A Kaitiaki Approach to Geothermal Development: Encompassing the Maori Worldview in New Zealand's Growing Renewable Energy Industry

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Left: Wairakei Geothermal Power Station. Right: Maori carving of Ngatoroirangi in Lake Taupo

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Abstract

New Zealand's unique geological endowment offers its citizens an abundant resource from which a great deal of value can be derived, whether as cultural landmarks, aesthetic scenery or an economic asset. Geothermal energy is emerging as an alternative to fossil fuels for electricity generation because of its relative environmental soundness, renewability and cost-effectiveness. Most undeveloped geothermal hotspots in New Zealand's Taupo Volcanic Zone rest on Maori-owned land, and have the potential to generate a plethora of benefits to Maori communities, mainly economic, if they are developed in a responsible manner. This project explores the ways in which *kaitiakitanga*, guardianship of the earth, and *mauri*, life force or potential, which are central to Maori worldviews, can inform geothermal development in a way that is consistent with and beneficial to Maori livelihoods and belief systems. The Mauri Model is a powerful decision-making tool that can be used to determine and analyze the effects of an undertaking such as geothermal development on people and places. Finally a theoretical geothermal development project will be created here with the Mauri Model and its four categories of wellbeing—economic, environmental, social and cultural—as the basis for discussion. This paper will pave a path to development that is inclusive of all worldviews and shows the industry's promise for increased holistic welfare.

Introduction

The Maori worldview is both acknowledged and valued in New Zealand culture and society, and is recognized legally as per the Treaty of Waitangi (1840) and the 1991 Research Management Act (RMA). As observed by Morgan (2006a and 2006b), the arenas that constitute wellbeing as denoted by the government parallel indigenous interpretations of wellbeing. In a bicultural nation such as New Zealand, it is imperative that its diverse knowledge systems are weighted in such a way that the needs and wishes of all affected parties are accounted for. Especially as sustainability grows as a beacon on the national agenda, traditional beliefs and practices are becoming more and more relevant, as they

tend towards environmental mindfulness. This mindfulness is encapsulated in the Maori term *kaitiakitanga*, or stewardship of the earth, also tied to the belief that humans should leave the earth as they received it. Insofar as geothermal development on Maori land is sought after for its economic viability and promise as a renewable energy source, a weaving of western science and indigenous worldviews becomes appropriate.

To formalise these common interests around geothermal development, a comprehensive model is sought in this project. Methods of extracting the abundant geothermal energy of the Taupo Volcanic Zone have been implemented with varying effects on people and places (Rybach, 2003; Cody, 2007; Boothroyd, 2009). Certain practices, such as extensive geological research prior to drilling or reinjection of waste water, can transform these effects, and thus determine the success or failure of a given project. A model that informs development decisions must inherently be based on its potential outcomes and implications with regard to involved worldviews. The Mauri Model is a powerful means to achieve just this. The four aspects of wellbeing defined in New Zealand sustainability legislation—economy, environment, society and culture—are paralleled with four levels of *mauri*, the Maori concept of wellbeing in terms of life potential: mauri of the whanau, ecosystem, community and hapu, respectively (Morgan, 2006b). The Mauri Model, along with considerations of its various contexts, forms the substance of a theoretical geothermal development scheme.

This project shows the viability of incorporating *kaitiakitanga* and *mauri* in such an endeavour, and examines how cooperation between the various affected players might ensue. Essentially costs and benefits with regards to environmental, social, cultural and economic wellbeing were scrutinised (Kristmannsdottir and Armannsson, 2003; Thain *et al.,* 2006) to determine that with an effective reinjection scheme, a path to a worthwhile geothermal development project is tangible. Advantages and shortfalls of the model are evaluated, with the conclusion that the incorporation of diverse worldviews in contemporary decision-making processes is paramount to creating a sustainable future. Most importantly, this model provides a framework for the empowerment Maori groups, through which they can pioneer an industry that benefits them and the world holistically.

