Navigating risk within iwi/hapū environmental decision-making - Potential pathways based on the published literature

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Report

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About the Sustainable Seas National Science Challenge

Our vision is for Aotearoa New Zealand to have healthy marine ecosystems that provide value for all New Zealanders. We have 60+ research projects that bring together around 250 scientists, social scientists, economists, and experts in mātauranga Māori and policy from across Aotearoa New Zealand. We are one of 11 National Science Challenges, funded by the Ministry of Business, Innovation & Employment.

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Prepared for Sustainable Seas National Science Challenge

November 2021

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Executive Summary

The Sustainable Seas National Science Challenge recognises that tangata whenua, as Te Tīriti o Waitangi partners have important reciprocal and intergenerational relationships with their local environments. Therefore, understanding the risks from the perspectives and experiences of tangata whenua is crucial to building equitable processes and capability within marine decision-making processes. The project titled 'Decision-making under uncertainty – a review of new tools and approaches for assessing risk in complex environmental problems' reviewed and evaluated methods to support decision-making under conditions of significant uncertainty around risk (Inglis et al. 2018). The following review seeks to complement Inglis et al. (2018) and provide examples of frameworks, processes and methods developed with and/or by Māori, to support iwi/hapū/whānau and their assessments of the direct and indirect environmental risks of different activities.

Tangata whenua are intimately bound to oceans, estuaries, rivers, lakes, and streams through whakapapa. Thus, these environmental aspects are a fundamental tenant of personal and tribal identity for tangata whenua. Māori have interconnected relationships with the environment as a component of the natural order, rather than as controllers and exploiters of resources. Therefore, the environment and associated natural resources are taonga, and how tangata whenua engage is crucial to their well-being, integrity, culture, ability to uphold kawa and tikanga, and keep cultural practices alive. On a daily basis, whānau, hapū and iwi are confronted with a plethora of proposals for resource use and development that all need to be assessed for the potential risks and impacts from a Te Ao Maori perspective.

To inform this review we drew on existing published and readily discoverable literature from the environmental regulation, biosecurity, environmental health, hazards, and climate change disciplines. We chose these examples to reflect a range of methods, processes and protocols that may be familiar to various government agencies with responsibilities in these areas and therefore anticipate that many of the common learnings expressed through these studies will also be relevant to Ecosystem Based Management and the Sustainable Seas National Science Challenge.

This review briefly touches on nine case studies that explore culturally appropriate approaches for framing risk and evaluating potential impacts to Māori interests:

1. Mātauranga Framework and impacts of environmental activities: This case study demonstrates how the Environmental Protection Authority (EPA) is taking a proactive approach to ensuring that the principles of Te Tīriti o Waitangi and Māori interests, values and perspectives are incorporated into its processes, policies and decision-making.

2. Take-Utu-Ea Framework and pest management: This case study demonstrates how tikanga and mātauranga Māori-driven frameworks can empower iwi/hapū perspectives in their assessments of risk to inform contemporary issues around emerging biotechnologies.

3. Tapu-Noa Model and marine risk management: This case study demonstrates how a predetermined approach and outcome sought by an agency undermined iwi/hapū participation and the contribution of their mātauranga. The case study is included to show how the collective experiences of the Māori, marine and social science team were able to work together to provide an alternate approach that was more acceptable to iwi/hapū.

4. USEPA Risk Assessment and contaminants in wild-caught kai: This case study demonstrates how an internationally accepted method can be complemented to accommodate mātauranga Māori and whānau harvest behaviours to provide risk assessments, fish consumption and remediation advice that is location specific and relevant to Māori.

5. Mauri model and point source and diffuse discharges: This case study demonstrates how mauri, a universal concept in Te Ao Māori, can be used to derive new methods that support iwi/hapū/marae communities and their assessments of environmental impacts and risks.

6. Ngāi Tahu Māori Recovery Network and disaster management: This case study demonstrates how iwi/hapū knowledge, networks, capacity, and resourcing is essential to inform risk reduction responses.

7. Perspectives of tamariki and resilience to volcanic hazards: This case study brings together mātauranga Māori, geoscientific knowledge and performing arts to include the perspectives of tamariki to increase cross-cultural and cross-disciplinary understandings and promote conversations about risks within the wider community.

8. He huringa āhuarangi, he huringa ao and the National Climate Change Risk Assessment: This case study demonstrates a Māori-driven approach to informing the National Climate Change Risk Assessment.

9. Serious games and flood adaptation pathways for marae: This case study demonstrates how new emerging methods, like serious games, can be co-developed to better understand social and cultural issues for marae communities and inform their risk assessments and responses to climate change.

Based on the successes and challenges raised by the case studies above, this report summarises some of the key learnings that can be used to support iwi/hapū and their assessments of the direct and indirect risks and impacts of different environmental/marine-based activities.

1 Project scope and report structure

It is the position of the Sustainable Seas National Science Challenge ('the Challenge') that ecosystem-based management depends on the effective application of science and mātauranga Māori to reduce uncertainty in policy decisions about environmental risks. However, decisions about natural resources are being made when knowledge about an activity or its potential effects on the environment is incomplete and when existing scientific data and mātauranga Māori are insufficient to characterise risk. The project titled 'Decision-making under uncertainty – a review of new tools and approaches for assessing risk in complex environmental problems' reviewed and evaluated methods to support decision-making under conditions of significant uncertainty around risk (Inglis et al. 2018).

Decisions about the utilisation and care of environmental elements (including 'natural resources') entails making predictions about how ecosystems will respond to prospective changes of people's interaction with these spaces (such as protection, use, extraction). Any predictions about complex systems holds a level of risk and are therefore contested given the different ways of perceiving various interactions, which coincides with peoples individual and collective worldview and values.

Inglis et al. (2018) collated a representative range of 'best-practice' tools and approaches that are being applied across a spectrum of risk problems of differing complexity and uncertainty. The following report seeks to complement the review completed by Inglis et al. (2018) and provide examples of frameworks, processes and methods developed with and/or by Māori, to support iwi/hapū and their assessments of the direct and indirect environmental risks of different activities.

To inform this review we drew on existing published and readily discoverable literature. We outline the methods used to produce this review in Section 2. Through a series of case studies, we introduce some examples of decision-making processes that explicitly considered risk either with and/or by Māori (Sections 3-7). Section 8 summarises key learnings that are common across the case studies highlighted.

For clarity, we did not engage with an iwi/hapū to contribute to or endorse this review. It is not the intention of this review to conflict with, replace or supersede the distinct perspectives of iwi/hapū and any respective outputs, actions, or initiatives they use to inform their decision-making processes. It is also not the intention of this review to focus on the conventional definitions and typologies associated with field of risk analysis, risk assessment, risk evaluation, risk identification and risk management.

2   Methods

To complete this review, we drew on existing published and readily discoverable literature, to provide examples that demonstrate how various hapū/iwi have incorporated assessments of risk that draw on their mātauranga and support their participation in a variety of environmental decision-making fora. In the selection of case study examples, preference was given to publications authored or co-authored by Māori researchers and/or where the outcomes clearly benefited the iwi/hapū/marae community involved.

In this review we have provided a selection of examples from the environmental regulation, biosecurity, environmental health, hazards, and climate change disciplines. We have chosen these examples to reflect a range of methods, processes and protocols that may be familiar to various government agencies with responsibilities in these areas and therefore anticipate that many of the common learnings expressed through these studies will also be relevant to Ecosystem Based Management and the Sustainable Seas National Science Challenge.

3 Environmental Regulation

3.1 Mātauranga Framework and impacts of environmental activities

> The purpose of this case study is to demonstrate how the Environmental Protection Authority (EPA) takes a proactive and comprehensive approach to ensuring that the principles of Te Tīriti o Waitangi and Māori interests, values and perspectives are incorporated into its processes, policies and decision making. He Whetū Mārama is a framework that guides the EPA's obligations to Māori. Their Mātauranga Programme is designed to educate EPA staff and decision makers and provides guidance as to how mātauranga Māori should be incorporated into decision-making.

The Environmental Protection Authority (EPA) is the government agency responsible for regulating activities that affect New Zealand's environment, including hazardous substances and new organisms, the emissions trading scheme, infrastructure plans or public works projects of national significance, and marine activities in Aotearoa-NZs offshore waters. For the purposes of this case study, the focus is on the EPA's core environmental regulatory functions[1] under the Hazardous Substances and New Organisms Act 1996, the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (including as amended by the Resource Legislation Amendment Act 2017) and the Resource Management Act 1991 as these are the contexts where Te Tīriti o Waitangi and Māori interests, values and perspectives arise.

Kaupapa Kura Taiao (the EPA Māori Policy Unit), and Ngā Kaihautū Tikanga Taiao (the EPA Statutory Māori Advisory Committee) work proactively across the EPA and are guided by the He Whetū Mārama framework to support EPAs statutory and other obligations to Māori.

He Whetū Mārama provides a framework for the EPA to direct its efforts towards ensuring informed decision-making and productive relationships with Māori and work focussed on incorporating Māori perspectives. At the core of He Whetū Mārama are Te Tīriti o Waitangi principles that are either encapsulated in the relevant legislation or specifically referred to in provisions requiring notification of affected Māori, and empowering Ngā Kaihautū Tikanga Taiao to advise the EPA and other decision makers from a Māori perspective across its regulatory functions.

