Applying and communicating Indigenous land management knowledge systems and practices to climate change adaptation

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Abstract

In the context of anthropogenic climate change, Pacific Indigenous knowledge systems are a source of opportunity, albeit a vulnerable one. Opportunity arises because Indigenous systems embed cultural practices that confer resilience, which can facilitate knowledge of adaptation in the face of rising seas and floods. But the impact of economic globalisation threatens to diminish these same cultural practices and their resilience-strengthening attributes. The intent of this research is to reveal the opportunities for making use of Indigenous knowledge systems in a way that might defuse their vulnerabilities. The method involved the speculative design of land management practices and projects, framed by three interconnected attributes of Indigenous knowledge systems – ecological knowledge, locally-based decision making, and oral stories—and informed by western scientific knowledge of climate change. The research entailed collaboration with the people and the culture of two Pacific Indigenous communities: one was located on a Māori farm in New Zealand; the other in the town of Levuka in Fiji. Both are threatened by sea level rise and other climate change impacts. The outcomes offer accessibility and understanding of climate change adaptation at the interface of western science and Indigenous knowledge systems through a range of multivalent adaptive strategies, visual communication techniques, and a process of local decision-making based upon ecological thresholds.

Introduction—the Pacific situation

Climate-change induced sea-level rise and increasing storm events now threaten many isolated low-lying low-density villages and farms inhabited by Indigenous communities throughout the Pacific Islands (UNOHRLLS 2009). Although the timing of the climate-change impacts may be uncertain (IPCC 2018), at some point in the future adaptation will be necessary, and will need to be far-reaching. In the limited economic climate of the rural Pacific Islands today, broad scale resilience is less likely to be achieved by capital-intensive protectionist infrastructure projects, and more likely to be the product of a number of smaller adaptive interventions that make use of the traditional 'knowledge and capacity that exists at the local level' (Mercer et al. 2012). Local community-driven adaptations have the benefit of not only being less capital-reliant, but they also harbour the potential to catalyse long-term and broad scale social / environmental benefits because 'local issues and local landscapes… are fundamental to the interdependent scalar dimensions of resilience' (UN Habitat III 2017). A focus on the local has another opportunity in this locale: to apply Indigenous cultural knowledge in the adaptation process, and thereby conserve inter-generationally the resilience-strengthening values embedded in Indigenous knowledge systems.

UNESCO describes Indigenous knowledge (also known as 'Traditional Knowledge', 'Traditional Indigenous Knowledge', and 'Traditional Ecological Knowledge', Lagi 2015) as 'a cumulative body of knowledge, know-how, practices and representations maintained and developed by peoples with extended histories of interaction with the natural environment…[It is] a cultural complex that encompasses language, naming and classification systems, resource use practices, ritual, and spirituality. [Its foundation is a] worldview… of the symbiotic relationship between humans and nature' (UNESCO 2002). Thus, it 'embodies environmental ethics, values of respect, sharing, reciprocity and humility' (Berkes 2000), and 'kinship' (Lagi 2015).

Indigenous knowledge provides, amongst other things, the basis for 'local level decision making …[and]… for the management of ecological relations of society and nature' which encourages 'adaptation to environmental or social change' (UNESCO 2002). Indigenous cultures have traditionally been familiar with naturally-occurring climate variability and environmental flux (Dartnell 2018; Turner et al. 2009), knowledge of which was generated (and continues to be generated) by long-term physical and cultural connection to land, and transmitted between generations through oral histories and creation stories (Green et al. 1996). These values are manifest in management practices for: 'resource abundance; resource rotation; ecosystem structure and function; biodiverse heterogeneity; watershed-basins; ecological processes at multiple scales; pulses and surprises; and sources of ecosystem renewal' (Berkes 2000). Each of these practices recognises the unpredictability of environmental change. In doing so, they facilitate communities' capacity for adaptation and confer resilience (Berkes 2000). Not surprisingly, though somewhat ironically, the attributes that confer resilience – community cohesion, local decision-making, and ecological practices – are concomitant with the attributes that generate vulnerability – isolation, small population and unpredictability (Kelman et al. 2011).

