaptation strategies (both in use and proposed). Indeed, we suggest that climate adaptation as a field remains imagined and enacted through imaginative geographies that are wedded to biophysical science and colonial logics of modernity which constrain scholars' and decision-makers' capacities to think beyond the status quo and recognise other ways of knowing the world (and adapting to changing environmental conditions) (Nightingale et al., 2020).

Indigenous and other peoples (often situated outside of modernity) have long emphasised the existence of and critical need to recognise multiple and relational ontologies (Sundberg, 2014; Yates et al., 2017); yet the lines of exploration we present in this paper remain under-examined in climate adaptation-related scholarship (exceptions include Nightingale et al., 2020 and Nursey-Bray, 2015; Nursey-Bray et al., 2020). In this paper, using the case study of Pentecost Island, we draw attention to the pluriverse to examine the continuing importance of ILK to Indigenous communities in Pentecost Island (Vanuatu) for understanding and responding to changing social and environmental conditions. The data presented in this paper is based on extensive empirical fieldwork research conducted in rural villages in the Northern area of Pentecost Island (hereafter termed NP) over a three-month period (December 2017 and February 2018) by the lead author who is an Indigenous researcher who grew up in NP. The results of the fieldwork reveal how ILK forms a highly critical component of the adaptive capacity of NP communities as well as what community members considered as an appropriate and sustainable adaptation for them. More significantly, we argue that ILK also underpins how local people understand their life-world (their worldview which is grounded within their ontologies and epistemologies) and the relationship between society and nature (socio-natures). We maintain that more significant efforts are required (by scholars and practitioners) to engage with the implications of plural ontologies and epistemologies (that underpins ILK) within efforts to engender sustainable adaptation within Indigenous societies. Such sensitivity is required in settler-colonial and postcolonial situations where modern (Western) environmental ontologies remain hegemonic in the adaptation space.

We ask what would be involved to take the potential of multiple climate ontologies and epistemologies seriously, and what the consequences of this would be for climate adaptation in theory and practise. We add to the growing body of scholarship that is reframing understandings of human-environment relations and reformating the fundamental question of what climate change adaptation is for different communities (Mehta et al., 2019a, 2019b; Nightingale et al., 2020; Nursey-Bray et al., 2020; Tschakert, 2020). We argue that embracing multiple ways of knowing the world, including different cosmological accounts of climate change, can enrich the process of adaptation and create the opportunities for the reimagination and enactment of culturally-situated, equitable, and effective policies and strategies by allowing social groups (including different Indigenous peoples) to live in ways that are meaningful to them.

## **ILK: concept and scholarship**

ILK is a place-specific nested knowledge system of information-practises-values that consists of three key dimensions (as outlined in Figure 1). ILK includes people's information about their local environments, how they perceive and respond to environmental risks, their ways of life, and what people considered to be acceptable (or unacceptable) behaviours in any given circumstances (Berkes, 2012). ILK is, as Berkes and numerous other scholars previously observed, highly dynamic and derived from the accumulation of collective past experiences of a particular group of people about their local environments and their relationships between environments, living things (including people), and phenomena (biophysical and metaphysical) (Aikman, 2019; Leonard et al., 2013; Nalau et al., 2019). A specific attribute of groups with historical continuity of occupation and resource use in a particular area and environment, which includes non-Indigenous peoples, ILK is collectively held and local-scale rather than western scientific knowledges universally applicable and global-scale (Murray et al., 2006; Neis, 1992). Furthermore, the collective nature of ILK means that often different members of a community or tribal group (such as elders, specialists, families, and gender) possess various aspects of ILK, which are passed on often through oral transmission and practical learning rather than written (Ohmagari and Berkes, 1997; Turner and Turner, 2008; Voeks, 2007; Zobolo and Mkabela, 2006).



**Figure 1.** Components of ILK.

Over the last two decades, a small but growing number of studies highlighted how many Pacific communities use ILK, derived from their collective experiences and interactions with their local environments, to reduce their vulnerabilities to environmental risks and changes (Chand et al., 2014; Fletcher et al., 2013; Nalau et al., 2019). Such knowledge about local environments allows people to monitor and identify changes in environmental conditions, and informs decision-making about how to sustainably use resources and maintain livelihoods (Armatas et al., 2016; Nyong et al., 2007). ILK is also dynamic and ever-changing, building over the years, including within colonial history, to create a palimpsest of knowledge, which over time, builds a compelling evidential base of change (including climate) (Nurse-Bray et al., 2020). ILK, therefore, comprises not only information about environmental conditions but also associated socio-cultural governance structures, natural resource management (NRM) systems, and disaster risk reduction (DRR) strategies, all of which is critical to how information about local conditions are translated into adaptive practises designed to minimise risks and take advantage of opportunities.

Recent scholarship demonstrates how some Ni-Vanuatu communities, especially those in rural areas who maintain subsistence-based livelihoods, continue to employ ILK-based horticulture and agroforestry practises that ensure greater capacities to adapt to climate variability and extremes (Davies, 2015; Granderson, 2017; Le Dé et al., 2018; Mondragón, 2018). These include the

planting of a diversity of different crops (such as sweet potato, yams, and taro) within their household and communal gardens to ensure food security across seasons and variable social and environmental conditions. ILK-based food security practises continue to be used in many rural areas of Vanuatu, including our case study location of Pentecost Island, and provide a wide array of crops that can withstand differing climatic conditions. In addition to gardening, the storage and preservation of certain foodstuffs (so-called famine foods) were historically widely employed by Ni-Vanuatu communities, however, as John Campbell (2015) observes, the introduction of imported foodstuffs (specifically canned goods) reduced the use of ILK-based food storage and preservation techniques.

Despite the significance and benefits of ILK indicators for weather forecasting and the associated (NRM) and DRR strategies, a lack of systematic documentation and recording of ILK are key challenges identified by other scholars (Chand et al., 2014; Radeny et al., 2019). Not only is ILK not well-documented through western-style data collection approaches (in written, audio or visual records) but also ILK is often not being transmitted orally (as per customary practises) as reported by Granderson (2017). There is a widening inter-generational gap between ILK-holders (generally older people) and youth, often associated with migration to the capital city, Port Villa, and overseas to seek greater economic and educational opportunities (Davies, 2015; Granderson, 2017). The significance of the loss of ILK is reportedly contributing to decreased resilience to withstand climate extremes, as noted by Warrick (2010) in regard to tropical cyclones, as well as the loss of cultural identities and social cohesion (Granderson, 2017: 61). Some scholars suggest that due to the unprecedented pace and scale of climatic changes (Fernández-Llamazares et al., 2017; Nakashima et al., 2018), ILK will no longer be valid or reliable in the future, and that such loss of knowledge is therefore inevitable and unimportant. Yet, we argue that this ongoing discourse about the demise of ILK is rooted in misunderstanding about the nature of ILK.

ILK is not a singular or static collection of information that is handed down from one generation to the next with little change (Nakashima et al., 2018: 11), rather it is a dynamic body of knowledge between people and their local environments; this includes the relationships between human and more-than-human actors (Parsons et al., 2021). Each generation assesses and adapts existing ('old') knowledge to create and accumulate 'new' knowledge in a process. It is, therefore, a shared body of knowledge wherein people possess a collective capacities to re-shape and exchange information in a web of social actors. "Rather than *what* one knows, it is more about *how* one learns and how information about one's surroundings is compiled and renewed" (Nakashima et al., 2018: 11). Furthermore, each ILK is underpinned by Indigenous ontologies and epistemologies (interwoven with the worldview dimension of ILK as shown in Figure 1). In this article, ontology refers to a "set of beliefs and arguments about what exists or is real", and epistemology "comprises a set of beliefs and arguments about how we can reliably acquire knowledge about those things we take to exist or to be real" (Nakashima et al., 2018: 11). Although culturally distinct, Indigenous ontologies and epistemologies share many common features, including the principle of holism and concern about maintaining the balance within the world. Holism is focussed on interrelatedness and need to maintain balance between the material (biophysical), emotional, intellectual, and spiritual realms, which are all needed to ensure health and wellbeing amongst both individuals (human and more-than-human beings) and communities (social and ecological) (Bryant-Tokalau, 2018; Thomas, 2015).

The significance of holism within Indigenous thought is shown through in images and artworks that depict various types of circles or spirals, which are used to symbolise completeness, connectivity, and wholeness. In Figure 1 we depict ILK in circle form to indicate the holistic nature of ILK. Following on from Leonard et al. (2013) and Parsons et al. (2018) we organised ILK into three components: 1) information about environmental conditions (as well as socio-economic, political and spiritual); 2) governance and management strategies (wherein people take the information and

use it to make practical decisions); 3) worldviews, ethics and values (Leonard et al., 2013). Yet, we (like many scholars) argue that it is impossible to divorce Indigenous ontologies and epistemologies from their ILK, with worldviews (the cornerstone of all ILK) interwoven with ontology and epistemology. Indeed, Berkes (2012, p.4) and McGregor (2014) conceive of ILK as philosophic- and verb-based (a “way of knowing and doing through” with ILK as a process as well as practical actions) interwoven into Indigenous epistemology (Vaiolati and Morrison, 2019). Unlike non-Indigenous conceptualisations of epistemology, which focus on the nature of knowledge acquisition and belief systems, many Indigenous scholars define Indigenous epistemology more broadly to include specific spatial practises and ways of doing (thus interweaving it with ILK as information-practises-values) (Parsons and Fisher, 2020).

Both ILK and Indigenous epistemologies, be it in Pacific SIDS, or countless other Indigenous societies, humans constitute and are constituted by *socionatures* (Robertson, 2017; Winter, 2018, 2019). In relation to ILK and Indigenous epistemology, Vine Deloria Jr highlights how Western science strives for universality and avoids the body and emotions in favour of the supposedly neutral representation of the ideas (Deloria, 1999; Deloria et al., 2018). By contrast, ILK’s emphasis on wholeness grasps the unity of knowledge, experience, feelings and beliefs. Indigenous scholar Orville Huntington (from the Koyukon Nation in Arctic North America) and Annette Watson’s discussion of Indigenous “epistemic spaces” demonstrate how embodied experiences and emotions shape how Koyukon hunters go about harvesting animals (Huntington, 2000; Watson and Huntington, 2014). They argue that emotions and practical experiences are all underpinned by a relational ontology (a holistic worldview) and, in turn, ethics, values, and politics focussed on maintaining the health and wellbeing of collective (Watson and Huntington, 2014).

As these and countless other studies attest (Aikman, 2019; Leonard et al., 2013), ILK is distinguishable from hegemonic Western knowledges because it promotes a view of humans as part of the world, wherein “epistemology and being in the ecology of life and an ethico-political prioritisation of the collective” (Robertson, 2017: 185). Yet, the majority of the existing scholarship about Indigenous adaptation almost exclusively focuses on ILK as a collection of environmental information and practises that Indigenous peoples use (or historically used) to monitor, plan for, and respond to variable and changing environmental conditions. Yet, we argue in this paper that the ontological and epistemological dimensions of ILK are often overlooked by scholars, and in doing so many of scholars unwittingly reinforce the dominant Western paradigm (Pearce et al., 2015).

### *ILK integration efforts*

The majority of ILK-focussed climate adaptation research centres on the use of western science as the basis to collect and analyse ILK to augment gaps in data on local-level weather conditions, phenology, distribution of biota, and environmental changes. Such studies, conducted in Vanuatu (Plotz et al., 2017; Walshe and Nunn, 2012), elsewhere in the Pacific (Aswani and Hamilton, 2004; Lauer and Aswani, 2010) and around the world (Basdew et al., 2017; Rocha et al., 2017), often involves outside experts who decide what aspects of an Indigenous society’s knowledge is of value to others; and, therefore, it can be used to improve scientific knowledge about local environmental conditions and ecosystem functioning: knowledge which can be tested and verified through scientific methods. A recent study by Johnston into how Fijian and Tongan communities (two other Pacific SIDS) used their ILK to forecast tropical cyclones exemplifies this approach in the Pacific context (Johnston, 2015). Johnston reported how members of island communities in both nations employed ILK to predict the path of cyclone events (months and weeks in advance) and took preparatory actions that reduced their risks. However, Johnston argued that scientific studies were required to determine the validity of ILK-based environmental

indicators. As only following scientific verification could such indicators be integrated into western scientific knowledge to create a “comprehensive warning system” for tropical cyclones in the Pacific (Johnston, 2015: 218). Johnston’s call for knowledge integration projects parallels those of other scholars (Moller et al., 2004; Riseth et al., 2011; Rocha et al., 2017).

However, the integration of ILK with Western science is hampered by a lack of recognition of the ontological and epistemological differences between the different knowledge systems (Klenk et al., 2017; McCoy et al., 2017; Smith, 2013; Suaalii-Sauni and Fulu-Aiolupotea, 2014). As Pyhälä et al. (2016) argue, such an approach “runs the risk of biasing the actual perceived changes at the local level with imposed Western epistemological frameworks that are disconnected from particular cultural contexts” (Pyhälä et al., 2016). Indeed, integration of different knowledges often involves subsuming and depoliticising the governance arrangements, management approaches, and socio-cultural values through which different ways of understanding are authorised and deemed useful for climate adaptation, and the kinds of human-environment relationships that are possible (Crate and Nuttall, 2016; Nightingale et al., 2020: 4; Smith and Stirling, 2010). Attempts to record and then test components of ILK (such as indicators of extreme weather events) against those of western science as a means to prove (or disprove) the accuracy of ILK are underpinned by the idea that the whole world (the nature of reality) and knowledge can be divided into separate parts, which need to be catalogued and therefore controlled (Nurse-Bray, 2015). Such a process also embeds power differentials between these different systems of knowledge and creates power asymmetries that too often privilege scientific over ILK. As Mehta et al. (2019b: 1534) note, this can “end up creating new uncertainties and vulnerabilities, especially for poor and powerless people, constraining their livelihood choices, and also narrowing pathway for socially just adaptation”.

### *Moving beyond integration to consider Indigenous ontologies and epistemologies*

A growing number of Indigenous and non-Indigenous academics, practitioners, and decision-makers around the world are calling on the need to move beyond the ILK-Science integration model to embrace one that recognises and respects ILK as complete knowledge systems to be employed alongside other knowledge systems (Chant, 2011; Denny and Fanning, 2016). Scholars including Maxwell et al. (2018) and Nurse-Bray et al. (2020) employ frameworks that bring together different knowledges as equal partners and in doing so seek to deconstruct the colonial- or Euro-centric approaches that continue to dominant climate change adaptation and environmental management research, policy-making and practical actions. Nurse-Bray (2015); and Nurse-Bray et al., (2020) use a co-existence framework in their research into climate adaptation planning and the development of cultural water indicators with the Indigenous Australian Arabana people (Nurse-Bray, 2015). Whyte (2018a, 2018b) highlights how ILK is founded on collaboration, and mutually respectful learning can come about when different people (holding other knowledges and values) come together to learn from one another. Such collaboration, however, is not about making one perspective or knowledge system fit into the other (as with the integration model) but instead a longer-term process of relationship building and reciprocal learning.

Such an equal-to-equal approach must include a process that allows Indigenous and non-Indigenous peoples (be it ‘experts’, decision-makers, community members and adaptation practitioners) the opportunity to investigate and interpret social and environmental issues from their own perspectives, which includes allowing them to freedom to employ different practises, as well as respect for different protocols and timelines. Such an approach is described by McGregor (2008), and Nurse-Bray et al. (2020) as “co-existence” to refer to approaches wherein ILK and non-ILK-based initiatives (including research, formulation of policies, and risk assessment) are conducted in parallel but distinctly separate approaches. Such an approach does



not seek to integrate ILK into other knowledges (most commonly that of Western science), but instead it emphasising the value of drawing on the strengths of each knowledge system to work towards a common purpose (such as adapting to the impacts of climate change). In doing so the power differentials that are impede the formation of socially justice adaptation (Mehta et al., 2019a, 2019b) are able to be addressed. Moreover, Indigenous peoples are able to manage uncertainties (knowledge as well as climate-related) through exercising of their own agency and capacities to manage risks (Lyons et al., 2019).

