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# Indigenous Knowledge contribution to Watershed Management

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The conference theme suggests aspirations towards harmony between humanity and nature, yet scientific evidence of the impacts that human development has on Ecosystem watersheds provides a persuasive argument that contemporary decision making is wanting. Is decision making based on approaches such as Cost Benefit Analysis providing the best results and are there alternative decision making approaches that could assist achieving the conference aspirations noted in the main theme?

Integrated watershed management is a complex issue, that some consider the 'holy grail' for water resources and hydrology. While the aspiration of integrated watershed management is acknowledged within the literature as an improvement on most contemporary approaches, its implementation is difficult, and few examples of its successful implementation exist. The competing objectives of land-use, economic priorities, institutional agenda, international relations, property rights, and water ownership, along with uncertainty resulting from pollution risk, water scarcity and climate change combine to create a daunting challenge.

Considering practices in integrated watershed management, this paper will discuss the potential contribution of indigenous knowledge sources and how an alternative ontology could assist in achieving genuine integration of the competing objectives in a way that results in long-term improvements in overall well-being. In particular a decision support tool that combines the Analytical Hierarchy Process with an indigenous concept for well-being, Mauri or Kibun, will be shared as an opportunity to progress towards the harmonisation of humanity within ecosystems.

## Introduction

Humanity represented by the “developed” world has aspirations towards harmony with nature. In some contexts, the driver may be largely self-interest, for example “green marketing” of products and services, in other contexts, possibly driven by concerns for the survival of humankind. In either case however these aspirations reveal an underlying set of beliefs and a value system that considers humanity and its desires as separate from nature. The separate consideration of nature, frames the environment as a collection of resources available to humanity for their instrumental value. The exploitation of ecosystmes is now being constrained by scientists concerned about the accumulation of physical impacts of activities creating irreversible imbalances in ecosystems. Described in contemporary terms as tipping points (Hansen, 2007. Schellnhuber, 2009), once these thresholds are exceeded scientists are anticipating catastrophic ecosystem collapse.

Alternatives exist that that consider humanity is an inseparable part of nature. Might these alternative ways of thinking hold the key to understanding sustainable development? Indigenous knowledge systems are holistic integrating many sources of information that are considered incompatible from a scientific worldview. This capacity to integrate many sources of information is useful in understanding the inherent complexity of integrated watershed management. To illustrate this idea, two examples are provided that are analysed using a decision support tool, known as the Mauri Model Decision Making Framework.

Case Study 1: Watershed Impact Comparison for Land Development Approaches

The Haumingi housing development on the shores of Lake Rotoiti in the North Island of New Zealand, was a radical departure from established engineering practice in the late 1980’s when the Trust administrators secured planning consent to proceed. The 13 Hectare land block is multiple owned Māori land, with more than 100 recorded owners.

Two development opportunities were considered; a conventional Development based on typical engineering practices (Development A), and an alternative development created from first principles based on the collective aspirations of the Māori owners (Indigenous$^{+}$). Development A provided seven half acre allotments with a maximum of 2 dwellings per site. Indigenous+ provided 10 dwelling sites. Indigenous$^{+}$ (alternative design) was chosen because the approaches considered best practice by both the local authority and professional advisors to the Trust were not accepted by a meeting of owners. Many of the features of Development A were inconsistent with the indigenous concepts of kaitiakitanga (enhancing the intrinsic value or *mauri* of the land and ecosystem). Table 1 gives the different methods used in the two developments.

Table 1: Conventional and Alternative Development Approaches Considered for Haumingi Papakainga

| Feature | Option 1: Conventional | Option 2: Indigenous+ |
|---|---|---|
| Carriageway | Impervious surface, dual carriageway | Porous pavement, narrow carriageway |
| Footpath | Impervious surface | Grassed walkways |
| Car parks | Impervious surface | 20% impervious |
| Site Coverage | Maximum 2 per lot, 14 @ 140 $m^2$ | 10 @ 140 $m^2$ |
| Minimum Impervious | 30% minimum impervious surfaces | 10% impervious area of Option 1 |
| Stormwater Management | Kerb & channel to stormwater sewerage discharge | Roof runoff to soakaway |
| Native Bush Cover | Level ground cover and fence lots | Areas returned to bush |

