

Working with nature, working with Indigenous knowledge: Community priorities for climate adaptation in Samoa

Anita Latai-Niusulu^{a,b}, Susana Taua'a^{a,b}, Tuputau Lelaulu^{a,c}, Maibritt Pedersen Zari^{a,c,*}, Sibyl Bloomfield^{a,c}

^a NUWAO (Nature-based Urban design for Wellbeing and Adaptation in Oceania) Research Project, Moananui Oceania, Aotearoa New Zealand

^b National University of Samoa, Apia, Samoa

^c Te Wānanga Aronui O Tāmaki Makau Rau Auckland University of Technology, Auckland, Aotearoa New Zealand

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ABSTRACT

The culturally diverse region of *Moananui* Oceania, is where many of the world's nations that are most impacted by climate change are located, including Samoa. Nature-based solutions (NbS) offer significant potential for effective climate change adaptation and are increasingly being explored and utilized in the region both in terms of (re)exploring traditional human designed living-systems created over connected land and oceanscapes, and in relation to contemporary NbS strategies. To explore nature-based adaptation agendas that link closely to Indigenous ecological knowledge and understandings of wellbeing, and that can enhance cultural connections to NbS in an urban climate change adaptation context, the Nature-based Urban design for Wellbeing and Adaptation in Oceania (NUWAO) Vaisigano Project in Samoa was conceived. The project examines and draws upon contemporary and traditional relationships between human settlements and nature in Samoa, as a means to advocate for regenerative urban environments that enhance entwined socio-ecological wellbeing and resilience as a climate change adaptation measure. We conducted a series of household interviews along a ridge-to-reef transect in the Vaisigano Catchment and then conducted *fa'afaletui* focus groups to ascertain community understandings and priorities related to NbS for climate change adaptation. Findings include that there is great potential in combining local Indigenous knowledges and worldviews with contemporary nature-based approaches to create culturally effective, just, and resilient climate change adaptation measures in Samoa, and in wider *Moananui* Oceania.

1. Introduction

1.1. Positionality: *Sina faamatalaga i e na tusia lenei mataupu*

An important part of decolonizing research practices is to make the positionality of researchers apparent [1,2]. The authors of this article include Indigenous Samoan academics and professionals, as well as researchers who are Māori (Indigenous New Zealanders) and Pākehā (New Zealanders of European descent), all of whom are involved in research related to Pacific peoples' well-being, climate change adaptation, and NbS as part of the Nature-based Urban design for Wellbeing and Adaptation in Oceania (NUWAO) project. Further details about the positionality of each author and NUWAO as a group are available at www.nuwao.org.nz. NUWAO is a three-year project funded by the New Zealand Government through a Royal Society of New Zealand Marsden

grant, aiming to develop nature-based urban design solutions, driven by Indigenous knowledges that support climate change adaptation and individual and community wellbeing in diverse *Moananui* Oceania urban settings.

We have used Samoan words throughout the paper. These are in italics and include a translation in brackets to English where they first appear. Table 1 summarizes non-English words in a glossary. We use the term *Moananui* alongside Oceania rather than terms such as Micronesia, Polynesia, and Melanesia in an effort to use terms recognizable in local languages.

1.2. *Moananui Oceania, climate change, and living systems*

Many of the most vulnerable nations to climate change impacts are found in *Moananui* Oceania [3]. Some Pacific researchers argue that this

* Corresponding author at: 55 Wellesley Street, CBD, Auckland, Aotearoa New Zealand.

E-mail address: maibritt.pedersen.zari@aut.ac.nz (M. Pedersen Zari).

Table 1
Glossary of Samoan terms.

Aiga	family
<i>a'ai</i>	Central residential and/ or village settlement
<i>fa'afaletui</i>	A culturally relevant research framework that embraces Samoan values of respect, love and obedience essential to meaningful discussions on social matters
<i>fa'amatai</i>	Samoa Chiefly and relational system.
<i>fa'a-Samoa</i>	Samoa ways of being; cultural practices and customs.
<i>fale</i>	Vernacular Samoan house.
<i>fa'u'iala</i>	Synonym for nu'u; household units; prehistoric Samoan settlement system.
<i>Gagana Samoa</i>	The Samoan language.
<i>nu'u</i>	A typical Samoan village.
<i>pitonu'u</i>	Segment of a village; communal ward.
<i>talamoa</i>	Conversation or dialogue; a research framework.
<i>tui</i>	To weave or stitch.

perceived 'vulnerability', is often through a Westernized lens [4], and that the islands of *Moananui* Oceania can be thought of instead as highly dynamic settings, leading to increased opportunity and capacity to adapt and therefore be resilient [5]. High exposure to the impacts of climate change exists in the region, despite the very low levels of global contribution (0.03 %) to green-house gas emissions both historically and in a contemporary context [6]. Adaptation to the impacts of climate change is therefore crucial across *Moananui* Oceania. These nations are at the forefront of systemic climate change challenges, ranging from rising sea levels and ocean acidification to increasingly severe weather events [7]. In the vast expanse of *Moananui* Oceania (Fig. 1), innovative climate adaptation techniques (both traditional and contemporary) that work with nature have emerged or are emerging as pivotal strategies to adapt, where possible, to the impacts of climate change [8]. Overlapping categories of such strategies include 'social-environmental', 'social-ecological' and 'regenerative living systems' popularized by Indigenous and regenerative scholars and practitioners [9-11], along with 'nature-based' and 'ecosystem-based adaptation' practices [12].

It is Indigenous peoples globally, and certainly including those in *Moananui* Oceania that will be most impacted by climate change [13]. Aside from the French territory of New Caledonia where 41 % of people are Kanak, the US state of Hawai'i where 22 % of people are Indigenous, and Aotearoa New Zealand where 17 % of people are Māori, the other nations and states of *Moananui* Oceania are majority Indigenous populations. In Samoa for example, 96 % of people are Indigenous. Understanding how to work with existing ecological knowledge, values, and priorities of Indigenous peoples is therefore key to effective and just NbS in *Moananui* Oceania [14].

Working with nature is not new in the region. In *Moananui* Oceania, living systems include coral atolls (e.g. the Tuamotu Archipelago), volcanic high-islands (e.g. Hawai'i), small and infertile volcanic islands (e.g. Rapa Nui), and temperate subcontinental islands (e.g. Aotearoa New Zealand). Living systems were understood, adapted to, and cultivated to produce complex and sophisticated social-environmental systems that supported growing populations, and place-specific cultural values, customs, and worldviews [9]. The evolution of living systems in *Moananui* Oceania offers a compelling narrative of resilience and adaptability and reflects a deep understanding of sustainable resource management, social organization, and environmental stewardship, showcasing the diversity and complexity of Indigenous approaches to living in harmony with nature [9]. These ancient living systems include *ahupua'a* in Hawai'i; *va'a mataeina'a* in Tahiti; *tapere* in Kuki 'Airani Cook Islands; and *pā kāinga* in Aotearoa New Zealand [9,15]. These living systems exist and are increasingly being researched, remembered, and revitalized in other *Moananui* Oceania nations, including in Samoa (see Section 1.2.1) [16-19].

Ahupua'a in Hawai'i (Fig. 2) represents a social-environmental system, with natural features demarcating boundaries and incorporating a range of *wao* (ecological zones) [18,20]. Each zone serves a specific purpose, from the sacred *Wao Akua* (the realm of the gods, the upper forested regions of watersheds) to the productive *Wao Kanaka* (the realm of people, where everyone lives and works) and *Wao Kai* (the realm of the ocean), ensuring access to diverse resources and sustainable use through the *kapu* system (the cultural law system that ruled over

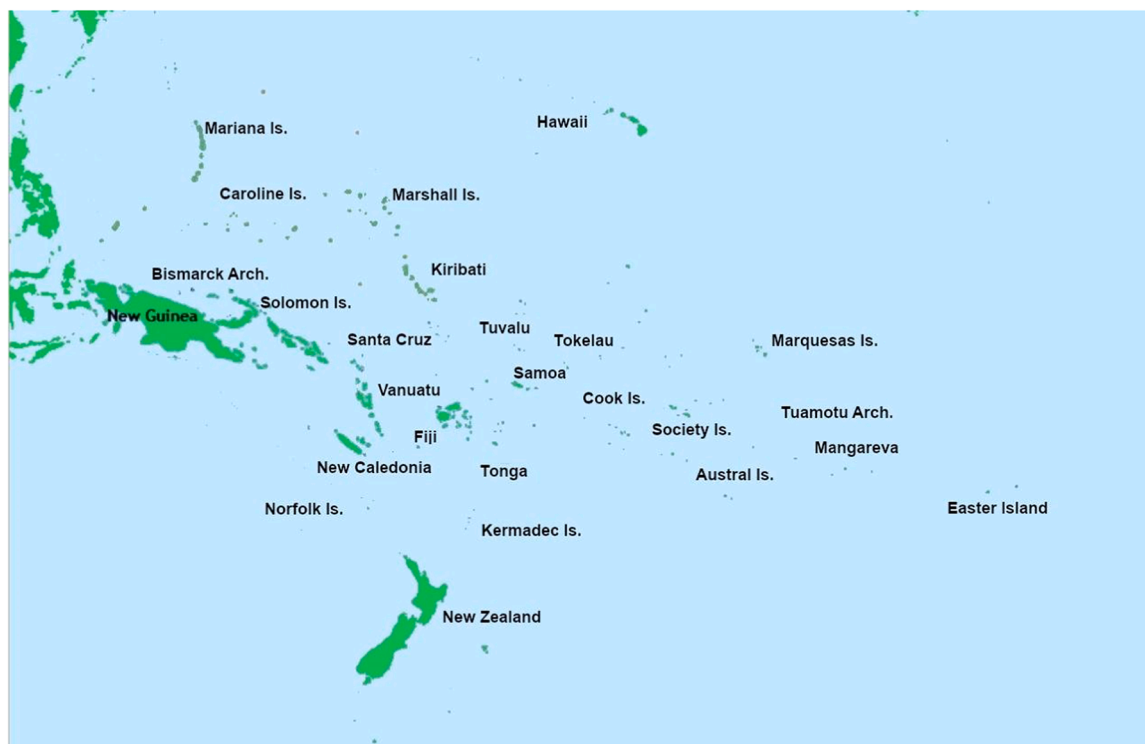


Fig. 1. Moananui Oceania. Image by Sam Wood, 2024.



