Achieving societal collaboration and impact in Aotearoa-New Zealand through transdisciplinarity

Aotearoa-New Zealand (A-NZ) faces growing complex environmental challenges and a persistent knowledge-action gap that leaves many social and environmental problems unresolved. The Ministry of Business, Innovation, and Employment, a major science funder, has called for transdisciplinary modes of research to address increasingly complex problems in an integrated and collaborative fashion. We explore what is needed for transdisciplinary research (TDR) to achieve societal collaboration and impact in A-NZ. We introduce mātauranga Māori, *A-NZ's Indigenous and foundational knowledge system, and discuss how* mātauranga Māori *and Western science currently interact. We examine some social and environmental consequences when* mātauranga Māori *is marginalised and conclude by discussing how TDR must evolve in order to help tackle complex social and environmental problems in such contexts.*

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This Forum article arose from a plenary panel of the *2021 International Transdisciplinary Conference (ITD21)* that focused on transdisciplinary research (TDR) for societal collaboration and impact, in this case in Aotearoa-New Zealand (A-NZ). Although the term TDR is increasingly used and promoted in A-NZ, there are concerns about its interactions with *mātauranga Māori,* the knowledge system of the Indigenous Māori people. To explore this relationship, we begin by briefly describing *mātauranga Māori* and its revived usage in environmental management. We juxtapose *mātauranga Māori* and Western science and describe interactions in the environmental domain and the consequences of marginalisation. We conclude by briefly exploring the necessary evolution of TDR for societal impact in A-NZ.

What is *mātauranga Māori* and how does it influence environmental management in Aotearoa-New Zealand (A-NZ)?

Mātauranga Māori is the Indigenous knowledge system of A-NZ. It includes the body of Māori knowledge, both traditional and modern, contained within a dynamic and evolving knowledge system of the observations, experience, study, and understanding of the world from an Indigenous perspective (Harmsworth et al. 2013). *Mātauranga Māori* incorporates *Te Ao Māori* (the Māori worldview), values, systems, and methods of knowledge creation, transfer, and storage, and all the knowledge generated by those methods (Hikuroa 2017). It is locally specific and based on long-standing interactions between people and their environment.

The influence of *mātauranga Māori* on environmental management in A-NZ has oscillated dramatically. Before the colonisation of A-NZ by European settlers in the early 19th Century, *mātauranga Māori* (although not a term used then) was the only knowledge system, and it had developed over centuries through understanding how to live in reciprocity with the environment (Harmsworth and Awatere 2013). *Te Ao Māori* thus shaped ways of knowing pre-colonisation, where people are seen as a part of, and genealogically connected to, the natural world, and interconnectedness and holism are fundamental concepts (Harcourt et al. 2022). Colonisation quickly led to the marginalisation of *mātauranga Māori* in favour of Western values and systems of government, and soon Māori were actively discouraged from practicing their culture (Walker 2003). Western notions of land ownership fuelled land wars, ultimately leading to physical and spiritual disconnection of Māori from their lands (Moewaka Barnes and Mc Creanor 2019), undermining the knowledge system itself (Ngata et al. 2018).

Since colonisation and the signing of *Te Tiriti o Waitangi*/the Treaty of Waitangi *(te Tiriti)* between the British Crown and Māori in 1840, Western governance systems have dominated A-NZ's

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BOX 1: Example of *mātauranga Māori* influence on water management

In 2020, the national policy of freshwater was updated for the fourth time in ten years. A significant change was the increased prominence of *Te Mana o Te Wai (TMOTW)* as the fundamental policy concept. *TMOTW,* which broadly refers to the authority of water itself, is a concept form *mātauranga Māori.* It gives prominence to Māori values, with the health, *mana* (prestige, authority) and *mauri* (spiritual life-force) of freshwater given the highest priority, followed by drinking water for human health, and then other uses of freshwater. This is a significant shift from previous science framing, for example, ecosystem health.

BOX 2: Example of *mātauranga Māori* influence on data sovereignty

Indigenous data sovereignty is part of a global conversation that encompasses how Indigenous people socialise, exchange and access data and information (Kukutai and Taylor 2016). Although A-NZ is yet to formalise their position on how to ensure compliance with the *Nagoya Protocol,* a groundswell of initiatives has ensured Māori voices are included at the table when issues of data and information are being discussed, for example, guidelines on genomic research with Māori (Hudson et al. 2016).

environmental policy and legislative frameworks (Harcourt et al. 2021). In 1991, local governments were, for the first time, required to take account of Treaty principles and to acknowledge the relationship Māori have with their environment. In practice, however, Māori have struggled to have Māori values, issues, and knowledge incorporated within environmental management (Muru-Lanning 2012).