Currently Indigenous knowledge systems have varying degrees of tenure amongst Pacific communities. In many places Indigenous practices have been overlaid with engineered agriculture and market-place economies, based on the 'universalistic, not social' values of western science and globalisation networks (Nabobo 2008). Nonetheless, there are a number of recent UNESCO programmes that recognise the 'possibility of dramatically extending the [Indigenous] knowledge base of Indigenous people and transforming the understanding of the social cultural world' (Abdullah & Stringer 1999). Partnerships between western scientific and Indigenous knowledge systems are expected to encourage sustainable development (UNESCO 2002), especially because scientific ecology and Indigenous knowledge are complementary (Berkes 2000). But this hybrid is not always clearly communicated or understood as climate change impacts escalate (Walshe 2018).

The aim of this research was to address anthropogenic climate change impacts in Indigenous communities, whilst providing potential for the transmission of Indigenous values intergenerationally. Accordingly, the research has been directed by two objectives: to develop strategies and processes whereby Indigenous knowledge and cultural practices, together with western scientific knowledge, can influence adaptation to climate change impacts; and to communicate visually these findings in order to make more accessible the synthesis of Indigenous knowledge systems and western science with respect to climate change.

Methodology

The authors undertook the research through speculative design in two case studies on threatened sites. One, in New Zealand, was a part of a larger research project called 'Adaptation Strategies to Address Climate Change Impacts on Coastal Māori Communities,' undertaken with Māori coastal communities in the Horowhenua – Kāpiti rohe (region) and a project team that included Indigenous researchers, climate change scientists, geomorphologists, landscape architects and artists. The project was funded by the New Zealand Government's Vision Mātauranga (knowledge) strand of the Te Kōmata o Te Tonga (Deep South) National Science Challenge. The second case study, in Fiji, set out to address the conflict between climate change resilience and conservation of the colonial world heritage town in Levuka, Fiji, and was

funded by Victoria University Wellington. The project team included a team of fifteen landscape architects and architects. In both cases the process entailed discussions and presentations with elders and community, studies of traditional knowledge and the landscape that has influenced it, observations of daily life and its relationship to the environment, mapping at the scales of the local, regional and the global, strategy development and designs for small scale interventions.

Our Indigenous partners in New Zealand suggested using attributes of Indigenous values – i.e., local community decision-making, and the inextricable connection between people and place – as the frame for our collaboration with communities where western practices have altered and eroded traditional land-based ecological relationships. This protocol recognises one of the priority actions of the Sendai Framework for Disaster Risk Reduction: the 'use of traditional, indigenous and local knowledge and practices, as appropriate, to complement scientific knowledge' (United Nations 2015).

Our collaborators also embraced the opportunity to explore communication techniques alternative to text-based media. Pacific Indigenous cultural practices have traditionally relied on oral narratives to transmit Indigenous knowledge intergenerationally and geographically (Berkes 2000). Currently 'there is a dissonance in the diverse way teachers, the media and communities perceive and relate to climate change' (Walshe et al 2018) and contention between individuals within communities concerning the interface between western science and Indigenous knowledge (Lagi 2015). Speculative design, being largely a non-textual form of communication, offers media to generate a discourse on the physical and spatial possibilities that are not always apparent in the outputs of western science.

The Tahamata case study in New Zealand

In the New Zealand case study, we addressed the future of the 300ha Tahamata Incorporation farm in the Horowhenua, on the North Island's west coast lowlands, between the waterways of the Kuku Stream, the Ōhau River and the Kuku Ōhau estuary. Prior to European settlement, this land was regularly recharged with the flooding waterways that spread across the plain. The extensive wetlands and aquifers created an abundant and biodiverse environment. In the last 100 years, rivers have been channelised, wetlands reclaimed, vegetation cleared and fertilisers added for productivity-driven dairy farming, all of which has resulted in elevated concentrations of nutrients in the water systems, fragmented ecosystems and biodiversity loss (Smith et al. 2011). Over the next hundred years climate change is likely to dramatically decrease the area of arable land on the farm, increase ground water salinity, erode the coastal dunes, increase the frequency and severity of flood events and threaten the habitat of the remnant wetlands behind the dunes (Manning 2016). Farming practices will inevitably need to change, but science cannot say exactly how much change is needed and when to start.