Therefore, the EPA prioritises investment in reciprocal, productive and enduring relationships with Māori to ensure they are productively involved in their decision-making and associated activities. This is further evidenced in the EPA's vision: "An environment protected, enhancing our way of life and the economy" supported by their wawata (aspiration) from He Whetū Mārama: "*Ka whai mōhio ā Te Mana Rauhī Taiao whakatau i te hononga ake, i te hononga motuhake a Ngāi Māori ki te Taiao*" (the unique relationship of Māori to the environment informs EPA decision-making). It also recognises that the EPA's decisions can be more robust and effective when they incorporate Māori perspectives. In this regard the Productivity Commission (New Zealand Productivity Commission

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[1] As well as the EPA Act, other Acts administered at least in part (or under which the EPA has a role) by the EPA are the Resource Management Act 1991 (RMA), the Hazardous Substances and New Organisms Act 1996 (HSNO Act), the Climate Change Response Act 2002 (CCRA), the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (including as amended by the Resource Legislation Amendment Act 2017) (EEZ Act), the Imports and Exports (Restrictions) Act 1988 (I&E Act) and the Ozone Layer Protection Act 1996 (Ozone Act).

2014) identified the EPA as an example of best practice in terms of incorporating Te Tīriti o Waitangi into regulatory design and practice to build constructive and trust-based relationships with Māori.

In 2003 the Environmental Risk Management Authority established a Māori National Network to improve the participation of Māori in Hazardous Substances and New Organisms Act-related decision-making. When the Environmental Risk Management Authority was disestablished in 2011, this network was transferred under the broader environmental management umbrella of the EPA. The network was re-established and re-named as Te Herenga Network under the EPA. Te Herenga is founded on:

1. Māori cultural values, knowledge and language as well as the principles of Te Tīriti o Waitangi,

2. The unique knowledge, innovations, customary activities and experience of kaitiakitanga,

3. A recognition of the value of kaumātua wisdom and knowledge, and the vigour and passion of rangatahi,

4. The role of kaitiaki, and

5. The recognition that members may represent their iwi, hapū or Māori organisation, but as a collective group does not represent or replace the views and opinions of iwi, hapū or Māori organisations.

Te Herenga is made up of Māori resource and environmental managers, practitioners, or experts who voluntarily represent their iwi, hapū or Māori organisation on matters of relevance to the activities and decision-making of the EPA. Te Herenga is a place that kaitiaki and environmental resource managers and experts can come together to discuss important environmental issues. Within this roopu, the Ngā Parirau o te Mātauranga, a collective of koroua and kuia from Te Herenga, oversee the tikanga and kawa of the group and its activities.

Under He Whetū Mārama the EPA invests in the need for decision makers to have a greater understanding of mātauranga Māori in order to understand the Māori perspectives being given, make better informed decisions and truly understand the issues and implications of their decision-making. This led to drawing together representatives from Ngā Parirau o te Mātauranga, Te Herenga Network, Ngā Kaihautū Tikanga Taiao and other experts to inform the development of the EPA's Mātauranga Programme.

The purposes of the Mātauranga Programme are to ensure that mātauranga becomes embedded as 'business as usual' and to enable decision makers to actively incorporate mātauranga in their decision-making. It is effectively leading towards a paradigm shift in thinking whereby decision makers accept that knowledge comes in different, but equally valid forms. The Mātauranga Programme provides EPA staff with a greater understanding of mātauranga and decision makers with the knowledge and decision-making frameworks they need to be able to receive, test and assess the weight of mātauranga that may be presented as evidence by Māori in EPA processes. Equipping EPA decision makers to ensure that Māori perspectives that are informed by mātauranga are not only heard, but genuinely understood and reflected in decision-making (EPA 2020).

The resulting EPA Mātauranga Framework is analogous to a cultural risk assessment framework. When making environmental management decisions the EPA decision makers value the knowledge

of tangata whenua alongside that of contemporary science and recognises that cultural practices have a strong environmental basis, which enhances environmental management processes. From a government agency perspective, the EPA provides one of the few examples of how mātauranga Māori is being used to improve environmental decision-making. The EPA draw on the 'Waka Hourua' as a metaphor for their approach to mātauranga, where the waka hourua represents two knowledge systems, mātauranga and science, working and moving together in the same direction. The EPA's decisions are informed by advice, evidence and risk assessments which is represented in the interwoven sail of the waka hourua (EPA 2020).

In terms of the impacts or risks of various activities, the mātauranga framework provides some specific questions that can be used by decision makers to ensure that they more fully grasp the depth of the information being presented by iwi/hapū and are able to explore the significance of these impacts, as experienced and expressed by iwi/hapū (Figure 1). More information about the mātauranga work programme and framework[2], and a companion guide[3] is available via the EPA website[4] (EPA 2020).

He aha ngā pānga?
What are the impacts?

Can you explain what impact this application will have on:
· the cultural concepts, values and practices of members of your whānau/hapū/iwi (historical and contemporary)?
· the health and wellbeing of members of your whānau/hapū/iwi?
· the relationship between your whānau/hapū/iwi and resources?
· the economic development and sustainability of your whānau/hapū/iwi?

How significant are the impacts you've told us about?

Can you give other examples of these effects (eg, other places or situations where this has happened)?

Are there any benefits to your whānau/hapū/iwi from this application?
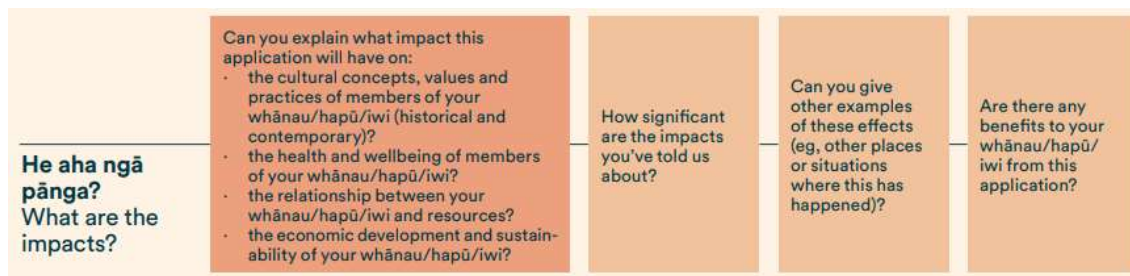
Figure 1:   He aha ngā pānga? – Excerpt from the EPA Mātauranga Framework. (Source: EPA 2020).

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[2] https://www.epa.govt.nz/assets/Uploads/Documents/Te-Hautu/Matauranga-Maori-Report_Framework-Report.pdf
[3] https://www.epa.govt.nz/assets/Uploads/Documents/Te-Hautu/Matauranga-Maori-Report_Companion-Guide.pdf
[4] https://www.epa.govt.nz/te-hautu/matauranga/

4   Biosecurity

4.1   Take-Utu-Ea Framework and pest management

> **The purpose of this case study is to demonstrate how tikanga and mātauranga Māori-driven frameworks can empower iwi/hapū perspectives in their assessments of contemporary pest management risks. The Take-Utu-Ea Framework was developed to understand how difficult issues were traditionally managed to inform contemporary assessments of contentious issues.**

Predator Free 2050 is the Government's goal to remove the most damaging introduced predators from Aotearoa. As part of this initiative, new technologies are being explored to increase the efficiencies and effectiveness of various strategies. Many of the new technologies being explored include a focus on genetic technologies, specifically biotechnological controls for targeted species. However, in order for these new technologies to be picked up and actioned at scale, a level of social acceptance is required. To better understand contemporary issues associated with pest management, Palmer et al. (2020) explored Māori perspectives on novel biotechnological controls using Tā Hirini Moko Mead's (Mead 2003) take-utu-ea (TUE) framework.

The TUE approach is a part of Mead's (2003) tikanga framework which includes the five tests of: tapu, mauri, take-utu-ea, the precedent and the principles. This framework emerged at the time of the Royal Commission on Genetic Modification and sought to better understand Māori perspectives on genetic modification. Mead (2003) expresses that to address, understand and debate contemporary issues, there needs to be a tikanga Māori position – not *the* position, but *a* position. The TUE test involves identifying a take (issue) as an event or issue which has or will breach mauri and/or tapu. Once the take has been agreed upon, utu (cost) is introduced as a means of acknowledging how the breach or imbalance will be addressed. The final step of the TUE test is ea (resolution), which is a state of satisfaction or acceptance where relationships are restored.

Palmer et al. (2020) drew together the outcomes from three studies which included the perspectives of tertiary students enrolled in a Māori and Indigenous studies paper (Mercier et al. 2019), Māori businesses that may be impacted by wasp pest management (Palmer 2019), and Māori with strong spiritual and/or religious beliefs and practices (King-Hunt 2019). The TUE approach allowed participants to identify risks associated with wasp management biotechnologies based on their understandings of mauri and tapu. In this example the *take* was identified as the overabundance of wasps. Infringements identified to *tapu* and *mauri* included the impacts of wasps on flora and fauna (e.g., biodiversity, conservation, and extinction threats). When a resource is damaged, so is the mauri which can successively cause injury to humans, both spiritually and physically. *Utu* was concerned with the types of cost, including the weighing up of the cultural costs and benefits associated with biotechnologies and genetic editing. Here the potential risks associated with biotechnologies explicitly extended across the natural environment, including the whenua, rongoā, practises/ceremonies and mātauranga. The risks identified included unforeseen consequences, and the potential domino effect of a particular intervention, particularly on cultural resources and practises.

When asked to rank current pest management strategies, the option to 'do nothing' was ranked as least agreeable and was worse than manual trapping and non-targeted poisons. However, for Māori, a range of additional issues were raised relating to tikanga, social licence to operate, consent and

ability to engage as Māori, and control in the conversation, development, and decision-making. In summary, Palmer et al. (2020) argues that conventional approaches underpinning social licence to operate generally reflect the greater population's perspective on such issues, and in doing so, ignore indigenous relations and practices with the environment. They propose that Māori and their values and practices must be recognised and supported as agents of the transformation required to achieve Predator Free 2050.

4.2 Tapu-Noa Model and marine risk management

To improve risk management in the marine environment, a Government agency commissioned research to map the environmental, economic, social, and cultural values associated with Aotearoa-NZ's coastal and marine environments. However, the predetermined approach of the agency, restricted resourcing and lack of partnerships and trust meant that iwi/hapū were unwilling to divulge the types of information the agency was seeking. The purpose of this case study is to demonstrate how the collective experiences of the Māori, marine and social researchers were able to adapt and provide an alternate approach that was more acceptable to iwi/hapū.