Background

Culture

New Zealand's diverse landscapes are of great importance to the Maori worldview. Most groups trace their heritage, or *whakapapa*, to rivers, mountains, or other landforms, thus defining themselves by the earth. Certain *korero*, or oral histories, describe the origins of natural features and their relationships to important Maori ancestors, and geothermal springs are no different. According the Maori belief, water from the earth, in the form of rivers and springs, are *Nga Puna Tapu O Nga Atua*, or tears of the earth mother, *Papatuanuku*. Rain, conversely, is *Nga Roimata O Ranginu*i, or tears of the sky father, *Ranginui*. These two entities weep that they have been separated by their children, who govern the realms that lie between the sky and the earth. Thus, the water from the rain and water from the springs are *tapu*, or sacred, and contain mauri, as water is required for all life. The practices surrounding taking water from the earth are thereby potential points of conflict with the Maori worldview if not conducted in a mindful manner (Morgan, 2006a).

More specifically there are korero that apply to specific geographies, such as the western-named Taupo Volcanic Zone, which is New Zealand's hotbed of volcanic activity and geothermal heat. Ngatoroirangi was one of the first Maori to land in New Zealand from the Polynesian homeland of Hawaiki, as the history is told. As leader of his *waka*, or canoe, Ngatoroirangi took it upon himself to forage inland from the coast to find a suitable place for his people to settle. Upon seeing Mount Tongariro, he commenced to climb its frosty slopes. Dismayed by the unexpected, crippling cold, Ngatoroirangi sent out a cry to his sisters in Hawaiki, Kuiwai and Haungaroa. In response, they sent him heat—in some korero this heat was in the form of taniwhas, or spirit guardians. The heat-bearing taniwhas made stops along the way, which resulted in the volcanoes and geothermal heat that span almost in an exact line from White Island, off the coast of the Bay of Plenty, to Mount Tongariro. Western geologists have attributed this line to the Pacific and Indo-Australian plate boundary (McLintock, 1966). Some groups still refer to the sacred heat pools in geothermal fields as "eyes of the taniwha," and all revere the source for its contribution to the salvation of an essential ancestor (K. Morgan pers. comm. 2010).

For centuries, geothermal features have been part of Maori cultures and livelihoods. The everyday livelihood practices of preparing food, bathing and heating utilized the heated ground and water. Maori also used the waters for ceremonial healing, and the surrounding minerals and vegetation for artwork and wood preservatives (NZGA, 2010). Some men purportedly submerged themselves in certain boiling pools as a ritualistic form of suicide (Rakato- Tohunga pers. comm.. 2010). As Maori are connected to the land, the aesthetic features of their landscape are important as well.

Kaitiakitanga is a concept central to Maori customs, as it encompasses the described relationship with the earth. Marsden (1992) explains the relationships and discourses that guide kaitiaki thinking—an important one of which is the idea that nothing shall be done that has no way of being undone. This is another way of representing intergenerational sustainability, or the idea that it is irresponsible to affect something so much that it cannot be restored and rejuvenated to its natural state for the future. While kaitiakitanga can be translated to mean stewardship, Marsden (1992) emphasizes the importance of ridding the aspect of hierarchy resonant in "stewardship", as humans do not own the Earth. Instead, there is a holistic system of interdependence that Western thought fails to grasp. Certain cultural practices exemplify kaitiaki attitudes, one of which is *rahui*, or a prohibition of use for a certain section of the environment so that it may restore itself. Another is the custom of asking permission when extracting the earth, or blessing places upon arriving at them (Marsden, 1992). The roles that Maori assume as kaitiaki will be critically influential in any discussions regarding use of their land.

Governance

The 1991 Resource Management Act (RMA) governs the responsible use of geothermal resources. Before the RMA, there was little geothermal regulation and this poor management resulted in the transformative effects on geysers and fumaroles in certain areas such as Orakeikorako and the Craters of the Moon site. The RMA operates at the three levels of governance: the central government, regional councils and district councils, and has set up a system of resource consents, for which groups need to apply in order to start development. RMA considers geothermal energy a renewable source, so consents are allotted as long as guidelines are followed—one of which is that the activities that use the

resource take into consideration the maintenance of economic, environmental, social and cultural wellbeing. Most of New Zealand's geothermal fields lie within the Waikato and Bay of Plenty Regional Councils' dominions, and thus the councils have detailed regulation and management systems. Central to these policies is the designation of specific geothermal bodies, which are defined by their hydrological separation from each other in the upper few kilometers of the earth (Boothroyd, 2009).