The predominate focus of much ILK research and adaptation theorising enacts the “world as universal” (Abreu et al., 2017; Fernández-Llamazares et al., 2017; Johnston, 2015), which is underpinned by the ontological postulation of a singular reality about which distinct socio-cultural groups may hold different interpretations of the nature of reality (to paraphrase Sundberg, 2014: 38). At the heart of such adaptation projects, therefore we argue, rests the undercurrent of what Rojas (2016) terms the ongoing realities of the colonial logics of modernity, which was and still is built on colonial science and technologies (Rojas, 2016: 370–371). As Latour and Blaser delineate, modernity frames the nature of reality as something only discernable by and through western science and values; from this viewpoint culture is something negotiable whereas the environment (and by extension climate change) is not (Blaser et al., 2013; Latour, 1999). Following Blaser and Sundberg, we suggest that this assumption (of the universal and singular) pervades climate change discourses and serves to reinforce the privileged position afforded to Western knowledge, values, and practises over those of Indigenous societies. Climate adaptation (in theory and practise), we argue, “sustains itself through performances that tend to suppress and or contain the enactment of other possible worlds” (Blaser, 2009: 16). The enactment of the pluriverse (of multiple ontologies) is a critical goal of decolonising climate change adaptation (in theory and practise).

Ontological politics are used by academics as an analytical frame to examine a variety of different issues of relevance to Indigenous peoples (Blaney and Tickner, 2017; Ludwig, 2016; Todd, 2016). Paul Nadasdy (2007) provides one example in his exploration of the ontological assumptions of scientists who work to design and implement biodiversity conservation projects in Northern Canada. He shows how their ontologies (that emphasised human-environment separation) contributed to the dismissal of Indigenous ontologies of hunter-animal relations (based on the principle of reciprocity) (Nadasdy, 2007). Scientists and decision-makers rejection of Indigenous ontologies often results in Indigenous peoples and their knowledge being excluded from the design and implementation of biodiversity conservation management plans and climate adaptation strategies (Barnett and Campbell, 2010; Buggy and McNamara, 2016; Johnston, 2015; Nakashima et al., 2018; Westoby et al., 2019).

Indigenous epistemologies assert the need to circumvent epistemic snags centred on “objectivity” and “universality” (Cameron et al., 2014; Kovach, 2015; Smith, 2013; Sundberg, 2014). Often perceived as the twin pillars of positivist science, Indigenous and non-Indigenous decolonial scholars reject that “objectivity” and “universalism” are “unique fabric of truths” (Clement, 2020: 284). For Linda Tuhiwai Smith, objectivity does not reflect neutral observation but rather is both performative and normative; performative because (despite assertions of the authoritative declaration of its objective truths) positive science relegated other ways of thinking to outside the field of knowledge, and normative as it only measures by “imperial eyes” (according to Western understandings of what is rational and fundamental ideas) (Smith, 2013: 58, 172). Accordingly, Indigenous ways of knowing and being in the world (which are encapsulated within our broader definition of ILK) are considered to be irrational, unreliable, and backward, and therefore devalued as cultural (myths and legends) and spiritual beliefs, or superstitious and primitive (Hemstock et al., 2017; Walshe et al., 2018). Scholars and practitioners frequent dismissal of Indigenous understandings of climate change, which differs from those whose view is trained through a different lenses

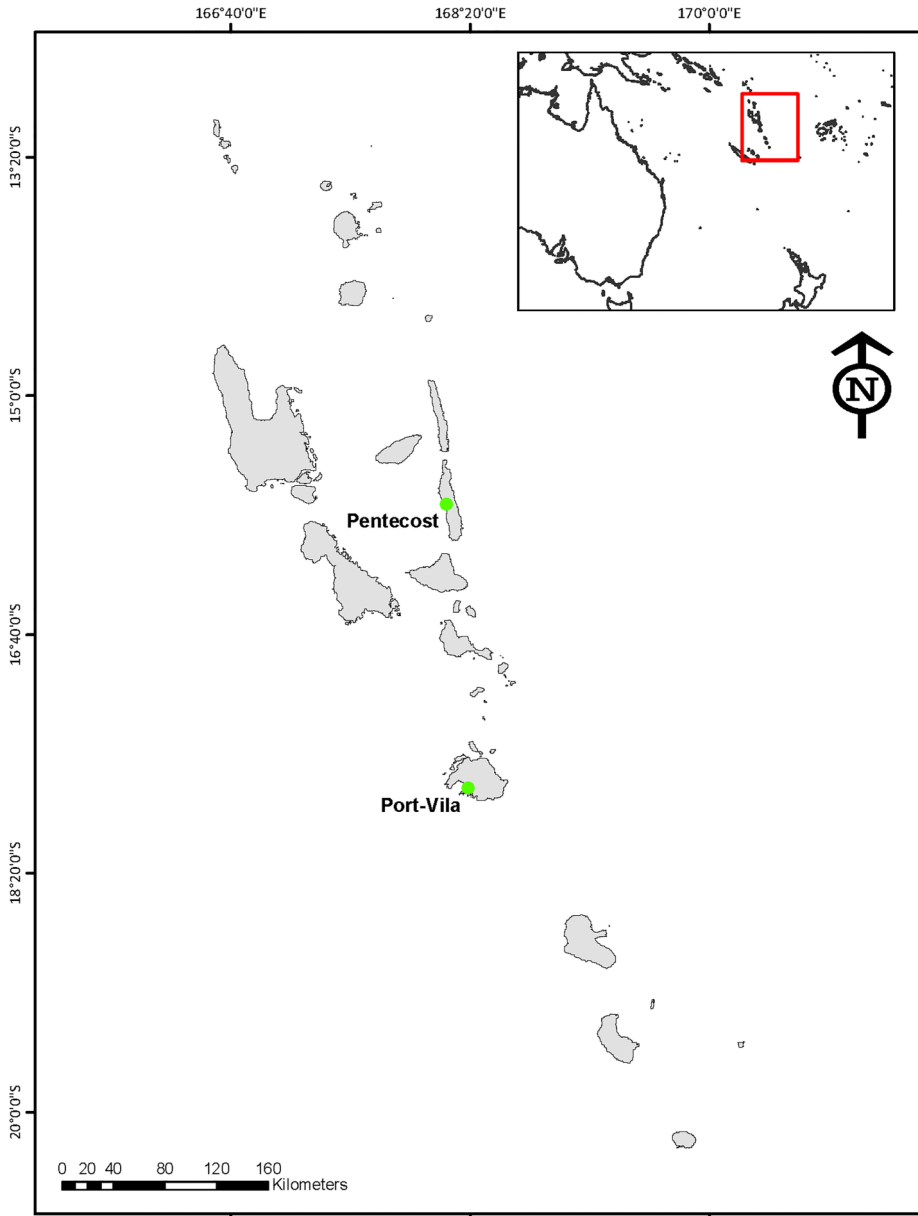
(oftentimes that of Western scientific knowledge), as uninformed and naïve is used as evidence to justify efforts (narrated as resilience- or capacity-building adaptation projects) to educate Indigenous people about climate change (Johnston, 2015; Kagawa and Selby, 2012; Pondorfer, 2019). Yet, as Clement recently points out, it is vital to take note of the “semantically related to the ‘object’ and the ‘objectification’, which in the context of research with Indigenous peoples revives the colonial ‘positional superiority’ of the researcher over the researched” (Clement, 2020: 284).

### *Ontological pluralism*

Ontological pluralism exists in many Indigenous societies, including in Pacific SIDS. In the Pacific, as we document earlier, climate adaptation is predominately based on scientific and technocratic worldviews, with most interventions designed to reduce environmental risks and enable sustainable adaptation failing to acknowledge the significant influences on decision-making of Indigenous and Christian belief systems. As Kuruppu (2009), Luetz and Nunn (2020) and others identify, the almost total Christianisation of Pacific SIDS populations during the last century means multiple ontologies and epistemologies (Christianity, Indigenous, Western) coexist in the region (Mortreux and Barnett, 2009). Yet, adaptation policies and initiatives generally overlook the significant role that Christianity plays in shaping Pacific peoples’ perceptions of and responses to climate change (Luetz and Nunn, 2020); with many people drawing on both Christian and Indigenous values in their daily lives. We suggest that adaptation scholars and practitioners need to consider what ontological pluralism (which includes spirituality and connection with more-than human entities) means in the design, funding, and implementation of adaptation efforts.

Ontological pluralism, particularly in the context of Indigenous ontologies, frequently extends to include both human and non-human entities (Howitt and Suchet-Pearson, 2006; Tengö et al., 2017). As De La Cadena (2010) outlines, the Andes mountains considered to be living entities (more-than-human actors) are included in political debates as a way to challenge the hegemonic (colonial modernist) conceptualisation of nature as something separate from society. However, challenges often emerge when groups (including non-Indigenous scientists, adaptation practitioners, and officials from development agencies) unfamiliar with ontologies of mountains and rivers as living beings, for instance, are not capable of understanding that humans possess social, political, cultural, emotional and existential obligations to more-than-human entities. These points of dispute and contestation reflect partial connections between these different life-worlds, and these incomplete connections offer possibilities for mutual political discussions and cross-cultural dialogue.

In this paper we provide an empirical case study of adaptation in practise that investigated whether conventional tropes of Indigenous peoples as vulnerable, and adaptation as a modus operandi (largely conceptualised through a Euro-Western gaze) (Blaser, 2014; Yates et al., 2017) are relevant in the Pacific. We sought to understand the intersection between Euro-Western and Pacific Indigenous knowledge systems and how they coalesce in adaptation practise. We argue that conventional modes of understanding about knowledge and climate, limit the potential and scope of Pacific Indigenous invention and imagination. Our work shows that where local ontologies and epistemologies are deployed, appropriate adaptations can be established that build resilience and that explicitly use and recognise multiple forms of knowledge. These approaches, therefore, recognise Indigenous peoples’ experiences of ‘colonial situations’, Indigenous peoples’ rights of self-determination, and centrality of Indigenous knowledges, ontologies and epistemologies in the research design and practises.



**Figure 2.** Map showing the location of Vanuatu.

## **Methodology and case study location**

### *Location: Pentecost Island*

Our research was undertaken in NP (northern area of Pentecost Island, Vanuatu) (location shown in Figure 2). Vanuatu is exposed to the diversity of geologic- and climatic-driven natural hazards (Ballu et al., 2011; Garschagen et al., 2015; Le Dé et al., 2018) and is classified by the IPCC as

one of the most highly vulnerable countries on the negative impacts of climate change. Impacts include sea-level rise, more intense extreme weather events (drought and tropical cyclones), and changing rainfall and temperature, which are increasing existing and create new vulnerabilities.

Pentecost is a mountainous island with a total landmass of 490 square kilometres that is located 190 kilometres north of the Vanuatu capital of Port Vila. The climate is humid tropical, with a rainy season (November–April) and dry season (May–October). Pentecost Island does not possess any significant towns on the island, and the majority of the population (numbering more than 17 000) live in small villages. Livelihoods centre around subsistence agriculture plus the growing cash crops (sold at markets) (Jolly, 1981). A wide range of crops are grown for local consumption, as well as kava (a narcotic root prepared into a drink) which is the island's main export. While Pentecost Island is known internationally for being the birthplace of bungee jumping (based on the practise of *Gol* – land-diving), within Vanuatu, the island is also known for its inhabitants' commitment to *kastom* (a Bislama term that most closely equates to the Ni-Vanuatu ILK) and opposition to colonial rule (Harding, 2007; Jolly, 1981; Kalkao, 1980). For instance, Walter Lini (the so-called 'father of the nation') led Vanuatu to independence from joint British and French colonial rule in 1980 and was from the North Pentecost village of Laone (Kalkao, 1980). Pentecost Island was more recently the birthplace of the Turaga Indigenous movement, which rejects the modern capitalist economic system (seen to contribute to poverty and dependency of international aid) and promotes the "kastom economy" (Harding, 2007). The movement seeks to maintain ILK-based subsistence livelihoods and promote the continuation and revival of Indigenous systems of exchanging goods (rather than selling products for cash), forms of currency (such as woven mats and pigs), and even operate their own banking and educational systems. The movement, however, is critiqued by many within Vanuatu for being backwards-looking, incompatible with Christianity (introduced alongside colonial rule in the nineteenth century) and they promote their version of "traditional" culture that is incompatible for modernity. Despite these critiques, over the last decade there has been a renewed emphasis within Vanuatu to promote the *kastom* economy; the National Cultural Centre and the Vanuatu National Council of Chiefs, for instance, declared that 2009 and 2010 were the years of the "customary (*kastom*) economy" (Mahit, 2016; Westoby, 2010a, 2010b). People throughout the country are expressing concern about the links between poverty, food insecurity, and the alienation of land from Indigenous peoples, the shift away from subsistence-based to market-based agriculture (crops are grown for export rather than domestic consumption), and the growing reliance on tourism and external investment. The recent promotion of the "kastom economy" is, Westoby (2010a) suggests, representative of Indigenous resistance to the cash economy and modernity more broadly.

Despite the promotion of the *kastom* economy and the continued operation of Indigenous governance structures at local levels (within villages and on each of the 83 islands), the national governance system since independence adheres to the British Westminster political system (Miles, 1998). The governance of Vanuatu is now comprised of a national government, under which there are six provincial governments; also, multiple area councils operate on each island to connect communities with provincial governments (Nalau et al., 2019). Indigenous laws are recognised under the Constitution through the *Malvatumauri* (National Council of Chiefs) as a formal source of law but are not necessarily used by the judiciary (British-informed court system). There are two systems of law – the Western legal system and the Indigenous legal system – operate in Vanuatu and run in parallel to one another. An example of legal pluralism. Legal scholar Davis argues that the "pluralist system in Vanuatu [is] subordinating the customary legal system for the Western or European legal frameworks" (Davies, 2016). Yet, Davies (2016) maintains that Indigenous law is in a "better positioned to inform local communities on environmental ... issues", including climate change, because ILK forms the basis of how communities govern and manage natural resources and implement DRR.

The national government primarily directs climate adaptation plans and projects. The top-down approach, Nalau et al. (2019) note, is partly a result of Vanuatu's local governments (provincial and island) lacking the financial, human, and technological resources to implement adaptation projects and programmes (Nalau et al., 2019). Accordingly, adaptation planning and actions are mostly the domain of central government-administered mainly through the National Adaptation Board (NAB), which coordinates all climate change and DRR projects and programmes in Vanuatu (Nalau et al., 2019). The two policy arenas of climate adaptation and DRR are integrated and seemingly inseparable in Vanuatu (Nalau et al., 2019); this adheres to the Pacific regional framework's aim of addressing climate adaptation, DRR and sustainable development together to enhanced community resilience (SPC, 2016). In Vanuatu adaptation and DRR efforts are mostly implemented by or with external bodies such as development banks (Asian Development Bank, World Bank), through arrangements with bilateral donors (Australia, New Zealand, EU, USA, China), international non-governmental organisations (including Red Cross and Oxfam) and local community-based organisations (Buggy and McNamara, 2016; Clarke et al., 2019; Le Dé et al., 2018; Warrick, 2010; Westoby et al., 2019). The shared division of responsibilities for implementing adaptation was set out under the Vanuatu National Adaptation Programme of Action in 2007 (which continues to be in operation in 2020). The various actors and levels of governance involved in adaptation efforts influence the types of measures undertaken in Vanuatu.