Introduced species are recognised as one of the greatest threats to natural environments worldwide. Between 2005-2008 a project funded by (the then called) MAF Biosecurity NZ sought to map the environmental, economic, social and cultural values associated with Aotearoa-NZ's coastal and marine environments – focused on nine harbours (Whangārei, Waitematā, Manukau, Tauranga, Wellington, Marlborough Sounds, Nelson, Lyttleton and Bluff) in seven regions that contain nationally significant shipping ports which provide international import and export facilities. The project was unsuccessful in capturing tangible site-specific values, due to the unwillingness of iwi/hapū to provide sensitive information for MAFBNZ's purposes. One of the key points that was clearly articulated by tangata whenua is that cultural mapping cannot and should not take the place of MAFBNZ building relationships with Māori. Many Māori were suspicious that the value mapping exercise would deemphasise the need for meeting "kanohi ki te kanohi" (i.e., face to face), thus removing them from the interpretation of the knowledge and further discussions as to its use.

Further, it was identified early in the project that it would be difficult to provide for the holistic world view of Māori in the spatial mapping exercise sought by MAFBNZ as this approach did not fully take into account intangible values such as tikanga and manaakitanga which are fundamental to Te Ao Māori. In this situation the collective experiences of the marine, kaupapa Māori and social researchers involved in the project were able to adapt and provide an alternate approach that was more acceptable to iwi/hapū (and the client). Patuawa et al. (2008) utilised the Tapu-Noa model as a means of articulating tangible and intangible cultural values in a respectful and safe way (Figure 2). that did not require iwi/hapū to rank and place their values into a hierarchical scale that was disconnected from their cultural context.

Tangata whenua interactions with the environment are governed by principles and ethics and regulated by a system of tikanga, rules, customs, protocols, and laws that regulate actions and behaviour related to the physical environment and people. Ritenga includes concepts such as tapu (restriction), rāhui (temporary prohibition), and noa (unrestricted), which are practical rules to sustain the wellbeing of people, communities, and natural resources. The Tapu-Noa model is based

on the core concepts of tapu and noa which guide and protect Māori interactions. The model was deliberately described as a dynamic system as iwi and hapū may have differing perspectives on whether something is in a state of noa or tapu. The concept of tapu and noa are complementary opposites but are inextricably linked together to make a whole.

Tapu acted as a protective mechanism for both people and natural resources from possible dangers or degradation. Offence against breaches of tapu and mana govern the behaviour of individuals and groups. Although adherence to tikanga reduces the risks to both individuals and society from abnormal behaviour or wrongdoing, it is sometimes essential that normally prohibited protocols/actions is required (Roberts & Fairweather 2004). A respectful relationship to that which is tapu ensures balance, health, and well-being, while a relationship of abuse leads to disharmony and imbalance (Satterfield & Roberts 2008). Therefore, tapu or the state of tapu ensures that the community abide by appropriate behaviour. On the other hand, noa denotes a state of relaxed access, requiring no protective mechanism or restrictions – the value of everyday, ordinary relaxed human activity (Mead 2003).

The values at the centre of the model (Figure 2) reflect some of the core principles discussed by iwi/hapū involved in the project. For instance, manaakitanga is a core value for Māori ways of being in that certain standards of hospitality need to be upheld when hosting manuhiri. When this value is upheld, iwi and hapū reputation is upheld. When this value is not upheld, it can bring shame to those who are hosting. In this sense, the Tapu-Noa model is concerned about safety and survival which is underpinned by these pluralistic values. The Tapu-Noa model is presented in a dynamic circular form expressing the relationship between tapu and noa as taonga/values which are fluid. Furthermore, the values may be in either tapu or noa depending on factors which dictate the safe use of certain objects or areas, or of a natural resource. The model supported iwi/hapū knowledge holders to reflect the interconnectedness of their values within Te Ao Māori without placing them (or the sites/area/species that support these values) into a hierarchical ranking system.
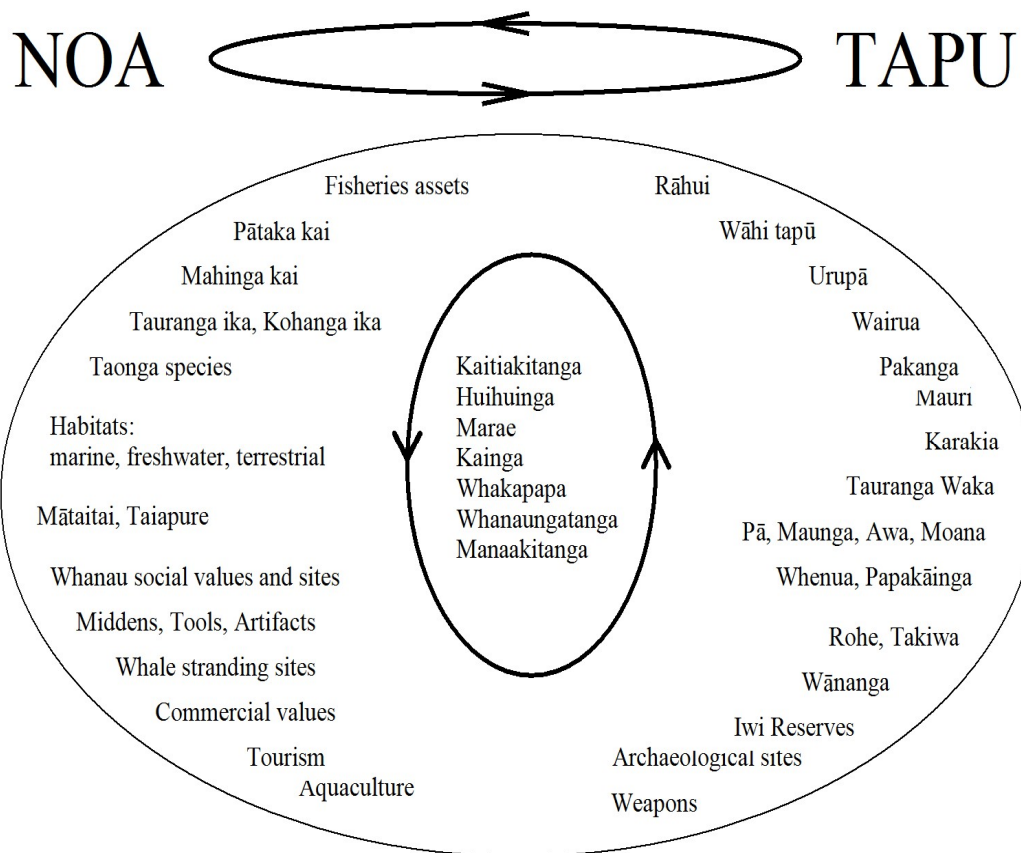
Figure 2: **Tapu-Noa model developed to support iwi/hapū to describe cultural values that may be at risk from biosecurity threats.** The model presented here is a dynamic system. The circular representation between tapu and noa indicates that these values are not fixed in the described framework, and that they may be in either a tapu or noa state depending on many factors which dictate the safe use of certain objects or areas, or of a natural resource. Such influences are known through tikanga Māori, and as such the Tapu-Noa model greatly emphasises the contribution of tangata whenua to all decisions which impact them. (Source: Patuawa et al. 2008).

5 Environmental Health

5.1 USEPA Risk Assessment and contaminants in wild-caught kai

> **The purpose of this case study is to demonstrate how an internationally accepted method can be complemented with fit-for-purpose approaches that accommodate mātauranga Māori and whānau harvest behaviours to provide risk assessments, fish consumption and environmental remediation advice that is location specific and relevant to the target audience, i.e., customary harvesters.**

Anthropogenic pollution enhances the natural background concentrations of many metals and contributes a wide range of organic contaminants of concern to human health (e.g., PAHs, PCBs, dioxins, and furans). Even at low concentrations contaminants, particularly organic compounds, can cause long-term impacts and pose significant risks to the health of biota and humans. In the aquatic environment contaminants transported by the air and in the water are highly likely to be eventually deposited in sediments, where in turn, fish and shellfish are exposed. Contaminants are generally stored in the lipids of biota and can be biomagnified up the food-chain. Human health may be threatened either by the direct consumption of fish and shellfish contaminated with pollutants, or by direct exposure (via water and atmosphere during collection) to them (Boesch & Paul 2001).

Māori have expressed grave concerns regarding the state and use of the environment, the impacts on customary wild kai (e.g., mahinga kai, kaimoana) resources, and how this is affecting their health and wellbeing. Māori associate their health and well-being as individuals and as members of whānau, hapū and iwi, with maintaining the health of the natural environment. When one of these becomes unbalanced, the other equally suffers. Therefore, the sustainability of the natural environment and the long-term well-being of Māori are seen as one and the same thing (e.g., Tipa & Teirney 2003).

There is clear evidence and findings from, for example, Waitangi Tribunal cases WAI 6 Motunui Report (Waitangi Tribunal 1983), WAI 4 Kaituna Report (Waitangi Tribunal 1984), WAI 9 Orakei Report (Waitangi Tribunal 1987), WAI 22 Mohaka River Report (Waitangi Tribunal 1992a), WAI 27b Ngai Tahu Report (1992b), and WAI 119 Muriwhenua Fishing Report (1988), demonstrating that Māori are prepared to go to court for grievances that include the impact of anthropogenic contaminants on their traditional fishing areas. For example, in WAI 6 the Tribunal found that the Te Atiawa people of Taranaki were prejudicially affected by the discharge of sewage and industrial waste onto or near certain traditional fishing grounds and reefs, and that the pollution of the fishing grounds was inconsistent with the principles of Te Tīriti o Waitangi. The Tribunal stated that the hapū are prejudicially affected, in that the reefs and associated marine life suffer from various degrees of pollution, and that those near to the mouth of the Waitara River in particular are badly polluted and stand to be polluted further (Waitangi Tribunal 1983). In light of the concerns presented by tangata whenua, and to progress Tribunal findings such as these, it is very important that Māori have access to the tools necessary to assess the risks posed by the presence of environmental contaminants.

