PROTECTING AN ICON MANAGING SOURCES OF DIFFUSE NUTRIENT INFLOW TO LAKE TAUPO, NEW ZEALAND

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ABSTRACT
Lake Taupo is a large, near pristine lake in New Zealand, highly valued for its clear blue waters. Increasing loads of nitrogen from the surrounding catchment threaten lake water quality. A management proposal is presented that promotes a sustainable development pathway for the lake community thereby protecting the lake for all New Zealanders. A community change process to protect the environmental, economic, cultural and spiritual values of a lake is described

Keywords: Community, economy, Lake Taupo, land use, management, nutrients, policy, water quality

INTRODUCTION
Lake Taupo is the largest lake in New Zealand (area 620 km^2, mean depth 95m). It is highly valued for its crystal blue water and dramatic vistas. These features provide the basis of an international tourist mecca and a world-class trout fishery as well as an important local recreation area and preferred retirement location. The lake is also important spiritually and culturally to the local indigenous people, Ngati Tuwharetoa.

Lake Taupo's excellent water quality is derived from extremely low levels of plant nutrients and phytoplankton. Unlike many other lakes, nitrogen availability rather than phosphorus limits phytoplankton growth in Taupo. Increased nutrient flows, especially nitrogen, from intensifying rural land use and urban growth in the catchment promotes algal and phytoplankton growth and threatens water clarity and the excellent water quality of the lake. Nitrogen also encourages some types of nuisance weeds and slimes that grow adjacent to lake shore settlements. Declining water quality is measurable and becoming apparent to the local community.

This paper describes a significant resource management issue in New Zealand that touches at the heart of sustainable development and challenges the community and environmental management agencies to respond effectively. At first glance this project is about protecting water quality in an important, near pristine lake. In practice it is a community change process to protect the environmental, economic, cultural and spiritual values of a lake that melds complex information, community based processes and (in New Zealand) the principles of the Treaty of Waitangi[1].

MANDATE FOR ACTION
Scientific evidence
Lake Taupo is among the very cleanest of lakes in New Zealand (Livingston *et al*., 1986). In Lake Taupo, levels of the plant nutrients nitrogen and phosphorus, and the freely floating phytoplankton whose growth they support, are low (Gibbs, 2002). As a result the water is clear and blue. Most of the nutrient found in the lake enters in the inflowing rivers and streams. Nutrient levels therefore reflect land use in the catchment. Unlike many lakes, phytoplankton growth is nitrogen limited in Lake Taupo (White and Payne, 1977; Hall *et al*., 2002). The relatively higher phosphorus levels found in the lake are derived from the surrounding volcanic sediments.

Historically, the catchment of Lake Taupo was covered in tussock grassland and native forest (Leathwick, *et al*., 1995). Since 1840, much of the tussock has been replaced with pine plantations and pasture (Figure 1). In response to concern about erosion of pumice soils following the development of the Taupo catchment in the 1960s, many streams and eroding hillsides were fenced to exclude stock, and some riparian areas were planted with native wetland species to reduce nutrient runoff to the lake. Even so, nitrogen inflow has increased in all measured streams by between 50% to 300% since the 1970s. Nitrogen concentrations are also increasing in the bottom waters of the lake (19 t/y) as are levels of chlorophyll a (a measure of phytoplankton biomass) by 0.1 mg/m^3/y (Gibbs, 2002). Potentially toxic algal blooms (*Anabaena spp*.) are occurring more frequently. Nutrient dependent slimes and weeds are growing more abundantly near lakeside settlements (Rae *et al*., 2000).

Pastoral agriculture in the catchment is dominated by sheep and beef farming, but intensification and a shift to more intensive dairying began recently (Edgar, 1999). Elsewhere in the Waikato, intensive pastoral systems, especially dairying, release high loads of nitrogen to surface and ground waters (Vant, 1999; Wilcock *et al*., 1999). In contrast, plantation forests yield very low nitrogen loads similar to those from indigenous forests.

