Environmental performance indicators

Confirmed indicators for air, fresh water and land

October 1998

Signposts for sustainability

You can forward your comments, or a request for further information on the EPI Programme, to:

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About the Ministry for the Environment

- Making a difference through environmental leadership

The Ministry for the Environment advises the Government on policies, laws, regulations, and other means of improving environmental management in New Zealand. The significant areas of policy for which the Ministry is responsible are management of natural resources; sustainable land management; air and water quality; management of hazardous substances, waste and contaminated sites; protection of the ozone layer; and responding to the threat of climate change. Advice is also provided on the environmental implications of other Government policies.

The Ministry monitors the state of the New Zealand environment and the operation of environmental legislation os that it can advise the Government on action necessary to protect the environment or improve environmental management.

The Ministry for the Environment carries out many of the statutory functions of the Minister for the Environment under the Resource Management Act 1991. It also monitors the work of the Environmental Risk Management Authority on behalf of the Minister.

Besides the Environment Act 1986 under which it was set up, the Ministry is responsible for the Soil Conservation and Rivers Control Act 1941, the Resource Management Act 1991, the Ozone Layer Protection Act 1996, and the Hazardous Substances and New Organisms Act 1996.

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Signposts for Sustainability

Introduction

This document is designed to be a concise guide to the environmental indicators which have been confirmed for air, fresh water and land. It explains how the indicators fit into the wider EPI Programme and how the three strands of air, fresh water and land knit together. Finally, it canvasses the next steps from here in the implementation of the indicators that have been selected.

Why do we need Environmental Performance Indicators?

Quantities of information are pumped out each year to help economists monitor the health of the economy. Economists closely examine fluctuations in food prices, house prices, the Consumer Price Index and economic growth.

In comparison, those making decisions about the environment are poorly served in the quality of information they can draw on. The vast majority of environmental monitoring is not coordinated or standardised across the nation, with national environmental information often difficult to assemble.

The Resource Management Act 1991 (RMA) requires the Minister for the Environment to monitor the effect and implementation of the Act and to monitor and investigate other matters of environmental significance as necessary. The Environment Act 1986 also requires the Ministry for the Environment to provide advice on "procedures for the assessment and monitoring of environmental impacts."

Indicators are important because they enable us to detect environmental change through regular monitoring of a few symptoms or signs of change. To be useful nationally, indicators need to be measured using standardised methods and protocols.

The Ministry's Environmental Performance Indicators (EPI) Programme is addressing this need. It focuses on sets of core indicators, corresponding to each of the priority areas identified in the *Environment 2010 Strategy*.

The EPI Programme encourages collaboration between the monitoring programmes of councils and other resource management agencies. In this way, common techniques can

be developed and research and planning can be better targeted and coordinated.

The information from the EPI programme will also form the basis of future national reports on the state of the environment. It will be available to the public through the World Wide Web and can be used for policy evaluation and other purposes.

The first stage is to work on indicators for which data is available now. The next stage is to pinpoint gaps in our environmental knowledge and decide what new monitoring is needed to complete the range of indicators.

First to be implemented will be indicators for air, fresh water, land, ozone and climate change. Next will come the marine environment, waste and terrestrial and freshwater biodiversity. Later will come transport, energy, hazardous substances, and pests, weeds and diseases.

We intend to have a tool-box of core environmental performance indicators available for use by the year 2000.

How did we arrive at the indicators for air, fresh water and land?

In October 1997 we released Environmental Performance Indicators: Proposals for air, fresh water and land, and opened it up to submissions.

The final set of indicators outlined in this document were arrived at through an intensive programme of work with a range of professionals. The aim was to work with others to assess how the proposed indicators could be implemented and to gain endorsement for the core set of indicators from monitoring agencies, such as regional councils.

We have used a consultative approach to confirming these indicators for air, fresh water and land, to ensure we have support for them. Our team visited each region in New Zealand late in 1997 and talked to regional councils and territorial local authorities. In addition, we received 73 written submissions.