The impact of environmental contamination on the resident "wild kai" (e.g., mahinga kai, kaimoana), and in turn, on Māori iwi/hapū consuming them, has not been widely investigated. A review of wild food in Aotearoa-NZ identified gaps in knowledge of contaminants in non-commercial wild-caught foods, especially in terms of consumption levels (and hence exposure) (Turner et al. 2005). While existing consumptive advice is available for some species of relevance to Māori, this advice is based

on average national consumptive patterns and doesn't account for potentially higher consumption rates of specific traditionally harvested foods by Māori, with its concomitant elevated food security and exposure risks.

This issue is not unique to Aotearoa-NZ – coastal indigenous communities eat nearly four times more seafood per capita than the global average, and about 15 times more per capita than nonindigenous peoples in their countries (Cisneros-Montemayor et al. 2016). However, compared to the international literature very little research of this nature has been completed in Aotearoa-NZ. To address these gaps, new methodologies have been developed with iwi and hapū to provide the targeted information needed to keep whānau harvesters safe and accommodate differences in harvest behaviours (Figure 3) (e.g., Tipa et al. 2010a & b, Stewart et al. 2011, Phillips et al. 2014, Stewart et al. 2014). While conventional methods such as the US EPA risk assessment (USEPA 2000) is a necessary component of this approach, interviews and kai consumption surveys are designed to engage whānau harvesters, and inform field sampling campaigns that target the appropriate species/life stages, time of year and locations they are gathering from. These surveys also collate quantitative data about how much is gathered and then consumed – considering that some individuals will share their harvest with multiple whānau members (i.e., not consume it all themselves). This information is needed to inform the risk assessment and design appropriate communication strategies that convey the results in a way that is accessible to the community of interest, in this context, mahinga kai/kaimoana harvesters.

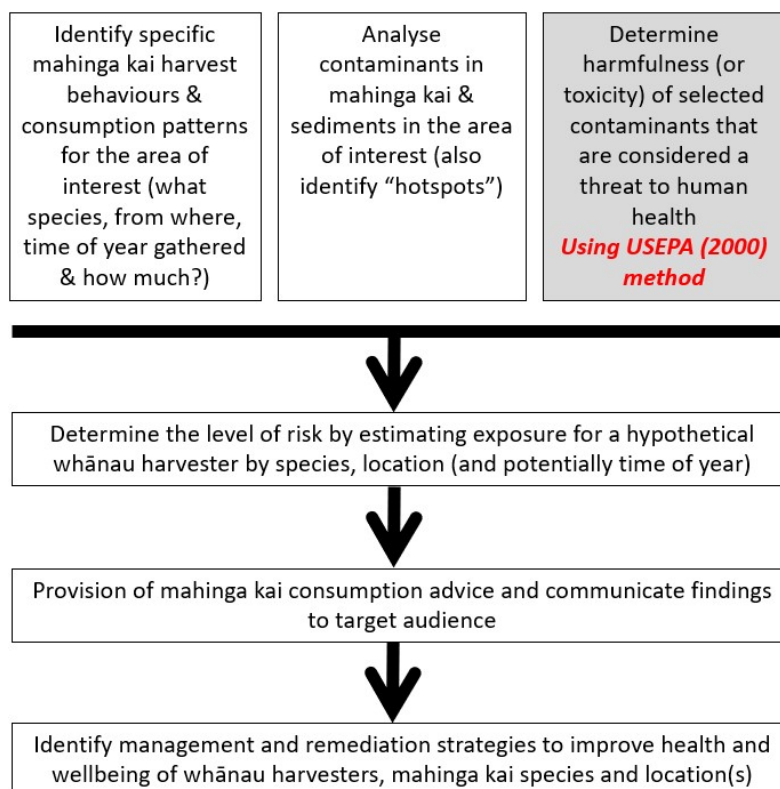**Figure 3:** **Approach designed to assess the risks of environmental contamination on mahinga kai/kai moana, and in turn, on whānau consumers.** While the conventional USEPA Risk Assessment method is part of this approach (grey box), interviews and kai consumption questionnaires are also needed to direct the field sampling strategy and provide the targeted information needed by iwi/hapū communities (adapted from Stewart et al. 2013).

5.2 Mauri model and point source and diffuse discharges

> **Māori practices and interactions with the environment are inherently holistic, therefore, ways of addressing and understanding risk need to reflect this. The purpose of this case study is to demonstrate how mauri, a universal concept in Te Ao Māori, can be utilised to support iwi/hapū/marae communities to assess environmental impacts, risks, and the cultural acceptability of mitigation activities.**

For generations, Māori have voiced their concerns at the continual modification and manipulation of the waterways within their tribal territories (e.g., Waitangi Tribunal 1991, 1995, 1998). Many streams, rivers, estuaries, and coastlines are degraded because of what Māori perceive as inappropriate use and development. For example, the water quality of numerous rivers in Aotearoa-NZ has generally been declining over the last 25 years, despite a very large expenditure on improved treatment (or diversion from rivers) of city and factory wastewaters. Iwi/hapū do not approve of direct/indirect discharges to waterways. Discharges contribute organic, suspended solid, nutrient and pathogen loadings to the environment affecting drinking water and activities such as swimming and harvesting mahinga kai.

Mauri is vital to Te Ao Māori as it informs Māori ways of thinking and seeing (Pohatu & Pohatu 2011). Mauri can be simply understood as a life force that binds and sustains the spiritual and physical worlds (Marsden 2003). Mauri restores, maintains, and enhances life. Therefore, without mauri, the spiritual and physical worlds are fragmented and as a result life cannot exist (Hikuroa et al. 2018). Several Māori scholars have utilised mauri to support iwi/hapū/whānau in their assessments of sustainability (and therefore risk).

The Mauri Model is promoted as a useful alternative to conventional decision support tools like Cost Benefit Analysis (which includes considerations of risks and uncertainty) which are unable to effectively integrate qualitative and indigenous values[5]. The initial Mauri Model (Figure 4) developed and tested by Morgan (2006) assessed the mauri of whānau (economic wellbeing), the mauri of community (social wellbeing), the mauri of hapū (cultural wellbeing) and the mauri of the ecosystem (environmental wellbeing) in relation to wastewater discharge and associated infrastructure. Impacts are rated using the Mauri Meter (Figure 5) which allows for the mauri of each indicator of wellbeing to be described tangata whenua – as defined and assessed by them, which implicitly includes discussions around the potential risks of various scenarios to their cultural values – which are then weighted to provide an overall rating.

Hikuroa et al (2018) describes the four phases of the approach, where "*mauri is a matangaro – a hidden face, never actually seen, instead it is ngā tohu – the indicators, that show whether mauri is thriving or struggling*". The first phase determines the list of impact indicators (e.g., food costs - having to buy food due to loss of mahinga kai) and assigns them to one of four well-beings – environmental, social, cultural, and economic. The second phase assesses the impact to each mauri indicator, while the third phase determines worldview and bias. The fourth phase determines the overall impact to mauri.

Hikuroa et al. (2018) expresses that by using mātauranga Māori as the basis of this impact assessment, this approach promotes the use of indigenous knowledge in evidence-based inquiry,

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[5] http://mauriometer.org/

disaster risk reduction and resilience efforts, and freshwater and resource management. This methodology has been used to support iwi/hapū/whānau impact assessments across a variety of contexts, including wastewater (Morgan 2006, Ormsby & Morgan 2015), stormwater (Cunningham & Morgan 2016) and industrial discharges (Hikuroa et al. 2011, Hikuroa et al. 2018) and the mitigation of the *Rena* disaster (Fa'aui & Morgan 2014). It has been used to hindcast cumulative impacts on mauri (e.g., Fa'aui & Morgan 2014, Ormsby & Morgan 2015, Hikuroa et al. 2018) and is suggested as an on-going monitoring and evaluation tool (Cunningham & Morgan 2016, Hikuroa et al. 2018).
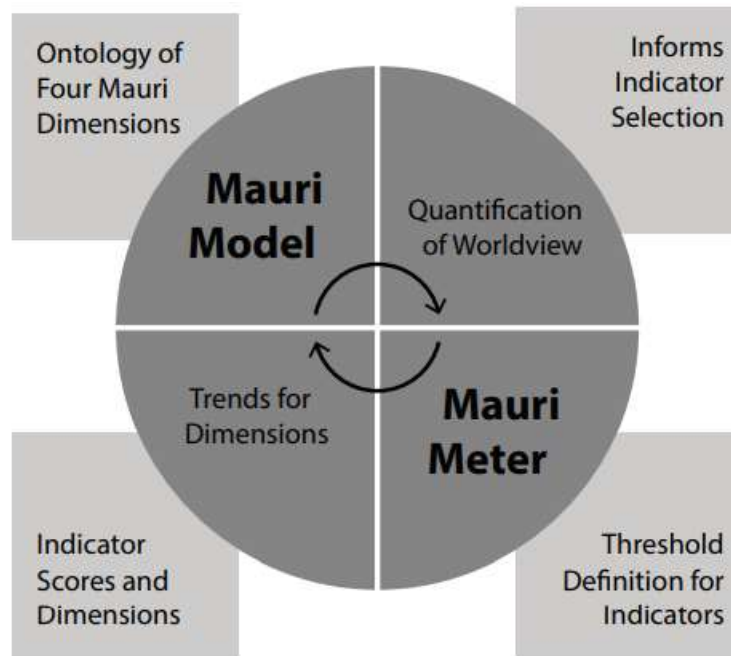
Figure 4: **Key components of the Mauri Model Decision-making Framework.** The Mauri Model combines a stakeholder/community worldview analysis with an indicator measurement process (Mauri Meter) to determine the sustainability of the scenario being assessed, using mauri as the base metric (Source: Sterling et al. 2017).
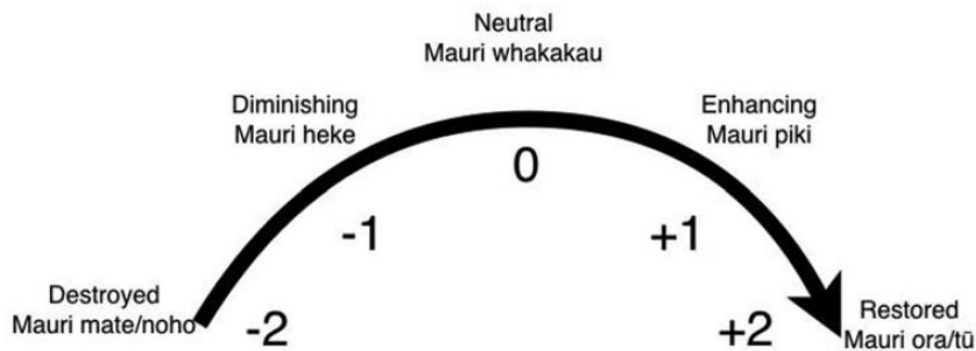
Figure 5: **The Mauri Meter uses a Likert scale for iwi/hapū/whānau indicator scoring (between -2 to +2) to depict possible states of mauri** The Likert scale ensures objective assessment of indicators, as once the tolerance for a negligible indicator impact is defined (where '0' = no impact; -2 and +2 = full impact), any other outcome is either sustainable (positive) or not (negative) (Source: Morgan 2006).

