

## Managing soil biodiversity: The New Zealand experience

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### Abstract

*Species diversity is a very important component of a healthy soil ecosystem, and a necessary condition for long-term sustainable development. However, it is widely recognised that soil degradation and species extinction are on the increase in New Zealand, as land resources come under pressure from urban expansion and modern agribusiness. New Zealand's soils, flora and fauna have evolved many unique elements during their long isolation from other land masses. Habitat destruction and introduced plants and animals have, therefore, had increasingly detrimental effects on indigenous biodiversity. New Zealand must conserve what remains.*

### Introduction

Despite an active official conservation programme, New Zealand soils are under threat. As international experience elsewhere has shown, the conservation of biodiversity draws greatly on the commitment of local land resource users and communities, rather than government intervention or planning regulations alone. Nevertheless, landuse planners and soil managers can have an important role to play in this respect, because they are experienced in mediating between the somewhat incompatible interests of conservationists, resource users and local communities. However, to be effective in this mediation role, New Zealand landuse planners and soil managers have to consolidate their professional skill base with greater awareness of soil biodiversity and ecosystem functions, and with more commitment to the involvement of the indigenous Maori in the process.

The potential for conflict between urbanisation and agricultural production, on the one hand, and the need to preserve soil biodiversity, point to the possible role of landuse planners and soil managers in the areas of process, community consultation,

and conflict resolution. Both landuse planners and soil managers can look for compromises and trade-offs within land production systems that encourage landowners and farmers to retain areas of native vegetation wholly or in part, to restore soil ecosystem functions and allow the survival of some elements of native flora and fauna.

### Soil biodiversity

Despite a widespread perception to the contrary, productive soils in New Zealand are rare, and account for as little as 5% of the country's soils (Hewitt, 1999). From an ecological point of view, it is important to be aware of this situation because identifying sustainable soil productivity allows decision makers to evaluate the economic value of any land area, its versatility, production capacity and environmental (protection) value. Similarly, knowing the geographical distribution of good quality soils would militate against their neglect; and local authorities can develop Regional Policy Statements and District Plans with greater effectiveness.

Traditionally, New Zealand soil managers have been mainly concerned with soil quantity, focusing on erosion control. Now, however, regional environmental policies also require a focus on soil quality (so-called "soil health"). Land managers must maintain the quality as well as the quantity of their soil resource, and there are national and international reasons why the maintenance of soil biodiversity is a desired outcome for New Zealand policy makers. Three biodiversity-related status indicators of soil quality have been proposed by New Zealand's Ministry for the Environment as national indicators of soil health. These are soil acidity, organic carbon loss, and compaction. The most predominant of these indicators of degradation is strong acidity, which often results in mediocre natural fertility. This situation explains the heavy dependence on fertilisers that has characterised New Zealand farming for over a century (Ministry for the Environment, 2000).

For the vast majority of New Zealand soils, the pressure is not spurred by pollution but by degradation or depletion. High acidity, organic carbon loss and compaction, which affect most New Zealand soils, are primarily indicators of degradation rather than pollution. Degradation indicators are of particular significance in soils used for agricultural production and horticulture, where intensive use has degraded these soils to such an extent that remediation may take more than one generation. In an area of Central Otago (South Island), soil scientists used Caesium-137 to estimate soil losses caused by erosion. They measured losses of 25 mm over the previous 40 years, averaging about 0.6 mm per year. Were soil loss to continue at this rate, the region's soil would have a life expectancy of about 100 years (Hewitt et al., 1998).

About 60% of the area of New Zealand is in pasture, and the introduced (largely northern hemisphere) plants forming the basis of these pastures have generally required more soil nutrients than the local soils have been able to provide. High lime and fertiliser rates have been needed to sustain these plants, and it has taken a massive effort by the farming industry to transform and maintain the fertility of the

country's soils. This degree of intervention has resulted in the development of new soil ecosystems that form the basis of the country's relative affluence. However, the new ecosystems are strongly dependent on the continued importation of nutrients, predominantly phosphorus.

As Hewitt (1999) noted:

When we observe the boundary between native ecosystems and derived pastoral agroecosystems, we can readily appreciate the degree of changes that have occurred above ground, and we know about some of the more rapid changes that have occurred in the topsoils: changes to soil organic matter and nutrient levels. But we have no comprehensive understanding of the changes that have occurred below ground. What have we really done over the past 150 years to our soils? One thing we can be reasonably sure of, is that because many soil attributes adjust very slowly to changes above ground, it is likely that soils are still adjusting to changes in land cover that occurred last century and that consequential changes will continue.

Long before New Zealanders heard of globalisation and thought of its ramifications, they had already globalised a large proportion of their country's ecosystems, transforming them into entities totally dependant on nutrient imports. Apart from the obvious ecological risks involved in this trend, this level of dependency on nutrient imports suggests that continuing maintenance of the country's soils is at risk from potential disruption of fertiliser supplies prompted by economic, trade or military crises (Bennett et al., 1999).