The Air Quality Working Group, with representatives from all regional councils, from government departments, Crown Research Institutes and consultants, was involved in developing the air indicators.

Water indicators are being developed with assistance from a riparian assessment working group, a periphyton working group, a macroinvertebrates working group, from a lake

working group and from a water chemistry and statistics working group. These teams were made up of people from councils, industry, green groups and central government.

Land indicators were reviewed by regional council staff, government departments and selected scientists – most from Crown Research Institutes.

We have also involved Maori in the development and confirmation of the air, fresh water and land indicators. Advice has come from Maori consultants and through the Maori Environmental Monitoring Group set up in early 1998.

Have a look at our website for indicators data and more information about the EPI Programme:
www/mfe.govt.nz/monitoring/indicators.htm

Table 1 Summary of confirmed indicators

Air	Stage 1 - ready to implement	Stage 2 - further development required
	Particulate matter (PM_{10}) Carbon monoxide (CO) Nitrogen dioxide (NO_2) Sulphur dioxide (SO_2) Ground level ozone (O_3)	Benzene Particulate matter ($PM_{2.5}$) Lichen diversity/coverage Visibility
Fresh water	**Stage 1 - ready to implement**	**Stage 2 - further development required**
	Dissolved oxygen Ammonia Temperature Clarity Trophic State Index (TSI) % population with good water supply Periphyton (effects of slime on bathing)	Occurrence of native fish • Giant kokopu • Red finned bully Macroinvertebrates (insects in rivers) Periphyton (effects of slime in rivers) Riparian condition Wetland condition and extent Groundwater • nitrates • abstraction quantity Water abstraction
Land	**Stage 1 - ready to implement**	**Stage 2 - further development required**
	Changes in areas susceptible to hill country erosion % change in area of slip at selected sites	Change in area susceptible to high country degradation Acidity or alkalinity of soil Organic matter Change in area susceptible to agricultural impacts Change in area susceptible to reduction in soil health Bulk density of soil pH soil test Organic carbon

Confirmed indicators for air, fresh water and land

Air

What are we aiming for?

Clean air is one aspect of the environment that New Zealanders value highly. The goal set for air quality in *Environment 2010 Strategy* reflects this.

The goal is *to maintain air quality in places that enjoy clean air and to improve air quality in places where it has deteriorated.*

Air quality is governed by the quantity of contaminants in the air from human and natural activities, weather conditions and the formation of other substances through chemical reactions.

Issues in measuring air quality

Our first priority has been to develop indicators that tell us directly about the state of our air. For this reason, most of the indicators selected so far are chemical and physical indicators. They are extremely useful for estimating potential adverse health and environmental effects without having to measure them directly.

All the Stage 1 indicators chosen monitor substances which have the greatest potential to affect human health when present in excessive amounts.

Changes we have made as a result of submissions

We have added benzene, particulate matter ($PM_{2.5}$) and lichen diversity and coverage as Stage 2 indicators as a result of submissions.

Fresh water

What are we aiming for?

Two main policy goals are behind the development of freshwater indicators:

- *to maintain and enhance the life supporting capacity of aquatic ecosystems*
- *to maintain and enhance human uses and values associated with water resources.*

Issues in measuring water quality

Different indicators are needed for different types of waterbody, especially to measure the life-supporting capacity of aquatic ecosystems. Therefore distinct indicators are used for rivers, lakes and wetlands.

Measuring indicators of human uses of water is more straightforward, with the same indicators tending to be used across different bodies of water. For example, the same indicators for bathing suitability can be used in rivers and lakes.

We have used a combination of specific numerical criteria and ecotyping sites to assess the state of the environment. For example, in mudstone catchments, we would use turbidity as a key measure of ecosystem health. In intensive agriculture shingle streams, periphyton (slime) would be the measure.

Ecotyping enables water managers to identify sections of rivers sharing similar ecological characteristics, such as the braided rivers of Canterbury. Ecotyping will help us decide where to monitor and what to expect there.