1 Founding relationship between the Crown and Maori, the indigenous people of Aotearoa, New Zealand

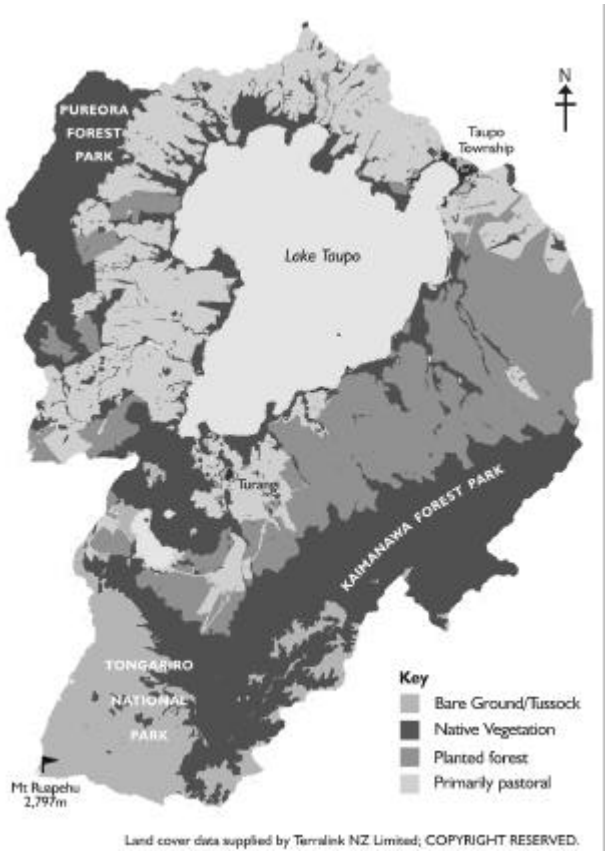

Figure 1: Land use in the catchment of Lake Taupo

Vant and Huser (2000) derived a nitrogen budget for Lake Taupo. They estimate that the current nitrogen load to Lake Taupo is about 1100 tonnes per year. This compares with a predevelopment load of about 650 tonnes per year (Elliott & Stroud, 2001) and the development-induced nitrogen load of about 400 t/y from rural sources and 30 t/y from sewage and urban runoff.

Given the present declines in water quality due to additional nitrogen from current development, plans for pastoral intensification and conversion to dairying are likely to cause further decline in lake water quality. Vant and Huser (2000) estimated that annual nitrogen load to the lake will increase by 630 tonnes, to 1710 tonnes, should 250 km^2 of land suitable for dairying be developed. The effect of this would be a marked reduction of lake water quality becoming apparent first in the embayments fed by nitrogen enriched streams, and later in the better mixed, deep water of the lake. These assessments have been supported by modelling of chemical and biological processes in the lake (Spigel *et al*., 2001).

Determining whether the nitrogen loads from current land development are in equilibrium with those entering the lake is necessary before developing management options to protect the lake. If nitrogen loads are in steady state, nitrogen emissions can be held at current levels with reasonable surety of maintaining lake water quality. If they are not, then an estimate of the nitrogen yet to come is required so that the emissions can be reduced at source by a suitable amount.

The amount of nitrogen yet to come before equilibrium is reached with current land use has been estimated in several studies as being between 10% and 20% (Elliot, 2001); 10% to 40% (Vant, unpublished); and between 30% to ~100% (Vant and Smith, 2002). This evidence suggests that reduction of nitrogen loads of at least a 20 % from urban and rural land is required to maintain the current lake water quality.

Economic imperatives

A concern for the community is the possible economic impact of nitrogen restrictive policies. In 1998, the gross domestic product of the Lake Taupo catchment was NZ$780 million dominated by tourism ($90 million) and forestry ($88 million). Agriculture contributed approximately NZ$18 million (McDermott Fairgray, 1999). These authors examined the economic impacts of several development options for the lake catchment to determine development pathways that were economically viable yet ensured minimum nutrient flows to the lake. Table 1 describes the development options, economic value added and nitrogen emissions from each development scenario. At a macro scale, forestry or tourism development scenarios provide the greatest economic growth opportunities with least nitrogen emissions compared with agricultural development pathways.