Māori researcher and Massey University Professor Dr Huhana Smith (Ngāti Tukorehe, Ngāti Raukawa ki Te Tonga) who led the Deep South project, provided Indigenous interpretations and direction. She facilitated a series of wānanga (workshops) and hui (meetings) with local iwi shareholders to discuss adaptation. Five site-specific principles for resilience ensued:

Whanaungatanga ki te whenua: bringing whanau (family) back to the whenua (the land);

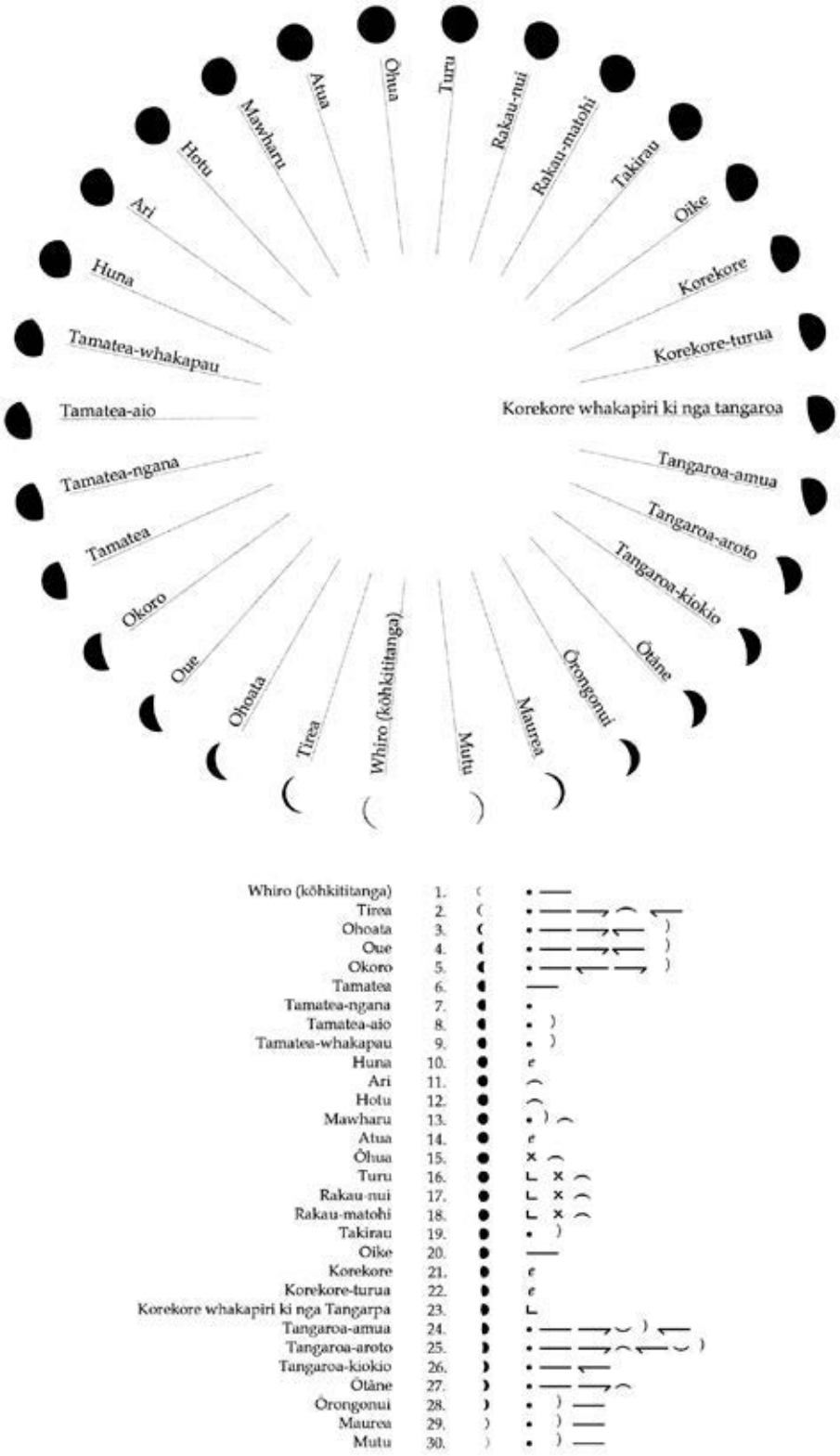
Puāwaitanga o te whenua: ensuring the farm is economically viable;