Where standards are not available, benchmark sites in pristine condition, or representing best management practice, will be used as a basis against which to compare other sites. By comparing with benchmark sites, water managers can assess the condition of a site.

Changes we have made as a result of submissions

Using a native fish, the Giant Kokopu, as an indicator is a world first. A number of submissions have argued that the fish's endangered status makes for too sensitive an indicator. We have responded to these concerns by adding a more common species of native fish, the red-finned bully, as another Stage 2 indicator. An enhanced groundwater indicator has also been added for the second stage.

Land

What are we aiming for?

With an economy heavily reliant on the farming sector, all New Zealanders have a stake in maintaining the quality of our land and soil.

Our goal is *the maintenance and enhancement of the quality, productivity and life supporting capacity of soils and soil ecosystems.*

Issues in deciding on land indicators

Work on land indicators is not as well advanced as that for air and fresh water. Methods for monitoring, reporting and the presentation of indicators all require more development.

Indicators are oriented around four priority soil susceptibility issues: hill country erosion, high country degradation, agricultural impacts on water bodies and the reduction of soil health in intensively used lands.

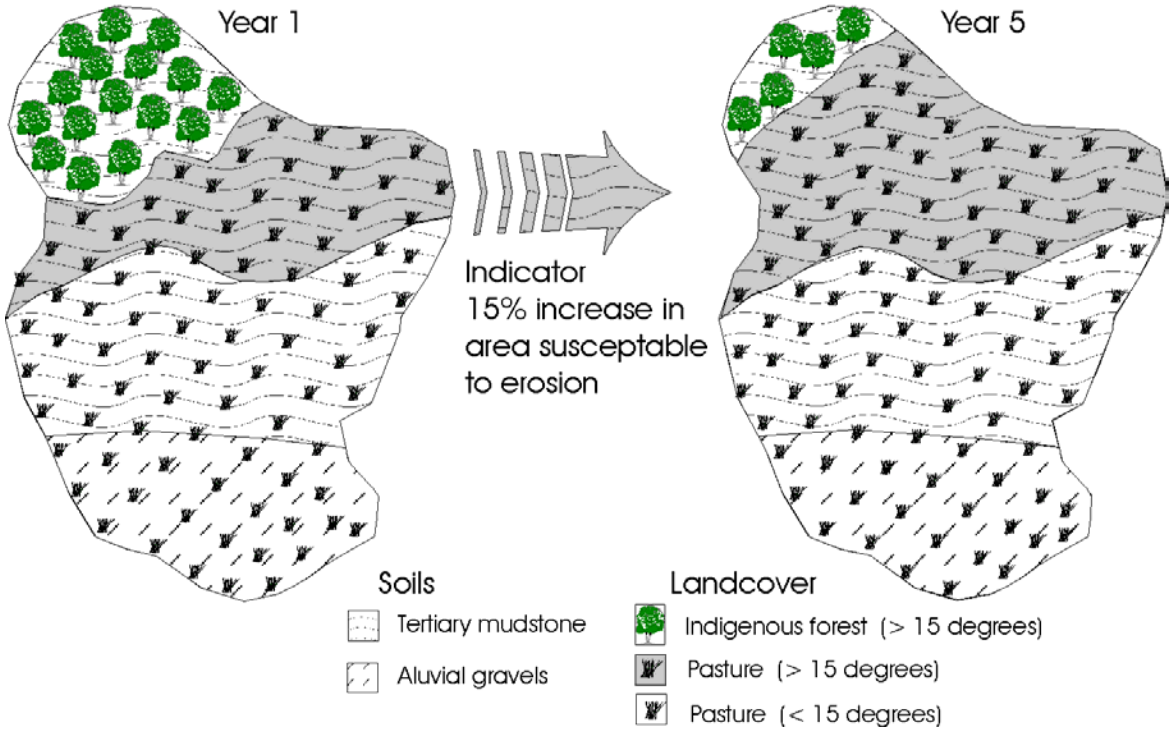
The land indicators hinge on our ability to define the relationship between land use and land capability. Land capability (or susceptibility or risk) is determined by its resilience (how fast soil recovers) and the resistance (the strength with which it withstands pressures) of a soil to a variety of land use practices.