Table 1: Economic value added between 1999 and 2030 and nitrogen emissions for development options in the Taupo catchment compared with 1999 values. GDP for 1999 is NZ$780 million.

Development option	Economic value added (NZ$ million)	Nitrogen emissions (tonnes/y)
Current (1999)	-	1100
Moderate[1] agricultural intensification	186	1350
High[2] agricultural intensification	176	1725
Forestry[3]	190	1000
Tourism[4]	272	1100

[1] 10,000 ha of sheep and beef converted to dairy with current forestry area and tourism growth.
[2] 25,000 ha of sheep and beef converted to dairy with current forestry area but current tourism growth ceases at 2020 due to a discernible decline in water quality.
[3] 10,000 ha of sheep and beef land converted to forest with current tourism growth.
[4] Historical tourism growth (4%/y) increased to 4.4% with current agricultural and forestry area

Contrasting the macro scale economic information is the economic impact of nitrogen restriction policies on farms. Thorrold *et al*. (2001) estimated that policies requiring a 20% reduction in rural nitrogen emissions cause a typical sheep and beef farm to become uneconomic and for land values to reduce. More intensive dairy farms remain marginally profitable although land values will reduce, possibly by 25%. Nimmo-Bell (2002) estimated the opportunity cost of nitrogen restriction policies for the farmers to vary between $112 million and $175 million over the next ten years depending on the development scenario forgone.

The economic information shows several sustainable development options are available to the Lake Taupo community in the face of nitrogen restriction policies to protect lake quality. A cost benefit analysis using the economic information available shows that the benefits of restricting nitrogen emissions to Lake Taupo exceed costs by a factor of three (Environment Waikato unpublished data, 2002). However, the economic impact will fall heavily on rural land owners, many of whom lack the resources or desire to fund a change to low nitrogen emitting land uses (e.g. forestry). For many, farming is their lifestyle and livelihood and has been so for decades.

Community perceptions and aspirations

The local people value the lake highly and recognise the role the lake plays in supporting a vibrant and sustainable community. Public attitudes and perceptions were surveyed early in the project giving a robust insight[2] into how the community values the lake (Stewart *et al*., 2000). Of the lake characteristics, clean, clear water was most highly valued (96% of respondents), followed by public access to the lake, natural character and cultural values (especially by Maori). Furthermore, a strong community ethic for environmental protection was identified, with 90% of respondents ranking protection over development. Recognising the implications of placing a priority on protection, 87% of the respondents identified a collective responsibility for protecting the lake.

Although there appears a strong community mandate for protecting the lake, there remains the challenge of supporting pastoral landowners to change their land use when the solution (a reduction of N emissions by 20%) threatens their livelihoods. Their sentiment was expressed simply by one land owner a at public meeting who said "no body here is volunteering to go broke!" Ngati Tuwharetoa express similar concerns. As owners of the lakebed, 55% of the pastoral land and most of the plantation forests in the Taupo catchment, they are acutely aware of the interactions between nitrogen emissions, the productivity of their land, and their desire to protect the lake.

RESOURCE MANAGEMENT FRAMEWORK

New Zealand's main environmental statute is the Resource Management Act 1991, which requires the sustainable management of natural and physical resources. Environment Waikato, the environmental management agency for the Waikato region, proposes, through its polices for water, to protect the water quality of outstanding water bodies. Lake Taupo is one of New Zealand's outstanding water bodies.

Under the Resource Management Act, Environment Waikato's functions also include the control of the use of land for maintaining and enhancing water quality in water bodies. To date this section of the act has been used infrequently in New Zealand as it challenges the presumed property rights of landowners. Furthermore, the development and application of management tools and models to link land use and water quality are only now becoming available for the New Zealand environment.