Legislation was passed by the Vanuatu Government in 2016 that coupled climate change science, adaptation, and DRR together (Republic of Vanuatu, 2016). The statute, paralleling those of many other nations, adopts the language of the global climate change knowledge and principles (such as the precautionary principle). It contains just two mentions of ILK both focussed on the functions of the Director of Meteorology and the Director of Climate Change to understand and recognise ILK about “weather and climate through observation of weather indicators in nature and by other means” (Republic of Vanuatu, 2016). In the 2016 legislation ILK is referenced in regard to how specific information can be used (integrated with) Western science to improve weather forecasting systems (Republic of Vanuatu, 2016). Disaster Risk Management Act of 2020 similarly includes one passing mention of ILK in regard to disaster risk management adopting a “whole-of-society approach” that is “gender responsive and respectful of indigenous and traditional knowledge systems” (Republic of Vanuatu, 2020). However, both statutes fail to acknowledge that ILK: 1) is an important component of adaptive capacity; 2) the basis of Indigenous communities' place-specific adaptive strategies; 3) can inform the development of new locally-led values-based climate adaptation plans and projects.

The Vanuatu Climate Change and DRR Policy 2016–2030 does acknowledge the challenges of decentralised governance and recognises the role of Indigenous (*kastom*) governance systems working in parallel to the official government (legal pluralism). The implementation of adaptation projects is meant to follow the dual governance (Indigenous and Western) structure that operates in Vanuatu, which includes the Indigenous (‘traditional’) governance structure operating at the local level (village council) and the western governance structure that operates at the national level (central government down to area council level). Policies and decision-making about adaptation are typically made at the national and provincial levels and do not necessarily allow for village councils (or local communities) to participate in the design of adaptation projects in any meaningful way.

There are increasing efforts in Vanuatu to ensure that government policies allow for Indigenous governance, knowledges, and values to be incorporated (Republic of Vanuatu, 2015). In 2018, for instance, the central government implemented a new decentralised structure, with area administrators appointed to each area council (on each island) and given responsibility for implementing projects (including climate adaptation). Also, following Cyclone Pam (2015), the central government transferred responsibilities over for the distribution of disaster relief to village-based Community

Disaster Committees (rather than provincial governments, chiefs, or church leaders) (Le Dé et al., 2018; McDonnell, 2019). The decentralised approach was meant to ensure that policies and projects were locally appropriate and allowed for ILK to be incorporated. However, there is limited evidence of ILK-led or ILK-informed adaptation being translated from theory into practise (Clarke et al., 2019; Granderson, 2017; McDonnell, 2019). Instead, western scientific-led approaches continue to dominate the creation and implementation of adaptation plans and projects throughout the country.

Decisions about adaptation are being justified and rationalised by government officials and practitioners on the basis that these projects are urgently needed to reduce Indigenous communities' vulnerability and 'old ways' (kastom) are largely overlooked by decision-makers. For instance, Ahmed and McDonnell (2020) observe how the majority of recovery projects post-Cyclone Pam (March 2015) focussed on external aid operations that were "not well received locally as they were not tailored to the Vanuatu context" (Ahmed and McDonnell, 2020: 6). One project, NevHouse, involved the construction of 14 prefabricated cyclone-resilient houses made from recycled materials in Australia, which were then shipped to the Vanuatu island of Tanna (Unknown, 2016). The NevHouse project never progressed beyond initial 14 houses because it was too financially costly, slow and inefficient, and did not draw on the knowledge, skills, and resources of Ni-Vanuatu communities (Ahmed and McDonnell, 2020: 6).

## Methods

We employed a qualitative case study method for this research, which involved semi-structured interviews (which included walking interviews), as well as the collection of secondary documents (Ritchie et al., 2013: 4; Taylor et al., 2015: 8–9). Numerous researchers employ semi-structured interviews to investigate Indigenous NRM, DRR, and adaptation; accordingly, we elected to use the same approach in our study (Beaumier and Ford, 2010; Egeru, 2012). In line with cultural protocols, we sought and gained the permission of the local government and the chiefs of each village in the Renbura area of North Pentecost Island (henceforth referred to as NP) prior to undertaking the fieldwork (conducted between November 2017-February 2018). Our potential participants were identified by village elders and chiefs as being the ones in their villages who possessed a large amount of ILK, following this the lead author directly approached the individuals to invite them to participate in our study. He carefully explained the purpose of the study, taking time to ensure they understood that they were not under any obligation to participate and could withdraw at any time, and answered their questions. In total, 25 people agreed to be interviewed (24 men and 1 woman) who ranged in age from 40 years old to 108 years old.

Participants selected where they wanted to be interviewed, with most electing to be interviewed in their residences and then later choosing to move around their local area (including their villages, gardens, and forests) as they talked. The ability to talk in home environments provided them with the ability to talk in private away from other members of the community, away from the noise and other distractions of the villages and made them feel able to speak more freely on the topic (Roulston, 2010; Rubin and Rubin, 2011; Seidman, 2013). As interviewees were talking, they often pointed out parts of their environment (be it the water tanks, rivers or gardens) that they wanted the lead author (the interviewer) to photograph (as it connected to the ILK they were explaining). Interviews were done in languages Raga (NP language) and Bislama (the lingua franca of Vanuatu) in order to capture the rich vernacular context where ILK exists. Interviews were audio-recorded and later translated verbatim into English by the lead researcher (who is from NP and speaks Raga, Bislama and English fluently). Ethical approval was obtained from the lead author's academic institution (protocol number 020020) before fieldwork being undertaken, and research followed ethical procedures of the university as well as the ethical and cultural protocols of NP.

The interviews were thematically analysed using a six-step process using Braun and Clarke's (2006) six-step thematic analysis technique. The steps included (i) data familiarisation, (ii) initial coding, (iii) identification of themes, (iv) reviewing themes and mapping against research questions, creation of sub-themes (v) final themes, (vi) write up. Three key themes emerged from the data, which consisted of 1) information about biophysical and ecological conditions and processes; 2) NRM and DRR strategies; and 3) worldviews, values, and beliefs.

## Limitations of research methods

From the outset the research project set out to investigate ILK of all genders in NP as previous studies made us aware that different genders hold specific types of ILK within Indigenous societies and different responsibilities for NRM, DRR, and adaptation (Aikman, 2019; Leonard et al., 2013; Ohmagari and Berkes, 1997). In addition, we noted that the vast majority of studies into ILK in the Pacific either failed to explicitly mention the gender of research participants or noted that few or no women were interviewed as part of their studies (Nalau et al., 2019; Walshe and Nunn, 2012). The lead author, therefore, requested that NP chiefs and elders identify women (as well as men) in their villages who were ILK experts. However, the chiefs and elders (who were all men) only a handful were identified a handful of women and only one agreed to be interviewed by the lead author.

Our difficulties recruiting women to participate in our study was not an unique experience and was similarly reported by other researchers in their studies undertake on Pentecost Island Vanuatu (including in NP) (Chambers et al., 2017; Walshe and Nunn, 2012). The patriarchal power structures of found within NP communities, as well as many other parts of Vanuatu, mean that men in positions of authority (be they elders, chiefs or government officials) do not consider that women are capable of possessing any ILK of importance (due to women's lower social status and limited capacities to participate in village or household decision-making) (Jolly, 1991). Another potential contributing factor relates to marriage customs, which see a woman move from her home village to her husband's village following her marriage (the roles are never reversed, women are the ones who always migrate). This practise, as Walshe and Nunn (2012) suggest, means that many women feel that they are not IK experts (even after several decades living in their husband's village) because it is not their ancestral territories and they still feel like newcomers.

Many scholars conclude that the best methodological practise in such instances is to conduct women-only individual or group interviews (involving women interviewers and interviewees) change (Norgaard et al., 2018; Vinyeta et al., 2016); such interviews offer local women greater opportunities to participate and make women interviewees more comfortable in sharing their views. However, in this research project we were unable to ensure gender diversity in the fieldwork because it was the lead author's (a NP man) Master's thesis and he was required to undertake the data collection himself. We note that research projects often encountered difficulties translating the gender equitable principles into practise as reported in the Secretariat of the Pacific Regional Environment Programme (SPREP) and the Australian Bureau of Meteorology's study into ILK weather forecasting in Pacific SIDS (Chambers et al., 2017; Malsale et al., 2018; Plotz et al., 2017). The research team included both men and women (Indigenous and non-Indigenous) and sought to ensure that women researchers interviewed women and men interviewed men in their case study locations (Vanuatu, Fiji, and Samoa). However, in Vanuatu they were not able to gain permission from government and/or village chiefs to allow women researchers (both Indigenous and non-Indigenous) undertake the data collection as it was declared too dangerous for women. Accordingly, far less Ni-Vanuatu (natives of Vanuatu) women answered the questionnaire than Ni-Vanuatu men (unlike in the other two countries where respondents were equal amongst the genders) (Chambers et al., 2017; Malsale et al., 2018; Plotz et al., 2017). Thus,

while we recognise the limitations of our study, we argue that such limitations are common amongst the a vast majority of research projects on ILK in Vanuatu.

## Results

The ILK of NP villagers who participated in our research project is presented in our results within the three interwoven components: worldviews, NRM and DRR strategies, and environmental information. Significantly we found that ILK existed as a nested system of knowledge-practises-values underpinning local people's conceptualisation of society-environment relations, climate change, and responses to changing environmental conditions. All of these became interwoven components of their socionatures.

### *ILK as values: worldviews and understandings of environmental changes*

Our research participants highlight how their day-to-day activities, including their observations and interactions with living and non-living things, were intertwined with not only their environmental knowledge but also their broader ontological beliefs, values, and ethics. In this way, ILK was not divided off from the other dimensions (social, cultural, economic, political, spiritual, and environmental) of their life-worlds (ALD7, 2018). Interviewee AUD1 explains how local people understand weather phenomena as being linked to the spiritual domain:

“First, ... *Matanvanua* ... [the] person or spirit [who] lives on the mountain tops ... watches over [the] lands [which includes all] living things ... If [*Matanvanua*] sees that nature is [being] improperly treated [for instance] suffering [from] heat, then it speaks to the atmosphere (*Muganmahava*). *Muganmahava* [the atmosphere then] speaks to the three main winds [who dwell] within the clouds [and] drop ... rain [onto *Matanvanua*] to cool it off and sustain the life to [all] living things”. (AUD1, 2018)

The above storey highlights how NP people's ontological understandings of weather and its connectivity with socio-natural relations differs substantively from western ontology and epistemologies. Within NP communities, as with many Indigenous communities around the globe, the material and the non-material, the physical and the metaphysical, the social and the natural are read together. The belief that humans are part of nature creates feelings of connectivity and belongingness amongst local people, with place attachment derived from these kin-centric values (humans as kin with all living and non-living beings in their local environment). This relationality wherein everything is bound together is summarised in the quote:

“Every living thing on this planet has a chance to work and rely on each other to live. From human being to weather, everything connects to each other. You cannot find anything that survives alone. Every living thing depends on each other” (AHD10, 2018).

Many participants similarly narrated extreme weather events as an expression of the correct functioning of the socio-natural world, which allowed for the renewals for all things, and not disasters as typically interpreted with western societies. Rather than being external disruptions or threats to human communities, participants narrated these events as part of ongoing relationships as well as evidence of how everything connects and works together to maintain balance and healthy socionatures. Tropical cyclones, for instance, as one participant declared “come to clear up the blockages in the water systems or remove the heat and stabilise the temperature” (of the air, land, and water) (ALD7, 2018). In doing so, ALD7 observes, tropical cyclones were essential



to maintaining the health and wellbeing of all beings (despite the damage and losses people experience as a consequence of cyclones).

Indeed, NP communities, like other Indigenous peoples, do not exist in isolation from ‘outside’ knowledges, experiences, processes of change or peoples, and their worldviews are now informed by their encounters with modernity, coloniality, Christianity, and Western knowledge systems. While our participants routinely employed NP Indigenous polytheistic spiritual beliefs to explain why a change in one part of their socio-nature impacted, on the whole, some participants also used drew on Christian narratives of a single creator to explain these same phenomena. This emphasis on Christian narratives underscores how Pacific islanders concurrently hold both colonially derived (Christianity) and traditional world views, and how the pluriverse is enacted in daily practise.

Participant ALD7, for instance, expressed the view that all knowledge comes from the “creator (God)” with people part of “natural world” and with nature giving people “the signs or indicators months or weeks before the onset of [an extreme weather] event” (ALD7, 2018). Discussion of how “all living beings” were tied together was, in this instance, interpreted through multiple, co-existing, and not necessarily mutually exclusive, ontological lens. Participant ALD7 went onto state “If you have that [ILK] and can read the signals ... of extreme events, then you can be prepared in advance, and you will not suffer”, thereby drawing on both Indigenous and Christian beliefs (ALD7, 2018). Far from adopting a fatalistic view of their socio-natural world, NP participants different understandings of environmental conditions and extreme events are, we argue, evidence of how diverse knowledges, values, and beliefs shape problem-definition and decision-making surrounding what constitute appropriate (or inappropriate) actions, strategies, and processes in response to environmental risks and changes.

### *ILK as practise: NRM and DRR strategies*

Scholarship demonstrates that people involved in climate-sensitive livelihood activities (such as farming, fishing, and hunting) often employ environmental indicators to anticipate weather conditions and make decisions about the use and management of resources (Kalanda-Joshua et al., 2011). In NP, the majority of people’s livelihoods still centre on subsistence agriculture and fishing, accordingly our research highlights how IK-holders use environmental indicators to inform their NRM and DRR strategies to reduce their vulnerability to the negative impacts of climate variability and extreme weather events.

*NRM and livelihood strategies.* Local people in NP also employed a variety of food management strategies to prepare for and recover from extreme weather events, thereby maintaining their food security. The planting of a diverse array of disaster resilient crops including wild yam (*Dioscorea numularia*), domesticated yam (*Dioscorea alata*), Fiji taro (*Xanthosoma sagittifolium*), sweet yam (*Dioscorea esculenta*), wild Taro (*Alocasia macrarrhizos*), and sweet potatoes are essential to ensuring households and villages possess secure food sources despite variable environmental conditions. Some crops grown are more climate sensitive than others are requires special attention to reduce their vulnerability to climate variability. For instance, cassava, a crop introduced by colonial officials in the twentieth century, is widely planted in NP villagers household gardens but is especially vulnerable to damage by high winds (link to storm or tropical cyclone activity). Accordingly, NP people employ ILK-based weather forecasting to predict when a tropical cyclone or storm front is approaching and cut the stems of cassava plants to ensure their crops are not destroyed by winds (as depicted in Figure 3). Banana and taro leaves are also cut to reduce friction by wind strength. Some food crops are particularly climate resilient, for instance, traditional food crops including sweet potatoes and yams both produce tubers in the soil that are



**Figure 3.** Local man cutting stems of cassava plants in preparation for forecasted high winds (source: author's own) insert here.

safe from direct impacts of strong winds (associated with tropical cyclones) and the heat of the sun (during droughts), and are able to grow in diverse locations (hilltop and coastal gardens). Vovohe (*Ficus wassa*) tree is one of the most frequently used trees as a source of food following a tropical cyclone. Described by AHD10 as the ‘wisest tree’, Vovohe bears its fruits from the stem near the roots rather than on the branches so that when high winds break the branches its fruits remain attached. The tree, which is fast growing, provides people with fruit after a cyclone, which are collected, wrapped in leaves and baked in an earth oven or cooked in bamboo pipes.

Many participants declare that historically NP households always planted wild yams as an anticipatory adaptation strategy to manage environmental risks, but now some NP people are purchasing imported foodstuffs (such as rice and biscuits) instead of growing yams. They argue that households should return to planting wild yams and other traditional crops to enhance their capacities to adapt to climate variability and change (AHD4, 2018; AHD5, 2018; AHD7, 2018). Wild taro (*Alocasia macrorhiza*) is another crop that participants spoke about being about being capable of surviving “extreme weather and climatic events” so long as the correct techniques are practised. These include removing the “young middle part of the young leaves of the taro to disturb its growth” and the “tube[r] part of the taro [then] gets [the] nutrients (water) from the soil ... and ... keeps the taro for more than a year” (ALD1, 2018). Such climate sensitive gardening techniques help to ensure that NP communities are able to maintain high levels of food security despite variable and sometimes extreme environmental conditions.