Where soil is at risk, for example if it is susceptible to erosion, selected state indicators are proposed for measurement. These include land slipping, soil carbon and nutrient budgets.

Changes we have made as a result of submissions

We have clarified that the land indicators relate to the three priority areas identified in the Sustainable Land Management Strategy, plus soil health. We dropped some of the proposed state indicators – in particular nitrogen, potassium, phosphorous and wind erosion - because they are not critical to our identified priorities.

Figure 1 : Example of land cover to land capability, susceptability indicator for hill country erosion



Bringing it all together – integrated monitoring

Frameworks that will give us the big picture

A great deal of information about the environment is already being collected, all over the country, by regional councils, government departments and other agencies. Our challenge is to bring that local information together to give a reliable *national* picture of our environment.

Part of the task of drawing up indicators for air, fresh water and land has been to find ways of taking information from individual sites to draw conclusions about a much bigger picture. For example, what do macroinvertebrates and insects in the Waikato River tell us about the health of our waterways generally? And do they tell us the same thing about the water quality in a river in Canterbury?

Spatial frameworks are being developed that will use maps to relate information from different locations. Classification systems are also being developed to allow us to extend information over representative areas.

These frameworks should also allow us to better understand what is "normal" and when indicators are telling us an environmental problem exists.

A framework for air

A monitoring framework for air has been developed, showing how many monitoring sites and what types should ideally be developed for particular pollutants. This "typing" approach is simple for air, and is already being implemented.

A framework for fresh water

We have developed an ecotyping framework for water indicators, starting with rivers. Using this framework, water managers are able to strategically select monitoring sites across a region and provide a defensible basis for extrapolating monitoring data to unmonitored sites.

Trends at one site can be extrapolated to other ecotypes in a region. Councils involved in the ecotyping trial agree that the ecotyping approach provides a far more powerful and effective tool for developing and rationalising monitoring programmes than the tools currently available.

The ecotyping approach may also allow comparisons to be made between rivers in different regions, where the ecotypes are the same. For example, the health of similar river ecotypes in Northland and Southland may be able to be compared, through the ecotyping framework.

Indicators will vary according to the river ecotype (eg large, small, shingle, muddy-bottomed) and the pressure on the river. The indicators we have selected do not need to be measured everywhere, in fact, some are mutually exclusive. For example, some of the biota that are being measured do not occur together in the same type of river. The ecotyping protocol that we are currently developing will guide water managers to collect the most relevant data in a particular location.

A framework for land

The preferred land indicators rely on our ability to define the land use to land capability relationship (that is land susceptibility or risk). Originally developed for agricultural production purposes, the land capability framework can be adapted and updated for the EPI Programme. The key new building block for this system is satellite mapping of land cover.

Land use (land cover) relative to land capability is important because it measures the match of land use to a particular land type. Land pressure indicators can be measured by the percentage change over time to an aspect of the soil condition. The land use/cover to land capability approach applies to both soil intactness and soil health.

As with air and water, the land capability framework is a risk-based approach. Only important parameters are measured at a site in relation to specific land use issues, for example total carbon for soil health. In effect, the land indicators are selected based on the risks imposed by land uses to the soil sustainability and life supporting capability.

How indicators for air, fresh water and land come together

As mentioned earlier, air, water and land are the first set of environmental indicators from a work programme that will ultimately provide a whole array of indicators for taking the pulse of the environment.

One of the most exciting aspects of the EPI Programme is the way indicators will mesh together, throwing forth a rich picture of the environment. Indicators designed directly to measure the health of one aspect of the environment will often also give secondary information about a different

aspect of the environment and the pressures it is facing (see Figure 3).

We can see this already in the way indicators for air, water and land complement each other. A land use indicator designed to measure nutrient levels in soil also gives us information about the pressures our water systems are under as a result of runoff from farmland.