Process

A traditional, regulatory approach for controlling nitrogen emissions from the lake catchment was unlikely to be effective in promoting change and community acceptance for sustainable development. Instead, a focus on participation, information sharing and involvement in developing acceptable community solutions was pursued, with the hope that the approach would engender self-sustaining change. Initial meetings focussed on the farming community. These meetings

2 (n=650; sample representative of local demographics; 3% margin of error)

were frank, with disbelief and scepticism expressed openly. Scientists and policy analysts were challenged on the facts and were requested to provide further information and undertake new studies specifically in the catchment. These investigations were undertaken and the results reported back by independent scientists and consultants.

The farmers formed a group called Taupo Lake Care to consult with Environment Waikato and to build relationships with other sectors of the community. Taupo Lake Care's goals are to maintain economic viability and flexibility of their farms and maintain the water quality of the lake. Meetings were held monthly and attended by independent, trusted, agricultural scientists and facilitators. The basis for these meetings was that structured, interactive exchange of ideas and views would result in earlier resolution and a better outcome for the stake holders and the lake. Also, a stance of non-engagement and eventual non-compliance with potential regulation, advocated by some farmers, would be avoided. Mutual understanding of each other's points of view has occurred and the relationship built should survive difficult times as policy is developed and implemented (Clark and Lambert, 2002).

Similar processes and relationships were developed with Ngati Tuwharetoa. They expressed deep concerns for their economic well being but balanced with concerns for their toanga[3], Lake Taupo. Central Government officials attended the meetings with Tuwharetoa because of the special relationship between Maori and the Crown.

Environment Waikato also consulted with numerous community groups, industries and service clubs. Principal among these are Lakes and Waterways (a community group concerned with lake health), the dairy industry and professional societies of bankers, real estate agents and accountants.

At a political level, Environment Waikato, Taupo District Council (the local territorial authority), Central Government and Tuwharetoa have agreed on a collective approach to protect Lake Taupo. These agencies recognise the national economic, cultural and spiritual benefit Lake Taupo confers all New Zealanders. To support this belief, all are involved in a community vision setting process (2020 Taupo-nui-a-Tia) and sustainable development planning and funding.

MANAGEMENT PROPOSAL

Protecting the lake is a central part of sustainable development for Lake Taupo's catchment. Any solution to protect Lake Taupo must consider equity, the community's capacity to sustain change, and the social and economic and cultural wellbeing of the local and national communities who value the lake. The proposal to protect the lake involves partnership between local, regional and central Government, and Ngati Tuwharetoa.

Actions

A change in the way urban and rural land is managed is required to reduce manageable sources of nitrogen by 20%. A key premise is that change can be spread over fifteen years (based on the lag times apparent in land and lake biophysical processes).

The management proposal seeks to achieve these changes in urban areas by higher environmental standards for new subdivisions utilising new nitrogen stripping technologies and upgrades to existing septic tanks and community sewage schemes to improve nutrient removal.

For rural areas, the proposal suggests changes to farm management systems so that less nitrogen is leached from existing sheep, beef, deer and dairy land uses, and increasing the amount of land use with low nitrogen leaching losses (e.g. forestry, silage crops or new horticultural crops).

Challenges

In rural areas, the challenge is to find alternative land uses that yield low levels of nitrogen while returning profits comparable with traditional farming. Present alternative profitable rural land uses include: forestry, providing good returns after long periods of investment; and those with potentially extremely good returns but uncertainty about investment costs and future market demand (e.g. horticultural crops and forage export off-farm). The forestry industry also offers untapped potential in downstream wood processing. Further development of tourism and recreation is possible for rural land near the lake.

Upgrading sewage systems is expensive but the new regulations will not affect peoples businesses or livelihoods to the same degree as restriction requiring changed farming practices or conversion of pastoral land. Loss of opportunity costs and value of land are substantial under the proposal and may make many of the farms unviable. Clearly, if nitrogen restrictions are imposed on people without any assistance this could result in adversity, high compliance costs and an uncertain future for the lake and landowners living around it.