Geothermal and the New Zealand Context

Geothermal means simply "heat of earth", and refers to the heat caused by the magma underneath the earth's crust—which, like the sun, is an endlessly renewable source of heat energy. In places like the Taupo Volcanic Zone in New Zealand, magma from the mantle is closer to the surface and heats large underground reservoirs of water that lie in fractures in the subsurface rocks. This water, sometimes at temperatures higher than 350° C, can be extracted for electricity generation, heating systems, timber drying, and a plethora of other purposes, depending on the water's temperature. There are 29 geothermal areas identified in the TVZ (NZGA, 2010, see Figure 1).

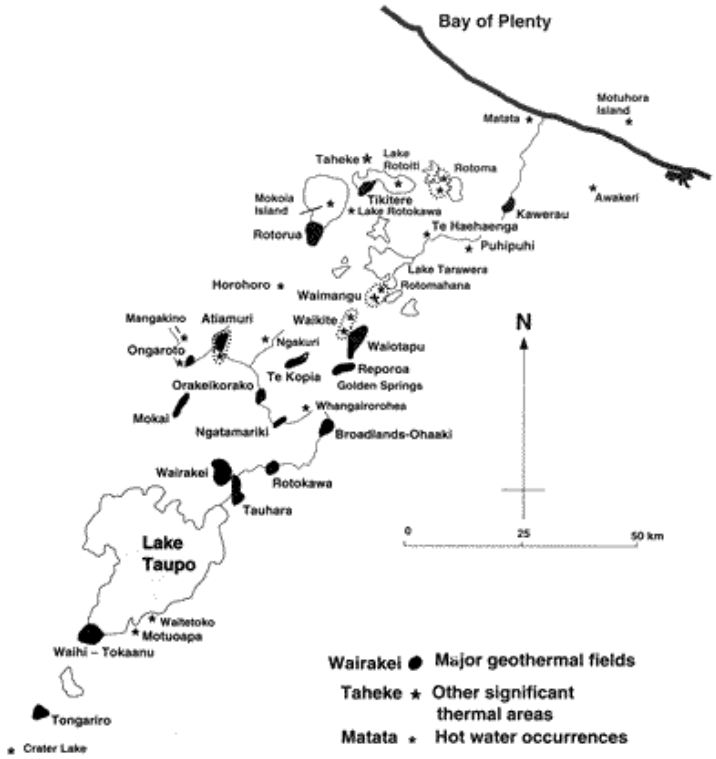


Figure 1:Location of Geothermal fields in the TVZ, Source: NZGA

In order to use geothermal energy as a source of electricity generation, engineers drill boreholes into the hot subsurface aquifers, and the resulting steam travels rapidly through pipes and ultimately spins a turbine, which creates electricity. This technology has been used for over 50 years in New Zealand, but only after the oil shocks of the 1970's were research and development enhanced significantly. The water that has condensed after being extracted as steam can then be reinjected back into the subsurface rocks so that 1) the underground reservoirs are not completely diminished, and 2) to maintain levels of pressure to avoid surface disruptions. These sites are very dynamic, and developing geothermal has high risks. For one, it has huge upfront costs—millions of dollars for each hole drilled. No one knows how long holes will be productive for, and the physical danger of working near such hot substances is another point of concern (NZGA, 2010). It is widely accepted that geothermal fields should be monitored for several years prior to development in order to mitigate wasted costs and unnecessary environmental alteration (Kristmannsdottir and Armannsson, 2003).

Direct use is another way to utilize wasted or unused geothermal heat other than for power generation. It is often on a much smaller scale, so environmental impacts would be low (see Table 1). These opportunities include using heat for drying timber, heating pools, heating buildings, and for cultivating vegetables and flowers in greenhouses. Separate, lower-temperature boreholes can be dug to implement these systems, or waste heat from power generation could be utilized in a "cascading" method. While these systems require high up-front costs, the costs of maintenance once they are in place are very low. They would allow peoples' enterprises to be independent of energy prices in the market because they would have a constant source of income from the earth (Thain *et al*., 2006). Rybach (2003) displays the possible environmental results of direct use and evaluates the severity of their impact in Table 1.