6   Natural Hazards

6.1   Ngāi Tahu Māori Recovery Network and disaster management

> **The purpose of this case study is to demonstrate how iwi/hapū knowledge, capacity and resourcing is essential to inform Aotearoa's response to disaster risk reduction. The case study exemplifies the importance of incorporating Māori knowledge, experiences, and understandings in developing risk responses and community-led disaster recovery and demonstrates how Civil Defence and Emergency Management policies and disaster risk reduction practices are enhanced as a result.**

The Hyogo Declaration (United Nations Office for Disaster Risk Reduction 2005) is one of the key frameworks used for disaster risk reduction internationally. It is a layered model that ranges from macro level initiatives such as creating legislative frameworks to mitigate natural hazard risk to micro level actions aimed at encouraging individual preparedness. The Framework identifies five action areas, across all of which cultural differences should be considered when planning for disaster risk reduction, including, in an Aotearoa context, our responsiveness to Te Tīriti o Waitangi. The five action areas are:

- Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation,

- Identify, assess, and monitor disaster risks and enhance early warning,

- Use knowledge, innovation, and education to build a culture of safety and resilience at all levels,

- Reduce the underlying risk factors, and

- Strengthen disaster preparedness for effective response at all levels.

Researchers in partnership with Te Rūnanga o Ngāi Tahu documented ways in which they responded to, and led, disaster management during the Ōtautahi earthquakes (Kenney & Phibbs 2015, Kenney et al. 2015). A Māori Recovery Network[6] was established to ensure accessibility of the mainstream earthquake response was accessible to Māori (and other) communities, including marae communities, within Christchurch. The Māori Recovery Network includes (but is not limited to) Te Rūnanga o Ngāi Tahu, Te Puni Kōkiri, He Oranga Pounamu, Ngā Maata Waka, Māori Wardens, and Te Pāti Māori. Ngāi Tahu whānui knowledge, capability and capacity informed integrated risk management strategies that were developed collaboratively with national and regional agencies who are engaged in civil/disaster preparedness planning and the rebuilding of Christchurch (CER Authority 2012).

This case study reflects one of the many ways that Māori communities may make decisions about risk and is promoted as an exemplar of best practice in disaster response (Kenney & Phibbs 2015). Kaupapa Māori-based approaches to disaster related risk demonstrated the importance of including Ngāi Tahu mātauranga, experiences, whanaungatanga, skills and abilities to assess and manage risks. In the immediate aftermath of the disaster, community capacity was sustained through collective

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[6] Link: https://ngaitahu.iwi.nz/wp-content/uploads/2013/06/Maori-Recovery-Network.pdf

leadership, a sense of community (rather than as individuals) and commitment to place. Te Rūnanga o Ngāi Tahu has gained statutory recognition in the rebuild (i.e., Canterbury Earthquake Recovery Authority Act 2011) and moved to enhance the capacity of Ngāi Tahu whānui to address social and economic risk factors, such as poverty, unemployment and poor housing, that where identified by the tribe as increasing vulnerability and compromising their resilience in the aftermath of the earthquakes (Kenney & Phibbs 2015).

6.2   Perspectives of tamariki and resilience to volcanic hazards

> **This case study presents a participatory methodology which brought together mātauranga Māori, geoscientific knowledge and performing arts. It shows how experiencing bodily movement can assist with understanding scientific concepts. Furthermore, this case study highlights the importance of including the perspectives of tamariki to increase cross-cultural and cross-disciplinary understandings and promote conversations about volcanic hazard risks within their community.**

To understand and develop resilience within Māori communities requires an examination of the role of traditional knowledge within volcanological hazards, risk communication, and emergency management. This requires multiple disciplines and therefore distinct cross-cultural method(s) to bring together and analyse data (Gabrielsen et al. 2018). Pardo et al. (2015) present a unique methodological approach that sought to bring different knowledge systems across multiple generations together to reduce social vulnerability in an active volcanic region. The methodology was developed in collaboration with Ngāti Rangi who's ancestral maunga is Ruapehu. For Ngāti Rangi, Ruapehu is Matua te Mana, the guardian of mana who uses volcanic activity to share part of his mana with the people, and to replenish and revitalise the land and Ngāti Rangi (Gabrielsen et al. 2018).

The participatory method of Pardo et al. (2015) explored the combination of body language (e.g., dance) and other expressive forms (e.g., writing, drawing) to learn about geological and volcanological concepts – with the dual aim of increasing the scientists' understandings of Ngāti Rangi's relationship with their active volcanoes, whilst providing Ngāti Rangi whānui with scientific knowledge in various forms to maximise their awareness of their exposure to volcanic events. In particular, this approach focused on the perspectives of tamariki who attended Te Kura Kaupapa Māori o Ngāti Rangi in 2012-2013.

The gap between western-scientific based hazard management/monitoring frameworks and mātauranga Māori adaption strategies can be bridged through determining mātauranga Māori-based cultural descriptors or indicators that are traditionally used to monitor volcanic hazards and plan for risk (Gabrielsen et al. 2018). In Pardo et al. (2015) the first phase of the research focused on increasing understandings of mātauranga-a-Ngāti Rangi, and the various terminologies (and epistemologies) used by the partnerships involved. From this a database was developed that identified the similarities between mātauranga-a-Ngāti Rangi and the geological sciences, with a focus on volcanology. Analogies between Te Ao Māori and Te Ao Pākehā were recognised and these concepts then informed the topics which then guided the activities with tamariki. These topics were: (1) The origin of the Universe, Solar System, and Planet Earth; (2) The Structure of the Earth; (3) Earth dynamics (covering tectonics, earthquakes, magma, and volcanic activity).

Through a series of workshops, the next phase focused on new ways to teach geosciences through using body language teaching techniques and performing arts exercises. Importantly, Te Ao Māori perspectives were presented first, and then the scientific/geoscientific perspectives were shared. The focus of these workshops included: 1) Te Whakapapa o Papatūānuku (from the big bang to the origin of planet earth); Rūaumoko shakes (an introduction to earth dynamics and earthquakes); 3): Te Whare Toka ō Paerangi (tectonic rock cycle); 4) Matua te Mana and Crystals (magma and introduction to volcanic eruptions); and 5) Te Mahi o Ruapehu (volcanic products: events, deposits, and benefits).

Ngāti Rangi's perceptions of volcanic 'hazards' is communicated and influenced by oral traditions, language, waiata, and whakataukī (Gabrielsen et al. 2018). Ngāti Rangi view the processes of Rūaumoko as natural occurrences (Gabrielsen 2014). This point of view challenges understandings of 'natural hazard management' which aims to alter the natural world to keep humanity safer. Ngāti Rangi instead highlight the need for management options to focus on the removal of humans to reduce risk. Ngāti Rangi have then recognised these areas as tapu and advise others to avoid such areas of risk, as stated in their Ngāti Rangi Taiao Management Plan (Gabrielsen 2014):

- Ruapehu Maunga will not be altered or tampered with in any way as part of any management strategy to divert or withhold the flow of a lahar.

- No new buildings will be erected in known lahar paths.

- Monitoring and management of natural events in connection with Rūaumoko will involve Ngāti Rangi.

Through the merging of mātauranga Māori, volcanology and expressive body language teaching techniques, new and empowering approaches to understanding volcanic risks can be explored. This approach not only provided new ways of increasing awareness of living with active volcanoes but centred a perspective which is not usually accounted for – a tamariki point of view. Through this collaborative research (e.g., Pardo et al. 2015, Gabrielsen et al. 2018) Ngāti Rangi has developed its own volcanic hazard mitigation, response, and recovery strategies to work alongside and in tandem with conventional/western science-based hazard management plans.