3 Treasures, possessions and features of the Maori world

THE PROPOSAL

Leadership by central and local Government.

Central and local Government could achieve the 20 % nitrogen reduction on rural land with no direct cost on existing rural landowners. Public funds are suggested to assist rural land use change by purchase or lease, provided that permanent nitrogen covenants or low yielding nitrogen crops were placed on the land. Mechanisms for public assistance for land use change should be flexible as possible. Purchase of private land voluntarily for sale, followed by conversion to low nitrogen yielding land use, or covenanted and onsold for other ventures, are but two examples.

Research on new farms systems and alternative land uses and market opportunities.

Publicly funded research into the viability of alternative farm systems and to investigate market opportunities will improve profitability per unit of nitrogen emitted from current pastoral systems and reduce the risk of new ventures. One such trial is already occurring on Tuwharetoa land.

Partnership between Tuwharetoa and central and local Government.

The Treaty of Waitangi assures Maori of protection of their natural resources and management and use rights. The land use solutions proposed are being developed within the treaty principle of partnership.

Enhanced recreation and tourism.

Tourism and recreation are already economically important for the Lake Taupo area. The current Government sustainable development initiatives identify actions, agencies and new opportunities to capitalise on the Lake and its environs.

Regulations.

Rules under the Resource Management Act will be introduced that place a catchment wide cap on nitrogen emissions on all remaining farm properties and business, so that total nitrogen emissions can be held at current levels and to assure the effectiveness of the publicly funded land use change. Decision support and nitrogen models (e.g. Ledgard *et al*., 2001) will be used to benchmark and estimate future nitrogen emissions from rural properties. Refinements to existing regulations will be implemented to reduce nitrogen discharges from industrial and urban sources including sewerage and storm water and from on-site sewerage treatment systems and septic tanks.

Achieving national or international obligations.

The land purchased could be retained as public forest parks to assist with national biodiversity objectives or international obligations such as the Kyoto agreement. Government owned land could play an important role in these objectives.

Thus the proposal envisages a 20 % reduction in manageable nitrogen emissions to the lake with the burden of change shared by all in the community. In rural areas, public funds will be used to make the 20% reduction in rural nitrogen emissions by supporting land use change. Continued viability of pastoral land will be supported by publicly funded research of alternative systems. In urban areas, continued community growth will need to be offset by further land use conversions (without public funding) or improvements to existing sewerage treatment systems.

In this way, the benefit of a clean lake accrues to all New Zealanders and sets the local community on a sustainable development pathway assuring protection of the lake. Businesses have the flexibility to operate, provided manageable nitrogen sources do not increase. Nitrogen trading may be an option to ensure economic efficiency in future nitrogen management.

RESOLUTION AND CONTINUING RELATIONSHIPS

Throughout this process of change public agencies have sought to build a long-term relationship with the community. Support from community groups, elements of local and central Government, farmers and Ngati Tuwharetoa, has been essential to achieve the progress to date. Important factors in the relationship include:

- acknowledging the role of Ngati Tuwharetoa as Kaitiaki[4] and principal land owner,
- a willingness to meet with the community at their place to answer questions and concerns,
- a responsiveness to provide new information to clarify their issues,
- providing consistent messages yet acknowledging uncertainty in scientific information,
- involving those sectors of the community facing the greatest change, the farmers, at a science, economic and policy level with sufficient time to cover all issues to their satisfaction.
- utilising local and traditional knowledge, and
- articulation of a long term vision for the community and lake which values the natural resources and the community aspirations.

Time has been necessary for people to move from shock and disbelief to a more receptive state for change. The use of trusted advisors (especially for the rural community) and a sharing in the development of solutions and proposal of

4 Indigenous ethic for environmental management

restricted self-management has increased the sense of self-determination and willingness to buy in to the proposals. Undoubtedly this would not have been achieved under a science dominated and rules based scenario of change.

We are only part way through a community change process. Achieving the changes necessary to protect Lake Taupo will bring significant challenges and draw heavily on community commitment and political will.

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