Fig. 2. Ahupua'a System of Resource Management. Image by Limahuli Gardens, accessed 2024.

almost every act of Hawaiian life) [21,22]. The *ahupua'a* system underscores the interconnectedness of land, water, and community, embodying principles of *Mana'o'i'o* (faith, respect for nature), *Mālama 'Aina* (caring for the land) and *Kamolewai* (respect for all water resources within the *ahupua'a*) [22,23]. *Va'a Mataeina'a* in Tahiti is characterized by its division of land and sea resources, similar to the *ahupua'a* but distinct in its cultural and environmental adaptations specific to Tahiti. This land system organizes land into sectors radiating from the mountain to the sea, integrating agricultural, residential, and fishing zones [24]. It demonstrates the Tahitian approach to balancing human needs with environmental preservation, highlighting the role of traditional relational knowledge in resource division, management [25], and the inextricable link between people and the land [26]. *Tapere* in the Cook Islands is the land division system within each island, functioning as sub-districts controlled by individual *mataiapo* or *ariki* (chiefs), and occupied by *matakeinanga* (families or clans) [27]. Each *tapere* includes access to inland resources and the sea, promoting a diversified approach to agriculture, fishing, and foraging [28]. This system emphasizes the autonomy of family units within a communal framework, allowing for tailored management practices that reflect the unique characteristics of each *tapere*. *Kāinga* in Aotearoa New Zealand focus on communal living arrangements traditionally organized around *whānau* (extended family) and *hapū* (subtribe) structures near significant natural resources [19, 29]. *Kāinga* are based on ancestral lands, integrating *marae* (meeting house complexes), housing, agriculture, and resource management in a way that strengthens social interdependency, community ties and cultural identity [29,30]. This system highlights the interconnection of all living things in *Te Ao Māori* (The Māori worldview), along with Māori values of *kaitiakitanga* (guardianship) with the land and waters, ensuring sustainability for future generations [31].

These systems, evolving through centuries of migration, settlement, and technological advancement, epitomize the ingenuity and ability to live in harmony with nature of *Moananui* Oceania's inhabitants. By harnessing the principles of these ancient systems, alongside newer ideas for working with nature that come from places outside of the region, modern *Moananui* Oceania communities are exploring ways to regenerate and strengthen their ability to adapt to climate change where

possible, proposing and exemplifying living systems as dynamic models for climate adaptation and global change [9].

1.2.1. Samoa, climate change adaptation, and working with nature

Samoa is located in the south-central Pacific Ocean (Fig. 3). It has a west-northwest to east-southeast orientation [32], and a total land area of 2934 square kilometers. The island group is made up of four inhabited islands: Savai'i, Upolu, Manono, and Apolima. There are several nearby islets adjacent to their coasts [33]. The 2021 census indicated that the population of Samoa increased from 195,979 in 2016 to 205,557 in 2021 [34], with more than 70 % living in 330 villages along the coasts of the two main islands, Upolu and Savai'i [35]. Samoa, like many islands, is exposed to interacting drivers of physical and social change and is ranked as 30th most vulnerable among countries with three or more converging risks globally [36].

Climate change, tectonic volatility, colonization histories, and globalization continue to pose socio-ecological risks to the development of the country and the lives of its people. Samoa moved from 'least developed country' status to 'developing country' status in 2014 and is ranked as 94 out of 182 on the global human development index [37]. *Fa'amatai* or the Samoan chiefly system and the communal nature of land and living world 'ownership' is still prevalent today. *Fa'amatai* comprises multiple and multi-layered kinship connections that prove crucial to the survival of Samoan communities and people. The prevalence of *fa'amatai* is evident in Samoa's current land tenureship where more than 80 % of Samoa's land is collectively owned [38,39], and every Samoan has access to customary land, either through their mother's or father's side [39]. 60 % of households live on customary land and 36 % live on private or freehold land [34]. Samoan communities are increasingly vulnerable to the systemic issues stemming from climate change, including coastal erosion, changing rainfall patterns, pollution, and the disruption of traditional livelihoods [36]. Climate adaptation that supports community wellbeing is an urgent task.

The impacts of Western colonialism must be taken into account in a climate adaptation context, and considering the importance of traditional spiritual beliefs in relation to local notions of wellbeing and relationships to nature in *Moananui* Oceania. Samoa has been independent

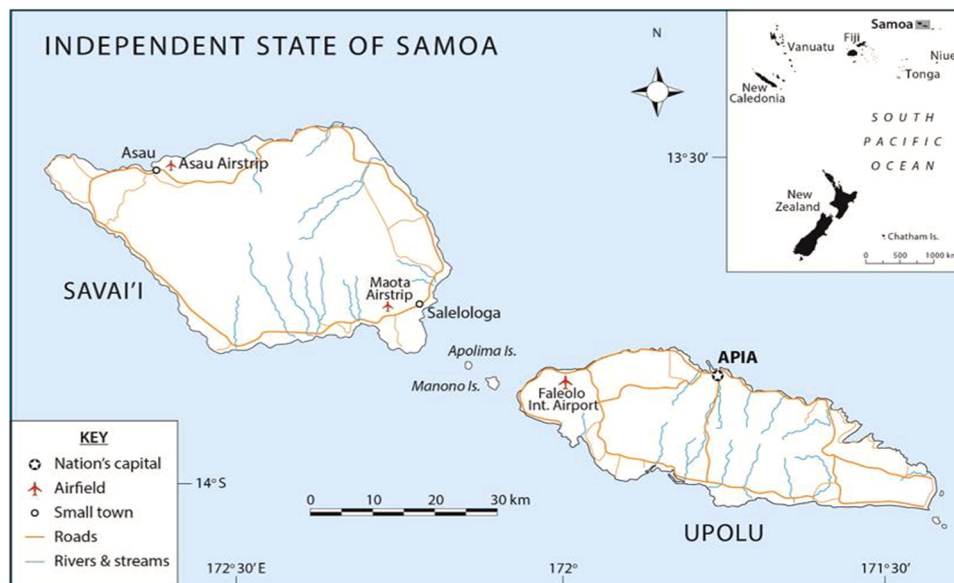


Fig. 3. Map of the Samoa islands. Source [40].

since 1962 but has a complex history of colonization or shifting power dynamics since the late 1800s with Germany, The United States of America, The United Kingdom, and Aotearoa New Zealand (itself independent but still part of the United Kingdom Commonwealth) [41,42]. As a phenomenon accompanying colonization, the conversion of most Oceanic peoples to Christianity is of particular significance [43]. This is true in Samoa where Christianity and *fa'a-Samoa* (culture and practices) are deeply entwined, though religion is typically not considered in formal discussions of development [44]. The influence of colonization, and resulting wide adherence to Christian perspectives and values in the Pacific, is significant and important to consider because there is potential tension between climate adaptation measures and some religious doctrines, and between traditional and Christian notions of human relationships to nature [14]. For example, the Judaeo-Christian tradition of human dominion over nature, as expressed in parts of the Bible, has been linked to environmental degradation and is at odds with many traditional Indigenous belief systems in *Moananui Oceania* [45]. There is, however, strong and diverse involvement of Christians in climate change and resilience responses in *Moananui Oceania*, and in Samoa specifically [46,47]. Luetz & Nunn [48] describe how climate change decision-making in Pacific Island nations is likely to be influenced by tradition and local practice (including the highly-respected teachings of religious leaders).

In Samoa, nature-based climate adaptation takes a distinct form, rooted in the island's unique ecological and cultural landscape. The *fua'iala* [49-53] in Samoan culture encapsulates a dynamic and living system, emphasizing the reciprocal relationship between humans and nature. Unlike the more static concept of *nu'u*, which connotes a fixed sense of place and ownership, *fua'iala*, translated as "unfolding pathways", illustrates the Samoan view of space as a continuous, evolving entity, where community and environment are interlinked through literal and metaphorical pathways [49]. This system, historically signifying a village division or a network of interconnected family residences [52-54], showcases the indigenous Samoan philosophy where space is not merely inhabited but actively engaged with, creating a living system replicating the natural cycles and rhythms of the environment [49,55]. The various components of *fua'iala* or *'a'ai* (family residence) and *pitonu'u* (clusters of *'a'ai*) [52,53], are nested within each other, forming a holistic structure that underscores the Samoan values of balance, reciprocity, and respect for nature [55]. Through this system, Samoans demonstrate a deep-rooted acknowledgment that the well-being of the community is intrinsically tied to the health and vitality of the land [56]

thereby fostering a sustainable and interconnected living environment that is responsive to the evolving needs of both the people and their natural surroundings.