7 Climate Change

7.1 He huringa āhuarangi, he huringa ao and the National Climate Change Risk Assessment

> **This case study demonstrates a Māori-driven approach to informing the National Climate Change Risk Assessment. He huringa āhuarangi, he huringa ao presents the climate change-related impacts and risks to whānau, hapū, iwi and Māori businesses as described by a variety of Māori researchers who are actively working with Maori communities across the areas of interest. It demonstrates the need for holistic and diverse approaches to increasing understanding of these issues and assessments of risk that are undertaken by, and for the benefit of, Māori communities.**

The recently released 'He huringa āhuarangi, he huringa ao: A changing climate, a changing world' report produced by Ngā Pae o Te Māramatanga Centre of Research Excellence and Manaaki Whenua explores Māori perspectives on climate change risks, impacts, pressure points, mitigation and adaptation options for the benefit of whānau/hapū/iwi and Māori business (Awatere et al. 2021a&b). In part, the report was produced in response to criticisms around the poor engagement with Māori during the development of the National Climate Change Risk Assessment (NCCRA) (Ministry for the Environment 2020), the perceived lack of understandings around the specific vulnerabilities of Māori rights and interests, and a lack of specific guidance for whānau/hapū/iwi with respect to climate change adaptation and mitigation.

Awatere et al. (2021a) developed Arotake Tūraru to inform their approach (Figure 6). They argued that the value domains determined by the NCCRA report restricted an in-depth analysis of Māori interests and values in relation to climate change impacts and risks. In response they applied kaupapa Māori-driven approaches to determine the at-risk domains, from a Māori perspective, to focus their efforts, which were:

- He Kura Taiao – Living Treasures,
- Whakatipu Rawa – Māori Enterprise,
- He Oranga Tāngata – Healthy People, and
- Ahurea Māori, Tikanga Māori – Māori Culture, Values and Principles.

The risk assessments were conducted by Ngā Pae o te Māramatanga climate change researchers using a consensus-based expert judgement approach, rather than being done separately, or by several people independently of each other (Awatere et al. 2021a). Māori subject experts identified components of interest for each domain and the risk assessment scale proposed by MfE (2019) was used to inform the scores for each domain of interest (Figure 7).

The first domain, He Kura Taiao – Living Treasures considers how climate change impacts on natural ecosystems and biodiversity will affect iwi, hapū and whānau. He Kura Taiao is broken down into terrestrial, freshwater, and coastal-marine spaces. This has allowed for the authors to provide discussion on risk and uncertainty associated to these different spaces and comment on options that may extend current understandings for future mitigation and adaptation. It is widely understood that natural ecosystems are under pressure due to the ever-changing climate where flora and fauna are

being exposed to various situations that are causing significant impacts. Awatere et al. (2021) expresses the need to better understand how different species/ecosystems are at risk, as climate change will not only affect the species itself, but also significantly affect cultural identity, cultural practices, and whānau/hapū/iwi well-being. Of relevance to Ecosystem Based Management, the risk ratings (for 2021, 2050 and 2100) and adaptation strategies proposed for coastal-marine ecosystems is reproduced in Figure 8.
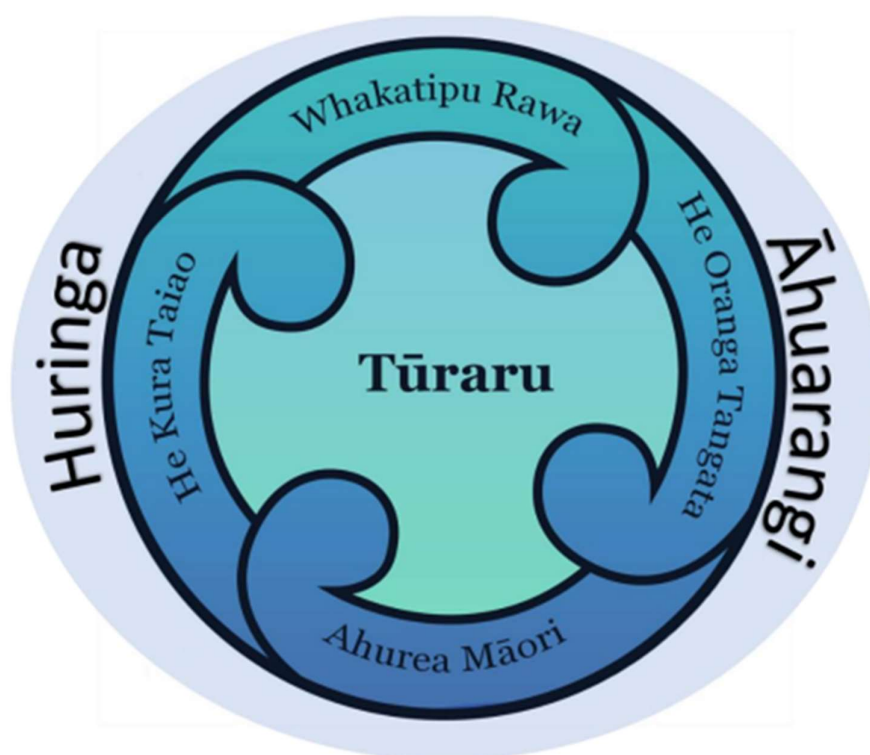
Figure 6: **He Arotake Tūraru.** (Source: Awatere et al. 2021a).

Insignificant	No significant change in impact nationally that can be handled through business-as-usual processes or some local or regional impacts with no specialised management required
Minor	Some minor impacts at the national scale that could be addressed through local or regional management and adaptation processes
Moderate	Significant impacts at the national scale of interest to national agencies to address adaptation, or a major impact for 1–2 sub-national climate zones
Major	Major impacts at the national scale of high interest to national agencies to quickly address adaptation, or an extreme impact for 1 sub-national climate zone
Extreme	Extreme impacts at the national scale (or even in a few sub-national climate zones) of heightened interest to national agencies to urgently address adaptation. May be of interest to international partners or financial or insurance institutions

Figure 7: **Risk (consequence) rating scale that was used to inform the National Climate Change Risk Assessment and He Arotake Tūraru.** (Sources: MfE 2019, Awatere et al. 2021a).

Sector	Group	Interests	Risk		Adaptation strategies
Coastal-Marine Ecosystems	Iwi, hapū, whānau and pan-Māori	Coastal lagoons estuaries and harbours	Now	Minor	• Monitor the variability and rate of change in water temperature, pH, and carbonate systems at different sites
			2050	Moderate	• Improve understanding of the effects of acidification on marine primary production, food quality, habitat availability, and aquatic species • Develop new approaches to ecosystem utilisation, protection, and management, that draw upon science and Mātauranga Māori
			2100	Major	• Monitor, remove, and control the spread of climate-induced invasive species as well as reduce sediment and nutrient runoff to lessen the risks of harm to coastal-marine organisms
Coastal-Marine Ecosystems	Iwi, hapū, whānau, and pan-Māori	Inshore and open ocean	Now	Minor	• Monitor the variability and rate of change in marine temperature, pH, and carbonate systems at different sites around Aotearoa-NZ
			2050	Moderate	• Improve understanding of ecosystem effects of acidification on marine primary production, food quality, habitat availability, and aquatic species • Develop new approaches to ecosystem utilisation, protection, and management, that draw upon science and Mātauranga Māori
			2100	Major	• Monitor, remove, and control the spread of climate-induced invasive species as well as reduce sediment and nutrient runoff to lessen the risks of harm to coastal-marine organisms

Figure 8: **Outcomes of the Arotake Tūraru risk assessment conducted for coastal-marine ecosystems within the He Kura Taiao domain.** (Source: Awatere et al. 2021a).

Sector	Group	Interests	Risk		Adaptation strategies
Commercial Fishery	Iwi, hapū, trusts and incorporations	Kōura, pāua, snapper, gurnard, hoki, scampi, tarakihi, ling, and orange roughy	Now	*Minor*	• Transition quota over time for kōura, pāua, hoki • Investigate management areas for snapper to determine individual risk/opportunity • Retain quota for gurnard and potentially purchase more
			2050	*Major*	
			2100	*Major*	
Aquaculture	Iwi, hapū, trusts and incorporations	Green-lipped mussels, salmon, and multi-trophic	Now	Minor	• Sell quota for green-lipped mussels • Relocate salmon farms offshore or further south • Enter sector for multi-trophic aquaculture
			2050	Moderate	
			2100	Major	
Marine Mammal Tourism	Iwi, hapū, trusts and incorporations	Marine mammal watching	Now	Minor	• Transition to other investments, invest in alternative businesses that utilise the same infrastructure and equipment
			2050	Moderate	
			2100	Major	

Figure 9: **Outcomes of the Arotake Tūraru risk assessment conducted for the commercial fisheries, aquaculture, and marine mammal tourism sectors within the Whakatipu Rawa domain.** (Source: Awatere et al. 2021a).

The second domain, Whakatipu Rawa – Māori Enterprises considers how the Māori economy will be affected by climate change. This section discusses the economies of commercial fisheries, marine mammal tourism, aquaculture, exotic plantation forestry, agriculture, horticulture, property, and employment, whilst also outlining potential climate change risks to these sectors for whānau, hapū and iwi. The authors also stress the need for better whānau, hapū and iwi understandings of these risks. Of relevance to Ecosystem Based Management, the risk ratings (for 2021, 2050 and 2100) and adaptation strategies proposed for commercial fisheries, aquaculture and marine mammal tourism is reproduced in Figure 9.

He Oranga Tāngata, the third domain, reflects the state of Māori health today and considers future impacts to Māori health and identity because of climate change. Importantly, this section acknowledges and discusses Māori health in the context of governing bodies associated with Māori health responses. However, there is recognition that various approaches are needed to address climate change-related health impacts for Māori. Understanding climate change impacts on Māori health involves understanding Māori culture and practices. Māori culture and practices should provide a foundation for how public health initiatives interact and engage with Māori, which also needs to be reflected in health policy.