Table 1. Potential environmental impacts of direct use geothermal projects; probability and severity. L= Low impact, M=Medium impact, H=High impact

Impact	Probability of occurring[b]	Severity of consequences[b]
Air pollution	L	M
Surface water pollution	M	M
Underground pollution	L	M
Land subsidence	L	L to M
High noise levels	H	L to M
Well blowouts	L	L to M
Conflicts with cultural and archeological features	L to M	M to H
Socioeconomic problems	L	L
Solid waste disposal	M	M to H

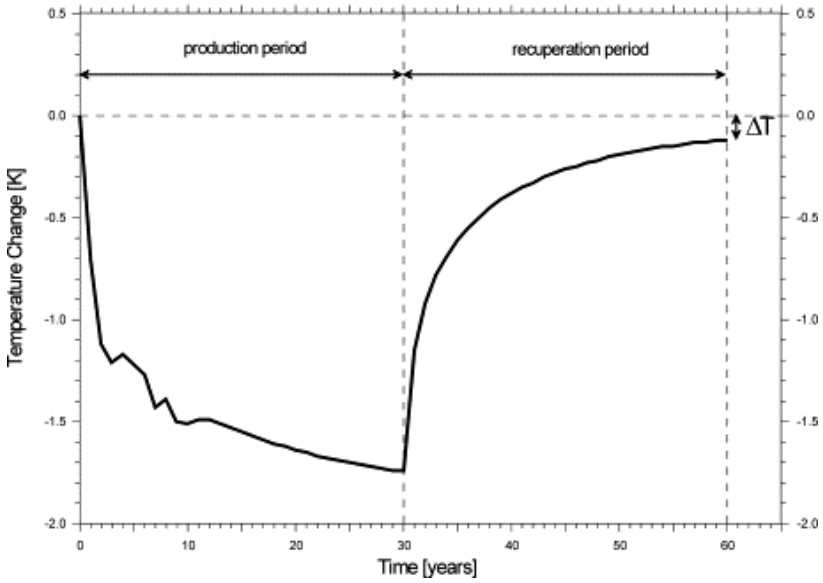
Source: (Lunis, 1989 used in Rybach, 2003: 469).

Environmental impacts associated with geothermal development are significant but manageable. Land subsidence, surface disturbances, seismic activity, fluid withdrawal effects (fumarole/geyser changes), water and air pollution are all potential implications. However, Bertani (2001) has shown that while CO_2 is emitted, "the development of geothermal fields makes no difference to the total CO_2 emanated from those terrains" (cited in Kristmannsdottir, 2003: 456). Many of the environmental impacts can be minimized if reinjection systems are in place, as reservoirs would be replenished and the contaminant-holding hot water and steam waste would be taken care of. Close monitoring of these effects both before and after development will also aid in keeping the *mauri,* or life potential of the land, healthy.

Maori groups have a strong commitment to passing down land to future generations in a condition that is as good as it was received. A scientific equivalent would be to show that the geothermal resources are renewable and will not be depleted completely if extracted correctly. Rybach (2003) shows the heat resilience of geothermal fields in Figure 2. In 30 years the heat is almost completely restored.

Economic profits would likely be significant, as apart from the large upfront costs, geothermal power is relatively low-cost, and incredibly reliable because it is independent of changes in climate, oil price fluctuations and geopolitical turbulence worldwide (NZGA, 2009). The people who benefit the most from geothermal energy are those that live the closest to the sites, as there are low transmission costs and the spin-off industries could lead to higher employment and community development. With Maori trusts reaping the

Figure 2. Calculated temperature change within a depth of 50 m and a distance of 1 m from a borehole heat exchanger, over a production period and a recovery period of 30 years each. After 30 years recovery is almost total (ΔT=0.1 °C).



Source: (Rybach & Eugster, 2002, used in Rybach, 2003: 466)

profits of geothermal energy, they would have many opportunities to invest in cultural endeavors (education grants, historical programs, etc), and to support community programs—thus there are many positive spinoffs from the financial boon. All of these impacts, and the categories of wellbeing to which they correspond, were analyzed with the Mauri Model, as will be discussed later on.

