Integration of Indigenous Knowledge and Science

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Abstract: Indigenous knowledge cannot be verified by scientific criteria nor can science be adequately assessed according to the tenets of indigenous knowledge. Each is built on distinctive philosophies, methodologies and criteria. Indigenous knowledge has been considered incompatible with Western empirical based science, mainly because of the inclusion of holistic and spiritual components in the former. While there is considerable debate about their relative merits, contests about the validities of the two systems distract from integration research, and the subsequent opportunities for creating new knowledge. A decision-making framework that achieves integration - the Mauri Model - is discussed.

Keywords: Indigenous Knowledge, Science, Integration, Mauri Model

Integration of Indigenous Knowledge with Science

ALL INDIGENOUS PEOPLES have a tradition of unity with the environment and have developed their own views of ecosystems throughout human history. Most of them based in traditional knowledge systems, which they use to understand and interpret their own biophysical environments (Durie 2004; Iaccarino 2003; Peet 2006). These systems of living as a part of and managing the environment constitute a key part of the cultural identity and social integrity of many indigenous peoples (Durie 2004; Mazzocchi 2006; Patterson 2009; Peet 2006). Additionally, indigenous knowledge embodies a wealth of wisdom and experience of ecosystems gained over millennia from direct observations, and transmitted – most often orally – over generations (Durie 2004; Mazzocchi 2006). "Indigeneity can be conceptualized as a state of fusion between indigenous peoples and their accustomed environments and arising from that fusion a system of knowledge developed" (Durie 2004, p. 4). The characteristics of indigeneity are identified as: unity with the environment (holistic); geographic relationship that reinforces belonging (place); endurance over many generations (time); development of a distinctive culture (identity); a system of knowledge; sustainability; and a unique language (Morgan 2006b). All of these characteristics are underpinned by the primary characteristic of the enduring relationship between peoples, their territories and the natural environment (Walker 1990; Durie 2005).

With increased pressure on the world's resources and ecosystems, the importance of employing indigenous knowledge for the security of biodiversity and the realization of sustainable development is becoming recognized internationally (e.g. Gadgil *et al*. 1993; Durie 2004; Mazzochi 2006, Morgan 2006a,b). There is an increasing international demand for transparent and stakeholder sensitive decision-making processes (Morgan 2006b). The op-

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portunity that this shift in the decision-making paradigm represents affords the opportunity for discussion of a sustainable future for the planetary ecosystem and consideration of more holistic approaches to decision-making worldwide (i.e. based on indigenous knowledge concepts). The shortcomings of science combined with a capitalist mindset are being appreciated, and a solution is being sought. An integrated indigenous knowledge and science approach may provide the solution. Furthermore, an integrated indigenous knowledge and science approach will likely engage a part of society that is currently not largely connected with science, if connected at all.

Indigenous Knowledge

The defining characteristic of indigenous peoples is a longstanding relationship with land, forests, waterways, oceans and the air and an underlying tendency toward what we would call today sustainability (e.g. Cajete 1994, Durie 2004; Peet 2006). Durie (2004) states:

> "The relationship between people and the environment forms an important foundation for the organization of indigenous knowledge, the categorization of life experiences, and the shaping of attitudes and patterns of thinking. Because human identity is regarded as an extension of the environment, there is an element of inseparability between people and the natural world" p. 4-5.

The individual is a part of all creation and the idea that the world or creation exists for the purpose of human domination and exploitation is absent from indigenous world-views (Duran & Duran 1995). The basis for knowledge creation is the dynamic relationships that arise from the interaction of people with the environment, generations with each other, and social and physical relationships (Durie, 2004). The three most distinguishing features of indigenous knowledge are said to be that it is a product of a dynamic system, it is an integral part of the physical and social environments of communities, and that it is a collective good (Viergiver 1999).

Whilst an indigenous knowledge system is often valued because of its traditional qualities, the dynamic, creative and inventive capacity that forms its core is often overlooked. The common perception of indigenous knowledge as applicable only to the distant past is erroneous and misses the thrust for development that is part of the indigenous journey (Durie 2004). The commonly held view is that indigenous knowledge is static and only relevant to the past. That view, however, is often a product of attempts to relegate first peoples to a pre-colonial era and part of the colonization process (Smith 1999; Durie 2004). Sadly that view is erroneous as it "overlooks the expansion of knowledge by indigenous peoples as they explored their environments, developed theories about social relationships and drew conclusions about the nature of the universe" (Durie 2004, p. 11). No culture is static and indigenous knowledge systems carry a tried and tested formula for exploring the future.