NP is also well-known for its use of specific gardens known as *Maliudu* and “tabu” gardens (*Aragogona*). *Malidau* are small shallow areas or small valleys adjacent to villages where local people typically grow certain root crops and fruit trees (agroforestry) for easy access during and immediately after an extreme event strikes. Communities can “survive during droughts or after cyclones” (ALD2, 2018) through using *Maliudu* and are also “essential for elderly or sick people who can no longer do arduous work and rely on *Maliudu* because it is closer to their ... homes” (AHD10, 2018). *Aragogona* are large hectares of land were equally divided and shared among the villagers to plant food crops, mainly yams and other root crops. *Tabu* gardens form an essential part of collective food security, embedded within the local

culture of the rural communities in NP, and involve restrictions on harvesting in certain areas for a set period to conserve resources. *Aragogona* also can include coastal marine conservation areas (which involve village chiefs placing restrictions of the harvesting of marine resources for periods over one area, while opening other places for villagers to use). Tabu is one practise also cited by indigenous peoples from the Vanuatu island of Espiritu Santo and Gau Island, Fiji. It involves tribal leaders placing restrictions on the prohibition of harvesting or use of resources, places at particular times of year (such as fishing areas). Tabu and other similar traditional resource management strategies such as rahui are employed throughout the Pacific and reduce the risks associated with fluctuating environmental conditions and food availability (Crook and Rudiak-Gould, 2018; Davies, 2015).

In addition to ILK-based NRM strategies, local people in NP draw on ILK to reduce the risks associated with extreme weather events, most notably tropical cyclones. One man (ALD7, 2018) described in detail how he and his community used their ILK to prepare for Cyclone Pam (which struck Vanuatu in March 2015):

“When I saw the signs, I told my family and the people in [my and other] communities. We collected firewood [and] clean water, prepared our houses by putting coconut leaves, bamboo and banana stems on [the] roofs” (ALD7, 2018).

He describes why it was vital for them to collect water and food (because “all [the] rivers, streams, and ocean” become polluted by run-off and high winds destroy households’ gardens and fruit trees) (ALD7, 2018). The stored food and water supplies helped to sustain NP families during and after Cyclone Pam and other tropical cyclones (including Cyclone Harold the directly struck Pentecost Island in 2020) (AHD7, 2018; AHD8, 2018). All the villages in our study area possessed traditional buildings known as *Gamali*<sup>2</sup> (see Figures 4(a) and 4(b)), which were used as tropical cyclone shelters by communities. The halls, which are made from local materials from the forest and typically 4–6 metres in width and 5–6 metres in height, are built-in sheltered locations (in valleys or shallow parts of villages protected from winds). *Gamali* can withstand strong winds of tropical cyclones when adequately constructed and maintained. The roof, made of woven thatch and going to the ground, is designed to reduce the risk of strong winds lifting the thatches. Similarly, the absence of windows (only doors front and back) reduces vulnerability to high winds and flying debris. After cyclones, participants also use *Gamali* as disaster shelters while they go about repairing their houses. Participants reported that their villages’ *Gamali* had withstood many tropical cyclones in the past and were one of the key ways they managed the risks associated with tropical cyclones. They also note how caves were historically used as shelters during cyclone events, but now were infrequently used (replaced by the use of *Gamali*).

In March 2020 (after the conclusion of our fieldwork), a large category five tropical cyclone (Harold) struck NP. Cyclone Harold caused widespread damage to Pentecost Islanders’ sago palm trees and houses (as shown in the photographs taken by the lead author), but there were no reports of loss of life. NP people successfully used their ILK to prepare for the cyclone, collected and store food and water supplies, and shelter from the cyclone (in their *Gamali*). Similarly, a recent study by Ahmed and McDonnell’s (2020) examining how Cyclone Harold damaged different three types of houses (traditional, hybrid and ‘modern’) in the southern Pentecost Island (SP) found that there were substantive risk reduction benefits associated with using ILK-based building design. People in SP sheltered in their *Gamali* (known as *Nakamal* in SP) and remained safe during and after the cyclone and those households whose houses were constructed using traditional housing design (with thatched roofs and walls made of sago palm leaves and wooden frames) generally experienced less damage than those



(a)



(b)

**Figure 4.** a. Interior photograph of Gamali (tropical cyclone shelter) (source: lead author's own).4b. External photograph of Gamali (tropical cyclone shelter) (source: lead author's own).

with hybrid or 'modern' houses. Buildings with corrugated iron sheet roofs were severely damaged (blown off and/or crumbled) by the high winds and also posed a hazard to people and animals (cutting hands and feet) in the clean-up work. Also repairs to hybrid or modern buildings were difficult due all the financial costs involved in sourcing and shipping in all

the building materials (iron sheets, nails, screw, concrete and so forth) to the island (from elsewhere in Vanuatu or overseas). It was far easier for local communities to harvest palm leaves and other building materials from their surrounding environment to quickly reconstruct damaged buildings. In some areas of SP, however, there were not enough palm leaves that were undamaged and thus SP villages made requests to their NP neighbours (who were less affected) for help (in the form of providing them with palm leaves). In line with their Indigenous worldviews centring on holistic, kinship, communitarianism and reciprocity, NP communities harvested and transported the palm leaves (in cooperation with humanitarian organisations working on the island) to SP.

*Changing livelihoods: Socio-economic changes.* The shift away from traditional subsistence-based livelihoods and modes of living is a causing concerns amongst some of our participants about the loss of ILK, social cohesion, as well as their capacities to manage environmental variability and changes (AHD10, 2018; AHD13, 2018). NP worldviews emphasise how individuals are part of and related to broader social and ecological communities and that the needs the group take precedence of the individual. However, the expansion of Western-style livelihoods, education, and modes of living in NP are seeing changing within people's worldviews, values, and modes of living. Some participants suggest that "Western [ways of] living ... are pushing aside traditional modes of living" and the NP worldviews and values are changing (AHD13, 2018).

One of our participants spoke about how "money speaks for everything now" with the focus on individual accumulation of wealth, rather than the collective wellbeing of everyone in their village (AHD13, 2018). The money people earn in the market economy (growing cash crops and/or working in urban areas) is used to purchase western-style goods and materials (including iron sheets for roofs, foodstuffs, and clothing). While some consider this evidence of progress and development within NP, others note how people are losing the knowledge and practical skills about how to manage their environment in a "sustainable way" (AHD13, 2018). For instance, all the "larger and older trees" in NP are now gone as a consequence of recent logging activities and the expansion of monocultural horticultural operations and the area is facing increasing issues with soil erosion, sedimentation of waterways, and heighten risk of landslides (following high rainfall events) (AHD13, 2018).

There is also a movement away from ILK-based horticulture centred on households' growing diverse crops in multiple garden sites for consumption (by the household and the village) towards more Western- or hybrid horticulture operations for sale (to others on and off the island). Individuals or households are increasingly grow only one crop for sale at a local market and for export (which includes non-food crops such as kava). The transition away from subsistence horticulture began under colonial government policies and continued in the post-colonial era, with international aid agencies keen to foster economic development in NP (like elsewhere in Vanuatu) through the livelihoods centred on the production of goods for export (be it timber, copra, bananas or kava). Many households in NP continue to still maintain household gardens (near their village) but not necessarily the multiple garden sites (especially the agroforestry gardens located in the hills). Often those who have few gardens, however, need to be supplemented their food they produce themselves with that they purchase from at the markets or stores (therefore making it a vital necessary for them to possess money to purchase enough food for their family's needs) (AHD7, 2018).

An increasingly large number of households now purchase some (or most) of their foods rather than growing it themselves (which is a substantive change notable over the last two decades). Imported foods (dried or canned goods) now contribute a significant portion of people's diets. Imported foodstuffs are highly processed and less nutritious than traditional foods, and also subject to market and transportation pressures, which means that after tropical cyclones and droughts people now run the risk that they will be without foodstuffs and will be reliant on external sources of support (government or aid agencies) (AHD7, 2018). Changes in dietary and lifestyle

preferences are contributing to youth being less interested in eating traditional foods as well as learning their ILK about food production and management (including how to grow and store ‘famine crops’) (AHD10, 07/01/2018).

As part of this socio-economic changes, shifting worldviews (from communitarian to individualism) is evident in how some NP people conceptualise food and who is responsible for providing food to those in the community. Now some consider it up to the individual (or household) rather than a community to ensure they possess adequate food supplies. Whereas the common pooling of foodstuffs (stored and then consumed at certain times of year or following a disaster) is an essential part of ILK of NP, not all NP individuals (particularly those who previously lived off the island) consider food a shared resource that needs to be carefully managed across seasons and years (AHD7, 2018). The use of imported foods and the shift away from highly diversified subsistence-based horticulture to market-based horticulture is linked to the loss of community resilience but also highlights that no society is static and the processes of change are ongoing.

Our participants report that since imported food could be easily purchased, stored, and did not expire for “long periods of time”, many villagers are simply choosing to forgo planting disaster-resilient crops and stored canned goods and bags of rice instead (AHD7, 2018). However, since the imported foods are expensive, it meant that not everyone can afford purchase imported foods. So while imported foods can partly offset the loss of resilience from traditional food production practises, it is not a complete substitute for ILK-based food security systems. Moreover, imported foods are not seen as collective goods but rather the property of individual households who earn the money and purchase the foods. Therefore people in NP are not necessarily purchasing and storing enough imported foods for their entire community to survive following a shock or disruption (such as following Tropical Cyclone Pam).

The introduction and uptake of Western products and practises which are now a feature of life for many local people in NP, used instead of or alongside Indigenous goods and ILK practises, require consideration of how ILK exists alongside other ways of knowing. Some of our participants argue that the Vanuatu government needs to be making it compulsory for adaptation and development projects (be it government- or NGO-led) be designed in a way that promotes not only ILK-based strategies (be it those centred on food security or water security or forests) but also the associated Indigenous values of collective wellbeing rather than an emphasis on individuals (AHD13, 2018; AHD7, 2018). These include thinking about the long-term growing of diverse horticultural crops (where, when, how they are grown and who can access those crops), and how the climatic changes meant crops can be grown in different locations than previously possible. The resilience of their communities, they maintain, is underpinned by the principles of holism, connectedness, and reciprocity (between humans and the natural world), yet current development and adaptation projects rarely seriously consider these principles. The knowledge and skills associated with sustainability growing food sources and constructing buildings using traditional materials are still possessed by NP (as with many other rural Ni-Vanuatu communities), but ILK is in decline and there is a critical need to not only confirm the value of ILK and explore the ways in which ILK-based food management, DRR, and building design can be protected, maintained or adjusted to fit with changing social and ecological conditions.

With the expansion of adaptation projects occurring in Vanuatu it is critical to consider how ILK-based governance structures and management practises can (and are being used) alongside other knowledges to maintain and enhance the resilience of communities (and not reinforced or create new vulnerabilities). These include the customary rules surrounding who can access particular forested areas to harvest building materials (used to build *Gamali* and houses) and when forest groves are closed for trees to regrow (which would be of benefit for NP its worsening problem of deforestation). Such an approach necessitates recognition of the co-existence of multiple knowledges and seeks to harness the strengths of each knowledge system (and its associated natural management practises) to

**Table 1.** Water sources and management practices.

Water Sources & Management	Management Description
<b>Bamboo (<i>Bamusa vulgaris</i>) Pipe</b>	Water is stored in bamboo pipes for use during droughts, or bamboo pipes are used to collect water from far away water sources to the village.
<b>Coconut stem</b>	Coconut stems are cut, and the inner part of the stem is drilled to allow water to be stored inside them during rainy days. This technique is done to increase water security in cases of dry periods.
<b>Water tanks (polystyrene &amp; cement)</b>	The water tank is usually locked and open once a day. The rainwater collected during the rainfall events is only for cooking and drinking. Cement water tanks were built and upgraded to polystyrene water tanks which contribute in managing water during droughts and el-Nino. Almost every household has water tanks.
<b>Coastal spring water (<i>Danu &amp; Wai non Taga</i>)</b>	Coastal spring water during low tide is used for washing and swimming. Spring water further up the coast is properly managed by building a reservoir to collect and store water for use by local communities.
<b>Jungle water holes dug in the ground (<i>Waironuhe</i>)</b>	Holes are dug in the soil to collect and store water. Usually, the holes are dug in the jungle or bushes. Water collected and stored here are used during long dry periods.
<b>Streams/Rivers</b>	Uses of rivers and streams for washing and swimming.
<b>Water in large tree roots/potholes on rocks (<i>Tumun Gai&amp; vatu</i>)</b>	Water is stored in large coiled tree roots. The water found is carefully drained into long bamboo pipes and brought home for drinking and cooking.

Source: Data from Fieldwork, January 2018.

enhance the adaptive capacity and reduce the vulnerability of Indigenous communities to environmental risks. In NP such a pluralistic approach is already being used by villages to manage water supplies.

*Water management.* The Indigenous peoples of the Ahivo and Aute districts (see Table 1), who rely on rainwater for their water supplies, employ a variety of water management strategies that draw on ILK as well as Western knowledge and technologies to manage variable rainfall (storage water tanks are extensively used in Ahivo and Aute districts to collect and store rainwater see Figure 5). Previously, water security was a persistent problem for local people because there were limited ways of storing rainwater for and during drought events, however, storage tanks. One participant recounts how, “in the past, it is quite hard or difficult to find water” during droughts (AHD12, 2018). The “only source of water [at dry times was the] coiled roots of larger older trees that hold water (*Tumu*)”. Local people traditionally used a variety of methods to store water, which continue to be utilised to a greater or lesser degree in different communities (being employed more in Aligu district than in Ahivo and Aute districts). Traditional storage devices include coiled roots of large trees, coconut stems, and dug ground wells (see Figure 6 showing a dug ground well). Communities in another district of NP (Aligu), however, continue to rely on streams and small rivers (as shown in Figure 7) as their primary source of freshwater as well as traditional storage devices. Although they report that water levels decreased during El-Nino (drought) periods, they are less concerned about water scarcity (both now and under changing climate conditions) due to their ILK.

Practises Many interviewees outlined how they manage water during dry periods associated with natural variability linked to El-Nino conditions; this includes a mixture of western



**Figure 5.** Community rainwater tank (source: lead author's own).

technologies (water storage) and traditional water management practises, with emphasis on community health and wellbeing. Despite the uptake of Western technologies, Indigenous people continue to maintain their worldviews (centred on relationality and communitarianism) mean that they continue to manage water resources according to their values and governance structures. Rather than emphasise individual water rights and usage (as is the norm within Western societies), water in NP is managed collectively and strictly monitored, with customary water governance continued to be exercised. One interviewee reports that in his community, the water tank is





**Figure 6.** Traditional freshwater well. (Source: lead author's own).

usually locked up and open once a day during drought periods. The water collected during [dry conditions] is only for cooking and drinking, with people going to the coast to use the spring water at “low tide for washing and swimming” (AHD8, 2018). People rely on coastal spring water for washing, and for saving water. During these times, food is cooked using earth ovens



**Figure 7.** Freshwater stream, which is still used for drinking, bathing, and agricultural activities (source: lead author's own).