Nitrogen inputs to land from activities such as dairying cause eutrophication in waterways. Figure 2 illustrates how the proposed indicators would track the causes and effects relating to this issue.

As each new set of indicators in the EPI Programme comes on stream, the picture we have will become richer and more complex. Indicators for waste, transport and energy will tell us about some of the pressures on our major resources of air, water and land.

Figure 2 An example of land and water integration

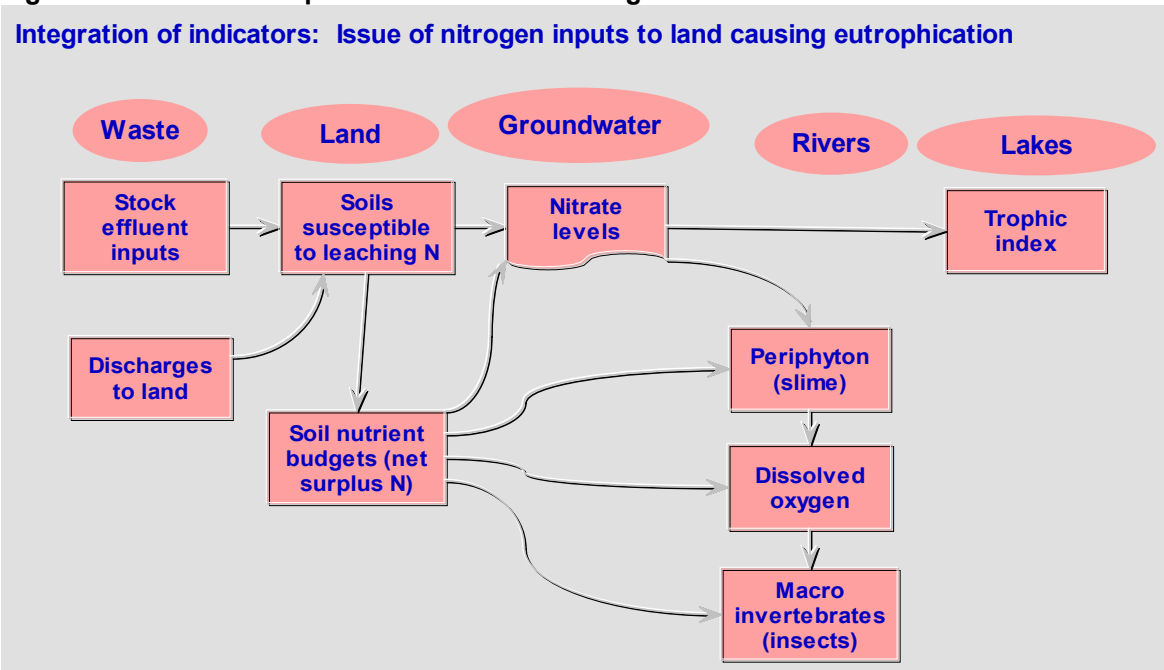
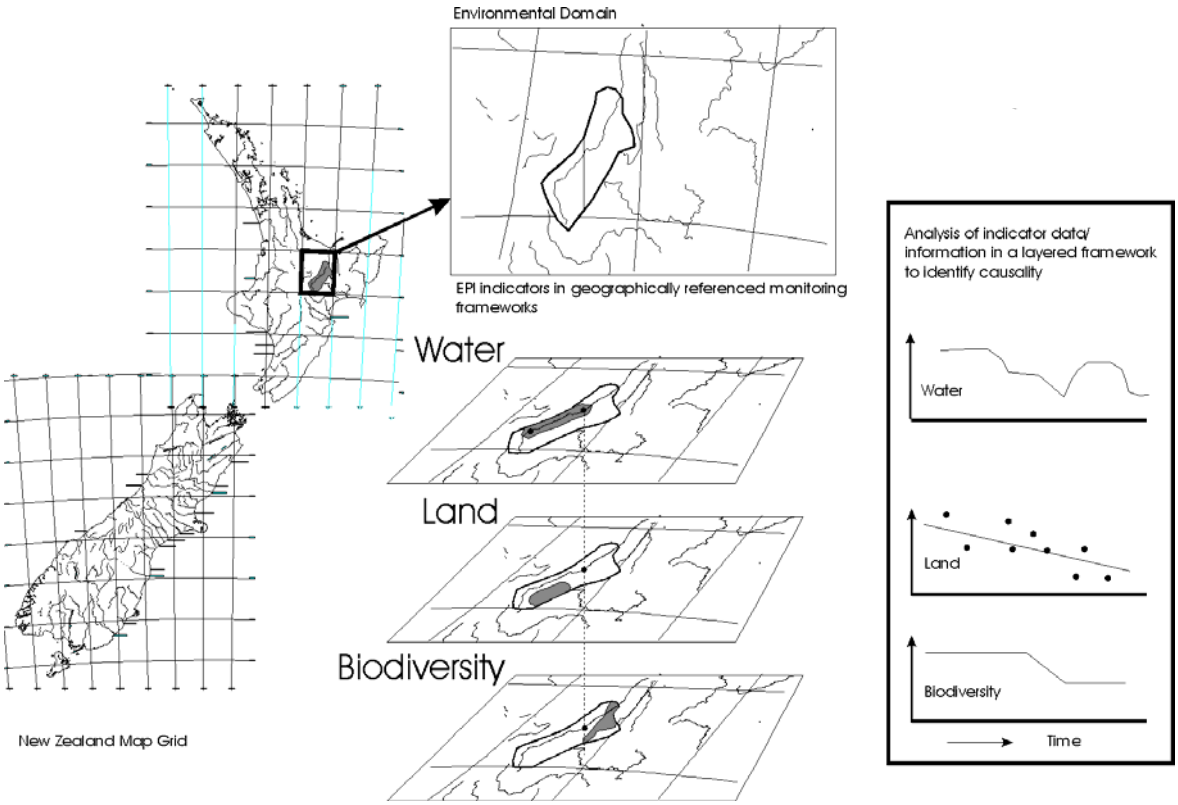