There are at least two Maori groups that currently stand to gain from the model designated in this project, both of which are located in the Bay of Plenty around the Kawerau geothermal area. They are the Ngati Tuwharetoa Settlement Trust (NTST) and the Kawerau A8D Trust. The NTST is currently using 20% of its consented amount of geothermal potential, in partnership with Mighty River Power, a geothermal energy generator. Kawerau A8D Trust has plans to develop geothermal power as well (Hikuroa, 2008). The Kawerau geothermal field falls under Environment Bay of Plenty (EBoP)'s group 1 classification which is currently denoted as places to be preserved, but depending on the wishes of the inhabitants and Maori groups, this classification could change (NZGA,

2010). With a model that embraces the culturally embedded concept of kaitiakitanga, these groups would be able to move forward with these plans.

Mauri Model

Recognizing the parallels between New Zealand legislation on sustainable development and Maori values, Morgan (2006b) created a decision-support tool to address contemporary practices in a manner inclusive of indigenous worldviews. As the name denotes, the Mauri Model uses the Maori concept of *mauri* as its central measurement tool. Mauri represents the life force of an entity, or its potential to foster healthy existence. The model assesses various effects of the practice being discussed, which are placed into the categories of environment, economy, community and culture. The four categories are goals stated in New Zealand legislation, and can be linked to levels of wellbeing encompassed in the Maori worldview. Mauri of the ecosystem is parallel to the environmental focus, which is central to Maori value systems as described in the kaitiakitanga section. Mauri of the community represents the social focus of the legislation, and encompasses the effects on the potential for everyday activities and community safety, health and wellbeing. Economic effects are categorized with mauri of the *whanau*, or family, as essentially it represents the direct effect on a family's wellbeing and capabilities. Finally, upholding cultural values are evaluated by the mauri of the *hapu*, or the Maori group that embraces the cultural knowledge, health, ancestry and identity practices. Development must address wellbeing across all of these categories in order to be sustainable (Morgan, 2006b).

The Mauri Model thus attempts to fairly integrate the various interests of opposing groups such that an inclusive decision can be made. Individual effects of the stated project are evaluated on a -2 to +2 scale, based on whether the mauri is perceived as being degraded, enhanced, or lying somewhere in between. The numerical significance given to these issues makes the model compatible with western science and thought, and does not take away from the legitimacy of the indigenous knowledge. Weighting of the four categories is essential as well, as for example, a business entity involved in the decision-making might value economic benefits higher than environmental, while the Maori group's interests may be the opposite. As all relevant worldviews are valued in the assessment, the

Mauri Model is an effective tool to ensure the empowerment of often otherwise marginalized indigenous groups (Morgan, 2006b).

Methods

Consultation with iwi leaders and geothermal developers in the field were the first methods performed for this project. Notes obtained through this correspondence in the Kawerau region were central to deciphering the project's significance. The iwi leaders were representing a Maori group in possession of undeveloped geothermal fields, and thus might benefit from the model developed here. Lectures, field trips and activities carried out in the geothermal fields were important research methods for this topic as well. Touring the developing geothermal site at Rotokawa gave particular insight into the logistics of this type of energy extraction, while playing the role of a tourist at Orakei-korako illustrated the aesthetic values and alternative uses of such a resource. The Craters of the Moon walk indicated the dangers of geothermal development without reinjection schemes, as the changes in pressure from the Wairakei power station caused massive surface eruptions in this nearby field.

Most of the subsequent methods involved compiling information on all the aspects of geothermal development and relating them to the context of a Maori worldview. A number of scholars have studied the economic and environmental effects of geothermal development using cases from around the world. Low-heat geothermal systems, and potential uses for the heat other than for electricity generation were also researched. Cultural and social impacts of geothermal development were less prevalent in the literature, but could be conceptualized and realized by studying the historical and potential future uses of geothermal features. Consultation with Kepa Morgan, the creator of the Mauri Model and thus a vital contributing source to this project, was also paramount in gaining an understanding of the importance of the Maori worldview in contemporary projects.

All of these researched topics were then narrowed into the four wellbeing categories and assessed with the Mauri Model. Theoretical indicators were created and evaluated for each category to produce an assessment of impact to mauri that would be a

powerful tool in a geothermal development discussion. A meeting with the iwi groups through which to gain more perspective on a potential development was planned, but due to circumstances did not transpire. Nonetheless, the research methods culminated in a framework around which the theoretical context can still be used and adjusted where necessary.