Most indigenous peoples have depended for millennia on their direct environment for subsistence and autonomy (Mazzocchi 2006). During that time they have developed systems and strategies to manage and use their resources that ensures their conservation for future generations (Mazzocchi 2006; Patterson 2009). The focus for such indigenous peoples was preservation of their society, culture and stability and integrity of their environment as opposed to maximizing production (Mazzocchi 2006). Accordingly, there is no exploitation of natural resources, which are not considered a collection of commodities. Indeed exploitation is

considered abhorrent when viewed in the concept of 'mother' earth, a common theme in indigenous peoples, i.e. one would not 'exploit' ones mother. On the contrary, an indigenous way of life is based on a strong sense of interconnection and interdependence (Mazzocchi 2006), mutual reciprocity was the code of behaviour (Cajete 1994), and in which resources are considered collective and intergenerational (Durie 2004), and management of which is based on shared meanings and knowledge (Berkes 1993).

Indigenous knowledge has developed a concept of the environment that emphasizes the symbiotic character of humans and nature (Mazzocchi 2006), and in many instances would not make a distinction between the two. That concept is taken one step further by the Maori of New Zealand, for whom by the personification of Papatuanuku – Earth Mother – and the trees and vegetation which clothed her body, were of special significance in that they saw the land as permanent and lasting, while they themselves were doomed to die as mere mortals (Pere 1982). Indigenous knowledge affords an opportunity for "development that is based on co-evolution with the environment, and on respecting the carrying capacity of ecosystems" (Mazzocchi 2006, p. 463-464). Such knowledge, based on long-term empirical observations adapted to local conditions and grounded in a paradigm of intergenerational continuity, ensures prudent use and management of the environment. Indeed the New Zealand Maori concept of kaitiakitanga – best translated into English as guardianship – demands that each generation passes on the resources in at least as good a state, but preferably improved.

So, arising from the creative potential of indigenous knowledge is the prospect that it can be applied to modern times in parallel with other knowledge systems (Durie 2004). The key question, however, is whether it can also be applied in association with other systems.

Science and Indigenous Knowledge

The concept of contested knowledges between indigenous communities was an accepted part of life (Smith, 1999). This likely led to creating an environment of tolerance, mutual respect and reciprocity between indigenous communities. However much of the debate between scientific research and indigenous knowledge takes three distinct forms: 1. opposition to the promotion of science as the only valid body of knowledge; 2. the rejection of science in favor of indigenous knowledge; 3. the misinterpretation of knowledge by the use of system-bound criteria.

> "Science has become a dominant global knowledge system and has often been accused of intolerance towards other persuasions. If a conclusion cannot be supported by empirical evidence, if practice is not evidence based, or if there is an inability to replicate results, then validity is in doubt. Method is all-important and objective measurement is the final arbiter" (Durie, 2004, p. 6-7).

Furthermore written text (seen as expert and research-based) has always been afforded a greater status than oral evidence (seen as anecdotal and fraught with respect to accuracy).

Systems of knowledge that do not subscribe to scientific principles are afforded lesser status and, if given any recognition at all, run the risk of being rationalised according to scientific principles (Semali & Kincheloe 1999). Furthermore, the concept of an interface between science and indigenous knowledge serves to retrench science in the Western-

European world and creates a position from which scientific academic tradition can potentially mine indigenous knowledge with impunity (Mercier, 2007).

Indigenous Knowledge and Science

Yet just as science has either ignored indigenous knowledge or reinterpreted it to fit in with scientific logic, indigenous people have in turn frequently dismissed science as a legitimate knowledge base due to its inability to explain spiritual phenomena or even recognize the existence of the natural world as something more than a scientifically-observable construct (Durie, 2006, Knudtson & Suzuki 1992).

A general distrust and opposition to science and to scientific research by many indigenous peoples is also linked to three other concerns as outlined by Durie, he states:

> "First the experience of some indigenous communities has been that scientific research has been used to characterize indigenous peoples in ways that reduce their standing in the eyes of other citizens, while second, some researchers have plundered indigenous knowledge, reconstructed its meaning and published findings as if they were their own. The third concern is linked especially to methodology. While analysis into smaller and smaller components is a standard scientific method, indigenous knowledge places greater emphasis on the construction of models where multiple strands can be accommodated to make up an interacting whole. Understanding comes not so much from an appreciation of component parts as from synthesis into a wider context" (Durie 2004, p. 7).