The current Samoan approach to Nature-based Watershed Management (NBWM) provides a microcosm of the broader *Moananui Oceania* experience. These systems, characterized by their integration with the natural landscape and traditional knowledge, are central to Samoan climate resilience [38]. The island nation is also at the forefront of implementing various watershed catchment restorations through agroforestry, reforestation, and invasive species management. Strategies and plans showcase a proactive approach to climate adaptation that could serve as a model for other island communities. This began in 2011 at least, and is ongoing. Examples of relevant projects include Economy-Wide Adaptation to Climate Change (EWACC); Integration of Climate Change Risks and Resilience into Forestry Management in Samoa Project (ICCRIFS); Strengthening Multi-sectoral Management of Critical Landscapes Project (SMSMCL); National Water Resources Management Plan (2021–2030); Community Integrated Management Plans (CIM); Samoa Climate Change Policy (2020–2030); and *Vai o le Ola* (2023). The most notable of these initiatives is perhaps the Global Climate Fund (GCF) Vaisigano Catchment Project (VCP) (2017–2023) [57].

1.2.2. The Global Climate Fund (GCF)- Vaisigano Catchment Project (VCP)

The VCP is a Government of Samoa (GoS) integrated flood management approach to reduce the impact of recurring floods in the Vaisigano River Catchment. It focused on watershed restoration and prioritized local community participation and increasing the resilience of households living within the VCP. Building upon longitudinal watershed-based initiatives, the project states:

'If customary and other landowners are supported and benefit financially through new sources of income to:

1. Protect and restore upland watershed areas through nature-based solutions, AND
2. Reduce gross greenhouse gas (GHG) emissions from the agriculture, forestry and other land uses (AFOLU) sector through SLM practices AND
3. Reduce vulnerability and build lowland resilience to flooding in priority watersheds...

then Samoa can accelerate the transformation towards climate resilient livelihoods and ecosystem services *management, and provide more efficient flood mitigation in priority watershed and provide additional benefits towards both semi-urban and rural communities.*' [57].

The intended aims of the VCP project are:

1. Put in place an integrated approach to reduce flood-related risk and vulnerability
2. 'Flood-proof' infrastructure along the Vaisigano River to increase resilience to the negative effects of excessive water
3. Upgrade drainage in downstream areas to increase regulation of water flow

Responsibility for coordination and implementation of the climate change adaptation activities in the VCP rests with the Ministry of Natural Resources and Environment (MNRE), but the project involves multiple ministries (Ministry of Finance, Ministry of Agriculture, Ministry of Women, Community and Social Development, Civil Society Support Programme, SUNGO) in its design, implementation, monitoring, and evaluation, and is funded through UNDP and the Green Climate Fund (GCF). Social protection of vulnerable populations and businesses in the Vaisigano Catchment Area underpins the purposes of the project activities. There are three sets of activities; Cash for Work, Ecosystem-based Adaptation Enterprise Developments (EBAED), and Payment for Ecosystem Services (PES) with a combined budget of US\$8 million from 2017 to 2023 [57,58]. The VCP demonstrates the practicability of an integrated catchment approach to address disaster-responsive social protection. Households (with a mix of genders, ages, and presence of disabled persons) and existing businesses (small and large) have been captured in the VCP which involves multiple government Ministries, community-based organizations (CSOs), and non-governmental organizations (NGOs) in its oversight, implementation and monitoring.

'Cash for work' programmes provide employment for thirty-five young people residing in the vicinity of the catchment who are contracted by MNRE and MoF to afforest the catchment. Their work is monitored by MNRE [58] (see Fig. 6). Five hundred and eighty two households, CSOs, NGOs, and existing businesses have received funding under the EBAED activity to develop various activities to enhance their resilience [57,58]. The project developers have documented the success stories of these activities [59] which this NUWAO project corroborated by interviewing some of the people involved. Alternative experiences of some households which have not been documented previously were also gathered as part of this study and are discussed in section 3. The PES activity is a replanting scheme piloted in Maagiagi and Malololelei and linked to upstream afforestation in the upper and mid-catchment areas to increase water retention and reduce flooding in the lower catchment [57,58].

1.3. The Nuwao Vaisigano Project

The VCP exemplifies the application of watershed-based solutions in a specific community context. This initiative represents a collaborative effort that aims to involve participatory design and ensure that local communities are active stakeholders in the adaptation process. The NUWAO Vaisigano Project complements and aligns with the efforts of the VCP, underscoring a commitment to sustainable and climate-resilient development in Samoa. However, what sets the NUWAO Vaisigano Project apart from the VCP is its foundational emphasis on participatory design, integrating and elevating the voices and knowledge of local communities. The aim with such an approach is to foster a sense of ownership among the Vaisigano population and ensure that proposed NbS are deeply rooted in the rich traditional ecological knowledge of the watershed. The NUWAO Vaisigano Project tests the potential of combining local Indigenous knowledge with contemporary approaches to create resilient NbS in the face of global environmental

challenges with local consequences. It is research-based, rather than an implementation project like the VCP.

2. Site and methods

2.1. Case-study catchment

For this study, the NUWAO Vaisigano Project, we focused on the Vaisigano Catchment Area (VCA) (Fig. 4). The VCA is located in the central north of Upolu Island and is characterized by a short, steep, funnel-shaped drainage morphology covering an area of approximately 33 km² [60]. It runs 12 km from sea level to an elevation of 1158 m along Upolu's volcanic spine [61]. There are three main tributaries that make up the Vaisigano River Catchment, and all three converge into a single channel at the Alaoa confluence 4.5 km from the coastline, exiting at the Vaisigano bridge in Apia (Fig. 5).

The VCA was selected for this research for two reasons. Firstly, the Vaisigano catchment is one of the largest catchments in Samoa with a total area of 3200 ha [62], providing water to 40,000 people and businesses in the Apia Urban Area (Apia is the capital city with a population of approximately 38,500 people). Secondly, the middle and lower parts of the VCA have proven to be the most vulnerable to flooding in the last 15 years as demonstrated in the major 2008, 2012, and 2020 floods [63, 64]. Intense land clearing for residential, church, and farming activities in the upper catchment area in the past 50 years has put pressure on village settlements situated on the lower slopes of the catchment area, hence the decision by the government in 2017 to invest in flood-proofing infrastructure as part of the country's programme on climate change-induced flood mitigation [57]. Additionally, we chose the VCP as an example of a national climate change adaptation project that could be nature-based because it incorporates elements of co-design and

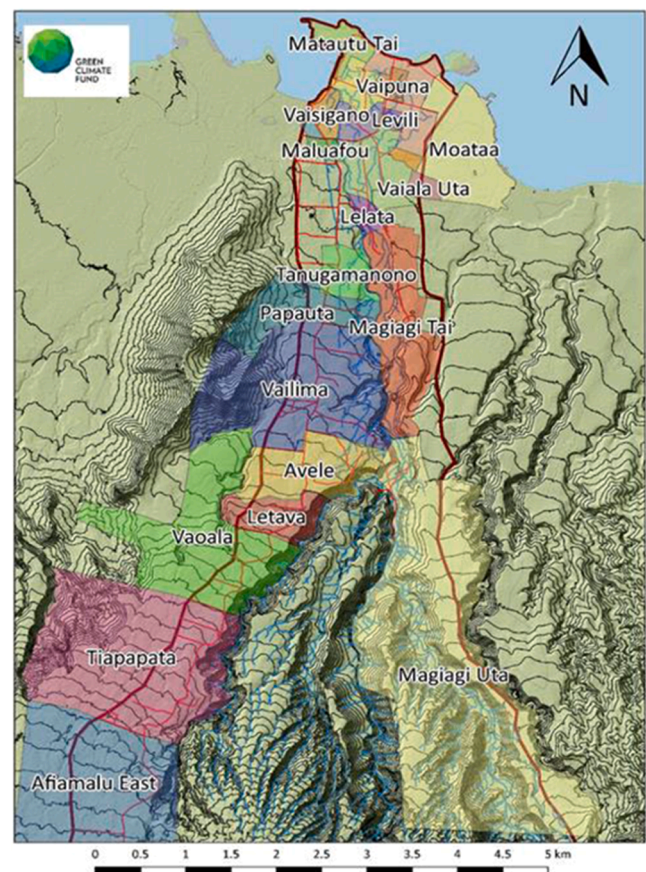


Fig. 4. Vaisigano Catchment Area. Image by GCF-VCP, 2024a.



Fig. 5. The Vaisigano Bridge. Image by Samoa Observer, 2020.

encourages ‘green, sustainable’ activities. This project was also deemed suitable because it covers much of the Apia Urban Area and the whole VCA (Fig. 4).

A whole-of-catchment, and more specifically, the ‘ridge-to-reef’ approach [65] was used to identify and select households residing approximately along a transect from the top to the bottom of the VCA. The ridge-to-reef approach enabled us to consider the holistic nature and connectivity of all of the ecologies from the mountains through to the urbanized areas, and to inshore marine life. This meant we could cover a larger area of the greater Apia Urban Area and include differing environmental characteristics and related experiences. It also ties the study to the ubiquitous presence and importance of the Ocean in Samoa, and to the Ocean Cities concept of greater *Moananui* Oceania [66]. Fig. 6 shows what different parts of the Vaisigano catchment look like.