In the 1970's, Māori culture began to experience a renaissance which has gained considerable momentum in the last few years, shifting societal and political views. An example of this increasing influence is that concepts from *mātauranga Māori* have recently become central to new environmental legislation and policy (e. g., MfE 2020). We illustrate this shift with two examples: water management and data sovereignty (boxes 1 and 2).

A-NZ has two underlying knowledge systems: *mātauranga Māori* and Western knowledge. Western knowledge systems refer to the content and context of knowledge systems driven by the values and cultures of Western civilisations, and its knowledge processes are encapsulated by the term Western science. Although Western science is an imperfect term as it incorporates knowledge from non-western epistemologies, the structure of Western science reflects western philosophical traditions (Hikuroa 2017). Hikuroa (2017) summarises some key epistemological differences between A-NZ's underlying knowledge systems (table 1). Building on the examples in boxes 1 and 2, we describe how these are approached by the two knowledge systems.

Approaches to water management tend towards either reductionism or holism. In the current national policy for managing freshwater, there are four compulsory values that all regulators must consider: ecosystem health, human contact, threatened species, and *mahinga kai* (MfE 2020). For the first three values, biophysical drivers, such as in-stream nitrogen concentration, have been identified, and acceptable amounts are defined nationally, providing the foundation for regulation. These determinants are then generally monitored through routine sampling. The fourth and most recently added value, *mahinga kai,* uses quite a different approach. The *mahinga kai* value is not able to be nationally defined. The exact meaning and derivation must be determined by the local *hapū* (local Māori community), which allows for local variations. The value is multi-faceted: whether gathered food is safe to harvest and eat; knowledge about traditional preparation and storage, and whether cooking is able to occur; whether the species involved are plentiful for long-term harvest; and whether the range of species desired is present across all life stages. The value also includes that the *mauri* (spiritual life force) of the place is intact, and that the *Te Mana o Te Wai (TMOTW)* principles of *Mana whakahaere, Kaitiakitanga,* and *Manaakitanga* are able to be enacted (table 2, p. 128) (Ruru et al. 2022). Many aspects of this value cannot be monitored or measured using scientific methods and approaches or even fully understood by the Western knowledge paradigm. Both setting and monitoring this fourth compulsory value require expertise and ways of knowing that are beyond science.

For data, the tension between the knowledge systems can be neatly articulated by the comparison of data principles. Technology advancements have accelerated the ability to collect and process a wide array of data. The *FAIR Guiding Principles for scientific data management* (Findable, Accessible, Interoperable and Reusable, Wilkinson et al. 2016) are becoming a best practice standard for scientific data management. These principles promote openness, efficiently building on others' data and not reinventing the wheel, and they respond to calls to make the ever-increasing body of data accessible and available. However, they do not reflect important considerations in using Indigenous data. Within *mātauranga Māori,* all the knowledge strands pertaining to, for example, a single plant species, have a complex set of interconnections that need to be carefully managed to ensure their integrity remains. It is essential to maintain the relationship between the plant species and the people associated with its source because, within *mātauranga Māori,* plants form part of genealogical connections, and because *mātauranga Māori* is inherently a local system of knowledge (Lambert 2014), and knowl- >

TABLE 1: Some differences between *mātauranga Māori* and Western science (Hikuroa 2017, p. 9).

MĀTAURANGA MĀORI	WESTERN SCIENCE
participatory "experiencers" of systems	detached "observers" of systems
explicit intrinsic values	implicit instrumental values
knowledge as belonging	knowledge for control
intuition as method	intuition rarely acknowledged
inclusion of facts and values	facts and values are separated
everything is connected	everything physical is connected

TABLE 2: The first three principles of implementing *Te Mana o Te Wai (TMOTW)* (MfE 2020).