The two development options considered by the Trust have been evaluated on the basis of their respective impacts upon mauri using the Mauri Model Decision Making Framework. In this analysis selected indicators are scored in terms of impact upon the mauri or life supporting capacity of each development option. Indicators are chosen to reflect the integrated analysis required by New Zealand law, which includes environmental, social, economic, and cultural well being dimensions of sustainability. An integer value ranging from -2 to +2 determines the change in mauri, depending on whether the change reflects full restoration of mauri, +2; partial restoration; no change, 0; partial degradation; or complete denigration, -2. The wellbeing dimensions are listed as Ecosystem mauri (environmental), Hapu mauri (cultural), Community mauri (Social), and Family mauri (economic).

The results of the analysis indicate that the Indigenous$^+$ development is mauri enhancing, while development A would have degraded mauri in the long term and therefore cannot be considered a sustainable option. The results are presented in table 2.

Table 2: Comparison of Land Development Options for Haumingi Housing Development

| Metric | Haumingi Land Development Comparison | Subdivision | Do Nothing | Indigenous[+] |
|---|---|---|---|---|
| Ecosystem | Life supporting capacity of Land | -1 | 0 | 1 |
| Ecosystem | Life supporting capacity of Forest | -2 | 0 | 1 |
| Ecosystem | Life supporting capacity of Lake | -1 | 0 | 1 |
| Cultural | Retention of Land | -2 | -1 | 2 |
| Cultural | Restoring Connection to Land (Ahi Ka) | 1 | -1 | 2 |
| Cultural | Availability of Traditional Plants | -2 | -1 | 1 |
| Community | Self determination of Traditional Lands | -2 | -1 | 1 |
| Community | Aesthetic qualities of Indigenous fauna | -2 | -1 | 1 |
| Community | Relationship with Community | -1 | -1 | 1 |
| Economic | Capital Expenditure | -1 | 0 | -1 |
| Economic | Maintenance Requirements | -1 | 0 | 0 |
| Economic | Reserves Contribution / Rates | -1 | -1 | 1 |
| Overall | Average impact on Mauri | -1.25 | -0.58 | 0.92 |

Case Study 2: Riperian Wetland Buffer Optimisation

The Tarawera River is also located in the Bay of Plenty and has its origins 65 km from the sea, where its headwaters are relatively pristine. The Tarawera Watershed is 980 km2 in area. Anthropogenic influences become more prevalent as the Tarawera River reaches its flood plains and the river has been redirected many times. Historically a wetland environment, the low lying land that the river now flows through has been drained. In many places the Tarawera River surface is actually higher than the surrounding land due to natural deposition. And coupled with wetland destruction within the watershed, increases the severity of flooding events.

Land use within the Tarawera Watershed is for dairy production, industry (Pulp and Paper Mill), and agroforestry of introduced Pinus Radiata to supply the paper mill with timber. There are a diverse range of different stakeholders within the Tarawera watershed that could be affected by riparian buffer implementation. The indigenous people own a large portion of the lands within the watershed, however cultural values dictates the treatment of land as a life supporting resource to be enhanced rather than exploited as a capital commodity. The restoration and preservation of wetlands is consistent with kaitiakitanga and has the benefit of providing habitat for valued resources such as eel and flax. Riparian wetland buffers (RWBs) can provide a low cost solution to water quality and runoff management issues. The creation of RWBs within a watershed can be optimized to minimize cost, and social and cultural impacts, by generating ecosystem benefits such as; erosion protection, sediment removal, nutrient removal, flood buffering, stream temperature regulation, biodiversity enhancement , habitat connection and large woody debris sourcing (Peacock et al, 2012).