2.2. Literature review, transect interviews, and fa’afaletui focus groups

The research began with a targeted scoping literature review to ascertain common themes present in the literature both for *Moananui* Oceania as a wider region, and for Samoa itself. The next step of the research was to select households located within the VCA from Afiamalu to Matautu and Moata’a to participate. Five households located in the upper catchment, five in the middle, and ten in the lower catchment made up the study group. A cross-section of households in terms of income, housing type, land tenure/ownership, existing urban infrastructure, buildings present, and adjacent roading network were selected. This brought about the opportunity to address the spatial distribution of households along the Vaisigano Catchment based on land tenure

/ownership as a secondary stream of the research, which is important because it is a determining factor in the type of house constructed by the twenty participating households. Experience suggests that if families reside on customary or leased land, then the type of house or structure built depends very closely on the lease conditions. For instance, small temporary shelters on leased lands and more solid permanent structures on customary or privately owned parcels of land are the norm. The twenty identified households were asked to take part in a household semi-structured interview. This study was qualitative because we wanted to gauge the perceptions of those involved in national climate change adaptation work as well as those living within the Vaisigano Catchment.

2.2.1. Semi-structured interviews

The first phase of data collection occurred between February and March 2023. People were asked about their perceptions, experiences, and engagement with the Green Climate Fund (GCF) Vaisigano Catchment Project (VCP) to understand the current context of co-designing Nbs to adapt to climate change in the Vaisigano catchment. Tauga’a and Latai-Niusulu interviewed the main actors in the VCP namely the Ministry of Natural Resources and Environment, the Ministry of Finance, CSSP, Green Climate Fund, and Small Business Enterprise Centre (SBEC). Face-to-face interviews and field observations occurred in four villages in the Vaisigano Catchment: Moata’a, Lelata, Maagiagi and Afiamalu with the identified twenty households (see pink dots, Fig. 7). Interviews were conducted in *Gagana Samoa* (the Samoan language), and followed a more discussional or conversational format in keeping with cultural norms, and methodologies such as *talanoa* [66–68].



Fig. 6. Left: A section of the Vaisigano Catchment at Malololelei where tree planting is occurring. Right: The upper section of the Vaisigano Catchment where tree planting is occurring. Images by Latai Niusulu, 2023.

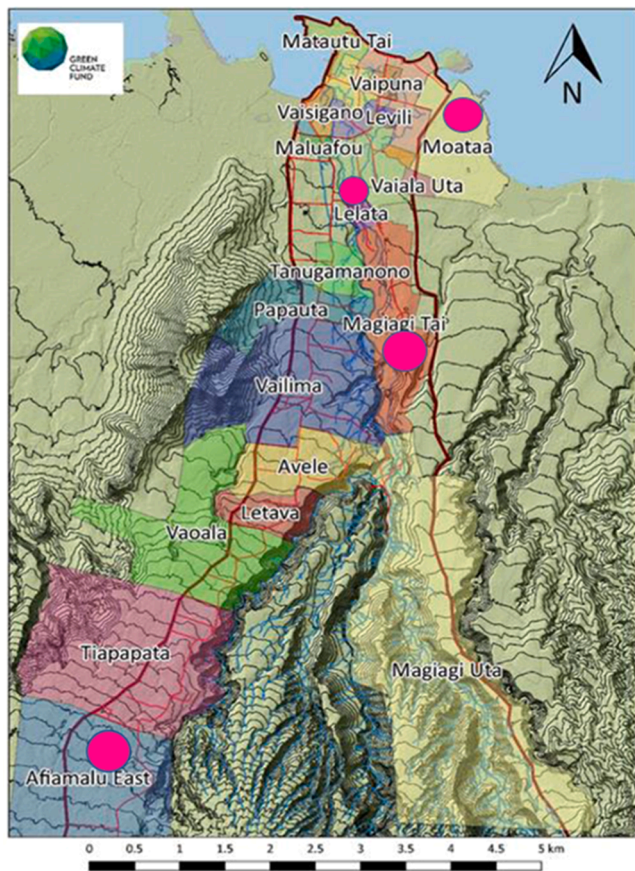


Fig. 7. Study sites that were selected and visited in the first part of the fieldwork. Image adapted by Latai Niusulu from [57].

These conversations explored how long the residents had lived in the area and how they are adapting to climate change impacts. Immediate and long-term needs, and what their aspirations are were discussed, and narratives regarding their wellbeing were explored. The latter phases of the interviews and site visits enabled us to ask the participants to talk about their involvement in the VCP and their perceptions of this project particularly in relation to climate change adaptation.

2.2.2. *Fa'afaletui* focus group

The final phase of data collection occurred in November 2023 when a *fa'afaletui* (focus group session) was held with thirty representatives from Tiapapata, Vaoala, Lelata, Maagiagi, Tanugamanono, Faatoia, Moata'a, Vaisigano and Apia which are villages located along the Vaisigano Catchment transect from ridge-to-reef. The majority of the *fa'afaletui* was in the Samoan language. Our aim with this *fa'afaletui* was to check that interview findings were correct, to ask about experiences of climate change, notions of wellbeing, and relationships to nature, and understand where people think problems areas are or could be, and where specific locations to make changes might be.

The *fa'afaletui* method is an established Samoan research framework that is culturally relevant and embraces Samoan values of respect, love and obedience essential to meaningful discussions on social matters. *Fa'afaletui* can be translated as 'ways of' [fa'a] 'weaving together' [tui] deliberations of different groups or 'houses' [fale]. It illustrates the *Moananui* Oceania philosophy of connectedness and a collective holistic approach and is used in mixed methods studies [69]. *Fa'afaletui* provides a system of relating between the focus group facilitators and researchers, and the participants [70]. The *fa'afaletui* explored the meanings of wellbeing from the perspectives of participants, climate-related problems, and opportunities and examples of Indigenous knowledge driven

adaptation activities that are already being done and could be implemented in the future. Talking and listening to each other during a *fa'afaletui* discussion encourages participants to think more deeply and reflect upon their views and knowledge [69]. This method also enabled the possibility for some of the research participants to validate, or expand upon the views they communicated earlier in the interviews. In this sense, *fa'afaletui* provided a process of *tui*, or the weaving together of the findings from the focus groups and interviews [70]. At the same time, our (Taua'a and Latai-Niusulu's) cultural awareness and lived experience meant we were aware that the *fa'afaletui* could lead to some participants feeling intimidated so that they might avoid speaking or saying what they thought. To counter this, the researchers employed methods such as reducing the group sizes and speaking to the quiet individuals on a one-on-one basis during the *fa'afaletui*.

Fa'afaletui are participatory in nature and tie in well to the aspect of the research that explored participatory design and research, already identified as being key in NbS design and implementation in *Moananui* Oceania [14]. The research was based on participatory design, and participatory action research methods. It was thought to be appropriate because participatory research is iterative and both qualitative and quantitative in a cycle of research, action and reflection, offering a framework for engaging with and co-designing with communities and making change both for and with those communities [71]. This is important in the context of increasingly top-down approaches to climate adaptation, and highlights the limited research available into the lived-experiences of communities, their concerns and priorities, and how they are coping with natural and climate change related hazards [72]. Participatory design empowers communities through collaboration and facilitates the expertise of communities to shape the design process. It leads to greater connection to and ownership of outcomes, creates collaborative connections, and is an inclusive way that designers can contribute to reducing inequality and shaping sustainable and appropriate outcomes for local communities [73]. Barcham [74] notes that "even with the best of intentions, our design tools, methodologies, and practices can nonetheless still be neocolonial in character and in practice." The positionality of the researchers, cultural awareness and sensitivity are important considerations in undertaking this research and prioritized the approach of *fa'afaletui* alongside participatory design and storytelling to provide a culturally safe space for Indigenous peoples to share their stories and experiences, and create a space and process where knowledge is co-created [74]. Additional specific details of the *fa'afaletui* process are included in Section 3.

2.2.3. Data analysis

A combination of descriptive and analytic coding [75] and thematic analysis [76] was used to organize and validate the collected information and produce the findings from both the interviews and *fa'afaletui*. Multiple readings of transcripts, producing summary tables of each interview and *fa'afaletui*, and reflecting on the non-verbal cues and tone used by research participants during the process of interviewing and *fa'afaletui* helped the researchers identify and validate significant codes and themes that helped to answer the research questions. These codes and themes were then organized and presented as the key findings of the study (Section 3.0).

3. Findings and results

Here, findings from the interviews conducted and the *fa'afaletui* are presented.

3.1. Findings from interviews

The distilled results from the transect household interviews revealed several key findings in relation to engagement with the VCP. These centered around 4 key issues:

1. Sharing local knowledge and resources
2. Nurturing social connections
3. Supporting low-carbon initiatives and
4. Challenges with the VCP

The first theme related to the sharing of local knowledge and resources. The VCP presented many households located within the Vaisigano Catchment the opportunity to apply for financial support to develop activities relevant to the aims of the project (i.e. building local resilience) that also supported livelihoods. As part of this process, the project developers and local communities and households were able to share knowledge and develop awareness of climate change and propose ways to cope with risks associated with these changes. Households were encouraged to think about activities that could help them adapt to climate related challenges they were experiencing such as flooding during times of heavy rainfall.