The situation whereby indigenous peoples mistrust of science and conversely scientific disbelief in indigenous knowledge, have in common a tendency to evaluate each other according to limited criteria (Durie 2004). Yet despite the methodological gulf between the two, there is room for each system to find accommodation by the other without distorting the fundamental values and principles upon which each rests (Morgan 2006a, b). Scientific knowledge is one body of knowledge acquired through certain procedures and indigenous knowledge is another. Whilst there are many similarities shared between scientific knowledge and indigenous knowledge, it is important that the tools of one are not used to analyse and understand the foundations of another (e.g. Durie 2004). Furthermore, the mindsets that conclude that a system of knowledge that cannot withstand scientific scrutiny, or alternately a body of knowledge that is incapable of locating people within the natural world, lacks credibility (e.g Durie, 2004) further polarize the debate. Enormous potential is to be found by moving beyond such arguments.

Indigenous Knowledge vs Science

Science is the dominant global knowledge system. Contests about the relative validity of science or indigenous knowledge are usually conducted on the assumption that one is inherently more relevant than the other (Durie 2004). Seldom does such a polarised debate generate wisdom and less frequently does it lead to the generation of new knowledge or fresh insights. Instead positions become more entrenched as proponents defend their ideological positions. In practice, however, it is not unusual for scientists or indigenous peoples to live comfortably

with the contradictions of different bodies of knowledge. Many scientists subscribe to religious beliefs that cannot be explained by science, and many indigenous people use scientific principles and methods in everyday life while at the same time holding fast to indigenous values.

Rather than contesting relative validities, there are an increasing number of workers who use the interface between science and indigenous knowledge as a source of inventiveness and inspiration (Durie 2004, Peet 2006). They have access to both systems and use the insights and methods of one to enhance the other. In this approach, the focus shifts from proving the superiority of one system over another to identifying opportunities for combining both. Further, tension between knowledge systems to establish superiority of one over another is not useful when the solution being sought cannot be provided by either knowledge system in isolation. Integration research attempts to utilize two sets of values and methods not simply to bridge the benefits that might arise from each, but ultimately to produce gains for indigenous peoples in the first instance, most of whom live at the interface, and the remaining global community in the second.

Comparing Indigenous Knowledge and Science

For many years indigenous knowledge and science have been considered incompatible with most of the focus on the differences between the two. The following is a summary of some the differences and similarities between indigenous knowledge and science (modified after Roberts 1998).

Empirical Databases

Similarities	**Differences**
Observation of nature	IK trial and error
Information accumulated over time, systemized, stored and transmitted either orally or in written form	WS experimentation repetitive; under controlled conditions
	IK holistic
	WS primarily quantitative
	IK over millennia
	WS short term

Theories and Predictions

Similarities	**Differences**
Theoretical constructs common to both systems	IK uses intuitive learning paradigm
	WS strong reliance on theory
	WS focus on predictability of results (variance)

Testability

Similarities	Differences
Seasonal practices involve repeatedly testing IK integrity	IK natural uncontrolled conditions
WS experiments, peer reviews, publication	WS pre-selected parameters

Explanations of Cause & Effect

Similarities	Differences
Both systems involve explanations of cause and effect as important components	WS limited to objective, ideally mathematical, linear, gender, culture & value-free, apolitical, analytical
	IK uses all information

Modified after Roberts (1998)

It is immediately apparent that most indigenous knowledge has been developed according to the principles of science. The key difference between the two is that indigenous knowledge is broader in its search for solutions. Science sets out to weigh, measure and otherwise quantify (Huxley, 1958), whereas indigenous knowledge "aims to understand the world in a holistic way that acknowledges of things that cannot be measured by tools, machines or implements of our making" (Mercier 2007, p. 25).

Exploring the Integration

Discovery of new knowledge is the core driver of all research. For integration research however, discovery owes its innovation to insights drawn from two knowledge systems that have moved together in directions not possible by recourse to one system only (Durie 2004). The challenge is to afford each belief system its own integrity, while developing approaches that can incorporate aspects of both and lead to innovation, greater relevance, and additional opportunities for the creation of new knowledge (e.g. Durie 2004, Morgan 2006b).

Sustainability legislation in New Zealand provides an interesting challenge for decision-makers such as planners, architects scientists and engineers. New Zealand's Action Plan for Sustainable Development requires 'taking account of the social, economic, environmental and cultural effects of our decisions'. The assessment of sustainability in NZ thus occurs in four dimensions. Internationally, cultural effects are generally considered within the analysis of societal effects. The separate consideration of cultural effects is necessary in New Zealand to acknowledge the status of the indigenous people, the Maori. The requirement for separate consideration of cultural effects was created in New Zealand's founding document, the 1840 Treaty of Waitangi. Although the addition of a cultural criterion to decision support tools (DSTs) could be considered a viable solution to accommodate the partnership obligations created by the Treaty, the extension of international sustainability DSTs in this way has not worked in practice. The acknowledgement of a specific cultural dimension in the definition of sustainable development seems to accept that New Zealand's prevalent societal values

and beliefs are not representative of its indigenous people. Therefore, in order to incorporate effectively indigenous values and beliefs into sustainability decision-making in New Zealand, an approach based on indigenous concepts is essential. The indigenous concept of mauri (binding force) has been identified for inclusion in a new DST that provides a culturally consistent measure of sustainability (Morgan 2006b). The result is the Mauri Model - a methodology for sustainability assessment, developed specifically for the New Zealand context, but which may also have wider international applications where decision-makers have limited knowledge and understanding of the indigenous people's culture, values and beliefs (Morgan 2006a,b).