The challenge for New Zealand soil managers is to determine the significance of the changes that have already occurred in the country's soil ecosystems: what are the significant land use pressures and how do they impact on key functions in the soil? Although it is difficult to reverse permanent losses when the soil mantle is dramatically stripped by erosion, exposing infertile or rocky substrates, erosion is relatively easy to assess and control when intercepted at an early stage. It is, however, much more difficult to counter losses caused by more subtle soil processes involving damage to soil biodiversity where changes are incremental or masked, and where there is a time lag between the pressure and the response.

Some loss of soil biodiversity may be recoverable, but this assessment is subject to many complicating factors. Soil structures and organic matter levels tend to recover under rotations, but the soil flora and fauna can take hundreds of years to recover and require prolonged, careful management. Another complication that could impede soil recovery is the somewhat unpredictable pattern of soil response to contamination. The soil's capacity to filter contaminants depends on, among other things, acidity and organic matter levels. If contaminated soils become acidified, or if they lose organic matter, they may switch from being a contaminant sink to a contaminant source (Sparling et al., 1998). This process, which has been termed the "chemical time bomb" effect by some scientists, has received considerable attention in New Zealand in recent years.

Loss of soil biodiversity may be masked by management and not noticed by the farmer (Bennett et al., 1999). Consequently, it is possible to continue arable cropping for long periods, with reasonable yields and profit levels, while running down soil health. Although New Zealand soil scientists have made good progress in choosing soil health indicators, they must now make progress in understanding the dynamics of changes induced by loss of biodiversity. This is necessary in order to predict the lag times involved between pressure and response, to anticipate soil resilience to specific land management practices, and to judge the significance of change in terms of its effects on soil ecosystem functions (McIntyre et al., 1996).

Soil plant and animal species evolve and adapt to the physical conditions of their environment over long periods of time, and in turn modify their ecosystem. Ecosystems and communities are, therefore, characterised by dynamic biological and physical processes, and an understanding of these processes is important for managing biodiversity. Healthy, resilient ecosystems are important in maintaining the resources we need (clean air, water and soils), mitigating the effects of pollution, and resisting pests and diseases. Healthy soil ecosystems are equally important for economic, social, cultural and ecological well-being (Forman, 1995). New Zealanders cannot afford to be complacent about their natural heritage, including their country's soil biodiversity, as large tracts of the countryside have become devoid of their indigenous icons. Like most industrialised states, New Zealanders have tended to subordinate nature - the islands' indigenous environments - to production and economic prosperity.

### **Legislation and the role of local government**

The conservation of biological diversity is increasingly recognised by environmental planners as an essential component of sustainable regional development. New Zealand ecologists are generally well qualified to contribute to the development and implementation of national biodiversity conservation plans and strategies. As a signatory to the 1992 Earth Summit agreement, New Zealand has been obliged to prepare "national strategies, plans or programmes for the conservation and sustainable use of biological diversity", according to Article 6 of the 1992 Convention on Biodiversity (World Commission on Environment and Development, 1987).

New Zealand's official environmental agencies act as an important vehicle for biodiversity conservation in a number of ways: by providing a legal mandate to promote environmental protection at local and regional level; by being accountable to individuals and communities for environmental conditions within their local area; by harnessing community involvement in environmental action and, finally, by providing the ongoing care that is necessary for long-term ecological protection and restoration.

In New Zealand, the district plans produced by local authorities are expected to make provision for the protection of native habitat. The techniques employed include the use of schedules of ecologically significant sites, restrictions on the clearing of native forest and provisions for encouraging the protection or restoration of riparian margins. Experience has shown that where the skills of environmental planners and soil managers in relation to community consultation have been fully involved, community acceptance of provisions for habitat protection has been much stronger than in situations where local or regional government have imposed such provisions without community consultation (Holland, 1996).

New Zealand has incorporated the principle of biological diversity within the government's Environment 2010 Strategy. The Strategy includes, as one of its main aims, the protection of 'indigenous habitats and biological resources by maintaining and protecting New Zealand's remaining indigenous ecosystems; promoting the conservation and sustainable management of biological diversity so that the quality of our indigenous and productive ecosystems is maintained or enhanced' (Ministry for the Environment, 2000).

The legislative power of local government in New Zealand is provided through a number of statutes including the Resource Management Act 1991 and the Local Government Act 1974. These laws encourage a degree of environmental responsibility, which is particularly important for soil biodiversity protection because it extends to land in private ownership. The Resource Management Act 1991 requires compliance in all activities relating to the development and use of air, water, soil, land and associated natural and physical resources (apart from minerals), including native plants, animals and ecosystems. The Act states, as a matter of national importance, that, 'all persons exercising functions and powers under it...shall recognise and provide for...the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna'.

However, experience suggests that legal instruments alone are seldom sufficient to encourage greater environmental responsibility towards soil resources. Of equal importance is providing incentives to conserve. Froude (1997) observed that landowners tend to react negatively to regulatory mechanisms of conservation, preferring positive approaches such as incentives and provision of information. Landcare groups have been initiated by some councils as a means of promoting environmental education and individual motivation, and have been shown to be effective (Environment Waikato, 1997).