The second theme interviewees discussed related to opportunities to nurture social connections and the importance of the church. Many families interviewed were aware of the VCP and actively engaged in the funding application phase and related community meetings. Some mentioned that their local church groups also applied for funding for initiatives. One participant living at Vaillima stated:

“My son also said that our pastor had told their youth to put together a funding application to this project. We attended a couple of meetings where we met with the representatives from the government who came around and explained the project and how it could help us... This was a great opportunity for us, people, that are looking for ways to develop our families. These are blessings from God.”

Most of those interviewed, who applied for funding received help from another villager, a friend, or relative to fill out the application form. The process was challenging but participants reported that coming together and forging connections and teams to get through it was beneficial. As one man explained:

“It started out very scary this process, but then looking back, it became an opportunity for us to see our neighbors and get to know the other people of our village. As the word went out that this friend of ours is helping us, we had people coming to our house and lining up for a turn to see her. Soon, our girls were making coffee and sandwiches for everyone. Then the others turned up with snacks. We would work right throughout the night. Once I learnt how to answer the other questions, I helped out the others who turned up. Eventually we had to shift to our local church hall and set up a table there to help so many people who wanted to submit applications.”

Many interviews discussed the activities they applied for funding for in a third theme categorized here as supporting low carbon initiatives. Many of those surveyed successfully received funding (often \$20,000 - \$50,000 Samoan Tala) to support livelihood activities they were already engaging in while some received funding to develop income earning activities and small businesses (such as home gardening, piggeries, chicken farms, and plantations, through to sewing shops, flower shops, and bicycle rentals). The project gave the opportunity to residents to think about sustainable ways to adapt to the heat and heavier bouts of rainfall they are experiencing. A woman from the village of Moata'a explained she had been providing sewing services to the community by sewing basic clothing patterns for the past three years and was eager to build her capacity to earn income for her family. She stated,

“We reside at Moata'a along the boundaries of the mangrove area and the sea so we face flooding during the seasons of heavy rainfall as well as sea level rise as a result of climate change. There are 14 people in my household with only 3 people that are employed. Our household has insufficient income to support the livelihood needs of our family such as costs of water and electricity as well as food, housing repairs, school fees of my children, and obligations to the village and church. The project will provide income to pay costs that the household cannot meet at the moment. More importantly, it will provide money to pay for house repairs and landscaping of surroundings to reduce risks from flooding and other hazards.”

Some businesses are flourishing such as sewing businesses, gardens

and plantations, piggeries and the PJ Flower Shop at Moata'a.

The final key theme interviewees discussed related to perceived challenges of the VCP. The information from people involved in running the VCP revealed that the first two activities are progressing as planned except for the PES activity due to a shift in commitment from overseas based implementers. According to the project team, a more concerted effort is needed to ensure PES meets its obligations. This was reiterated by the household interviews. Other challenges relate to the lack of motivation for beneficiaries in the cash for work programme to work without full supervision by the officer in charge of the programme. Other project team members consulted stated that the procurement processes of the government are painstakingly slow and difficult for local people. Many have felt discouraged from following through with reporting and acquittals of funding received or yet to be received.

Perceptions of challenges of the VCP from the participating households often related to the funding application phase being extremely challenging. The application form included the submission of plans which require specialized knowledge. For instance, a SWOT analysis, a Disaster Risk Management Plan and a Market Analysis Plan. The questions required the applicants to explain how their activities link to the goals of the VCP and the Samoan Development Strategy. Most applicants that were successful and received funding requested assistance from government officers and teachers within their villages. One participant said,

“They [referring to the project personnel] came and offered this money that we could access but when I saw the form, it was like a slap in the face. I couldn't believe some of those questions.”

Another person stated,

“Most people who need this money did not even finish school so the money could end up in the hands of those who do not really need it. Those who can read and answer the application questions are those who are educated and have jobs. We're lucky we received help from a member of our village who works in the government and her relative.”

Changing family circumstances and limited capacity of current family members to manage the initiatives was also noted as challenging. Issues ranged from the death of the applicants, sibling rivalry on customary lands, and family members moving elsewhere in Samoa or abroad. A visit to a greenhouse project funded by the VCP at Moata'a showed that the greenhouse is run down for example. The man who applied and received the funding passed away and his younger brother took over. He make some money from bok choi (*kapisi saiga*) and cucumber sold to the local shop but when the funding ended he couldn't buy additional seedlings. This raises questions about the sustainability of some of these small operations. In the case of the greenhouse project, there was no training before the project was approved or during the implementation stage and there was no follow up. They only received the first tranche of funds, and when that finished that was the end of the VCP activity.

A final challenge concerns conflicting priorities and lack of support from private landowners. Many private landowners living in the upper part of the VCA continue to prioritize cattle farms over government initiatives to protect, conserve and reforest the watershed. Many cattle are seen roaming the government protected areas at Afiamalu.

3.2. Findings from the fa'afaletui focus group

In the *fa'afaletui* three key questions were asked around the themes of wellbeing, action, and relationships to nature. Following this, a participatory mapping exercise was conducted.

Question one - Wellbeing: Ola lelei poo le ola maloloina? What makes a good life?

The first question sought to establish what underpins wellbeing for Vaisigano Catchment residents. The purpose of asking this was to make sure that adaptation work is centered on preserving and improving wellbeing first, with technical considerations second. This establishes a clear motivation for adaptation work. Responses from participants

included:

- Being part of a healthy, happy family
- Safety and security for the family, a safe environment
- A healthy lifestyle and good health
- Having a good home
- Access to good education for children
- Being able to grow a vegetable garden
- Avoid arguments within the family
- Being provided for
- Partnership between families, the village council, and the government to provide wellbeing.

Question two - Actions: Faapefea ona tapena le olaga lelei mo lou aiga mo faalavelave faa-natura?

How can you develop a good life for your family to respond to natural disasters and/or climate change related hazards?

The second question sought to understand how people try to preserve or create wellbeing for themselves. The purpose of asking this was to understand existing cultural norms to build wellbeing and resilience. This establishes the ways people do, or think they should approach change or difficulty, which is useful to build upon when proposing adaptation interventions. Responses from participants included:

- Understand what is truly important to families and communities
- Family members working together to find solutions and draw on their existing strengths and resources
- Don't wait to be told what to do, but use existing knowledge and resilience to find answers
- Have a good mindset so you can reflect on past experiences to improve the present situation
- Develop partnerships between villages and the government
- Devise a plan A and a plan B
- Prepare an emergency bag
- Carefully choose suitable locations to build homes
- Have a solid foundation when building a house
- Plant trees near riverbanks to stop soil erosion
- Grow crops and vegetables for the family use and to sell to make money
- Grow other natural resources to use for rebuilding

Question three - Relationship to Nature: Pe faapefea ona malama-lama ma mafaufau tagata Samoa i le siosiomaga? How do you understand and think about nature?

The third question sought to understand how people relate to nature. The purpose of asking this was to understand cultural relationships to nature so that proposed adaptation interventions that work with nature could be more effective both technically and culturally. Some of the key terms used in the discussion were *siosiomaga* (nature), *foafoaga* (Creation), *vaai* (looking at nature), *iloa* (understanding), and *sootaga ma le siosiomaga* (relationship with nature). Responses from participants included:

- Nature is God's creation. Humans are the pinnacle of God's creation, so their role is to look after the land and everything God created
- We are stewards of God's creation. We must live in harmony with nature
- Climate change is getting worse because of humankind neglecting their responsibility to look after the land
- People look after nature; people are part of nature
- Nature looks after us people and we are to look after nature as well.
- Nature is an ongoing cycle of life
- Rivers and the ocean are alive
- Changing a river is as meaningful as changing your ancestors

Activity: Participatory mapping

The activity that followed the discussion centered around the three questions of the *fa'afaletui* and sought to engage communities in spatializing where specifically known problems are, particularly concerning flooding, where sites of significance are, and to identify other issues/ places that impact on their ability to have a good life. Participants were invited to break into groups related to where they lived in the catchment (high, middle, or lower parts). People worked around a series of large maps of the VCA and after locating their homes on the map, added stickers, marks, and notes directly onto maps to identify places (Fig. 8). The purpose of the exercise was to understand *where* the issues were in terms of origin and then impact. This is useful when planning nature-based adaptation interventions because in highly interconnected small island ecosystems, the ridge-to-reef context means that where impacts are felt is often not where the issue stems from. An obvious example is that during floods in the Vaisigano catchment, a large amount of soil and tree trunks and branches are washed down the rivers and end up damaging bridges and the ocean. The place to intervene is not at the bridges or ocean, but high in the ridges where the soil and trees come from.

Following locating sites of significance, groups were introduced to the NUWAO NbS cards. These are a set of forty small cards with an image of a typical NbS on one side, and a brief written explanation on the other. These forty NbS were selected to potentially suit typical urban conditions on Pacific Islands across a range of ecosystem types from ridge right through to reef (Fig. 9). Participants were asked to select NbS they thought might be useful, and to then roughly locate where these might work on their maps. This encouraged people to begin to discuss practical and tangible ways to intervene in systems for positive adaptation and to switch from talking about problems and risks to ways to change the system. The cards also encouraged people to ask questions about different kinds of NbS. Some were familiar to people (like riparian planting), and some were unknown by this group in the Samoan context (such as rainwater gardens). The spatial locating of potential ideas on the maps focused discussion and drew out people's knowledge of specific places. Fig. 10 shows a finished map with the stickers, notes, and overlaid NbS cards.