Whakahokia ngā kai o te awa: practicing traditional resource management;

Kaitiakitanga mō āpōpō: protecting the farm for future generations; and

Tiakitanga o ngā wāhi tapu: acknowledging and protecting cultural/ ancestral sites and burial areas.

To frame the development of resilient strategies and practices, Dr Smith proposed three Māori cultural methods from Matauranga Māori (traditional cultural knowledge). '*Whakapapa* (to layer) has important resonances with ecosystem thinking, particularly in its codification of the [connections] between ecological, meteorological and human events. *Hīkoi* (walking



Whiro (kōhkititanga)	1.	
Tirea	2.	
Ohoata	3.	
Oue	4.	
Okoro	5.	
Tamatea	6.	
Tamatea-ngana	7.	
Tamatea-aio	8.	
Tamatea-whakapau	9.	
Huna	10.	
Ari	11.	
Hotu	12.	
Mawharu	13.	
Atua	14.	
Ōhua	15.	
Turu	16.	
Rakau-nui	17.	
Rakau-matohi	18.	
Takirau	19.	
Oike	20.	
Korekore	21.	
Korekore-turua	22.	
Korekore whakapiri ki nga Tangarpa	23.	
Tangaroa-amua	24.	
Tangaroa-aroto	25.	
Tangaroa-kiokio	26.	
Ōtāne	27.	
Ōrongonui	28.	
Maurea	29.	
Mutu	30.	

Figure 1: Maramataka – the moon calendar – which draws parallels between phases of the moon and cultural practices (Source: Huhana Smith and Abdallah Richards).

and talking on the land) encourages first-hand knowledge of the land', which empowers the capacity for local decision-making. '*Kōrero tuku iho* (oral narratives) tell stories of the past, the present and the future, building on whakapapa and hīkoi understandings to establish physical associations between lands, waterways and people' (Bryant et al. 2017).

The three Māori methods informed our design research for an enhanced ecological environment which included future farming activities and settlement (Figure 1). Drawing from the connectedness of *Whakapapa,* design strategies built on Indigenous ecological practices. One strategy entailed protection of extant parts of the ecosystem (the dunes, the waterways, remnant habitats) to maintain patches of biodiverse heterogeneity; and protection of arable lands to ensure that the farm continues to be economically viable for as long as possible. A second strategy, based on watershed management, proposed options for bigger wetlands as sites for water storage; and another, based on diversification, proposed options for farming practices that would renew habitats, and maintain resource abundance, while rotating resources. A fourth strategy would promote intergenerational transmission of knowledge by developing new infrastructure either for cultural events, or for settlement to 'bring the whanau back to the whenua.' Notably, all these strategies were designed for the local scale so that they could be implemented by the local community, with or without dairying, over a period of time.

Figure 2: Design strategies at Tahamata: 1. Protect coastal dunes. 2. Protect wetlands. 3. Protect the most arable land. 4. Protect habitat and biodiversity. 5. Make room for water. 6. Diversify farming practices. 7. Develop adaptive infrastructure. 8. Celebrate the high ground. 9. Settle the high ground.
(Source: Penny Allan, Martin Bryant, Miguel Guilarte, and Charlie Curtin.)

But the designs themselves were not sufficient to enable decision making, because they only said how to act, not *when*. Implementation needed to be tied to mechanisms for local farmers to recognise evidence of the imminence of climate change impacts. The traditional Indigenous practice of managing pulses and surprises and other unpredictable environmental and climatic fluctuation provided avenues for knowing when to respond. This knowledge is generated by the *Hīkoi* which enables local farmers to recognise increasingly episodic collapse of coastal dunes, or a repeated failure of pasture species to thrive, or an increasingly frequent presence of standing water in the paddocks. These events would be indicators that climatic conditions are changing. When indicators recur, local farmers know to instigate adaptation of one of the design strategies. The repetition of environmental events are thus thresholds to action. In this way the design strategies are contingent, tied to the thresholds, and embedded in the important process of local decision-making.