To facilitate the establishment of RWBs, a land score system for siting RWBs has been developed. Unlike other buffer placement models, this technique does not assume that buffers will be placed adjacent to known streams. Instead, benefits are assessed using a combination of several quantitative metrics: terrain-landuse analysis to identify areas of high areal pollutant flux; distance from streams to encompass riparian functions such as stream temperature regulation, large woody debris and streambank erosion; and minimum cost corridor delineation to assess habitat connectivity. The Mauri Model decision-making framework is used to effectively incorporate human factors often difficult to quantify in consistent terms for meaningful comparison of impacts. The Mauri Model integrates the impacts upon social, cultural, environmental and economic well-beings in terms of mauri. The resulting tool is a simple, flexible wetland-siting technique that utilizes readily available data and can be implemented by land planners in a variety of watersheds.

Quantifying the social and cultural impacts of water quality improvement approaches such as RWBs is one of the most challenging aspects of watershed management decision making. The need to more completely assess the societal impacts of these measures has been identified in the literature (Ribaudo et al. 1999). This need is no more pronounced as where differences in values between capitalist society and indigenous peoples are relevant. In this case study, the Mauri Model (Morgan, 2006b), was used to interpret societal riparian buffer benefits. A spatial Mauri Model scoring rubric was developed for this project, and to adapt this model to GIS, each value in a data layer such as land use was assigned a value for change in mauri. The data incorporated into the Tarawera Watershed Mauri Model evaluation included land cover, historical wetland cover, historical flooding and geothermal features. The final Mauri Model score is provided in figure 1 and is a weighted combination of the four mauri dimensions. The lowland areas received relatively low scores except for locations in the middle where historical flooding has occurred. The lowland areas that were historically wetlands have smaller buffers surrounding the streams since these areas contribute less to temperature regulation and large woody debris.