Some key points participants made while engaging in the participatory mapping were:

- Traditional knowledge is important. People should recognize the inherent wisdom within it to devise solutions to climate change and natural disasters. The expertise of Indigenous people should be recognized.
- The active incorporation of research is important to find answers. This must include talking to the people affected by the impacts of climate change and the people affected by adaptation interventions. People want to be part of discussions to design and implement adaptation interventions and want to be asked about their experiences.
- Soil, including soil nutrients is eroding fast. Soil erosion is a key issue during disasters and climate related hazards. This affects the reefs and shore.

Overall, three key overarching themes emerged from the *fa'afaletui* and centered on the importance of:

- A village-centric approach to adaptation and natural disasters and/or climate change related hazards.
- Embracing nature-based and traditional kinds of disaster planning and regeneration.
- Grounding NbS in local world views and Indigenous Samoan knowledge.

The *fa'afaletui* underscored the imperative that NbS to climate change hazards and natural disasters should originate within the village context, emphasizing a partnership model that engages families, village

councils, and government entities. Participants highlighted the necessity for family members to collaboratively identify and leverage their strengths and resources, advocating for proactive engagement rather than a passive response to guidance from external authorities (who may not be Samoan). The discussions reinforced that continuous collaboration with government agencies is essential to access support and innovative solutions tailored to the villages' unique needs and contexts.

The participants expressed a preference for nature-based natural disaster and/or climate change hazard relief and regeneration methods over artificial, built solutions. The dialogue highlighted concerns about rapid soil erosion during disasters, including the depletion of soil nutrients, emphasizing the need for solutions that align with ecological balance. Participants proposed practical actions like cultivating vegetable gardens and planting trees along riverbanks to prevent soil erosion. This approach addresses immediate environmental concerns and contributes to long-term community resilience by providing sustenance and potential income through the sale of crops.

Finally, a theme that emerged and underscored all discussions across the interviews and *fa'afaletui* was the need to anchor NbS in Indigenous Samoan knowledge. Participants advocated for recognizing and applying local insights and practices in crafting responses to natural disasters and climate change impacts, emphasizing the value of Indigenous expertise. There was a strong sentiment that integrating research and NbS design with Indigenous knowledge could yield culturally innovative strategies that enhance the community's resilience and sustainability.

4. Discussion

In this section, we break our discussion into two parts. Firstly we discuss the usefulness of the methodologies employed for adding to knowledge about working with nature and climate adaptation in Samoa specifically, and *Moananui* Oceania generally. Secondly, we summarize general findings from the literature review, interviews, and *fa'afaletui* into a set of emerging concepts for both *Moananui* Oceania and more specifically for Samoan future NbS climate adaptation initiatives.

4.1. Eco-cultural driven, participatory methodologies

Using a ridge-to-reef transect approach to locate households for research participation was useful in tying social research methodologies (such as interviews) to the ecological realities and complexities of the Upolu context. Rather than group people by socio-economic status, or age, or other social factors, the ridge-to-reef transect and whole-of-catchment approach helped to order the research ecologically, and have participants understand their different needs and roles as inhabitants of different parts of the catchment. The group formation in the *fa'afaletui* reinforced this. To a certain extent, this enabled the realities of the catchment itself to be at the fore of the research. This is practically useful in climate adaptation research in Samoa, and in broader *Moananui* Oceania, where highly interconnected dynamic island ecologies are the reality.

The culturally driven *talanoa* (across the research) and the specific *fa'afaletui* focus group processes were key to grounding the research in culturally relevant processes that likely helped participants to feel more comfortable and able to discuss their thoughts more openly. We noted that people began to talk about their specific places with great animation when they interacted with the maps, despite some issues initially with understanding them. When the NUWAO NbS cards were introduced, a new set of discussions and considerations came to the fore, illustrating that making discussions about adaptation tangible, action-based, and place-specific is useful for engagement with communities and draws out specific and practical Indigenous knowledges about particular places.

4.2. Moving NbS forward in Samoa, and Moananui Oceania

Findings of the interviews and the *fa'afaletui* reinforced the researchers' previous experiences with Indigenous knowledge, NbS, and working in *Moananui* Oceania [7,8,12,14,77]. Findings also tied into results and recommendations found in the literature about Samoa, Moananui Oceania, and further afield. The results from this particular research do then contribute to the body of existing knowledge about working with nature and climate adaptation work in Moananui Oceania. Here we identify three key concepts emerging from our research that are relevant to Samoa and wider *Moananui* Oceania.

The first concept deduced, is that the Islands of *Moananui* Oceania can serve as 'model systems' [15,78-83] for understanding and implementing large scale, multi-ecology, whole system, NbS in climate change adaptation. The unique ecological and cultural contexts of the islands, and how people have integrated and expressed worldviews that are not based on resource extraction, but on considering the wellbeing of future generations and the ecosystems that support this, offer valuable lessons for global environmental stewardship and regenerative development strategies [9]. Many of these whole-of-catchment or whole-of-island systems have been removed or altered due to colonization and other factors. The recovery of knowledge of and re-instigation of such systems is important to support, particularly given the current converging crises of climate change and biodiversity loss. While further work is needed, watershed management is already innovative in Samoa and has gained traction in recent years. This is exemplified by the scaling-up of NbS for watershed management, especially through the 'ridge-to-reef' approach [38]. Initiatives include the Pacific Ridge to Reef Project in the Fagali'i Watershed Area, Apia, Samoa and the VCP as discussed in Section 1.2.2. These strategies integrate land, water, and coastal management, focusing on community-based climate adaptation, mitigation and flood resilience [38]. Nature-based watershed management in Samoa, in some instances, exemplifies how traditional practices can be adapted to contemporary environmental challenges, though integrating more specifically Samoan cultural or worldview practices into these contemporary projects is needed. This demonstrates the importance of local people driving projects, and/or participating in decision-making and design. By integrating Indigenous knowledge, community engagement, and nature-based practices, a blueprint for sustainable and resilient environmental management regionally and internationally may be apparent.

The second concept is that participatory design is a vital tool for fostering community engagement and ownership in environmental projects, and therefore increasing effectiveness [14]. This approach ensures that solutions are ecologically sound and socially inclusive, drawing on local populations' collective knowledge and experience. Within the VCP there was evidence and documentation of efforts to develop 'co-design' and enable community participation in the development of climate change adaptation initiatives which are nature-based. However, one of the key things understood from the *fa'afaletui* was that in the particular cross section of the community we worked with, they had not been asked how floods had affected them, or what they think should be done. Being able to speak about how difficult the floods had been seemed to be cathartic for many, as was expressing a sense of disappointment that no one had asked them before the *fa'afaletui*. This shows that while there were key successes in the VCP, there are places to make changes in future implementation-based projects.

The final, and perhaps most important concept is that relational worldview Indigenous knowledge has much to offer to NbS planning in the region and is vital in new climate adaptation projects. Indigenous nature-based systems are not new in *Moananui* Oceania. Indigenous communities in Oceania have long harnessed and integrated with nature-based systems as integral social-environmental systems [9,10,14,84,85]. Several innovative systems (see Section 1.2) along with specific technologies [84,86] prevalent now or in the past in the region, are deeply rooted in Indigenous knowledge. They emphasize the consistent

regeneration of ecosystems that people are deeply reliant upon, alongside a respect-driven relational approach to the act of living. This means relationships between people, both living and ancestral, and between people and the living world are fundamental to many *Moananui* Oceania worldviews and therefore cultural practices, ensuring sustainability and resilience [87]. Researchers highlight these systems and technologies' critical role in maintaining ecological balance *and* cultural heritage concurrently [9,15].

5. Conclusions

Samoa, and wider *Moananui* Oceania must urgently implement strategies to adapt to the impacts of climate change. The region is becoming a leader in global NbS strategies, particularly fit for small island nations (or large ocean states) that are based on traditional and contemporary approaches.

The study revealed synergies between notions and strategies for development and climate change adaptation. The development activities that the households identified for funding under the VCP project were for both sustaining their livelihoods and climate change adaptation for example. Here, sustainable livelihoods and climate change adaptation are considered inseparable.

We recommend that these three key concepts for effective NbS and climate adaptation in *Moananui* Oceania be taken into account with new NbS adaptation projects in both Samoa and the wider region:

1. *Moananui* Oceania islands can act as model systems for climate change adaptation globally related both to traditional Indigenous ways of living well within land and ocean scapes, and related to contemporary watershed management innovations
2. Participatory research and design are vital for fostering community engagement and empowerment in adaptation projects, and therefore in increasing their effectiveness
3. Understanding and incorporating Indigenous knowledge and languages and enabling these to drive NbS design and implementation processes as well as guide the form of outcomes is key in ensuring new climate adaptation projects in *Moananui Oceania* are effective

Designing systems that intervene in and work with nature for climate change adaptation must make the lives of the local peoples better and be driven by local notions of wellbeing. Cultural worldview and local knowledge then, must be an active part of NbS design and drive decisions alongside technical considerations. Local people understand their places in profound ways and know what they and their places need.