**Table 2.** The behaviour of fauna as indicators of tropical cyclone events.

Type of Indicators	Climate Event	Descriptions of Indicator Behaviour
<b>Emerald Dove (Ground-dove)</b>	Tropical cyclone	A ground-dove preparing its nest or laying its eggs on wild fern (Gasigasi), (Bwatmavoa) or rocks near the ground surface indicates that a cyclone is expected during the coming cyclone season.
<b>Bwagoh (small reef Fish)</b>	Tropical Cyclone	If you see a small fish called <i>Bwagoh</i> <sup>3</sup> coming out from their home or hiding places into an open area, then it signals that a cyclone or the very bad weather is approaching.
<b>Beach hoppers (Talitrus saltator)</b>	Tropical Cyclone	Beach hoppers usually do not come out, but if there is a possibility of a cyclone in the area, you see them coming out from their holes, under stones and climbing on stones, leaves, logs near the beach.
<b>Sea Bird (Laysan albatross)</b>	Tropical Cyclone	If a seabird called <i>Mansiroboe</i> (seabird) flies over land, then it indicates that a cyclone is near the island. These ocean birds only come on land during cyclone events looking for places to hide from the cyclone wind.
<b>Udu (Palolo worms)</b>	Tropical Cyclone/ Drought	The arrival and behaviour <i>Udu</i> (palolo worms) are used to predict the level of food productivity and extreme weather events (tropical cyclones or drought) in the upcoming season. Farmers recognise the presence and behaviours of the worms as signs that food production would be constant ( <i>Urd Matala</i> ) or higher ( <i>Udu Malageha</i> ), and the risk of tropical cyclones in the forthcoming cyclone season would be higher or lower. Similarly less food productivity and long dry weather conditions are expected when <i>Udu Rara</i> are observed (AUDI,09/01/2018).

Source: Data from Fieldwork, January 2018.

or roasted on open fires rather than boiled or steamed (AHD5, 2018). There is, interestingly, no mention of women's roles, responsibilities, and capacities to access water supplies (which is unsurprising given that only one woman participated in our research project).

All the participants reported that even though western water storage is employed, they still use traditional methods of water management to supplement their use of western water storage and management techniques during drought. For example, they dig ground wells in the bush and wash and swim in coastal spring waters during extended dry periods so that water saved in the water tanks are used for drinking and cooking. The combination of different knowledges and technologies (which were selected by Indigenous communities themselves rather than top-down interventions imposed on them) to manage water resources are, NP interviewees argue, serves to enhance their capacities of them to manage variable rainfall patterns and drought events. Such water management approaches demonstrate that there are multiple ways Pacific communities are drawing on diverse knowledges and practises to respond to environmental changes proactively and the use of Western knowledge and technologies does not mean that ILK is or should be abandoned (Belmar et al., 2016; Kuruppu, 2009). However, rather communities, researchers, and decision-makers should instead be prompting ways to ensure the co-existence of multiple knowledge systems and diversity of approaches wherein Indigenous communities around the world can choose options that best fit their socio-cultural, political, and ecological contexts.

**Table 3.** Use of flora behaviour as indicators for extreme weather events.

Type of Indicators	Climate Events	Descriptions of Indicator Behaviour
<b>Blossoming of fruits and plants</b>	Tropical cyclone	Early and abundance of blossoms on trees. Overabundance on fruit on trees. Some fruit pop out from the stem upwards. All are indicators that tropical cyclones will occur in upcoming cyclone season.
<b>Dry season continues into the wet season &amp; small jungle plant leaves start to drop</b>	El-Nino/ Drought	If the dry season continues into the wet season or the wet season does not start as expected, then we go into the jungle and cheque the leaves of small plants. If you see plant leaves start to drop, then this indicates longer dry periods ahead.
<b>Leaves of Sileage (<i>Pongamia pinnata</i>) tree</b>	Tropical cyclone	<i>Sileage (Pongamia pinnata)</i> tree leaves turning yellow and falling off the trees indicates the possibility of the cyclone in the coming season. This tree is the first to grow immediately after the cyclone.
<b>Moss (<i>Mosses</i>)</b>	Drought	Moss growing on the stem or trunk of trees to thicken the skin (cover-up of the tree) so that moisture is maintained on the tree. During droughts, the moss will dry and fall out including the thin outer skin of the tree, but there is still moisture to hold the tree during the dry time (drought).
<b>Adomwae (<i>Pipturus agenteus</i>) leaves</b>	Tropical cyclone	Leaves of <i>Adomwae</i> trees turn over with the lower part of the leaves visible from a long distance.
<b>The flowering of Raramemea (<i>Erythrina variegata</i>)</b>	Normal Dry Season	The flowering of <i>Raramemea</i> indicates time for slash and burn (May to August).

Source: Data from Fieldwork, January 2018.

### *ILK as environmental information: holistic readings of social-environmental changes*

Our participants reported that they employed a diversity of environmental indicators to forecast weather conditions and make decisions about NRM and DRR (see Tables 1 to 4). For instance, many interviewees described how the widespread blossoming of plants and over-abundance of fruits on trees in the months and weeks preceding the start of the cyclone season were clear signs to them that tropical cyclones were likely to strike their area (NP) during the cyclone season. The signs led them to enact DRR strategies (see Tables 2 and 3). One participant, for instance, (ALD7, 2018) uses his ILK to predict tropical cyclones (which he recounted was his family's collective knowledge, passed onto him via oral transmission). He noted that signs needed to be read together – cloud type and movement, the unusual behaviour of a bird (emerald dove), and El-Nino events – to forecast tropical cyclones successfully (Tables 2 and 3). Once he has observed all signs, he and his family then take steps to secure their food, garden, and household possessions.

*Observations of changing climate conditions.* Our interviewees reported that significant changes in environmental conditions within NP exceeded those previously observed by themselves as well

**Table 4.** Atmospheric conditions as indicators of short-term climate variability and extreme weather events.

Type of Indicators	Weather Events	Descriptions of Indicators Behaviour
<b>Large heaps of Clouds towards the east hill</b>	Immediate rain	Clouds appearing in large heaps on the hills to the east side of the island indicates immediate rain.
<b>N, NW, NE Winds direction and clouds movement</b>	Expecting rain with few hours	Prevailing northerly, north-westerly and northeasterly winds with corresponding low clouds movement.
<b>Alto cumulus cloud covering the sky</b>	Rain	If the alto cumulus clouds are covering up the sky, then this indicates that rain is expected during the next day. At night you would see it surround the moon.
<b>Fast moving low clouds, calm seas and surface winds.</b>	Approaching cyclone-cyclone within 3–4 days	A few days before the cyclone, there are calm seas and winds. Trees stand still without the effect of winds blowing. If the winds are blowing strong but the clouds do not move faster, then no cyclone is expected.
<b>Southerly winds and clouds lying parallel with the island</b>	Fine	If there is a long line of high clouds lying parallel with the island, then it indicates beautiful weather.
<b>Hot and humid during the day/ night</b>	Afternoon or evening/ night showers.	Sometimes it gets too hot and humid, and towards the late afternoon or night, you will feel fresh cold winds, this will indicate rain immediately.
<b>Clouds appear red on the western horizon (<i>Mera</i>)<sup>4</sup> (sunsets)</b>	Fine weather next day	The clouds are reddish orange in colour with a thin line of clouds. It indicates that the following day, there will fine or good weather
<b>Clouds appear red on the eastern horizon (<i>Mera singwahelea</i>)<sup>5</sup> (sunrise)</b>	Rain	If the reddish orange cloud is seen where the sun rises ( <i>Mera singwahelea</i> ) it will rain.
<b>Continued reddish Orange or yellow colour reflections of sun during sunset (<i>Mera</i>).</b>	Expecting long dry periods (Drought)	<b>Atmospheric indicators:</b> <i>Mera</i> is the local name given to the colour of clouds (reddish-orange or yellow colour), which appear to the western horizon during sunset and indicates fine weather. <i>Mere singwahelea</i> is the name given to the colour of clouds appear to the eastern horizon usually during sunrise which indicates rain. Continuous appearance of the <i>Mera</i> sunset indicates the possibility of long dry periods (drought). Likewise, continues dew in the morning for almost a month indicate that long dry period is ahead.
<b>Continues morning dew</b>	Drought (long dry period)	If there is continuous dew in the morning for almost a month, this indicates longer dry periods ahead.

(continued)

**Table 4.** Continued.

Type of Indicators	Weather Events	Descriptions of Indicators Behaviour
<b>Severe drought earlier (El-Nino)</b>	Tropical Cyclone or periods of heavy rain	An extreme event such as El Nino may indicate another extreme event to follow.
<b>Hazy (Like smoke) ocean</b>	Drought (El-Nino)	I get up every morning and when I look at the ocean, if it looks like the ocean is hazy, looks like smoke and during the night the place is cool, this indicates there will be long periods of dry time.
<b>A parallel line of clouds.</b>	Drought	The line of clouds up high in the sky lying parallel with the islands and remain for a month, indicates
<b>Hot and humid</b>	Heavy rain or tropical cyclone	hot and humid weather during cyclone season – expect cyclone.

Source: Data from Fieldwork, January 2018.

as those documented within their ILK. These included alterations in rainfall events, temperature changes (increased hot and humid weather), sea-level rise in their area (ALD5 2018), and changes in the behaviour of flora and fauna, which make it difficult for them to forecast weather conditions and make decisions regarding DRR and NRM (AHD7, 2018). Indeed, the rainfall data for the last 23 years from the Vanuatu Meteorology and Geo-Hazard Department (VMGD) for instance, reveals a steady increase in rainfall amounts for Pekoia rainfall station (the closest to our study site), which coincides with our interviewees' accounts of increased rainfall, (and is in line with climate change modelling projections for the region).

Changes in local weather conditions and associated phenological indicators were reported by our participants to be creating increased difficulties for NP villagers who used their ILK as a primary method to manage climate variability and extremes. One of our participants reported how a tropical cyclone recently damaged crops despite the village making the all standard ILK DRR preparations. He reported that the type of damage (crops in agroforestry and village gardens were waterlogged, vegetation stripped of leaves, trees uprooted, as well as widespread destruction of villagers houses and water tanks) was unheard of amongst his community and was a troubling sign of changing and more extreme weather conditions (AHD4, 2018). Our research participants also reported that the flowering and the fruiting of trees no longer accorded with local seasonal calendars and past timing of phenological events, and plants were growing in different places of the island (AHD9, 2018; AUD1, 2018; ALD1, 2018; AHD6, 2018), which paralleled the observations of other Indigenous communities in Vanuatu, elsewhere in the Pacific and around the globe (Chambers et al., 2017; Fernández-Llamazares et al., 2017).

While other studies suggest concerns that the use of ILK environmental indicators to forecast weather may no longer be accurate in the future because of climate change (Granderson, 2017; Pearce et al., 2015), our research participants felt confident that they could draw on ILK alongside other knowledges to forecast weather and implement adaptive management conditions. Climate-related uncertainties are, in their view, best managed through the continuation and expansion of their efforts to draw on multiple knowledges (epistemological pluralism) to monitor and make decisions in response to changing and emergent risks. Such a process, therefore, is one that they narrate as still being embedded within their worldview, values, and modes of living rather than those that come from elsewhere (from outside of NP or outside of Vanuatu). In this

way NP communities want to address uncertainty driven by a knowledge-deficit (ignorance-based uncertainty) can be addressed through their engagement with western science in meaningful and culturally situated ways that allow them to understand the impacts of climate change on their lives and livelihoods. In doing so they can create responses (at household and village levels) that are supported by government and other actors who share common interests.

*Strong support of ILK-based adaptation policies and programmes.* Our participants from NP expressed strong support for incorporating ILK into adaptation policies and strategies, with adaptation situated as being a process that is highly localised and place-specific (designed, governed, and implemented at the village-level rather than national- or island-scale) but at the same time as interconnected across places and peoples (a collective rather than individual activity spanning cultures, spaces, and time-scales) (ALD7, 2018; AHD7, 2018). This mode of adaptation implicitly aligns itself with the multiple ontologies we have established at play here while also highlighting that the dominant, Western-dominated modes of adaptation did not address key community priorities. They noted that most adaptation projects being implemented on Pentecost Island (such as construction footpaths, and the efforts to enhance water and food security) were based on western scientific knowledge and values, and focussed on things that matter to outsiders (non-NP) rather than insiders (Ni-Vanuatu or NP in particular). The expansion of the cash economy through projects aimed at economic development and poverty reduction, for instance, which did not capture their IK, values, and preferences (about how they should live, what they should do, and how they should adapt). They reported that while the central government did recognise the importance of ILK, the adaptation projects being enacted did not support or enhance ILK practises (AHD7, 2018; ALD7, 2018). Participants noted that the diversity of ILK strategies employed by Indigenous communities allowed community members to “live off the environment” in a way that was “free and accessible” and continuously available (taking into account variations in local conditions and continuous adaptive learning); this contrasted with the western development model being introduced to NP (under the auspices of sustainable development, DRR, and adaptation), which focussed on the expansion of the “cash income” economy, where people were required to “work harder to earn cash” that was highly unpredictable (dependent on local, national, and international conditions) and the market economy was “not always consistent” for current and “for future generations” (AHD7, 2018). These different strategies, based on Western and colonial ontologies, meant that when many of the projects come to the end of their funding, the communities find it challenging to maintain the schemes (be it keeping the newly constructed infrastructure functional or the economic venture financially viable). Since the continuation of adaptation efforts beyond the conclusion of an official project is a vital part of engendering a sustainable, efficient, and equitable adaptive pathway (with adaptation a process rather than a singular short-term intervention), such projects can be viewed as largely ineffective. Understandably, NP participants suggest that adaptation strategies based on ILK and that reflect their pluriverse, are a better, more sustainable option for their communities.

NP participants views’ of incorporating ILK into adaptation did not mean, however, mean a commitment to integration efforts, but rather the reframing of adaptation to encompass their understandings of socionature. For them, the central tenet of adaptation in NP should involve efforts to preserve, maintain and enact ILK (encompassing its information-practises-values which includes the use of Indigenous governance structures through the village council)” their world views. Therefore efforts to preserve local languages, maintain cultural practises, subsistence-based agricultural livelihoods (such as agroforestry), and the broader *kastom* economy (centred on the sharing of resources instead of selling goods for cash) were all considered as the inclusion of their conceptualisation of what adaptation is.

## Discussion

We now turn to a discussion of the insights this project yielded, firstly we reflect on the implications of the lessons we learned from this project for the Vanuatu government and policy landscape. We then widen the discussion to an analysis of the implications of considering ontological pluralism and diverse epistemologies in the context of climate change adaptation in NP, Vanuatu. Finally, we present insights for the climate change adaptation literature.

Our case study highlights the significant role that ILK continues to play in how NP people perceive and respond to climate-related hazards, and how they manage risks, yet ILK remains under-acknowledged within legislation; this includes multiple types of uncertainties. NP people's use of ILK-based weather forecasting as well as DRR and NRM strategies highlight the numerous ways in which ILK, which is underpinned by relational ontologies, is a key component of NP people's capacities to adapt to variable and changing environmental conditions. However, Vanuatu's legislation governing disaster risk management does not actively promote ILK, instead it is merely acknowledged as important to Ni-Vanuatu communities. References to ILK state that Vanuatu *kastom* should be 'respected' in, for instance creating 'whole-of-society' DRR (Republic of Vanuatu, 2020), but do not give recognition and further do not insist that initiatives actively incorporate ILK into the design and practises of adaptation and DRR projects. More broadly in Vanuatu, ILK remains an informal system that shapes people's lives and livelihoods that operates as separate from (and not necessarily equal to) the formal Western-based system (judiciary, government, education, and economic development) in many parts of Vanuatu, which similarly is being repeated within the context of climate adaptation and DRR (Davies, 2016; Granderson, 2017).