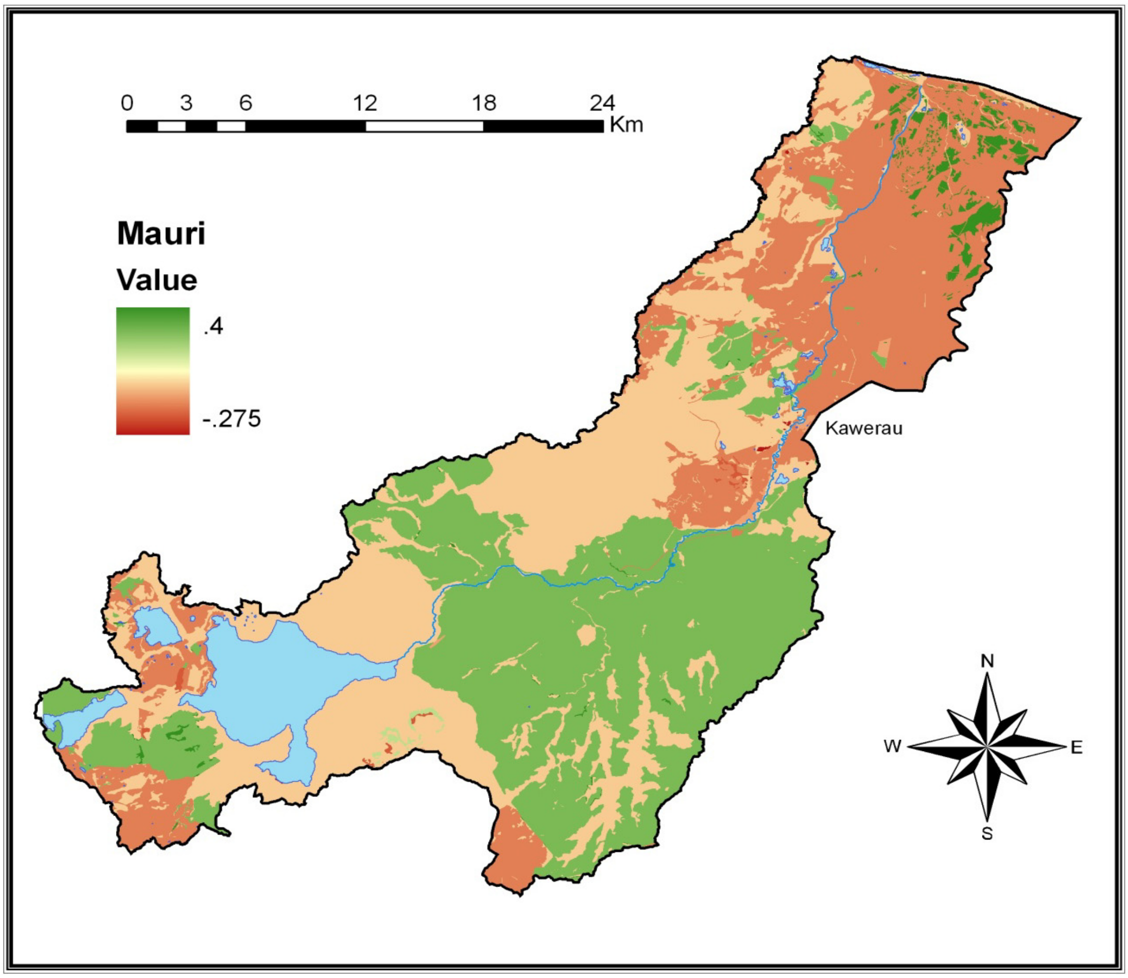


Figure 1: GIS based Mauri Model Assessment Results for the Tarawera Watershed

The restoration suitability of land is determined by combining the Mauri Model assessment results with pollution modelling, landuse assessment and cost estimation. The final ordinal land score for each raster cell is calculated for the Tarawera Watershed using the following formula:

$$S = \begin{cases} \log\left[\dfrac{\psi/\psi_{max} + M/M_{max}}{C}\right] & M > 0 \\ 0 & M \leq 0 \end{cases}$$

Where $\psi$ is a measure of pollution accumulation (Redfield, 1958); $M$ is the Mauri Model score; and $C$ is the estimated restoration cost. The results of this analysis are presented in figure 2.

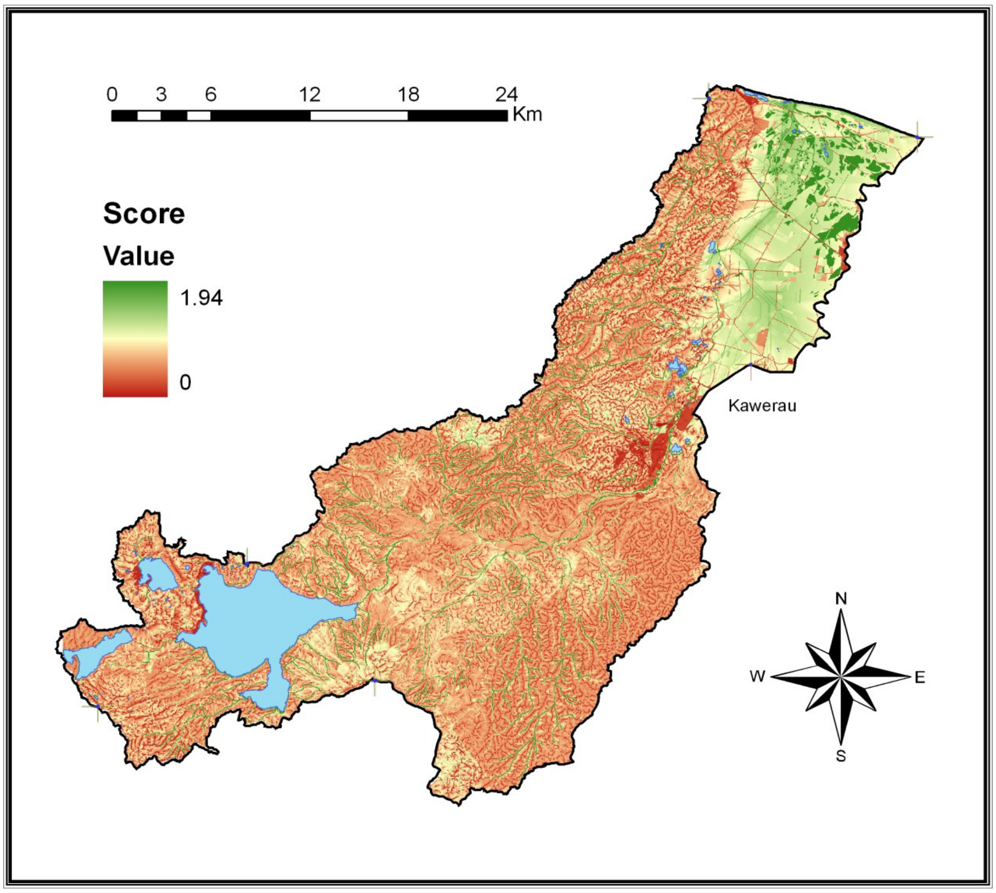


Figure 2: GIS based Restoration Suitability Identification for the Tarawera Watershed