PRINCIPLES OF *TE MANA O TE WAI*	MEANING
Mana whakahaere	the power, authority, and obligations of *tangata whenua* (Māori local to the area) to make decisions that maintain, protect, and sustain the health and well-being of, and their relationship with, freshwater
Kaitiakitanga	the obligation of *tangata whenua* to preserve, restore, enhance, and sustainably use freshwater for the benefit of present and future generations
Manaakitanga	the process by which *tangata whenua* show respect, generosity, and care for freshwater and for others

edge taken out of context can lose its meaning. More broadly, for Māori, having sovereignty over knowledge and how it is used is an essential dimension of self-government and self-determination (Kukutai and Taylor 2016). These concerns led to the development of the *CARE principles* (Collective benefit, Authority to control, Responsibility, Ethics, Carroll et al. 2020), specifically for Indigenous data.

Social and environmental consequences when *mātauranga Māori* is marginalised

Indigenous wisdom is increasingly recognised as having a significant role in tackling complex socio-environmental problems (Young 2021) drawing from a deep understanding of how to live in reciprocity with the environment, developed over centuries. Supporting this notion, Abson et al. (2017) identified "reconnection with nature" as one of three realms of leverage critical for achieving sustainable transitions. Thus, the marginalisation of *mātauranga Māori* in A-NZ has far-reaching consequences. With its inherent reductionist approach, an environmental management system framed by a Western worldview radically affects how the problems are managed. For example, for Māori, a waterbody embraces the entire landscape, including socio-cultural considerations, and management is predicated on a fundamental understanding that the health of any element within the landscape will have repercussions for other elements (Tipa 2009). This is at odds with a Western science freshwater management approach that focuses on the discrete management of chemical, ecological, and physical characteristics of the watercourse (Stewart-Harawira 2020).

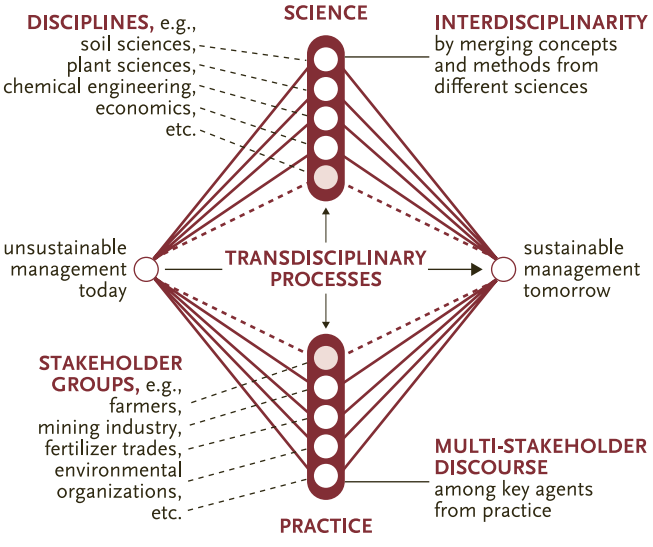
The framing of environmental management is not the only impediment to Māori participation in decision-making. Despite the obligations of *te Tiriti,* and acknowledging the recent shifts in environmental policy, there remains legislation that disempowers in part through decision-making processes being ill-suited to Māori ways of engaging (Paul-Burke et al. 2020), through Māori knowledge being largely marginalised (McAllister et al. 2022), and through disconnection from land, which prevents Māori from having the intimate contact with nature needed to understand the environmental needs and deliver the appropriate response (Ngata et al. 2018). Furthermore, the consequences of environmental degradation for Māori are profound, with an inextricable link between the health and well-being of water and the health and well-being of *tangata whenua* (Ruru 2012).

What role does transdisciplinary research have in A-NZ?

Exploring the role of TDR in A-NZ, we focus on Mode-2 TDR: 1. in part due to its reach; Scholz and Steiner (2015) consider that Mode-2 has become the third way of doing science, alongside mono- and interdisciplinary approaches. 2. In recent years, the Ministry of Business, Innovation, and Employment (MBIE) , the major science funder in A-NZ, has called for TDR to address increasingly complex social and environmental problems, describing TDR as enabling integration across research areas, conceiving of stakeholders, end users and Māori as research collaborators, and linking strongly with business, government and end users (MBIE 2019, 2021). MBIE's description parallels Mode-2 TDR, which focuses on bringing local, scientific and industry knowledge together to co-produce socially robust knowledge (Cole 2017, Scholz and Steiner 2015), and underpinning this approach is the juxtaposition and relationship between science and society (e. g., Jahn et al. 2012, Pohl et al. 2021, Scholz and Steiner 2015).