In our case study we highlight how ILK continues to be one of the ontological and epistemological foundations on which NP people (paralleling many rural Ni-Vanuatu) understand and respond to climate risks. Indigenous people can and are drawing on their own knowledge as well as drawing on other knowledges (co-existence rather than integration) to enhance Indigenous capacities to adapt to changing social and environmental conditions. ILK is thus a critical ingredient of the adaptive capacity of NP communities, which parallels the global scholarship on adaptive capacities of Indigenous societies (Boillat and Berkes, 2013), but is this is not reflected within the adaptation policy landscape of Vanuatu. Despite the co-existence and operation of such ontological and epistemological plurality in NP (and elsewhere in Vanuatu), ontological and epistemological pluralism is not being translated into the formal legislation and plans governing adaptation, nor into the various adaptation and DRR projects being enacted on-the-ground across the nation. DRR projects, as Westoby et al. (2021) observe, are frequently "inflexible and inappropriate" due to institutions "pre-determined agendas, prescriptive funding conditions, and insufficient consideration of local realities" (Westoby et al., 2021: 317). Far too often, as Westoby et al., and McNamara et al. (2020) argue, community-based adaptation projects in Vanuatu involve technical solutions that are based on the "expertise" of the external implementors (non-local, non-Indigenous consultants, NGO staff) and do not address the root causes of vulnerability. Moreover, we would add that external experts bring with them their own Western ontologies and epistemologies that influence how they conceptualize what adaptation is (or is not) (which often differ from those of Indigenous peoples). Consequently, emphasis is placed on science- and development-based solutions (be it the construction of a sea wall or the expansion of cash crops) that are based on the knowledge and values of external actors and are contributing to increased vulnerability (as demonstrated by Campbell's (2009) study and our study's discussion on the replacement of ILK-based crops and buildings with non-Indigenous alternatives. In this way, we suggest that there are unacknowledged ontological differences, conflicts, and politics at work in within adaptation planning and practises taking place in Vanuatu that are limiting the effectiveness, efficiency, and equity of adaptation efforts.

Westoby et al. (2021: 317) and McNamara et al. (2020) propose that locally led adaptation is the way forward, whereby local people and local institutions can “pursue their own diverse adaptation aspirations and outcomes”. Local people and local institutions are, they argue, are better equipped to understand and be able to incorporate local people’s lived realities, their diverse climate knowledges, their livelihood, and adaptation priorities, as well as the broader vulnerability context (climatic and non-climatic processes). We concur with Westoby et al. (2019; 2021) and McNamara et al. (2020) suggestion that a central part of locally led adaptation needs to be ontological and epistemological pluralism. We argue that combining community- or locally-led climate adaptation approach with an ontological pluralism can contribute to a more equitable, effective and productive way forward. Discussions about how different ontologies shape Indigenous people’s perceptions of and responses to climate-related hazards as well as what they consider to be appropriate adaptation options holds the potential to expand our understandings about how the design sustainable adaptation policies, plans, and projects.

Adaptation scholars and practitioners often discuss how adaptation is shaped by existing decision-making processes and governance regimes (the politics of adaptation), but there is little consideration of the intersections between ILK and adaptation governance within Vanuatu or other SIDs. In Vanuatu most adaptation projects are directed and governed by institutions (the central government, international funders and NGOs) external to both individual islands and villages. There is a need for (at least some) locally-led ILK-informed adaptation to be situated within Indigenous governance structures and management approaches, while also being able to draw on other forms of knowledge and approaches (as demonstrated by the hybrid water management system being employed in NP). As community members from Espiritu Santo (another island in Vanuatu) informed researcher Davies, that village “chiefs needed to continuously evolve their practises to accommodate the contemporary world including technological progress and system[s] of governance, so they are ‘paddling with two hands’” (Davies, 2015: 62). Embracing multiple ontologies as well as the critical significance of IK and associated NMR practises will be vital to ensuring that Pacific Islanders can continue to ensure sustainable use of resources across seasons, years, and generations of continuous occupation of an area.

The importance of examining empirical case studies like NP via a focussed ontological lens is evident at a governance level where we argue that ontological and epistemological pluralism need to be fully embedded in the formal legal system, legislation, governance arrangements, and management regimes. In Vanuatu, legal pluralism already operates (recognised in the Constitution) but the courts struggle to reconcile Western and Indigenous legal traditions and ways of knowing. The country’s adaptation and DRR legislation contain only occasional mentions of ILK and fall within the knowledge integration domain (Republic of Vanuatu, 2015, 2016, 2020). The limited inclusion of ILK means that, as we discussed previously, it is only being framed as something that can employed as an ‘add on’ to scientific knowledge as and when scientists or practitioners responsible for identifying and integrating those parts of ILK deem it useful. Yet, as our case study demonstrates, ILK is not a repository of information (or ‘facts’) about the local environments (be it hydrology, meteorology, ecology, or phenology). ILK is a holistic, relational, and dynamic knowledge system. It cannot, as Berkes (2012), Nursey-Bray (2015) and Leonard et al. (2013) argue, be divided into separate parts that can be tested and then integrated into scientific knowledge (to do so results in mistranslations and loss of meanings). We argue that this ontological and epistemological conflict currently constrains the development of sustainable climate adaptation pathways. Thus, changes need to be made to how ILK is discussed and formally recognised within legislation and governance arrangements/ This is already occurring in other contexts; learnings for example could be taken from the ways in which ontological and legal pluralism is emerging elsewhere (Bingham et al., 2021; Curran, 2019; Rohe et al., 2019). Doing so would reduce the distinction between ‘those who know’ (based on Western knowledges and practises) and ‘those who



believe' (Indigenous and other non-Western cultures who hold ILK), a division that is still widely embedded within climate change adaptation policies and frameworks (Bremer and Meisch, 2017).

Indigenous peoples' dialogical relationship with their local environments, as we showed in our case study, is different from Western, NRM and DDR approaches to adaptation which are scientific-led, based on a nature-culture binary and top-down (Howitt et al., 2012; Howitt and Suchet-Pearson, 2006; Parsons et al., 2019). ILK, founded on Indigenous relational kin-centric ontologies, includes intergenerational responsibilities to care for both human and more-than-human beings and emphasises wellbeing connections between people and their environments. A common thread throughout different Indigenous societies is the emphasis on reciprocity. Reciprocal relations include relations with family/village/tribe/community (strength of social networks, sharing of resources) *and* environments (of being looked after/looking after the environment) (Gould et al., 2019; Kimmerer, 2011; Parsons et al., 2018). This element is part of Indigenous worldviews that adopt a longer-term (intergenerational) outlook and seek to maintain harmony within and between communities (human and more-than-human). In NP the focus on sharing resources and working together to ensure sustainability and security (of food and water as well as people's lives and *kastom*) are evident, despite the introduction of new ideas (Western science, economics, and Christianity) and technologies; this parallels the findings of other scholars researching in different places in Oceania and beyond (see Nursey-Bray, 2015; Parsons et al., 2018; Winter, 2018). Our results, when read in tandem with these other studies, offer important insights for thinking about ILK within climate adaptation research and practise. We highlight how, despite of the introduction of new ideas, technologies, economic processes and forms of political governance, Indigenous ontologies and epistemologies remain at the heart of how NP communities are governing and managing their waters, lands, forests and foods as well as how they plan for and respond to climate-related hazards. Rather than being supplanted or lost as a consequence of the introduction of alternative systems of knowledge and beliefs (science and Christianity), Indigenous ontologies and epistemologies co-exists with other ways of knowing the world. Thus, NP people, like other Indigenous peoples (see Leonard et al., 2013; Nursey-Bray, 2015), still conceptualise climate change and adaptation through worldviews grounded in their ILK. Yet, the dominant ways in which adaptation and DRR are currently being narrated (in legislation, policies, and planning documents) and enacted (in on-the-ground projects) remains embedded in a prism of Western modernity.

Over a decade ago Hulme (2010) called for a shift beyond consensus building within "climate change knowledge" towards "epistemological pluralism" within academia and beyond (Hulme, 2010: 563). Although we agree with Hulme, we argue that it does not go far enough. Instead we argue that recognition needs to be given to *ontological* pluralism and this should be accompanied by changes to policies and practises, consistent with the calls of other scholars (Bremer and Meisch, 2017; Howitt, 2020; Parsons et al., 2021). Hulme writes that the:

"world possesses a multiplicity of climates and multiplicity of cultures, values, and ways of life. There are no global pathways to the future because world does not walk together; we walk along different ways towards different destinations." (Hulme, 2010: 563)

We maintain that researchers and practitioners need to critically consider how Western ontologies, which remain the cornerstones of adaptation research, policy-making, and adaptation projects, serve to reinforce existing or create new vulnerability.

As Nightingale (2016) observes, what adaptation is (ontology), as well as how people perceive and know it (epistemology), depends on how it is conceptualised, framed, and enacted in the world. There is, Nightingale writes, "no neutral knowing or observing adaptation" (Nightingale, 2016: 42) or within adaptation decision-making. For the NP participants we interviewed, all elders within their communities, adaptation was aimed at ensuring they (and future generations) were able to

live in ways they considered valuable and meaningful within their socio-natural worlds. At present Indigenous participants, as we and other scholars observe, are coming up against particular barriers imposed by an alternative worldview (Euromodern), ways of life, and practises that are constraining their abilities to imagine and articulate ILK-led adaptation strategies including how to deal with multiple and co-existing uncertainties and redress power differentials (Lyons et al., 2019; Mehta et al., 2019a, 2019b). Indigenous peoples (in NP and other geographical settings) are seeking to engage in climate change and adaptation dialogue in a holistic manner that allows them to draw on their ILK as well as other knowledges to address uncertainties, manage risks, create locally-led responses that address their specific socio-cultural, economic, and political interests (Carmichael et al., 2018; Hill et al., 2020; Lyons et al., 2020: 201; Nursey-Bray and Palmer, 2018; Tran et al., 2021). There is, however, a lack of recognition of ILK from those who feel it does not accord to the scientific standards and tools derived from the dominant conceptualisation of adaptation (Bell, 2018; , Billiot et al., 2019; Hofmann, 2017; Nursey-Bray et al., 2020). However, we suggest that by emphasising relationality and multiple ontologies and epistemologies in NP and elsewhere offers a critical analytical entry point that can decentre “the West” and create more sustainable adaptation strategies.

## Conclusion

The operations of different ontologies and epistemologies of human-environment relationships shape how people observe, conceptualise, and respond to changing environmental conditions, which means that what is deemed sustainable adaptation differs between contexts, peoples, and periods. Through our case study we highlight not only the importance of ILK as a knowledge system (comprised on information about local environmental conditions, DRR and NRM management systems, and worldviews) but the ways in which ILK co-exists with other forms of knowledge in dynamic, hybrid, and resilience-enhancing ways. We argue, therefore, that there is a crucial need to move beyond the rhetoric of recognitional politics whereby academics, policymakers, or institutions (be it governments, international aid agencies, or the UNFCCC) make formal statements that recognise the value of ILK for climate adaptation and DRR, but Indigenous ontologies and epistemologies remained marginalised. Sustainable, equitable and effective adaptation needs to move beyond the language of inclusion to actions that empower Indigenous peoples’ diverse ontologies and epistemologies and their priorities about how they live with and adapt to changing social, ecological and climatic conditions moving forward into the coming decades and centuries. Our case study emphasises the critical need to consider how diverse and multiple ontologies and epistemologies of climate change can empower and transform how adaptation is conceptualised and enacted to address the interests, needs, values, and priorities of Indigenous peoples in a more equitable, sustainable, and efficient manner. One that takes into account Indigenous peoples’ are already taking actions at the local-level to enact practises to manage the climate risks that they are confronted with, yet this is not formally acknowledge in legislation, included as part of adaptation plans, or financially supported by state or international actors.


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## Notes

1. Pacific Small Island Developing States (Pacific SIDS) include only independent nations rather than territories or dependencies including Fiji, Maldives, Marshall Islands, Federated States of Micronesia, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.
2. *Gamali*: Local name for traditional community hall (This community hall is used for village meetings, ceremonial activities such as deaths, marriages and ceremonies. During and tropical cyclone events the halls are used as shelters (from the storm and as they repair or built their houses). In other parts of Vanuatu, *Gamali* are referred to by a wide variety of other names.
3. Bwagoh – NP name for small reef fish that usually hides in its hole for most of the time, and once it appears or spotted outside its hiding places, this indicates a cyclone. The presents of Bwagoh outside signal to other fish that bad weather is expected in the near future.
4. *Mera* – NP local name given to the colour of clouds appear to the western horizon usually during sunset which indicates fine weather.
5. *Mere singwalelea* – NP local name given to the colour of clouds appear to the eastern horizon usually during sunrise which indicates rain.

## References

- Abreu JS, Domit C and Zappes CA (2017), “Is there dialogue between researchers and traditional community members? The importance of integration between traditional knowledge and scientific knowledge to coastal management”. *Ocean & Coastal Management* 141: 10–19.
- AHD10 (2018) *Interview of AHD10 by Interviewer Allan Rarai on Pentecost Island, 7 January 2018* (A. Rarai, Interviewer) [Personal communication].
- AHD13 (2018). *Interview of AHD13 by Interviewer Allan Rarai on Pentecost Island, 9 January 2018* (A. Rarai, Interviewer) [Personal communication].
- AHD4 (2018) “Interview of AHD4 by Interviewer [First Author], Pentecost Island, 7 January 2018”.
- AHD5 (2018) “Interview of AHD5 by Interviewer [First Author], Pentecost Island, 27 January 2018”.
- AHD6 (2018) “Interview of AHD6 by Interviewer Allan Rarai on Pentecost Island, 7 January 2018”.
- AHD7. (2018). *Interview of AHD7 by Interviewer Allan Rarai on Pentecost Island, 8 January 2018* (A. Rarai, Interviewer) [Personal communication].
- AHD8 (2018) “Interview of AHD8 by Interviewer [First Author], Pentecost Island, 4 January 2018”.
- AHD9 (2018) *Interview of AHD9 by Interviewer Allan Rarai on Pentecost Island, 9 January 2018* (A. Rarai, Interviewer) [Personal communication].
- AHD12 (2018) *Interview of AHD12 by Interviewer Allan Rarai on Pentecost Island, 9 January 2018* (A. Rarai, Interviewer) [Personal communication].
- Ahmed I and McDonnell T (2020) Prospects and constraints of post-cyclone housing reconstruction in Vanuatu drawing from the experience of tropical cyclone Harold. *Progress in Disaster Science* 8: 100126.
- Aikman S (2019) Indigenous knowledge, skills and action: Indigenous women's Learning in the Peruvian Amazon. *Studies in the Education of Adults* 51: 1–18. DOI: 10.1080/02660830.2019.1600786.
- ALD1 (2018) *Interview of ALD1 by Interviewer Allan Rarai on Pentecost Island, 13 January 2018* (A. Rarai, Interviewer) [Personal communication].
- ALD2 (2018) *Interview of ALD2 by Interviewer Allan Rarai on Pentecost Island, 26 January 2018* (A. Rarai, Interviewer) [Personal communication].
- ALD7 (2018) *Interview of ALD7 by Interviewer Allan Rarai on Pentecost Island, 12 January 2018*. (A. Rarai, Interviewer) [Personal communication].