The visual media outputs work were exhibited publicly to raise awareness of ecological relationships, the contingency of design strategies, and the thresholds for actions. Part of the work demonstrated and communicated the importance of ecological thinking in traditional knowledge systems of Māori, and how it prompted action. Underpinned by *whakapapa*, the maramataka (moon calendar), depicted in Figure 2, illustrated the contingent relationship between the cycles of the moon and specific activities, such as fishing, hunting and harvesting. Another set of images, showing current scenes together with the design strategies, and accompanied by the question 'what would you do if…?' (Figure 3) illustrated the thresholds that might instigate deployment of the design strategies. They showed the situation in a way that would generate K*ōrero tuku iho* (oral narratives) similar to the maramataka. These narratives connect future climate change impacts to adaptive responses, embedding the rhythms of everyday life with a call to action.

The work thus demonstrated how Māori methods (*Whakapapa, Hīkoi,* and K*ōrero tuku iho*) might address climate change in a way that is relevant to local communities and their knowledge systems. Providing mechanisms for reconnecting people and land, suggesting processes for threshold-based local decision making, and identifying non-visual narratives to explain these, offered ways to catalyse adaptive action.

Figure 3: The oral narratives exhibition which linked thresholds – what if's – to design strategies (Source: Penny Allan).

The Levuka case study in Fiji

The Fijian case study was undertaken in consultation with town elders, the Town Council, and community members. The intention was to research, through design, the potential for Indigenous cultural practices to strengthen resilience.

Levuka is a UNESCO Cultural World Heritage listed town on the eastern coast of the 104 square kilometre island of the volcanic island of Ovalau, but its listing relates primarily to its colonial heritage, rather than to its Indigenous fabric. Most of the coastal fringes of Ovalau are steeply sloping, but isolated settlements like Levuka occur on the alluvial flatland around the numerous creeks. At Levuka, an offshore barrier reef provides protected deep navigable water and a harbour.

Totoga Creek rises in high mountains at the centre of the island above Levuka and flows through Levuka, where it is central to daily life. The town elders explained that parts of the creek are sacred, and only visited according to certain protocols at designated times of the year. Its higher reaches provide drinking water, and its various waterfalls and water holes, surrounded by luxuriant vegetation, are places for the daily rhythm of washing clothes, bathing, socialising and playing. The town's main access road also runs up the valley beside the creek. Up high the housing, which is basic by western standards, is accessible only by foot. In the flat lowlands the creek structured the colonial layout: its margins are the locus of civic life today, with schools, churches, hotels and town council offices.

During Cyclone Winston in 2015, much of the low-lying parts of the town were flooded or severely damaged. The colonial town layout is still intact, but most of the heritage buildings are in need of repair. The harbour's facilities are less intact: most of the jetties have been washed away. The island's main road, which is still the high street in Levuka, hugs the coastline where it is occasionally inundated when the sea wall is breached by king tides and storms, or flooded from extreme upstream events. The cyclone proved that the whole of the island's coast hugging road, which is the only way to get from one village to the next, is vulnerable infrastructure. Post-cyclone, thoroughfare is often disrupted by repairs to the bridges which cross the numerous creeks.

Currently Levuka, with a population of about 1000, has limited economic opportunity. Notwithstanding the lure of a UNESCO Cultural World Heritage listed town, the tourist industry is underdeveloped, hampered by infrequent and irregular transport connections. And there is relatively little on-island food production: most food consumed on the island is produced off-shore. PAFCO, the globalised fish-packing cannery, is the only significant employer for most of the town's population, many of whom are migrants. For the locals, the generational occupational shift towards factory work has left younger people with little knowledge about cultivation and construction. Individualistic operation is being enhanced at the expense of the traditional clan system. Consequently there is a reduced capacity to manage traditional culturally diverse activities, such as resource sharing and cultivation (Lagi 2017), and Indigenous knowledge of ecological systems is eroding.