**Discussion of Case Study Attributes and the Contribution made by Indigenous Knowledge**

In the two case studies presented here a historic example of land development design based on the application of Indigenous values is assessed retrospectively using the Mauri Model, and in parallel the Mauri Model is adapted to the complex challenge of optimising watershed restoration efforts. The convergence of indigenous concepts and evolving sustainable design principles is identified in the Haumingi Indigenous+ development. While these sustainability principles may not have come from traditional Māori values, it is clear that techniques such as LID were being used long before what is now considered best management practice was documented. In summary, where indigenous values and knowledge were better understood within the context that the engineering solutions were being developed, those solutions were possible more than a decade earlier.

The contribution that indigenous knowledge makes to the modelling of the Tarawera watershed, parallels the land development case study, but on a much larger spatial scale. The integration of the Mauri Model and Cost Benefit Analysis techniques address complex challenges that have been evident for more than a decade. The Mauri Model uses readily accessible data in a way that can be understood and applied by people without strong technical backgrounds.

The assessments conducted at both land development and watershed scales are easily transferable to other contexts. Although the Mauri Model was developed for the New Zealand context, many other indigenous cultures share similar views (Morgan, 2006b). Furthermore, beyond indigenous cultures, populations of all nations can appreciate the four mauri (well-being or kibun) dimensions and the concept of mauri which is central to the analysis. The Mauri Model offers the distinct strength of being able to evaluate intrinsic value as well as monetary value, making it an essential part of any land development or watershed assessment. Figure 3 demonstrates the integrity of this assessment approach which encourages the ethic of kaitiakitanga (enhancing mauri) rather than modernised societies' current trajectory towards irreversible tipping points for the ecosystems.

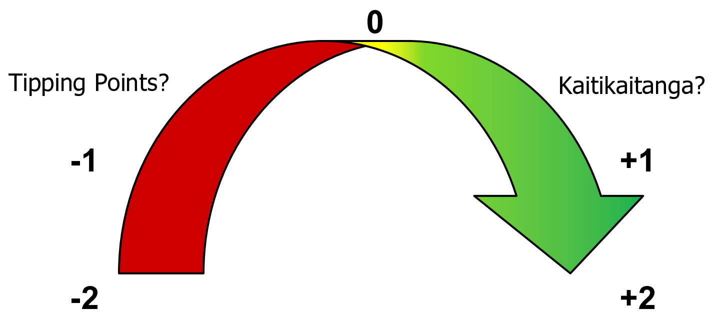


Figure 7: MauriOmeter Ontology Comparison: Tipping Points or Kaitiakitanga

## Conclusion

Integrated watershed management is a complex issue. It requires consideration of existing land-use, property rights, economic implications, pollutant accumulation, and possibly water ownership, all of which can be evaluated in monetary terms. But it can also involve trans-boundary relationships, human rights, cultural well-being, equality and inter-generational equity. These considerations are not readily able to be assessed in monetary terms, yet at least as important. While decision making continues to be based on approaches understood only in terms of monetary equivalence, the evidence of negative human development impacts on watershed ecosystems will continue to grow, ultimately threatening the future survival of humankind.

The potential contribution of indigenous knowledge to integrated watershed management has largely been ignored. The two case studies identify the potential contribution of indigenous knowledge to sustainable and integrated watershed management. Incorporating mātauranga Māori into watershed management tools or urban design and development creates another vehicle to promote sustainable design initiatives, whereby the intrinsic value and integrity of the ecosystem is considered in the design process without necessarily impeding development. Extending and applying this thinking to address contemporary decision making challenges illustrates the value of incorporating indigenous concepts and provides an evaluation option for parameters possessing intrinsic rather than monetary value.

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