Results

A Mauri Model assessment was carried out, with the indicators shown in the left-hand column below. With a dissection of this Mauri Model assessment, the framework for a kaitiaki approach is detailed in the discussion.

Geothermal Development Mauri Model Assessment

	Indicator	Status Quo	Geothermal: Reinjection	Geothermal: No Reinjection
Environmental (mauri of ecosystem)	Surface Features	0	0	-1
	Waste Water	0	0	-2
	Subsidence	0	0	-1
	Drilling water	0	-1	-1
Economic (mauri of whanau)	Cost/Benefit	0	1	1
	Cash Flow	0	1	1
	Employment	0	1	1
Cultural (mauri of hapu)	Ancestral Connection	1	0	-2
	Kaitiakitanga	1	1	-1
	Returning Home	-1	1	1
Social (mauri of community)	Sustainability	0	1	1
	Community Resilience	-1	1	1
	Aesthetic Environment	0	-1	-1
	Results:	**0.00**	**0.44**	**-0.15**

Discussion

Firstly, it is important to note that this Mauri Model assessment was carried out from the theoretical perspective of a Maori trust deciding whether to develop their geothermal asset. The numbers were thus assigned assuming a prioritization of culture and environment, though the importance of all areas is clear. Also important is that the numbers derived from such analysis are not to be confused with the decision to be made. They are helpful tools in empowering certain groups and generating debate around the complex effects of such an endeavour, not panaceas. Had a meeting with Maori groups transpired, these numbers could have turned out differently. The kaitiaki approach should thus involve the assessment but not rely on it completely—extensive discussion between players of the specific issues and worldviews are also imperative.

Potential players in the geothermal development scheme would be Maori groups, energy companies, a regional council, and local landowners. The perspective of each entity would be entertained in a collaborative discussion with the Mauri Model as a tool for elaboration. Weighting is another way to incorporate the viewpoints of all. Each group would denote by percentage their particular order of category importance—community, economy, environment and culture. By averaging each entity's weighting for each category, a compromise could be arrived at (Morgan 2006b). Each assessment will differ depending on the involved actors, but the arithmetic results make for easier deliberation.

The model not only delineates between the wellbeing categories, but it also can assess various methods of development in a comparative manner. In this assessment, the status quo—or leaving undeveloped land as it is—was compared with geothermal development with a reinjection scheme, and one without a reinjection scheme. Most of the indicators with regard to the status quo resulted in the mauri being left neutral. For example, without development the occurrence of subsidence associated with geothermal would never be an issue; the mauri is neither influenced positively nor negatively by maintaining no subsidence. If geothermal development with reinjection occurs, it is likely that the reinjection will prevent subsidence, so the level remains at 0. Without reinjection, however, subsidence is likely to occur, and thus the mauri of this land would be in decline.

The indicators for which the status quo had an impact on the mauri were mainly in the culture category. The ancestral connection refers to the significance of the geothermal

features with regards to Maori *korero* and cultural practices, such as seeing the pools as eyes of a taniwha, or as Papa's tears. With no development, this significance is respected and maintained, and the mauri of the practices are thus improving. With a reinjection scheme associated with geothermal development, no harm is done, but mauri is not being enhanced. Without reinjection, however, significant changes to nearby springs, geysers and pools are likely. This would completely disrupt the cultural significance of these landmarks—if a pool dries up, it no longer holds cultural identification, and thus the mauri is degraded.

Conversely, the category of "returning home" has the reverse effect on the area's mauri. Currently, Many Maori adults have migrated and are migrating to New Zealand's cities in search of work, resulting in a reduction in cultural health of iwi groups, and consequently a degrading mauri. With a new industry that offers employment and community wellbeing, Maori might be inspired to return to their ancestral land and thus enhance mauri. Similarly the idea of community resilience—or the effects of having a geothermal industry on the health of the community would restore mauri, as it is likely the financial benefits would cause the groups to thrive. The low-heat industries like greenhouses, timber-drying, and heating would promote community wellbeing and employment as well.