Vanua is a central part of Indigenous Fijian knowledge and culture. Ovaluan interpretations of *Vanua* descend from Rakavono, the first inhabitant of Lovoni, referring to 'people, land, sea, traditions and customs, traditional status and leadership, relationships, space, spirit, silence, respect and honour that is accorded to every part of the land and every relationship among all living things' (Lagi 2015). *Vanua* not only refers to the physical land and sea, but to its interconnectedness with social, spiritual and knowledge systems. The ecological connections between people and nature are most apparent in the link between agriculture and resilience: for example, breadfruit and mango fruiting patterns, fish abundance, bees nesting and the flight patterns of frigate birds are all important indicators of climate events such as cyclones or tsunamis (Lagi 2015). Talanoa (storytelling), and songs have been an important means for communicating this knowledge over centuries between generations and across regions. Cultural practices have traditionally relied on the intricate relationship between communities, kinship, nature and agriculture, and provide an underpinning for resilience to climate change, and other threats.

In Levuka, consultation with the local Indigenous people revealed mixed and conflicting priorities. Some placed importance on the repair of the colonial heritage fabric, even though there was minimal funding available for it. Others preferred to improve general living conditions and enhance the diversity, economic opportunity and infrastructure of the town to bring in more visitors. The latter presented an intriguing opportunity and prompted the question: How might design lead to a more sustainable settlement, building economic diversity, respecting Indigenous cultural methods for a town with a complex colonial history, and establishing a new type of resilience to climate change?

Within this complex cultural landscape, we realised the significance of Tatoga Creek as a place for the revival and development of new types of activity based on traditional practices. The foreshore with its High Street / arterial infrastructure, ocean views, and intriguing heritage fabric may have been the rational place to start economic revival. But the creek-line and its valley, with its varying topography and rich gardens, offered resilience-strengthening landscape-based cultural opportunities because of its diversity of microclimates, soil types, hydrology, social activity, outlooks, and situations. Accordingly we developed a speculative design concept