Figure 3: Environmental Performance Indicators Programme Spatial Frameworks and Information Management



What next?

Air

Significant progress has been made towards appropriate indicators for air quality in New Zealand. The stage 1 air indicators appear relatively straightforward to implement and are further developed than indicators for fresh water and land.

We still need to reach agreement with interested parties on the methods, protocols and systems for data collection, storage and access, in order to implement air indicators. Further work is also required to research indicators for human health impacts and to develop methodologies for the Stage 2 indicators.
Further work and discussions with regional councils are required to reach agreement on proposed monitoring methods and monitoring.

Air quality database

NIWA's Air Quality Database will assist with air indicators. Data can be fed into it and downloaded over the Internet, allowing it to be used as a central clearinghouse for air quality data. A number of agencies are keen to provide data to this database and to use it to store and extract information.

Indicators database

This prototype database has been developed by NIWA, and is made up of the "top level" indicator information, consisting of summary tables, graphs and maps. This information can be derived from NIWA's air quality database or directly from council databases. It is currently being trialed with three councils.

Fresh water

Groundwater indicators — Work is underway on strengthening the groundwater indicators in response to feedback that these indicators were insufficiently developed. We need a framework for selecting monitoring sites and aquifer systems to monitor them. Possible groundwater indicators are nitrates, risk of contamination and abstraction.

Giant Kokopu — We need to gain a better understanding of the use of Giant Kokopu as an indicator for ecosystems.

Monitoring sites — We plan to work with councils to identify monitoring sites for fresh water indicators. Initially the priority will be "at risk" and benchmark sites, but once ecotyping work is complete the sites will be reviewed to see whether they meet the needs of ecotyping models. Sampling protocols and laboratory techniques also need agreement with regional councils.