Given the dual knowledge system foundation of A-NZ, we ask how would *mātauranga Māori* fit in a science-centric conceptualisation of TDR like mode-2 (Cole 2006, 2017, Vilsmaier et al. 2017) such as shown in figure 1? It is neither science nor simply a stakeholder perspective, but a knowledge system with its own ontologies and epistemologies, and knowledge development ap-

FIGURE 1: A conceptual model of a Mode-2 transdisciplinary research process reproduced from Scholz and Steiner (2015, p. 529).



proaches (Cole 2017, Hikuroa 2017). If the TDR process is created and held according to Western science that privileges knowledge processes that, for example, separate subject and object and which exclude the sacred and metaphysical (e.g., Cole 2017), this is unlikely to provide a neutral space for a knowledge system that includes all three, wrapping facts and values together. The same question applies for Māori themselves; how would Māori fit in a TDR process such as figure 1? Māori are not just another stakeholder; the principles of *te Tiriti* provide for partnership, not consultation. Pohl et al. (2021, p. 20) describe TDR as bringing together "representatives" of perspectives such as "a biologist, a linguist, a feminist, a governmental official, a farmer, a member of an Indigenous community". However, how can one member "represent" a whole knowledge system, especially when that knowledge system would also have other equivalents to biologists, linguists, feminists, farmers and government officials?

We argue that the dimensions of science and society shown in figure 1 are necessary but insufficient for A-NZ, additional dimensions of *mātauranga Māori* and of Māori communities are missing. Further to this the type of "representation" mode such as that described by Pohl et al. (2021) can systematically disadvantage Indigenous knowledge and communities. A-NZ is not alone in grappling with this. Chilisa (2017) and Berger-González et al. (2016) both describe the challenges of overcoming epistemological biases and establishing parity within TDR especially in the context of colonisation.

In its most basic form, research is a way of discovering the world. But research is not a value-neutral activity. What is considered worthy of research and research approaches that are considered legitimate are culturally mediated and impacted by events, such as colonisation (Chilisa 2017, Cole 2017, Llanque Zonta et al. 2023, in this issue). We argue that, as research approaches have societal consequences, TDR approaches in A-NZ have a responsibility not only to be cognisant of Aotearoa's history and *te Tiriti*, but to actively engage with A-NZ's dual knowledge systems foundations.

How does transdisciplinary research need to adapt to perform a significant role in A-NZ?

Struggles over how to achieve sustainability have been characterised by clashes and controversies of knowledge (Van Kerkhoff 2014). In A-NZ, this is made more complex with two underlying knowledge systems. The need for research approaches that can comfortably work with these dual knowledge systems is even more pressing to achieve A-NZ society's environmental goals. TDR has many strengths, but to play a significant role in A-NZ we argue that it must adapt in several ways:

1 ***Theory.*** The relationship between Māori knowledge approaches and TDR needs further exploration (Cole, 2017), as does the theorisation underpinning a decolonised (Chilisa 2017, Cole 2017) TDR.

2 ***Method.*** The adaptation or development of research methods that do not assume a central position of Western science, scientific methods, and norms (Robson-Williams et al. 2020), and that have a dual knowledge of traditions and systems at their core (Berger-González et al. 2016, Chilisa 2017) are essential to ensure TDR does not become another colonising influence.

3 ***Evaluation.*** Theory is integral to evaluation; it is the underpinning theory that defines what evaluation is (Kerr 2012). The evaluation of TDR is already a challenging methodological problem (de Jong et al. 2011), and the challenges will be particularly acute in A-NZ, where conceptions of legitimacy and credibility (Harcourt et al. 2022) and questions of robustness, rigour, and replication and evaluations are often centred on scientific, or non-Māori perspectives (Hepi et al. 2021). As the need for evidence of the efficacy of TDR grows (e.g., Wiek et al. 2014), the refinement of TDR evaluations that can accommodate two knowledge systems will be necessary.

To conclude: In this *Forum* article, we introduce the dual knowledge foundations of A-NZ and argue that in order for TDR to achieve societal impact in A-NZ, it must evolve from a science-centric research approach to one that has the dual knowledge foundation at its core.

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