CRedit authorship contribution statement

Anita Latai-Niusulu: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. **Susana Taua'a:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Tuputau Lelaulu:** Writing – review & editing, Writing – original draft, Visualization, Investigation, Formal analysis, Data curation. **Maibritt Pedersen Zari:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Sibyl Bloomfield:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Maibritt Pedersen Zari reports financial support was provided by Royal Society of New Zealand. If there are other authors, they declare that they have no known competing financial interests or personal relationships

that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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References

- [1] A. Latai-Niusulu, E. Nel, T. Binns, Positionality and protocol in field research: undertaking community-based investigations in Samoa, *Asia Pac. Viewp* 61 (1) (2020) 71–84.
- [2] P.L. Tuhiwai Smith, *Decolonizing methodologies: Research and Indigenous Peoples*, Otago University Press, Dunedin, 2012.
- [3] D. Sanderson, L. Bruce, P. Sitko, Climate and disaster risks, challenges and opportunities for resilient Pacific towns and cities, *Urbanisation at Risk in the Pacific and Asia: Disasters, Climate Change and Resilience in the Built Environment* (2020) 22–33.
- [4] C.K. Weatherill, Sinking Paradise? Climate change vulnerability and Pacific Island extinction narratives, *Geoforum* 145 (2023) 103566.
- [5] A. Latai-Niusulu, T. Binns, E. Nel, Climate change and community resilience in Samoa, *Singap. J. Trop. Geogr.* 41 (1) (2020) 40–60.
- [6] L. Kumar, *Climate Change and Impacts in the Pacific*, Springer Climate, Springer, Cham, 2020.
- [7] G.L. Kiddle, T. Bakineti, A. Latai-Niusulu, W. Missack, M. Pedersen Zari, R. Kiddle, D. Loubser, Nature-based solutions for urban climate change adaptation and wellbeing: evidence and opportunities from Kiribati, Samoa, and Vanuatu, *Frontiers in Env. Sci.* 9 (2021) 723166.
- [8] G.L. Kiddle, M. Pedersen Zari, P. Blaschke, V. Chanse, R. Kiddle, An Oceania urban design agenda linking ecosystem services, nature-based solutions, traditional ecological knowledge and wellbeing, *Sustainability* 13 (22) (2021) 12660.
- [9] K. Beamer, T.M. Tau, P.M. Vitousek, *Islands and Cultures: How Pacific Islands Provide Paths Toward Sustainability*, New Haven: Yale University Press, 2022.
- [10] Vitousek, P.M. & Winter, K.B. (2022). Polynesian Islands as Model Social-Environmental Systems. In: *Islands and Cultures: How Pacific Islands Provide Paths Toward Sustainability*. Eds Beamer, K., Tau, T.M., & Vitousek, P.M. New Haven: Yale University Press.
- [11] P. Mang, B. Reed, Designing from place: a regenerative framework and methodology, *Build. Res. Inf.* 40 (1) (2012) 23–38.
- [12] M. Pedersen Zari, P.M. Blaschke, B. Jackson, A. Komugabe-Dixon, C. Livesey, D. I. Loubser, K.M. Archie, Devising urban ecosystem-based adaptation (EBA) projects with developing nations: a case study of Port Vila, Vanuatu, *Ocean Coast. Manag.* 184 (2020) 105037.
- [13] United Nations (UN), (2016). *State of the world's indigenous peoples: indigenous peoples' access to health services*. February.
- [14] S. Mihaere, M. Holman-Wharehoka, J. Mataroa, G.L. Kiddle, M. Pedersen Zari, P. Blaschke, S. Bloomfield, Centring localised indigenous concepts of wellbeing in urban nature-based solutions for climate change adaptation: case-studies from Aotearoa New Zealand and the Cook Islands, *Frontiers in Env. Sci.* 12 (2024) 1278235.
- [15] P.V. Kirch, Three islands and an archipelago: reciprocal interactions between humans and island ecosystems in Polynesia, *Earth & Env. Sci. Transact. Royal Society of Edinburgh* 98 (1) (2007) 85–99.
- [16] Koka'ua, L. (2023). *Te Mekameka o te Pā Maunga*. August 23. Available online: <https://www.youtube.com/playlist?list=PLkMKU0JvwTBB4oRFXF83DuPvvRnGuglWY>. Date accessed 13/03/24.
- [17] V. Wheeler, A. Duong-Pedica, An Island Conversation with vehia wheeler and anaia duong-pedica: unsettling knowledge production about/in the french-colonized pacific, *J. Island Studies* 4 (2023) 198–219.
- [18] Lincoln, N.K., Vaughan, M.B., & Kurashima, N. (2022). Hawai'i. In *Islands and Cultures: How Pacific Islands Provide Paths toward Sustainability* Eds Beamer, K., Tau, T.M., & Vitousek, P.M. (p. 224). New Haven: Yale University Press. Yale University Press.
- [19] J. Kake, *Rebuilding the Kāinga: Lessons from Te Ao Hurihuri*, Bridget Williams Books, Auckland, 2019.
- [20] J.S. Williams, *From the Mountains to the Sea: Early Hawaiian Life*, Kamehameha Schools Press, 1997.