An increasing number of regional and district plans incorporate policies specifically aimed at protecting 'high class soils' (Hewitt, 1999). Such soils are mainly lost through the construction of roads, housing, and industrial developments. New Zealand's semi-official soil management agency, Landcare Research, has been involved in clarifying the definition of land quality in relation to sections of the Resource Management Act (1991) and in providing expert opinion regarding land quality for specific proposals. Protection of 'high class' soils is based on their perceived value to future generations. Landcare Research scientists have identified

four qualities of a 'high class' soil that determine its importance for sustainable management and its value for future generations. According to this frame of reference, high class soils not only support the greatest range of land uses, but also have greatest energy-use efficiency for crop production, absorb pollutants (thus minimising contamination risks), and are most resilient to land disturbance (Lilburne et al., 2000).

## Maori participation

New Zealand's primary colonial constitution, the Treaty of Waitangi (1840), and subsequent legislation such as the Resource Management Act 1991, the Historic Places Act 1993, and the Maori Land Act 1993 require consideration of Maori cultural, historical, spiritual, and physical values in environmental and social planning. Such consideration extends to wahi tapu (sacred sites), marae (meeting houses), and natural resources such as geothermal areas and indigenous flora and fauna. The presence of this body of legislation and of a growing capacity among Maori to be involved in the process of formulating land management policies, means that Maori concepts of land tenure and sustainable management are receiving increasing attention in New Zealand (Crengle, 1993).

Soil resource managers are now required by law to consider the cultural values and concerns of Maori in relation to land, and Maori are developing an increasing capacity to be involved. This process is likely to increase as the legislation becomes entrenched, and will have flow-on implications for environmental planning requirements as the concerns of Maori become recognised in devising regional plans for biodiversity conservation and landscape protection.

Concern for Maori sensibilities has involved the incorporation of Maori terms within the body of environmental legislation. The historic Resource Management Act (RMA) was enacted "to promote the sustainable management of natural and physical resources". Among the principles articulated by the RMA is that all persons exercising functions under it, "shall recognise and provide for... the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, wahi tapu (sacred sites) and other taonga (treasures)". They must have particular regard to the exercise of kaitiakitanga (guardianship) and must, "take into account the principles of the Treaty of Waitangi". The Conservation Act 1987 is another important piece of legislation that combines concern for Maori principles of resource management, with conservation of natural and physical resources. Section 4 of the Act states that: "This Act shall so be interpreted and administered as to give effect to the principles of the Treaty of Waitangi" of 1840.

The concept of kaitiakitanga is one which perhaps most explicitly reflects and incorporates the relationship between Maori land management and environmental sustainability. It is defined in the Resource Management Act as "the exercise of guardianship; and, in relation to a resource, includes the ethic of stewardship based on the nature of the resource itself". Kaitiaki, or guardians, are those with rights to

ancestral land who are recognised by others of the land-owning group as having special knowledge in relation to the management of resources within that land. They are expected to protect the integrity of those resources in trust for future generations, by drawing on their traditional knowledge of indigenous habitats.

## Conclusion

Landuse planners and soil managers can, and should, adopt methods and principles of planning and design that protect landscape heritage and soil biodiversity. The loss of natural landscape habitats has become a matter of increasing concern at global, regional and local level. It is a particular problem within New Zealand because of the high rates of endemism characteristic of New Zealand (and Australian) species, and their vulnerability to habitat loss and the effects of introduced competitors.

Soil conservation has become widely accepted as a key element of environmentally sustainable development. The governments of New Zealand and its major regional partner, Australia, are both signatories to the UN Convention on Biological Diversity, and have pledged a commitment to promote biodiversity conservation through the protection of natural landscape habitats.

Local and regional government can also be helpful in this regard by introducing bylaws to mitigate the loss of native landscape habitats and soil environments, because they are the levels of government that directly affect actions of private landowners and managers on the ground. The Local Government Act empowers local and regional authorities to raise funds to purchase land for purposes such as riparian protection, while the Resource Management Act allows districts to impose regulations and conditions in certain circumstances, for example, at the time of land subdivision.

In a world where environmental conflicts and economic pressures are likely to grow, planning for preserving landscape heritage and soil biodiversity requires new knowledge and skills in relation to ecosystem processes and species biology. In New Zealand, the requirement for greater understanding of soil biological systems must be matched by a commitment to involve indigenous Maori in the planning process. Future protection of native species and ecosystems is likely to involve the development of systems of co-management where central government and local authorities are prepared to trust local Maori land-owning groups with the management of local biological resources.

Soil managers and ecologists assist in moving concepts and principles to policies and practice, by working to integrate the human considerations with the ecological. They can determine which areas of landuse conflict are based on substantive differences of interest, and which are based on ignorance or lack of information about the ecological value of a soil environment. In cases of major conflict, the resolution of differences can often be achieved by analysing elements of the landscape in terms of their relative value for the wider community. Where it turns out that some fragile

environments are particularly important for the conservation of native habitats, for example, landuse planners and soil managers can include provisions within plans of action that will seek to bring about the protection of such areas, through a combination of regulations and incentives.

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