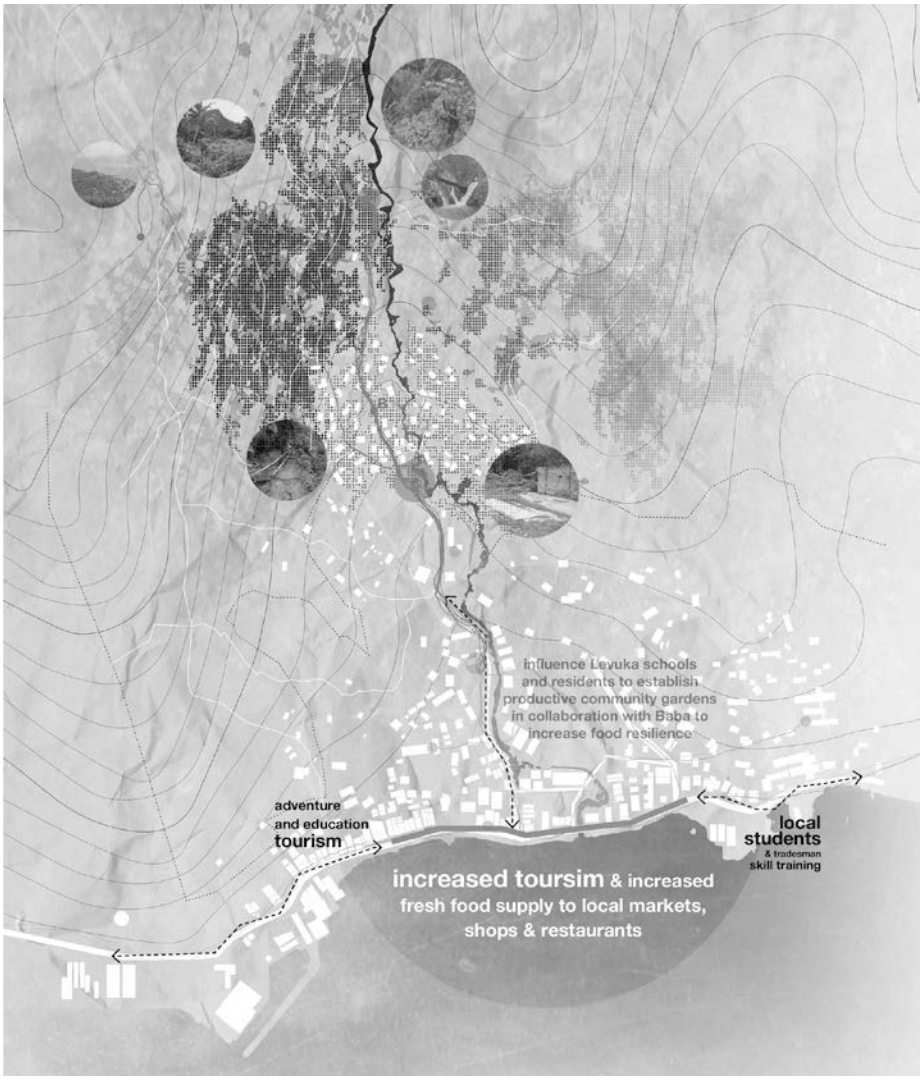


Figure 4: Map of Levuka that shows the strategy to insert design interventions long the creekline, rather than along the foreshore (Source Chelsea Kershaw).

focused on the creek-line. It recognised the inner workings of the town are structured along the creek where the potential for industry, agriculture, employment, and tourism could be expanded. The intent was to establish a more binding relationship between the town and its hinterland; and enrich the everyday and spiritual associations of the local people with the creek. It could capture interest in local culture, and extend the colonial cultural significance of the place to include the Indigenous ecological relationships fundamental to cultural identity. Figure 4 illustrates the approach, where the existing access road / path is extended to the peak of the mountain and loops back down to facilitate connection to new sites of agriculture both for practical use by farmers and for enjoyment by tourists. In doing so, the path would provide a transect of the diversity and abundance that the island's geomorphology offers. The concept suggests that the path / road and the creek—a local solution (rather than an improved coastal road—a broad scale solution) is the infrastructure that could catalyse renewed activity and interest, regenerate ecosystems and encourage new adaptive forms of cultural practice.

As in Tahamata, the concept was developed with a number of strategic but contingent design interventions that could be undertaken not necessarily at once, but as opportunities arose so as to protect (both physically and spiritually), diversify and re-inhabit the land. We describe some of these interventions below.

Figure 5: A community structure to encourage agritourism based on traditional practices. (Source Chelsea Kershaw).

A number of simple structures (Kershaw 2017) (Figure 5) could function as seed banks or nurseries. Here both locals and tourists might contribute their time and resources to support the food cultivation of this settlement; as erosion mitigation sites, as places for seedling protection or crop storage; as places for storytelling or song; or as wind protection in a cyclone. They could be built quickly using locally sourced materials and adaptable construction techniques as resource availability varies. They may also benefit the wider community by prompting skill training for younger generations; and as long-term educational hubs, allowing for the transmission of traditional knowledge. The quick construction techniques suggest they need not be permanent or fixed: they may shift location, form or function to instigate awareness and education around the growing needs of the community, the need for rotation depending on seasons, shifting ecologies, cyclone regularity, and other future events. Resonating with Indigenous practices, the adaptability and multi-benefits of these types of structures located on the creek line valley have the potential to increase resource and community resilience.

Another structure (Figure 6) connects the sea's resources, the economy of the High Street and the produce of the creek-line. Improvements to the sea wall with a sea jetty would facilitate markets at the mouth of the Totoga Creek (Paige 2017). Shelter structures here could provide a range of cultural opportunities, like communal practices of crafts such as weaving, carving and storytelling. The design subtly shifts the emphasis away from the colonial façade of the promenade and invites a variety of cultural practices to operate. It also encourages an expansion of trade in fish, fruit and vegetables between the town of Levuka and neighbouring islands, anticipating Levuka's new future in a network of agri-tourism and sea trade routes.