- [21] Millison, A. (2023, January 14). *Ahupua'a: native Hawaiians Taking Back Their Watersheds*. Available online: <https://www.youtube.com/watch?v=q7q8friw1p8&t=666s>. Date accessed 13/03/24.
- [22] L. Minerbi, Indigenous management models and the protection of the Ahupua'a, *Social Process in Hawaii* (1999), 208–205.
- [23] D. Blane, C. Chung, The Ahupuaa as a Traditional Hawaiian Resource Management Model for a Sustainable Coastal Environment, in: *Proc. Coastal Society 17th International Conference, Coasts at the Millennium*, Portland, Oregon, 2000.
- [24] V. Wheeler, Climate Change, Watershed Management, and Resiliency to Flooding: A Case Study of Papeno'o Valley, Tahiti Nui (French Polynesia), University of Hawai'i, 2018.
- [25] B. Finney, Resource distribution and social structure in tahiti, *Ethnology* 5 (1) (1966) 7.
- [26] M. Kahn, Tahiti intertwined: ancestral land, tourist postcard, and nuclear test site, *Am Anthropol* 102 (1) (2000).
- [27] R.G. Crocombe, Land Tenure in the Cook Islands, Australian National University, 1961.
- [28] P.S. Bellwood, Varieties of ecological adaptation in the southern cook Islands, *Archaeol. Phys. Anthropol. Oceania* 6 (2) (1971) 145–169.
- [29] J. Lee-Morgan, R. Hoskins, R. Te Nana, M. Rua, W. Knox, Ahakoa Te aha, Mahingia Te mahi: in Service to Homeless Whānau in Tāmaki Makaurau: a Report of the Manaaki Tāngata Programme At Te Puea Memorial Marae, Auckland: Te Puea Memorial Marae; Ngā Wai a Te Tūi Māori and Indigenous Research, Unitec Institute of Technology, 2019.
- [30] L. Pihama, Papakāinga: māori wellbeing in the context of collective living. Kāinga Tahī, Kāinga Rua: Māori Housing Realities and Aspirations, Auckland: Bridget Williams Books, 2022.
- [31] S. Awatere, S. Rolleston, Ngā hua papakāinga: habitation design principles, *Mai Review* 2 (2) (2009) 1–13.
- [32] Samoa. Government of, World Summit On Sustainable Development Assessment Report, Government of Samoa, Apia, 2002.
- [33] Ministry of Natural Resources and Environment (MNRE): Government of Samoa, Samoa's State of the Environment Report 2013, Apia: MNRE, 2013.
- [34] Samoa Bureau of Statistics, Samoa Population and Housing Census, Apia: Samoa Bureau of Statistics, 2022.
- [35] Government of Samoa, Samoa Post-Disaster Needs Assessment Cyclone Evan 2012, Government of Samoa, Apia, 2013.
- [36] S.H.M. Fakhruddin, M.S. Babel, A. Kawasaki, Assessing the vulnerability of infrastructure to climate change on the Islands of Samoa, *Natural Hazards and Earth Syst. Sci.* 15 (6) (2015) 1343–1356.
- [37] S. Taua'a, Climate change opportunities for small Island developing states (SIDS)–The samoan experience, *J. Samoan Studies* 8 (2018) 6–12.
- [38] MNRE: Government of Samoa, Annual Report 2020–2021: Working towards a Sustainable Environment for a Resilient Samoa, Apia: MNRE, 2021.
- [39] A. Latai-Niusulu, Transformation to Fa'amatai [Samoan Chiefly System]: implications for climate change resilience in Samoa, *The Journal of Samoan Studies* 8 (2018) 14–33.
- [40] A. Latai-Niusulu, *Exploring Resilience to Climate Change and Other Environmental Challenges in Samoan communities* (Doctoral Dissertation, University of Otago, 2017).
- [41] S. Heathcote, Legal models and methods of western colonisation of the south pacific, *J. History of Int. Law/Revue d'histoire du Droit Int.* 24 (1) (2022) 62–101.
- [42] U.L.F. Vaa, The faa-Samoa, in: A. Soo, U. Vaa, T. Lafotanoa, J. Boon (Eds.), *Samoa Human Development Report 2006: Sustainable Livelihoods in a Changing Samoa*, The Centre for Samoan Studies, National University of Samoa, Apia, 2006, pp. 113–136.
- [43] U.L. Vaai, We Are Therefore We live!: Pacific Eco-Relational Spirituality and Changing the Climate Change Story, Tokyo, Japan: Toda Peace Institute. Policy Brief No. 56, 2019.
- [44] B. Alofaituli, Religion and development in Samoa: time to draw on the strength of local culture? *Developm. Policy Rev.* 41 (2023) e12746.
- [45] L. White, The historical roots of our ecologic crisis, *Science* 155 (3767) (1967) 1203–1207, <https://doi.org/10.1126/science.155.3767.1203>.
- [46] N.H. Creegan, A. Shepherd, Creation and hope: Reflections On Ecological Anticipation and Action from Aotearoa New Zealand, Eugene, Oregon, United States: Wipf and Stock Publishers, 2018.
- [47] S. Purdie, Awhi Mai Awhi atu: Women in Creation Care, Philip Garside Publishing Ltd, Wellington, 2022.
- [48] J.M. Luetz, P.D. Nunn, *Managing Climate Change Adaptation in the Pacific Region*, Springer Link, 2020, pp. 293–311.
- [49] A. Refiti, The circulation of mana in centralized spaces, striated territories and shimmering houses in Polynesia, in: annual meeting for the Association for Social Anthropology in Oceania, Kona, Hawaii, 2014.
- [50] A. Krämer, The Samoa Islands: An outline of a Monograph With Particular Consideration of German Samoa, Polynesian Press, 1994.
- [51] G. Pratt, Fua'iala. A Grammar and Dictionary of the Samoan language, With English and Samoan vocabulary, 1st ed., Religious Tract Society for the London Missionary Society, 1893.
- [52] J. Jennings, R. Holmer, G. Jackmond, Samoan village patterns: four examples, *J. Polynesian Society* 91 (1) (1982) 81–102.
- [53] H. Martinsson-Wallin, P. Wallin, G. Clark, The excavation of pulemelei site 2002–2004, *Archaeology in Oceania* 42 (2007) 41–59.
- [54] G. Jackmond, D. Fonoti, Matiu.M. Tautunu, Did Sāmoa have intensive agriculture in the past? New findings from LiDAR, *J. Polynesian Society* 128 (2) (2019) 225–243.
- [55] T.A.T.T. Taisi Tupuola Tufuga Efi (Ed.), *In Search of Tagaloa: Pulemelei, Samoan Mythology and Science, Archaeology in Oceania*, 2007, p. 42.
- [56] United Nations, Vai o Le Ola: Samoa's response Plan to the Triple Planetary Crisis of Climate change, Biodiversity and Nature loss, and Pollution and Waste, United Nations (Cook Islands, Niue, Samoa and Tokelau), 2023.
- [57] Green Climate Fund (GCF) Vaisigano Catchment Project (VCP). (2024). Vaisigano Catchment Project Website, <https://www.vcp.gov.ws/about-the-project/#project-output-2>.
- [58] United Nations Development Programme (UNDP), Funding proposal: Integrated Flood Management to Enhance Climate Resilience of the Vaisigano River Catchment in Samoa, Green Climate Fund, 2016.
- [59] Green Climate Fund (GCF) Vaisigano Catchment Project (VCP), Success Stories of the Ecosystem based Adaptation Enterprise Development Program, GCF-VCP, 2024.
- [60] S. Williams, J. Griffiths, B. Miville, E. Romeo, M. Leiofi, M. O'Driscoll, G. Elley, An impacts-based flood decision support system for a tropical Pacific Islands catchment with short warnings Lead time, *Water (Basel)* 13 (23) (2021) 3371.
- [61] P.M. Baisyet, Vaisigano River Watershed Management Plan, Food and Agricultural Organization (FAO), Rome, Italy, 1990.
- [62] United Nations Environment Programme (UNEP). (2014). *Cities and Climate Change Initiative: abridged Report*, Apia, Samoa. Climate Change Vulnerability Assessment. United Nations Human Settlements Programme (UN-Habitat). Available from <https://www.mwti.gov.ws/wp-content/uploads/2022/09/Climate-Change-Vulnerability-Assessment-for-Apia-2014.pdf>. Date accessed 13/06/24.
- [63] J.P. Terry, R.A. Kostaschuk, Extreme river behavior in the Pacific Islands—case studies from Samoa and Fiji, in: *Proceedings of the Asia Pacific Association of Hydrology and Water Resources, 2nd Annual Conference*, 2004, pp. 5–8.
- [64] F. Scheele, T. Simi, J. Tarry Nimau, S. Williams, R. Paulik, S. Lin, P.Holland J. Ungaro, R. Woods, Applying New Zealand's risk tools internationally: case studies from Samoa and Vanuatu, in: *MATEC Web of Conferences* 331, EDP Sciences, 2020, p. 01003.
- [65] E. Wilmot, J. Wong, Y. Tsang, A.J. Lynch, D. Infante, K. Oleson, H. Clilverd, Characterizing mauka-to-makai connections for aquatic ecosystem conservation on Maui, Hawai'i, *Ecol Inform* 70 (2022) 101704.
- [66] M. Pedersen Zari, G.L. Kiddle, P. Blaschke, S. Gawler, D. Loubser, Utilising nature-based solutions to increase resilience in Pacific Ocean Cities, *Ecosystem Services* 38 (2019) 100968.
- [67] L. Tunufa'i, Pacific research: rethinking the Talanoa 'methodology', *New Zealand Sociology* 31 (7) (2016) 227–239.
- [68] D. Robinson, K. Robinson, *Pacific ways" of talk: Hui and Talanoa* (No. 36), NZ Trade Consortium Working Paper, 2005.
- [69] F. Goodyear-Smith, M. Ofanoa, Fa'afaletui: a Pacific research framework, *J Mix Methods Res* 16 (1) (2022) 34–46.
- [70] K. Tamasese, C. Peteru, C. Waldegrave, A. Bush, Ole Taeao Afua, the new morning: a qualitative investigation into Samoan perspectives on mental health and culturally appropriate services, *Australian & New Zealand J. Psychiatry* 39 (4) (2005) 300–309.
- [71] *Organizing Engagement*. (2024). *Models - Participatory Action Research and Evaluation*. Retrieved from *Organizing Engagement*: <https://organizingengagementnt.org/models/participatory-action-research-and-evaluation/>. Date accessed: 13/03/24.
- [72] J.P. Cauchi, S. Moncada, H. Bambrick, I. Correa-Velez, Coping With Environmental Hazards and Shocks in Kiribati: Experiences of Climate Change By Atoll Communities in the Equatorial Pacific, 37, *Environmental Development*, 2021, <https://doi.org/10.1016/j.envdev.2020.100549>.
- [73] R. Evans, A. Leah, E.K. Petrović, et al., Spaces of Empowerment: shaping Inclusive Public Places through Decolonising Participatory Design in Aotearoa New Zealand. Imaginable Futures: design Thinking, and the Scientific Method, in: Ali Ghaffarianhoseini, et al. (Eds.), 54th International Conference of the Architectural Science Association 2020, eds, Architectural Science Association (ANZAScA), 2020, pp. 996–1005.
- [74] M. Barcham, Towards a radically inclusive design–indigenous story-telling as codesign methodology, *CoDesign* 19 (1) (2023) 1–13.
- [75] N.J. Clifford, G. Valentine, *Key Methods in Geography*, Sage Publications, London, 2003.
- [76] M. Cope, Coding transcripts and diaries, in: N.J. Clifford, G. Valentine (Eds.), *Key Methods in Geography*, Sage Publications, London, 2003, pp. 445–459.
- [77] D.C. Major, P. Blaschke, V. Gornitz, E. Hosek, M. Lehmann, J. Lewis, A. Wejs, Adaptation to climate change in small island settlements, *Ocean Coast Manag* 212 (2021) 105789.
- [78] S.M. Fitzpatrick, The archaeology of western Micronesia, *Oxford Handbook Prehistoric Oceania* (2018) 252–270.
- [79] P.V. Kirch, The Polynesian outliers: continuity, change, and replacement, *J. Pac. Hist.* 19 (4) (1984) 224–238.
- [80] P.V. Kirch, Terrell: prehistory in the Pacific islands: a study of variation in language, customs, and human biology (Book Review), *Antiquity* 61 (232) (1987) 348.
- [81] P.M. Vitousek, The Hawaiian Islands as a model system for ecosystem studies, *Pac. Sci.* 49 (1) (1995) 2–16.
- [82] P.M. Vitousek, Oceanic islands as model systems for ecological studies, *J. Biogeogr.* 29 (5–6) (2002) 573–582.
- [83] P.M. Vitousek, *Nutrient Cycling and limitation: Hawai'i as a Model System*, Princeton University Press, 2004.
- [84] J. Bryant-Tokalau, *Indigenous Pacific approaches to Climate change: Pacific Island Countries*, Springer, 2018.

- [85] L. Carter, Indigenous Pacific Approaches to Climate Change: Aotearoa/New Zealand, Springer, 2018.
- [86] J. Barnett, S. Jarillo, S.E. Swearer, C.E. Lovelock, A. Pomeroy, T. Konlechner, R. Lowe, Nature-based solutions for atoll habitability, Philosophical Transactions of the Royal Society B 377 (1854) (2022) 20210124.
- [87] P.A. Matson, P.M. Vitousek, K. Beamer, T.K. Duarte, Sustainability in Polynesian Island Societies, in: K. Beamer, T.M. Tau, P.M. Vitousek (Eds.), Islands and Cultures: How Pacific Islands Provide Paths toward Sustainability, Yale University Press, Yale University Press, New Haven, 2022.