Economic effects were pretty straightforward. Mauri is neither enhanced nor degraded with the status quo, and money will be made with geothermal development, with or without reinjection. Firstly, the upfront costs would be surpassed by the long-term benefits of cheap energy production. The power plant's development, maintenance, and all of the low-energy secondary uses have the potential to provide jobs for locals. There might be a demand for more expensive infrastructure establishment if the industry flourishes, but the increased cash flow within the community would likely be able to afford such advances. The full extent of the economic benefits cannot be captured by the Mauri Model assessment because the advantages of more money often manifest themselves through the other categories, such as there being money for cultural programs and education.

The environmental soundness of geothermal energy is well captured by the Mauri Model. The only negative impact that geothermal development would have on the mauri of ecosystems would be the upfront extraction of a huge amount of water for initial drilling.

This is water that would not be restored to its source, and would thus negatively impact on the area's mauri. In this category the problems with no reinjection are the most striking. Waste water with no reinjection scheme would be dumped into the river. A hydroelectric scheme like Mighty River Power might enjoy the extra river pressure, but the geothermal water often contains contaminants like arsenic from deep inside the earth. The environmental damage, if all of the waste steam and water were let out, would be detrimental and inconsistent with the renewable nature of the Maori worldview.

It is safe to stay that despite extra costs, reinjection should always be required when developing a geothermal project—any practice whose result degrades mauri overall should not be pursued. Extensive research should also preclude any drilling so as to get a full understanding of the potential environmental and economic risks of undertaking such an endeavour. This Mauri Model assessment showed that with the status quo, the mauri will neither be enhanced nor degraded, and with reinjection geothermal development would enhance mauri by a half point. According to Morgan (2006b), this number should be closer to 1 to account for error, as there are often unaccounted for disadvantages when the projects come to fruition. Then again, whether to move forward with the undertaking should not solely be dependent on the Mauri Model, as discussions will be vital as well. There are going to be losses and gains with every potential project, but it is important to respect the process' ability to create a holistic view of wellbeing within a manageable decision-making tool.

In consultation with iwi leaders, they spoke about the importance of indigenous knowledge and history—how colonizers often acknowledge the "cultural importance" of Maori but do not consider their views legitimate or applicable in the real world. This is precisely the problem that would be addressed by a "kaitiaki" geothermal development approach, which considers indigenous values *and* technical solutions. They expressed an interest in having their geothermal resources developed, but implied that maintaining their kaitiaki roles would be imperative. Marsden (1992) emphasizes the same worldview in asserting that Maori values are not just fanciful stories, but are rather legitimate ways of viewing the earth's interconnectedness that can coexist with Western logic.

Conclusion

The global dependence on finite, pollution-causing energy sources is a modern day dilemma that can be ameliorated only by the resourcefulness and innovation of our generation. The kaitiaki approach to geothermal development offers New Zealand an opportunity to tap into its unique and endless geothermal resource in a holistically beneficial manner. Central to the model is the idea that the sustainability of developing this resource not only refers the environment, but encompasses cultural, social and economic wellbeing as well. Rather than disregard ecosystems and culture like past industries have done, geothermal development has the potential to utilize New Zealand's unique context to create something integrated and new. Synthesizing these embedded indigenous practices with the development of a renewable resource like geothermal energy is a promising framework that could be replicated in other parts of the world.

The fact that iwi groups happen own the majority of the promising geothermal fields left in New Zealand means a method of development that incorporates their interests is imperative. At least two groups—the Ngati Tuwharetoa Settlement Trust (NTST) and the Kawerau A8D Trust—stand to reap the benefits of such a framework with their undeveloped land. Currently Maori participation in geothermal development is low, and an interactive model which incorporates Maori values would enhance Maori involvement in the utilization of their valuable assets. The groups would be reaping the benefits associated with geothermal development while working within kaitiaki frameworks that run parallel to global aims of sustainability.

The Mauri Model and extensive deliberation of the complex effects of geothermal have illustrated that with adequate research and guidelines, New Zealand's geothermal resource can be exploited benevolently, and it stands to generate more than just clean, cheap electricity for the country. Intertwining the kaitiaki values of Maori culture with modern technology has promise to result in vast economic returns, maintained ecosystems and bettered livelihoods.

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