And lastly, Ahurea Māori, Tikanga Māori demonstrates how Māori interactions with each other and the environment are at risk due to climate change. This domain specifically focuses on language, customs, sports, festivals, tangihanga, and cultural infrastructure. This section highlights explicit links between changes in the climate and Māori ways of being. Not only do climate change risks need to be addressed in relation to the natural environment, but also to Te Ao Māori.

7.2   Serious games and flood adaptation pathways for marae

> The purpose of this case study is to demonstrate how new emerging methods, like serious games, can be co-developed to better understand social and cultural issues for marae communities and inform their decision-making and responses to the potential impacts of climate change on sites of significance. It demonstrates how the use of a variety of knowledge sharing formats enabled all generations to participate in the exploration of risks and potential options for the future of their marae community.

Adaptation requires a focus on the societal context of decision processes (Gorddard et al. 2016) and is especially true for Māori communities who have a variety of governance and decision-making structures and processes. In collaboration with the Tangoio Marae community the 'Exploring adaptation pathways for Tangoio Marae' project funded by the Deep South National Science Challenge developed and tested the eight step adaptation decision model Te Huringa ki te Rangi – He Rautaki Tāwariwari (Figure 10) to help facilitate the critical conversations required to better understand the impacts, experiences and risks associated with flooding.

A serious game, Marae-opoly, was co-developed and tested as a platform which assembled cross-cultural climate change knowledge to learn, safely experiment and inform adaptation decision-making by the Tangoio Marae community (Figure 11). Marae-opoly was bespoke to its intended context—to support the creation of mutually agreeable dynamic adaptive policy pathways (DAPP) for localized food adaptation. Mātauranga Māori, the experiences of the community, and the latest hydrological modelling were brought together and presented back to the community using a variety

of formats (e.g., flooding history reconstructions and timelines, videos, visualisations of hydrological modelling outputs) (e.g., Bind et al. 2018).
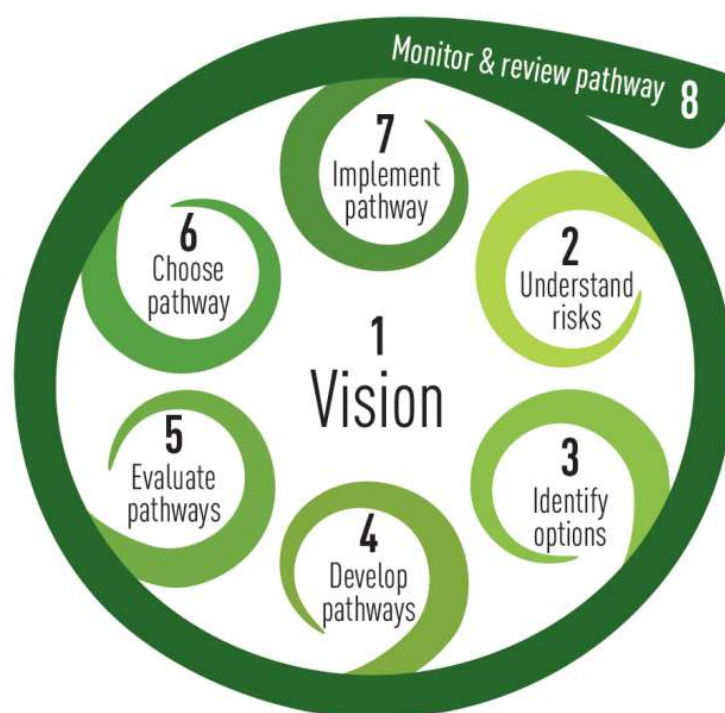

Figure 10:   The eight steps of the decision model, Te Huringa ki te Rangi - He Rautaki Tāwariwari.   The model is relevant to any complex decision-making processes involving competing objectives, uncertainty, and the flexibility to adapt to changing circumstance and knowledge (Source: Colliar & Blackett 2018; Graphic: Jackie Colliar, Aarti Wadhwa).

The variety of formats used enabled the wider community, some of whom may have not experienced extreme flooding events in their lifetime, to better understand the potential implications of different future climate change scenarios over a range of timeframes. These formats enabled all generations (i.e., not only the generation who have directly experienced extreme flooding) of the Tangoio Marae community to better understand how flooding has impacted Tangoio Marae previously, and therefore participate in the exploration of risks and potential options for the future of the marae (Colliar & Blackett 2018). These materials supported the creation of a credible gaming experience for the Tangoio Marae community and the in-situ co-development process used to co-create Marae-opoly was fundamental to inform the outcomes sought by Maungaharuru-Tangitū hapū (Blackett et al. 2021).

The Maungaharuru-Tangitū Marae Options Project (e.g., to relocate or protect and develop) was considered by many whānau to be the most important decision they would make about their marae and hapū. This research supported the Maungaharuru-Tangitū Marae Options Committee to explore all the options available to future-proof Tangoio Marae from floods. The investigation was considered to be thorough and necessary to explore all opportunities before committing to a particular option, i.e., to protect and develop the existing site (Maungaharuru-Tangitū Trust 2018).
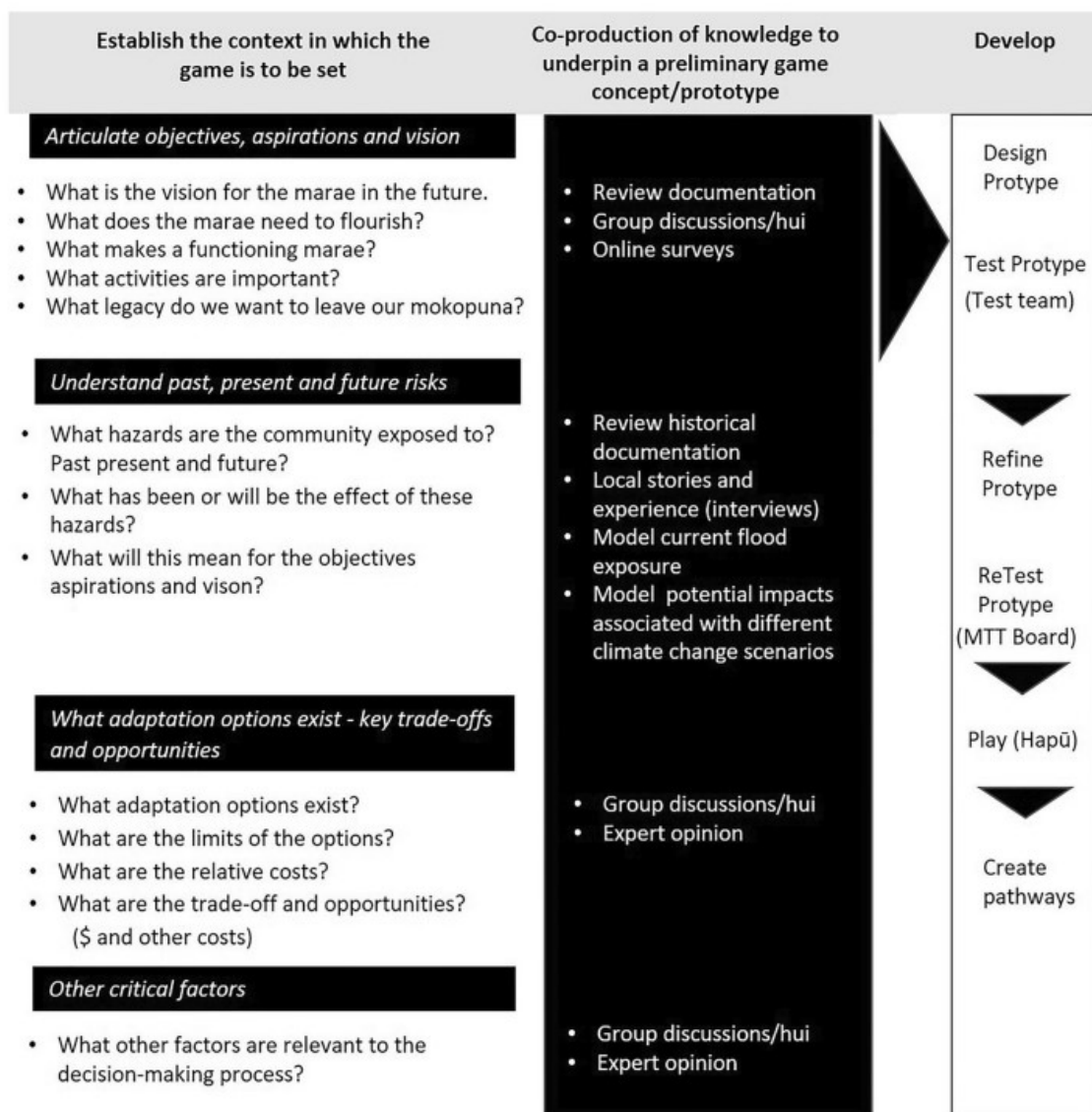
Figure 11: **Co-development process from inception to application used to inform a credible serious gaming experience (Marae-opoly) for the Tangoio Marae community.** (Source: Blackett et al. 2021).

8   Summary

Māori have a special relationship with the environment as an integral part of the natural order, rather than as controllers and exploiters of resources. Therefore, for tangata whenua the environment and associated natural resources are taonga, and how they engage with it is crucial to their integrity, culture, and ongoing ability to keep tikanga, mātauranga and practices alive. Māori values can be defined as instruments through which they make sense of, experience, and interpret their environment and can include values that are both transcendental and contextual, tangible and intangible, material and non-material, qualitative and quantitative (Henare 1988 & 2001, Marsden 1988, Barlow 1993, Harmsworth 1997, Mead 2003 & 2012). These values form the basis of Te Ao Māori and govern the responsibilities and relationships tangata whenua have with the environment which shape the way they make decisions about environmental management (Tipa et al. 2016). To sustain their mana, kaitiaki are bound to do everything they can to preserve and restore the mauri of the environment. Mauri, an internal energy, or life force derived from whakapapa is an essential essence sustaining all forms of life. Everything animate and inanimate possesses this life principle which also links the physical and spiritual worlds. It denotes a health and spirit that permeates all living and non-living things and damage or contamination to the environment is therefore damage to or loss of mauri (Awatere & Harmsworth 2014).