Ecotyping models — These are critical to the development of the freshwater indicators system we propose to develop. Some ecotypes will need to be monitored to check for reliability. An ecotyping pilot is underway with 5 regional councils, with further work planned. We expect to publish a protocol and relevant software in the 1999/2000 financial year, in collaboration with the Ecotyping Working Group.

Macroinvertebrates — Trials are also underway for the RIVPACS predictive modelling approach, with the Macroinvertebrate Working Group. This will be a collaborative project with the Australians.

Periphyton — Work is progressing on finalising a management and assessment protocol in collaboration with the Periphyton Working Group.

Trophic Index for Lakes — Work is underway on developing the manuals and software for the Lakes Trophic Index in collaboration with the Lake Managers Group. We will also need to discuss the desired national coverage for lake monitoring with the Group.

Land

A uniform and comprehensive process for collecting, collating and reporting information on land indicators is still several years away. In the meantime we propose to develop monitoring and reporting protocols with the data that is now available.

Work in the future will progressively develop and improve our reporting and presentation of the proposed indicators.

Trailing of soil health indicators

These trials are underway now on regional indicators which would be complementary to the national programme. Trials are also underway to establish protocols and agreements for collecting indicators from councils and farmers.

Further indicators which relate more specifically to land (eg amenity) rather than soil will be considered in subsequent strands of the EPI Programme, addressing concerns that the preferred indicators here are really about the soil resource.

Olsen P as an indicator

Soil scientists advocate including available phosphate in soil (Olsen P) as an indicator of soil quality. We do not propose to include it as we regard it as primarily an agricultural production measure.

The Land Cover Database

We need to consider the most cost-effective ways for all regional councils to gain access to the LCDB every five years for all classes of land. We also need to develop methods and protocols to ensure that the satellite imagery is used to best effect for the development of land indicators. Finally, we need to identify emerging technical developments of satellite imagery and how the indicator information derived from these images can be best reported and accessed.

Issues relating to hill country erosion

We need to determine which councils have updated soil maps and digital terrain models. We also need to know whether the New Zealand Land Registry Index coupled with the Land Cover Database would be a useful surrogate to determine the causal relationship between land cover/use and soil intactness for all types of erosion-prone hill country.

Work is needed on the process by which benchmark and representative sites will be selected for slip erosion, what degree of coverage is required and how information from these sites will be grouped together and reported nationally. Decisions are also needed on how often data should be collected and reported.

Issues for high country degradation indicators

The key issue is the land use risk, or susceptibility, indicator for high country degradation. We have not yet established a robust methodology for relating land cover/use and soils so that we can map the changes over time.

Considerable work is needed to tailor indicators to give good information about high country soil. Also in question is which localities in the high country will give the most useful information in tracking trends in soil health.

Understanding is limited on the relationships between soil condition and pressures on the soil, such as weeds, pests and sheep.

Given the lack of established methods, indicators for this priority area can only be advanced as part of the Stage 2 land indicator development. Work by Canterbury and Otago Regional Councils could provide a useful model for further development.

Issues relating to agricultural impacts on soil health and water bodies

We need to determine what soils are vulnerable to nitrogen leaching. We also need to identify the unconfined and shallow aquifers at risk from groundwater contamination. Further work is needed to investigate the feasibility and practicality of nutrient budgeting using the OVERSEER decision support system as a pressure indicator of land at a catchment scale.

Decisions also need to be made on the scale of representative and benchmark sites to extrapolate nutrient budget for "at risk' land use areas and catchments. And finally agreement is needed on who will be responsible for monitoring, collecting and reporting this information.

Issues relating to soil health

A susceptibility indicator in relation to soil health needs to be developed. We need to better understand the structural vulnerability and the role of organic matter in soils. We need to identify where these soils are in relation to their susceptibility to land use practices. Further work is needed developing the selection criteria for representative and benchmark sites for measuring soil health indicators. Decisions need to be made on how often measurements will be taken, on how many sites, on what soils and relating to which land use practices. Finally agreement is needed on who will be responsible for monitoring, collecting and reporting this information.