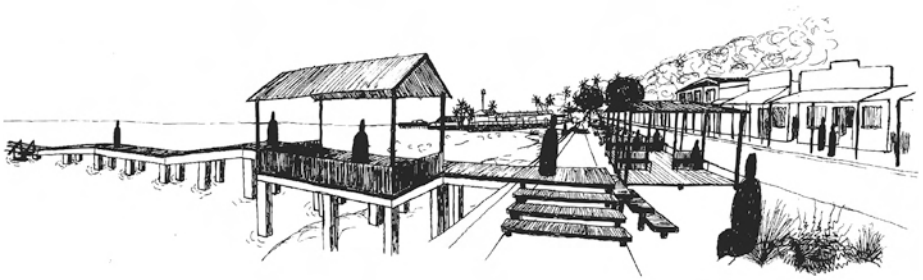


Figure 6: A market and jetty scheme on the foreshore. (Source: Paige Boyd).

A third strategy is not a physical intervention, but an event: an online tourist brochure might describe special waterholes in Levuka without actually pinpointing them on a map. It is a forerunner of augmented reality, a technological but non-textual based way which would protect sites of environmental and cultural significance (Freeman 2017). It draws on the spiritual qualities of the creek, and the idea of being 'invited' as a tourist to experience special places. This non-intervention prioritises and strengthens the local significance of the creek-line in simple ways, encouraging engagement with cultural practices, rather than turning them over to tourists. Grounded in local practice, this proposal is not specific in terms of location, but in line with current thoughts on Pacific conservation, it has powerful associations to cultural values, rather than to the values of heritage fabric (UNESCO 2002).

These designs address the complex relationships between settlement form, and economic activity, and offer an enhanced ecological environment, and much-needed diversification of the local economy. They suggest opportunities to generate local projects with local decision making to strengthen resilience to climate change and to re-establish Indigenous knowledge and cultural practices .

Discussion

The research suggests a different way to approach climate change impacts: through culturally appropriate and adaptive responses; and by using design with Indigenous frames and methodologies that re-engage with traditional methods of land management.

Hīkoi in New Zealand and *Vanua* in Fiji, prompted the research to examine catchment issues through the lens of local observations, processes and conversations. It encouraged strategies of protection, diversification and re-inhabitation: all part of an approach that starts at the local scale. The connectedness of things embedded in *Whakapapa* and in *Vanua* provided insight into the significance of the relationships between atmosphere, land, water and people. It bypassed large centrally-funded infrastructural solutions as the panacea for problems, and instead facilitated contingent options for agriculture and habitat to diversify and create abundance. In Tahamata, *whakapapa* emphasised the conditional relationship between threshold and response. *Hīkoi* provides a knowing of what constitutes a threshold, how thresholds 'look and feel' and what one might do about them. Knowing thresholds empowers communities to adapt, transferring climate change agency from governments to individuals, and from the global to the local. The transmission of knowledge through *talanoa and kōrero tuku ihata* offered opportunities to rethink how messages about climate change might be communicated, highlighting the value of non-text methods, and the spirituality of *whenua/vanua*.

When design is less concerned with finding an optimum solution, and more focused on synthesising different issues (such as those offered by different epistemologies) and exploring relationships (such as those associated with ecological processes), it has the capacity to use knowledge from different ontologies in a productive way. Design is also a powerful visual medium for communicating: it can convey the urgency of responding to rapid climate change,

linking environmental phenomena to action that anticipates and encourages adaptive, open ended change. By visualising contingencies and thresholds, and synthesising the complexity of global and local influences, it is a useful tool for addressing local land and culture-based issues at a local scale.

Conclusion

Indigenous knowledge is focused particularly on local relationships, and local stories, so it may seem difficult to universalise conclusions. Nonetheless the two case studies both have the potential to scale -up to enhance the macro- environment and macro-economy in a number of villages and rural areas across the Pacific. The significant aspect of the research is that the case studies have explored a way of combining non-text based methodologies to understand, interpret and conserve local culture, while also providing economic and environmental diversity. Such methodological possibilities are exemplary for a wide audience of coastal communities who are concerned with adaptations for climate change that conserve land-based values.

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