Mātauranga Māori informs kawa and tikanga which guide resource management practices used by tāngata whenua. The relationship with te taiao suffers when tangata whenua cannot fulfil their responsibilities, including managing resources to ensure mauri is preserved and that they are not depleted beyond their ability to replenish. These management responsibilities are embodied in the concept of kaitiakitanga which extends beyond purely protection or preservation of resources to use and enjoyment as well as for economic purposes.

On a daily basis, whānau, hapū and iwi are confronted with a plethora of proposals for resource use and development that all need to be assessed for the potential risks and impacts they may have on the environment, their culture and ways of life that are dependent on ecosystems being in a healthy state. This requires whānau, hapū and iwi to be active participants in a range of statutory and non-statutory environmental management processes (Tipa & Associates 2018). These processes require them to establish and communicate their cultural context, and identify, analyse, evaluate, and monitor risks. However, as Sections 3-7 demonstrate, iwi and hapū may not always use the same language/terminologies and/or methodologies as those working regularly within conventional risk assessment and risk management disciplines.

In this review we have included examples of different frameworks and methodologies that have been developed and tested to better understand risk for, and with, iwi, hapū and whānau. This is by no means an exhaustive list and we encourage the Challenge to regularly explore the published literature (e.g., recent 'mātauranga Māori' focused special issues produced by the New Zealand Journal of Marine and Freshwater Research, Journal of the Royal Society, New Zealand Journal of Ecology) to increase understandings of the diversity and innovation implicit in the new approaches that are being developed and implemented around Aotearoa-NZ.

Māori-centric frameworks have been created to increase understandings of contemporary issues and guide decision-making about their associated environmental risks (e.g., Take-Utu-Ea Framework, Tapu-Noa Model). New innovative approaches/methods that are able to bring mātauranga Māori and other knowledge systems together to explore potential risk management scenarios are being co-developed (e.g., Mauri Model, Serious games, Perspectives of Tamariki volcanic hazards) – some of

which have been adapted from international best practise to better respond to the needs of Māori (e.g., adaptation of the USEPA Risk Assessment method). These approaches are being used to strategically guide improved, impactful, and more holistic decision-making, that considers risk, for the benefit of Māori (e.g., He Whetū Mārama, Ngāi Tahu Māori Recovery Network, He huringa āhuarangi, he huringa ao).

From a Crown agency/partner perspective, the EPA Mātauranga Programme and Framework provides one of the few examples of an agency committing to the development and implementation of a clear organisational-wide strategy to increase understanding of mātauranga and move beyond current business-as-usual practises (EPA 2020). Based on the successes and challenges raised by the case studies some key learnings that can be used to support iwi/hapū and their assessments of the direct and indirect impacts and risks of different environmental/marine-based activities include:

- Creating genuine and forward-looking relationships, founded on face to face interactions as well as equitable input (i.e., respecting tangata whenua as experts) and resourcing.

- Engagement with whānau, marae, hapū, rūnanga and iwi at multiple levels that conforms to ethical guidelines and recognises the principles, tikanga, and the rights, roles, and responsibilities of tangata whenua.

- Mātauranga Māori provided and interpreted by iwi/hapū/whānau experts within the unique context/place within which the knowledge was/is being generated.

- Co-developed frameworks with the ability to integrate cultural and ecosystem components and overcome the artificial divides between humans and the environment (as required by the Māori worldview).

- Mātauranga Māori is treated (at least) equally alongside conventional perspectives/science to assess risks manage environmental impacts (including the exploration of potential unforeseen consequences and cumulative effects). The two paradigms do not always replicate one another and will strengthen and complement each other.

- Provide iwi/hapū with access to high-quality information and datasets in a variety of formats (e.g., reconstructions and timelines, videos, visualisations, interactive games, and activities) to enable all generations to participate.

9   Acknowledgements

10 Glossary of Te Reo Māori terms

Ahurea Māori, Tikanga Māori	Tikanga Māori – Māori Culture, Values and Principles (Awatere et al. 2021a)
Ea	To be satisfied
Hapū	Is a tribal grouping that consists of whānau who typically share descent from a common ancestor
He Kura Taiao	Living Treasures (Awatere et al. 2021a)
He huringa āhuarangi, he huringa ao	'A changing climate, a changing world' report produced by Nga Pae o Te Māramatanga Centre of Research Excellence
He Oranga Pounamu	He Oranga Pounamu Charitable Trust (Ngāi Tahu)
He Oranga Tāngata	Healthy People (Awatere et al. 2021a)
He Whetū Mārama	He Whetū Mārama is a framework that guides the Environmental Protection Authority in the undertaking of its statutory and other obligations to Māori.
Iwi	Is an extended tribal grouping that consists of hapū or whānau who typically share descent from a common ancestor and associate with a distinct territory
Kai	Food
Kaimoana	Seafood
Kanohi-ki-te-kanohi	In the context of this report, individuals coming together to meet face to face
Kaitiaki	Guardian
Kaitiakitanga	Guardianship
Kaupapa Kura Taiao	Environment Protection Authority Māori Policy Unit
Kaupapa Māori Research	Kaupapa Māori Research refers to an approach, framework or methodology for thinking about and undertaking research. Kaupapa Māori research is an approach especially for researchers who are Māori undertaking research with Māori. A Kaupapa Māori approach forces a Māori researcher to think through ethical, methodological and cultural issues from all sides, before, during and after they have conducted their research. Kaupapa Māori research focuses on Māori culture, language, values, history, people and contemporary realities (Source: http://www.rangahau.co.nz/rangahau/) For more information also see: http://www.katoa.net.nz/kaupapa-maori
Kawa	Marae protocol
Kaumātua	Elderly people
Koroua	Elderly man
Kuia	Elderly woman
Mahinga kai	Mahinga kai refers to the specific locations and actions that Ngāi Tahu undertakes to harvest and manage particular resources. The resources included plants, muds and clays, animals (for meat, fats, oils and feathers/skins), rocks, minerals and waters. The mahinga kai term incorporates tikanga, whakapapa, and a holistic knowledge and understanding of the interdependences between habitats, species and humans
Mana	Prestige, authority, control, power, influence, status, spiritual power
Manaaki Whenua	Landcare Research

Māori	Indigenous people of Āotearoa-New Zealand
Mātauranga Māori	Is a holistic perspective encompassing all aspects of knowledge and seeks to understand the relationships between all component parts and their interconnections to gain an understanding of the whole system. It is based on its own principles, frameworks, classification systems, explanations and terminology. Mātauranga Māori is a dynamic and evolving knowledge system and has both qualitative and quantitative aspects
Mātauranga-a-Ngāti Rangi	Knowledge of Ngāti Rangi
Matangaro	To be absent, hidden
Matua te Mana	Ruapehu as the guardian of mana who uses volcanic activity to share his mana
Mauri	Essential life force or principle, a quality inherent in all things both animate and inanimate
Maunga	Mountain
Ngā Kaihautū Tikanga Taiao	Environment Protection Authority Statutory Māori Advisory Committee
Ngā tohu	A sign
Ngā Pae o Te Māramatanga	New Zealand's Māori Centre of Research Excellence
Ngā Parirau o te Mātauranga	Kaumātua from Te Herenga (Environment Protection Authority National Maori Network)
Noa	Passive state with an absence of limitations or conditions
Rangatahi	Younger generation
Rāhui	Temporary ritual prohibition/restriction
Ritenga	Ritual
Rongoā	Remedy, medicine, drug, cure, medication, treatment
Rūaumoko	Atua of earthquakes and the youngest child of Ranginui and Papatūānuku
Rūnanga	Council, assembly
Take	Topic, subject, matter, issue, concern
Tamariki	Children
Tāngata whenua	People of the land
Tapu	To be sacred, prohibited, restricted
Taonga	An object or natural resource which is highly prized
Te Atiawa	Māori iwi with traditional bases in Taranaki and Wellington
Te Ao Māori	Māori worldview
Te Ao Pākehā	Pākehā worldview
Te Herenga Network	Environment Protection Authority National Maori Network
Te Huringa ki te Rangi - He Rautaki Tāwariwari	Eight step adaptation decision model to facilitate complex decision-making processes
Te Kura Kaupapa Māori o Ngāti Rangi	Primary school of Ngāti Rangi
Te Mahi o Ruapehu	The work of Ruapehu (volcanic products: events, deposits and benefits)

Te Pāti Māori	The Māori Party
Te Puni Kōkiri	The Ministry of Māori Development
Te Rūnanga o Ngai Tahu	New Zealand South Island Māori tribe
Te Taiao	The environment
Te Tiriti o Waitangi	Te reo Māori version of the treaty first signed on 6 February 1840 by representatives of the British Crown and Māori chiefs
Te Whakapapa o Papatūānuku	The genealogy of Papatūānuku
Te Whare Toka ō Paerangi	For the purposes of this report – tectonic rock cycle
Tikanga	Custom, ethic, etiquette, method, protocol
Utu	To repay, avenge
Waiata	Song
Waka Hourua	Double canoe
Wawata	Aspiration
Whakapapa	Genealogical connection, relationships within and between species and relationships among phenomena of different kinds
Whakataukī	Proverb
Whakatipu Rawa	Māori enterprise (Awatere et al. 2021a)
Whānau	A family group that consists of individuals who typically share a common whakapapa and identify with a common living or recent ancestor
Whānui	Be broad, wide, extensive

11   Glossary of abbreviations used in this report

EPA	Environmental Protection Agency (NZ)
HZNO	Hazardous Substances and New Organisms
NCCRA	National Climate Change Risk Assessment (NZ)
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
USEPA	United States Environmental Protection Agency

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