- Armatas C, Venn T, McBride B, et al. (2016). Opportunities to utilize traditional phenological knowledge to support adaptive management of social-ecological systems vulnerable to changes in climate and fire regimes. *Ecology and Society* 21(1). <https://www.ecologyandsociety.org/vol21/iss1/art16/>
- Aswani S and Hamilton RJ (2004) Integrating indigenous ecological knowledge and customary sea tenure with marine and social science for conservation of bumphead parrotfish (*Bolbometopon muricatum*) in the Roviana Lagoon, Solomon Islands. *Environmental Conservation* 31(1): 69–83. DOI: 10.1017/S037689290400116X.
- AUD1. (2018). *Interview of AUD1 by Interviewer Allan Rarai on Pentecost Island, 9 January 2018* (A. Rarai, Interviewer) [Personal communication].
- Ballu V, Bouin M-N, Siméoni P, et al. (2011) Comparing the role of absolute sea-level rise and vertical tectonic motions in coastal flooding, Torres Islands (Vanuatu). *Proceedings of the National Academy of Sciences* 108(32): 13019–13022. DOI: 10.1073/pnas.1102842108.
- Barnett J and Campbell J (2010) *Climate Change and Small Island States: Power, Knowledge, and the South Pacific*. Washington, D.C. and London: Earthscan.
- Basdew M, Jiri O and Mafongoya PL (2017) Integration of indigenous and scientific knowledge in climate adaptation in KwaZulu-natal, South Africa. *Change and Adaptation in Socio-Ecological Systems* 3(1): 56–67.
- Beaumier MC and Ford JD (2010). Food insecurity among inuit women exacerbated by socio-economic stresses and climate change. *Canadian Journal of Public Health* 101(3): 196–201. DOI: 10.1007/BF03404373.
- Bell A (2018) A flawed Treaty partner: The New Zealand state, local government and the politics of recognition. In Howard-Wagner D, Bargh M and Altamirano-Jimenez I (eds) *The Neoliberal State, Recognition and Indigenous Rights: New Paternalism to New Imaginings*. ANU Press, pp. 77–92.
- Belfer E, Ford JD and Maillet M (2017) Representation of Indigenous peoples in climate change reporting. *Climatic Change* 145(1–2): 57–70.
- Belfer E, Ford JD, Maillet M, et al. (2019) Pursuing an Indigenous platform: Exploring opportunities and constraints for Indigenous participation in the UNFCCC. *Global Environmental Politics* 19(1): 12–33.
- Belmar YN, McNamara KE and Morrison TH (2016) Water security in small island developing states: The limited utility of evolving governance paradigms. *Wiley Interdisciplinary Reviews: Water* 3(2): 181–193.
- Berkes F (2012) *Sacred Ecology 3rd ed*. New York: Routledge.
- Billiot S, Beltrán R, Brown D, et al. (2019). Indigenous perspectives for strengthening social responses to global environmental changes: A response to the social work grand challenge on environmental change. *Journal of Community Practice* 1–21.
- Bingham JA, Milne S, Murray G, et al. (2021) Knowledge pluralism in first nations' Salmon management. *Frontiers in Marine Science*: 8: 1–8. DOI: 10.3389/fmars.2021.671112.
- Blaney DL and Tickner AB (2017) Worlding, ontological politics and the possibility of a decolonial IR. *Millennium* 45(1): 293–311. DOI: 10.1177/0305829817702446.
- Blaser M (2009) The threat of the ymo: The political ontology of a sustainable hunting program. *American Anthropologist* 111(1): 10–20. DOI: j.1467-fj.1548-1433.2009.01073.x.
- Blaser M (2014) Ontology and indigeneity: On the political ontology of heterogeneous assemblages. *Cultural Geographies* 21(1): 49–58. DOI: 10.1177/1474474012462534.
- Blaser M, Briones C, Burman A, et al. (2013) Ontological conflicts and the stories of peoples in spite of Europe: Toward a conversation on political ontology. *Current Anthropology* 54(5): 547–568.
- Boillat S and Berkes F (2013) Perception and interpretation of climate change among quechua farmers of Bolivia: Indigenous knowledge as a resource for adaptive capacity. *Ecology and Society* 18(4).
- Braun V and Clarke V (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology* 3(2): 77–101. DOI: 10.1191/1478088706qp063oa.
- Bremer S and Meisch S (2017) Co-production in climate change research: Reviewing different perspectives. *WIREs Climate Change* 8(6): e482.
- Bryant-Tokalau J (2018) “Adaptation to climate change in the Pacific Islands: Theory, dreams, practice and reality”. In: *Indigenous Pacific Approaches to Climate Change*. Cham: Springer International Publishing, pp 33–57.

- Buggy L and McNamara KE (2016) The need to reinterpret ‘community’ for climate change adaptation: A case study of Pele Island, Vanuatu. *Climate and Development* 8(3): 270–280.
- Campbell J (2009) Islandness: Vulnerability and resilience in Oceania. *Shima: The International Journal of Research into Island Cultures* 3(1): 85–97.
- Cameron E, de Leeuw S and Desbiens C (2014) Indigeneity and ontology. *Cultural Geographies* 21(1): 19–26. DOI: 10.1177/1474474013500229.
- Campbell JR (2015) Development, global change and traditional food security in Pacific Island countries. *Regional Environmental Change* 15(7): 1313.
- Carmichael B, Wilson G, Namarnyilk I, et al. (2018) Local and Indigenous management of climate change risks to archaeological sites. *Mitigation and Adaptation Strategies for Global Change* 23(2): 231–255.
- Chambers LE, Plotz RD, Dossis T, et al. (2017) A database for traditional knowledge of weather and climate in the Pacific. *Meteorological Applications* 24(3): 491–502.
- Chand SS, Chambers LE, Waiwai M, et al. (2014) “Indigenous knowledge for environmental prediction in the Pacific Island countries”. *Weather, Climate, and Society* 6(4): 445–450.
- Chant L (2011) Whanau ora: Hauora Maori models for kotahitanga/co-operative co-existence with non-Maori. *Alternative: An International Journal of Indigenous Peoples* 7(2): 111.
- Clement V (2020) Geographical knowledge, empire, and the indigenous other: Engaging a decolonising introspection into early french colonial geography. *Area* 52: 741–749. DOI: j.1467-/area.12617.
- Clarke T, McNamara KE, Clissold R, et al. (2019) Community-based adaptation to climate change: Lessons from Tanna Island, Vanuatu. *Island Studies Journal* 14(1).
- Crate SA and Nuttall M (2016) *Anthropology and climate change: From encounters to actions*. Routledge.
- Crook T and Rudiak-Gould P (2018) *Pacific Climate Cultures: Living Climate Change in Oceania*. De Gruyter Open. DOI: 10.2478/9783110591415.
- Curran D (2019) Indigenous processes of consent: Repoliticizing water governance through legal pluralism. *Water* 11(3): 571.
- Davies K (2015) “Kastom, climate change and intergenerational democracy: Experiences from Vanuatu”, in climate change in the Asia-Pacific region. In: Leal Filho W (ed) *Climate Change Management*. Cham: Springer International Publishing, pp.49–66.
- Davies K (2016) Ancient and new legal landscapes: Customary law and climate change, a Vanuatu case study. *Asia Pacific Journal of Environmental Law* 18: 43–68.
- De La Cadena M (2010) Indigenous cosmopolitics in the Andes: Conceptual reflections beyond ‘politics’. *Cultural Anthropology* 25(2): 234–370.
- Deloria PJ, Lomawaima KT, Brayboy BMJ, et al. (2018), “Unfolding futures: Indigenous ways of knowing for the twenty-first century”. *Daedalus* 147(2): 6–16.
- Deloria V (1999) *Spirit & Reason: The Vine Deloria, Jr., Reader*. Golden: Fulcrum Publishing.
- DeLoughrey EM (2013) The myth of isolates: Ecosystem ecologies in the nuclear Pacific. *Cultural Geographies* 20(2): 167–184.
- Denny SK and Fanning LM (2016) A Mi’kmaw perspective on advancing salmon governance in Nova Scotia, Canada: Setting the stage for collaborative co-existence. *International Indigenous Policy Journal* 7(3). DOI: 10.18584/iipj.2016.7.3.4.
- Egeru A (2012) Role of indigenous knowledge in climate change adaptation: A case study of the Teso sub-region, Eastern Uganda. *Indian Journal of Traditional Knowledge* 11(2): 217–224.
- Farbotko C (2010) Wishful sinking: Disappearing islands, climate refugees and cosmopolitan experimentation. *Asia Pacific Viewpoint* 51(1): 47–60.
- Fernández-Llamazares Á, García RA, Díaz-Reviriego I, et al. (2017) An empirically tested overlap between indigenous and scientific knowledge of a changing climate in Bolivian Amazonia. *Regional Environmental Change* 17(6): 1673–1685.
- Fletcher SM, Thiessen J, Gero A, et al. (2013) Traditional coping strategies and disaster response: Examples from the South Pacific region. *Journal of Environmental and Public Health* 2013: 9.

- Ford J, Mailliet M, Pouliot V, et al. (2016). Adaptation and indigenous peoples in the United Nations Framework Convention on Climate Change. *Climatic Change*, 139(3): 429–443. DOI: 10.1007/s10584-016-1820-0.
- Garschagen M, Hagenlocher M, Kloos J, et al. (2015). *World Risk Report 2015*. Berlin: Bündnis Entwicklung Hilft and UNU-EHS. p. 68.
- Gould RK, Pai M, Muraca B, et al. (2019) He ‘ike ‘ana ia i ka pono (it is a recognizing of the right thing): How one indigenous worldview informs relational values and social values. *Sustainability Science* 14(5): 1213–1232.
- Granderson AA (2017) “The role of traditional knowledge in building adaptive capacity for climate change: Perspectives from Vanuatu” weather. *Climate, and Society* 9(3): 545–561.
- Harding A (2007) “Paying in pig tusks in Vanuatu” BBC News. <http://news.bbc.co.uk/2/hi/asia-pacific/6266274.stm> (accessed 26 January 2019).
- Hemstock SL, Des Combes HJ, Martin T, et al. (2017) “A case for formal education in the technical, vocational education and training (TVET) sector for climate change adaptation and disaster risk reduction in the Pacific Islands region”. In: *Climate Change Adaptation in Pacific Countries*. New York: Springer, pp. 309–324.
- Hetzel D and Pascht A (2017) Young ni-Vanuatu encounter climate change: Reception of knowledge and new discourses. In Dürr E and Pascht A (eds) *Environmental Transformations and Cultural Responses: Ontologies, Discourses, and Practices in Oceania*. New York: Palgrave Macmillan US, pp. 103–124. DOI: 10.1057/978-1-137-53349-4\_5.
- Hill R, Walsh FJ, Davies J, et al. (2020) Knowledge co-production for Indigenous adaptation pathways: Transform post-colonial articulation complexes to empower local decision-making. *Global Environmental Change* 65: 102161.
- Hofmann R (2017) Experiencing environmental dynamics in chuuk, micronesia. In Dürr E and Pascht A (eds) *Environmental Transformations and Cultural Responses: Ontologies, Discourses, and Practices in Oceania*. New York: Palgrave Macmillan US, pp. 75–101. DOI: 10.1057/978-1-137-53349-4\_4.
- Howitt R (2020) Decolonizing people, place and country: Nurturing resilience across time and space. *Sustainability* 12(15): 5882.
- Howitt R, Havnen O and Veland S (2012) Natural and unnatural disasters: Responding with respect for indigenous rights and knowledges. *Geographical Research* 50(1): 47–59.
- Howitt R and Suchet-Pearson S (2006) “Rethinking the building blocks: Ontological pluralism and the idea of ‘management’”. *Geografiska Annaler: Series B, Human Geography* 88(3): 323–335.
- Hulme M (2010) The idea of climate change – exploring complexity, plurality and opportunity. *GAIA - Ecological Perspectives for Science and Society* 19(3): 171–174.
- Huntington HP (2000) Using traditional ecological knowledge in science: Methods and applications. *Ecological Applications* 10(5): 1270–1274.
- Johnston I (2015) Traditional warning signs of cyclones on remote islands in Fiji and Tonga. *Environmental Hazards* 14(3): 210–223.
- Jolly M (1981) People and their products in south Pentecost. In: Allen M (ed) *Vanuatu: Politics, Economics and Ritual in Island Melanesia*. Sydney: Academic Press, pp.269–293.
- Jolly M (1991) ‘To save the girls for brighter and better lives’: Presbyterian missions and women in the south of vanuatu: 1848–1870. *The Journal of Pacific History* 26(1): 27–48.
- Kagawa F and Selby D (2012) Ready for the storm: Education for disaster risk reduction and climate change adaptation and mitigation. *Journal of Education for Sustainable Development* 6(2): 207–217.
- Kalanda-Joshua M, Ngongondo C, Chipeta L, et al. (2011) Integrating indigenous knowledge with conventional science: Enhancing localised climate and weather forecasts in Nessa, Mulanje, Malawi. *Physics and Chemistry of the Earth* 36(14–15): 996–1003.
- Kalkao G (1980) Vanuatu: Twenti wan tingting long teams blong independens [Vanuatu: twentyone contributions by the independence team] (Institute of Pacific Studies, University of the South Pacific, Suva), pp. 156–171.
- Kench P, Ford M and Owen S (2018) Patterns of island change and persistence offer alternate adaptation pathways for atoll nations. *Nature Communications* 9(1): 605–605.

- Kimmerer R (2011) "Restoration and reciprocity: The contributions of traditional ecological knowledge". In: Egan D, Hjerpe EE and Abrams J (eds) *Human Dimensions of Ecological Restoration: Integrating Science, Nature, and Culture*. Washington D.C: Island Press/Center for Resource Economics, pp.257–276.
- Klenk N, Fiume A, Meehan K, et al. (2017) Local knowledge in climate adaptation research: Moving knowledge frameworks from extraction to co-production. *Wiley Interdisciplinary Reviews: Climate Change* 8(5): e475. DOI: 10.1002/wcc.475.
- Kovach M (2015) Emerging from the margins: Indigenous methodologies. *Research as Resistance: Revisiting Critical, Indigenous, and Anti-Oppressive Approaches* 43.
- Kuruppu N (2009) Adapting water resources to climate change in Kiribati: The importance of cultural values and meanings. *Environmental Science & Policy* 12(7): 799–809.
- Latour B (1999) On recalling ant. *The Sociological Review* 47(1\_suppl): 15–25. DOI: j.1467-fj.1467-954X.1999.tb03480.x.
- Lauer M and Aswani S (2010) Indigenous knowledge and long-term ecological change: Detection, interpretation, and responses to changing ecological conditions in pacific island communities. *Environmental Management* 45(5): 985–997.
- Le Dé L, Rey T, Leone F, et al. (2018) Sustainable livelihoods and effectiveness of disaster responses: A case study of tropical cyclone Pam in Vanuatu. *Natural Hazards* 91(3): 1203–1221.
- Leonard S, Parsons M, Olawsky K, et al. (2013) The role of culture and traditional knowledge in climate change adaptation: Insights from East Kimberley, Australia. *Global Environmental Change* 23(3): 623–632.
- Ludwig D (2016) Overlapping ontologies and Indigenous knowledge. From integration to ontological self-determination. *Studies in History and Philosophy of Science Part A* 59: 36–45.
- Luetz JM and Nunn PD (2020) "Climate change adaptation in the Pacific Islands: A review of faith-engaged approaches and opportunities". In: Leal Filho W (ed) *Managing Climate Change Adaptation in the Pacific Region*. Cham: Springer International Publishing, pp.293–311.
- Lyons I, Hill R, Deshong S, et al. (2019) Putting uncertainty under the cultural lens of traditional owners from the great barrier reef catchments. *Regional Environmental Change* 19(6): 1597–1610.
- Lyons I, Hill R, Deshong S, et al. (2020) Protecting what is left after colonisation: Embedding climate adaptation planning in traditional owner narratives. *Geographical Research* 58(1): 34–48.
- Mahit LGL (2016) *Reconciling Kastom and Modernity in Contemporary Vanuatu*. Thesis, University of Waikato. <https://researchcommons.waikato.ac.nz/handle/10289/10740>
- Malsale P, Sanau N, Tofaeono TI, et al. (2018) Protocols and partnerships for engaging Pacific Island communities in the collection and use of traditional climate knowledge. *Bulletin of the American Meteorological Society* 99(12): 2471–2489.
- Maxwell KH, Ngāti Horomoana TW-H, Arnold R, et al. (2018). Fishing for the cultural value of kahawai (*Arripis trutta*) at the Mōtū River, New Zealand. *New Zealand Journal of Marine and Freshwater Research* 52(4): 557–576.
- McCoy K, Tuck E and McKenzie M (2017) *Land Education: Rethinking Pedagogies of Place from Indigenous, Postcolonial, and Decolonizing Perspectives*. Routledge.
- McDonnell S (2019) Other dark sides of resilience: Politics and power in community-based efforts to strengthen resilience. *Anthropological Forum* 0(0): 1–18. DOI: 10.1080/00664677.2019.1647828.
- McGregor D (2008). Linking traditional ecological knowledge and western science: Aboriginal perspectives from the 2000 state of the lakes ecosystem conference. *The Canadian Journal of Native Studies* XXVIII(1): 139–158.
- McGregor D (2014) Traditional knowledge and water governance: The ethic of responsibility. *AlterNative: An International Journal of Indigenous Peoples* 10(5): 493–507.
- McLean R and Kench P (2015) "Destruction or persistence of coral atoll islands in the face of 20th and 21st century sea-level rise?: Destruction or persistence of coral atoll islands". *Wiley Interdisciplinary Reviews: Climate Change* 6(5): 445–463.