The Mauri Model

The Mauri Model is a decision support tool designed to fit New Zealand legislation and meet the requirements of the Maori. The details of the Mauri Model can be found in Morgan (2006a,b), but a brief summary will be provided here. The Mauri Model achieves integration of indigenous knowledge and science by virtue of its expert-weighted decision matrix design that provides a culturally based template within which indigenous values are explicitly empowered alongside 'western' thinking (Morgan 2006b). The template comprises several stages of facilitated deliberation in sustainability assessment:

1. determination of a heirarchy of dimensions (whanau, community, hapu¯, ecosystem) and their weights using mauri as the yardstick (a brief description of mauri is given after the Summary)
2. selection of significant indicators for each dimension that are organised into a sub-heirarchy and given relative weights
3. analysis of potential options by measuring the impact upon mauri (barometer) for each indicator
4. arithmetic combination of all indicators, proportionally weighted within each dimension
5. arithmetic combination of all dimensions, proportionally weighted.

Both stages (d) and (e) can be carried out using computer spreadsheets in Microsoft Excel or higher level programming software. As the model can be used in parallel by groups with differing perspectives, each group's results can be readily compared and any divergence identified. The comparison then provides a framework for discussion and collaboration towards the most favorable option or, alternatively, the identification of appropriate mitigation measures (Morgan 2006b, p. 174).

Summary

Specifically the Mauri Model creates a framework within which indigenous values are explicitly empowered alongside scientifically based thinking (Morgan 2006b). The Mauri Model has provided a mechanism for integrating indigenous knowledge with science and actively engaged parts of society that have hitherto had little interest in or a complete mistrust of science. The incorporation of indigenous knowledge into a decision-making framework has sparked huge interest amongst scientists and indigenous knowledge alike. The combined contributions of the two knowledge systems provides the potential for integrated decision

making that can enhance the practice of sustainability for the benefit of our future generations, and find solutions for problems that cannot be provided by either knowledge system in isolation.

Mauri-Mauri is a concept that permeates all Maori thinking and is the binding force between the physical and the spiritual (Durie 1998). When actions impact negatively upon the mauri of something, this essential bond is weakened, and can potentially result in the separation of the physical and spiritual elements resulting in the death of a living thing or alternatively the loss of a thing's capacity to support other life (Morgan 2006b, p. 171).

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After completing a PhD for the British Antarctic Survey in Stratigraphy and Paleontology in 2004 that involved leading a deep field mapping expedition, I undertook a Post-Doc investigating climate change in the past and its effect on the oceans. However, during the course of my PhD I taught some courses for a Degree in Environmental Studies in a Maori Tertiary Institution which sought to include Maori knowledge where applicable. I have continued on this journey and am currently working with Maori groups on a variety of projects, including integrating matauranga with science for an industrial waste site remediation and also a geothermal development. Taking the science to society is an important component of the work I undertake, but just as important is taking society to science.

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Kepa is a Chartered Professional Engineer and is affiliated to the Ngati Pikiao tribe of Aotearoa New Zealand. Kepa has been recognised for his consulting expertise on numerous occasions, working at the interface between Maori and Engineering, and has broad experience in governance and leadership roles in state and indigenous organisations. Now in an academic role, the focus of his research has been the creation of an integrated decision making framework, the Mauri Model, to improve the quality of sustainability decision making and therefore the commitment to sustainable management of natural resources in Aotearoa New Zealand. Kepa's work has been published in ICE Engineering Sustainability and Desalination. The Mauri Model has been presented at international conferences as the topic of invited keynote presentations (Royal Society NZ Rotorua Lakes Symposium 2003, IPENZ Convention 2004, Maori Local Government Association 2004, Integrated Concepts in Water Recycling 2005, ANZSYS Systems Thinking / Managing the Complex V 2005, Sustainable Indigenous Communities 2006, IPENZ Congress Vision 2020) and most recently a sustainability workshop at the International Forum on Applied Sustainable Development in Quebec 2007 and Multi Criterion Decision Making 2008.

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