- McNamara KE, Clissold R and Westoby R. (2020). Marketplaces as sites for the development-adaptation-disaster trifecta: Insights from Vanuatu. *Asia Pacific Viewpoint* 61(3): 566–576. DOI: j.1467-/apv.12293.
- McNamara KE and Farbotko C (2017) Resisting a ‘Doomed’ fate: An analysis of the Pacific climate warriors. *Australian Geographer* 48(1): 17–26.
- Mehta L, Adam H N and Srivastava S (2019a) Unpacking uncertainty and climate change from ‘above’ and ‘below’. *Regional Environmental Change* 19(6): 1529–1532.
- Mehta L, Srivastava S, Adam HN, et al. (2019b) Climate change and uncertainty from ‘above’ and ‘below’: Perspectives from India. *Regional Environmental Change* 19(6): 1533–1547.
- Miles WFS (1998) *Bridging Mental Boundaries in a Postcolonial Microcosm: Identity and Development in Vanuatu*. University of Hawaii Press.
- Moller H, Berkes F, Lyver PO, et al. (2004) Combining science and traditional ecological knowledge: Monitoring populations for co-management. *Ecology and Society* 9(3).
- Mondragón C (2018) “Forest, reef and sea-level rise in north Vanuatu: Seasonal environmental practices and climate fluctuations in island Melanesia”. In: Nakashima D, Krupnik I and Rubis JT (eds) *Indigenous Knowledge for Climate Change Assessment and Adaptation*. Cambridge: Cambridge University Press, pp.23–40.
- Mortreux C and Barnett J (2009) Climate change, migration and adaptation in Funafuti, Tuvalu. *Global Environmental Change* 19(1): 105–112.
- Murray G, Neis B and Johnsen JP (2006) Lessons learned from reconstructing interactions between local ecological knowledge, fisheries science, and fisheries management in the commercial fisheries of Newfoundland and Labrador, Canada. *Human Ecology* 34(4): 549–571.
- Nadasdy P (2007) The gift in the animal: The ontology of hunting and human–animal sociality. *American Ethnologist* 34(1): 25–43. DOI: 10.1525/ae.2007.34.1.25.
- Nakashima D, Krupnik I and Rubis JT (2018) *Indigenous Knowledge for Climate Change Assessment and Adaptation*. Cambridge: Cambridge University Press.
- Nalau J, Lawrence J and Burton D (2019) The role of governance in sub-national adaptation policy implementation. In Keskitalo ECH and Preston BL (eds) *Research Handbook on Climate Change Adaptation Policy*. Edward Elgar Publishing.
- Neis B (1992) Fishers’ ecological knowledge and stock assessment in Newfoundland. *Newfoundland and Labrador Studies* 8(2).
- Nightingale AJ (2016) “Adaptive scholarship and situated knowledges? Hybrid methodologies and plural epistemologies in climate change adaptation research”. *Area* 48(1): 41–47.
- Nightingale AJ, Eriksen S, Taylor M, et al. (2020) Beyond technical fixes: Climate solutions and the great derangement. *Climate and Development* 12(4): 343–352.
- Norgaard KM, Reed R and Bacon JM (2018) How environmental decline restructures indigenous gender practices: What happens to karuk masculinity when there are no fish? How environmental decline restructures indigenous gender practices: What happens to karuk masculinity when there are no fish? *Sociology of Race and Ethnicity* 4(1): 98–113. DOI: 10.1177/2332649217706518.
- Nurse-Bray M (2015) Cultural indicators, country and culture: The Arabana, change and water. *The Rangland Journal* 37(6): 555–569. DOI: 10.1071/RJ15055.
- Nurse-Bray M, Palmer R, Stuart A, et al. (2020) Scale, colonisation and adapting to climate change: Insights from the Arabana people, South Australia. *Geoforum* 114: 138–150. DOI: 10.1016/j.geoforum.2020.05.021.
- Nyong A, Adesina F and Elasha BO (2007) The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation and Adaptation Strategies for Global Change* 12(5): 787–797.
- Ohmagari K and Berkes F (1997) Transmission of indigenous knowledge and bush skills among the Western James Bay Cree women of subarctic Canada. *Human Ecology* 25(2): 197–222.
- Parsons M, Brown C, Nalau J, et al. (2018) Assessing adaptive capacity and adaptation: Insights from Samoan tourism operators. *Climate and Development* 10: 644–663.
- Parsons M and Fisher K (2020) Indigenous peoples and transformations in freshwater governance and management. *Current Opinion in Environmental Sustainability* 44: 124–139.



- Parsons M, Fisher K and Crease RP (2021) *Decolonising Blue Spaces in the Anthropocene: Freshwater Management in Aotearoa New Zealand*. London: Palgrave Macmillan.
- Parsons M and Nalau J (2019) “Adaptation policy and planning in Pacific small island developing states.”. In: Preston BL and Keskkitalo ECH (eds) *Research Handbook on Climate Change Adaptation Policy*. London and New York: Edward Elgar Publishing, pp.277–290.
- Parsons M, Nalau J, Fisher K, et al. (2019) Disrupting path dependency: Making room for Indigenous knowledge in river management. *Global Environmental Change* 56: 95–113.
- Pearce T, Ford J, Willox AC, et al. (2015) Inuit traditional ecological knowledge (TEK), subsistence hunting and adaptation to climate change in the Canadian Arctic. *Arctic* 68(2): 233–245.
- Plotz RD, Chambers LE and Finn CK (2017) The best of both worlds: A decision-making framework for combining traditional and contemporary forecast systems. *Journal of Applied Meteorology and Climatology* 56(8): 2377–2392.
- Pondorfer A (2019) The perception of climate change: Comparative evidence from the small-island societies of Bougainville and Palawan. *Environmental Development* 30: 21–34.
- Pyhälä A, Fernández-Llamazares Á, Lehvävirta H, et al. (2016). Global environmental change: Local perceptions, understandings, and explanations. *Ecology and Society*, 21(3). DOI: 10.5751/ES-08482-210325.
- Radeny M, Desalegn A, Mubiru D, et al. (2019) Indigenous knowledge for seasonal weather and climate forecasting across East Africa. *Climatic Change* 156(4): 509–526.
- Republic of Vanuatu (2015) “Vanuatu climate change and disaster risk reduction policy 2016–2030”.
- Republic of Vanuatu (2016) “Meteorology, Geological Hazards and Climate Change Act”. <https://www.ilo.org/dyn/natlex/docs/ELECTRONIC/105148/128518/F-500801273/VUT105148.pdf>
- Republic of Vanuatu (2020) “Disaster Risk Management Act”. <https://covidlawlab.org/wp-content/uploads/2020/09/DRM-Act-23-of-201925Feb2020Actual.pdf>
- Riseth JÅ, Tømmervik H, Helander-Renvall E, et al. (2011) Sámi traditional ecological knowledge as a guide to science: Snow, ice and reindeer pasture facing climate change. *Polar Record*, 47(3): 202–217. DOI: 10.1017/S0032247410000434.
- Ritchie J, Lewis J, Nicholls CM, et al. (2013) *Qualitative Research Practice: A Guide for Social Science Students and Researchers*. London: Sage.
- Robertson S (2017) “‘Thinking of the land in that way’: Indigenous sovereignty and the spatial politics of attentiveness at Skwelkwek’welt”. *Social & Cultural Geography* 18(2): 178–200.
- Rocha P, Niella F, Keller H, et al. (2017) “Ecological Indigenous (EIK) and scientific (ESK) knowledge integration as a tool for sustainable development in Indigenous communities. Experience in Misiones, Argentina”. In: *Integrating Landscapes: Agroforestry for Biodiversity Conservation and Food Sovereignty*. New York: Springer, pp. 235–260
- Rohe JR, Govan H, Schlüter A, et al. (2019) “A legal pluralism perspective on coastal fisheries governance in two Pacific Island countries”. *Marine Policy* 100: 90–97.
- Rojas C (2016) Contesting the colonial logics of the international: Toward a relational politics for the pluriverse. *International Political Sociology* 10(4): 369–382. DOI: 10.1093/ips/olw020.
- Roulston K (2010) *Reflective Interviewing: A Guide to Theory and Practice*. London: SAGE Publications Ltd. DOI: 10.4135/9781446288009.
- Rubin HJ and Rubin IS (2011) *Qualitative Interviewing: The Art of Hearing Data*. London: SAGE Publications Ltd.
- Roosvall A and Tegelberg M (2015) “Media and the geographies of climate justice: Indigenous peoples, nature and the geopolitics of climate change” tripleC: Communication, capitalism & critique. *Open Access Journal for a Global Sustainable Information Society* 13(1): 39–54.
- Seidman I (2013) *Interviewing As Qualitative Research: A Guide for Researchers in Education and the Social Sciences*. New York: Teachers College, Columbia University Press. <http://ebookcentral.proquest.com/lib/auckland/detail.action?docID=3544963>
- Smith LT (2013) *Decolonizing methodologies: Research and indigenous peoples*. New York: Zed Books.
- Smith A and Stirling A (2010). The politics of social-ecological resilience and sustainable socio-technical transitions. *Ecology and Society* 15(1).

- SPC. (2016). *Framework for Resilient Development in the Pacific: An Integrated Approach to Address Climate Change and Disaster Risk Management [FRDP] 2017–2030* (p. 40). The Secretariat of the Pacific Community. [http://tep-a.org/wp-content/uploads/2017/05/FRDP\\_2016\\_finalResilient\\_Dev\\_pacific.pdf](http://tep-a.org/wp-content/uploads/2017/05/FRDP_2016_finalResilient_Dev_pacific.pdf)
- Suaalii-Sauni T and Fulu-Aiolupotea SM (2014) Decolonising Pacific research, building Pacific research communities and developing Pacific research tools: The case of the talanoa and the faafaletui in Samoa. *Asia Pacific Viewpoint* 55(3): 331–344.
- Sundberg J (2014) Decolonizing posthumanist geographies. *Cultural Geographies* 21(1): 33–47. DOI: 10.1177/1474474013486067.
- Taylor SJ, Bogdan R and DeVault ML (2015) *Introduction to Qualitative Research Methods: A Guidebook and Resource*. Hoboken, New Jersey: Wiley.
- Tengö M, Hill R, Malmer P, et al. (2017) Weaving knowledge systems in IPBES, CBD and beyond—lessons learned for sustainability. *Current Opinion in Environmental Sustainability* 26: 17–25.
- Thomas A C (2015) Indigenous more-than-humanisms: Relational ethics with the Hurunui river in Aotearoa New Zealand. *Social & Cultural Geography* 16(8): 974–990.
- Todd Z (2016) An Indigenous Feminist's take on the ontological turn: 'ontology' is just another word for colonialism: An Indigenous Feminist's take on the ontological turn. *Journal of Historical Sociology* 29(1): 4–22.
- Tran J, Divine L M and Heffner L R (2021), “‘What are you going to do, protest the wind?’: Community perceptions of emergent and worsening coastal erosion from the remote Bering Sea community of St. Paul, Alaska”. *Environmental Management* 67(1): 43–66.
- Tschakert P (2020) More-than-human solidarity and multispecies justice in the climate crisis. *Environmental Politics* 0(0): 1–20. DOI: 10.1080/09644016.2020.1853448.
- Turner NJ and Turner KL (2008) “Where our women used to get the food”: Cumulative effects and loss of ethnobotanical knowledge and practice; case study from coastal British Columbia. *Botany* 86(2): 103–115.
- Unknown (2016) “Nev House Vanuatu “ Inhabitat – Green Design, Innovation, Architecture, Green Building” Inhabitat. <https://inhabitat.com/aussie-surfboard-designer-makes-recycled-prefab-cyclone-resistant-homes/nev-house-vanuatu/>
- Vaiioleti TM and Morrison SL (2019) “The value of Indigenous knowledge to education for sustainable development and climate change education in the Pacific”. In: McKinley EA and Smith LT (eds) *Handbook of Indigenous Education*. Singapore: Springer, pp.651–670.
- Vinyeta K, Whyte K and Lynn K (2016) *Climate Change Through an Intersectional Lens: Gendered Vulnerability and Resilience in Indigenous Communities in the United States* (SSRN Scholarly Paper ID 2770089). Social Science Research Network. <https://papers.ssrn.com/abstract=2770089>
- Voeks RA (2007) Are women reservoirs of traditional plant knowledge? Gender, ethnobotany and globalization in northeast Brazil. *Singapore Journal of Tropical Geography* 28(1): 7–20.
- Walsh RA, Chang Seng D, Bumpus A, et al. (2018) Perceptions of adaptation, resilience and climate knowledge in the Pacific: The cases of Samoa, Fiji and Vanuatu. *International Journal of Climate Change Strategies and Management* 10(2): 303–322.
- Walsh RA and Nunn PD (2012) Integration of indigenous knowledge and disaster risk reduction: A case study from Baie Martelli, Pentecost Island, Vanuatu. *International Journal of Disaster Risk Science* 3(4): 185–194.
- Warrick O, 2010. “Climate change and social change: vulnerability and adaptation in rural Vanuatu”. PhD Thesis. The University of Waikato.
- Watson A and Huntington O (2014) Transgressions of the man on the moon: Climate change, Indigenous expertise, and the posthumanist ethics of place and space. *GeoJournal* 79(6): 721–736.
- Westoby P (2010a) Dialogue and disentanglement: Navigating tensions for sustainable community economic development within Vanuatu. *The International Journal of Environmental, Cultural, Economic and Social Sustainability* 6: 81–92.
- Westoby P (2010b) ‘We have plenty’: Re-thinking custom and community economic development within Vanuatu. *Journal for Development Support* 2: 20–38.

- Westoby R, Clissold R, McNamara KE, et al. (2021) Locally led adaptation: Drivers for appropriate grassroots initiatives. *Local Environment* 26(2): 313–319.
- Westoby R, McNamara K E, Kumar R, et al. (2019) From community-based to locally led adaptation: Evidence from Vanuatu. *Ambio* 49: 1–18. DOI: 10.1007/s13280-019-01294-8.
- Winter CJ, 2018. *The Paralysis of Intergenerational Justice: decolonising entangled futures*. PhD Thesis. University of Sydney. <https://ses.library.usyd.edu.au/handle/2123/18009>
- Winter CJ (2019) Decolonising dignity for inclusive democracy. *Environmental Values* 28(1): 9–30.
- Whyte K (2018a) Critical investigations of resilience: A brief introduction to indigenous environmental studies & sciences. *Daedalus* 147(2): 136–147.
- Whyte KP (2018b) Indigenous science (fiction) for the Anthropocene: Ancestral dystopias and fantasies of climate change crises. *Environment and Planning E: Nature and Space* 1(1–2): 224–242. DOI: 10.1177/2514848618777621.
- Yates JS, Harris LM and Wilson NJ (2017) Multiple ontologies of water: Politics, conflict and implications for governance. *Environmental Planning D: Society and Space* 35(5): 797–815.
- Zobolo AM and Mkabela QN (2006). Traditional knowledge transfer of activities practised by Zulu women to manage medicinal and food plant gardens. *African Journal of Range and Forage Science* 23(1): 77–80.