workingpaper

Evaluating the Soil Dataset

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About the Research Project Team

The Resource Project Team comprises of Jessica Prendergast, Nicola Bradshaw, Chris Aitken, Lisa Bazalo, Jean-Charles Perquin, and Steph Versteeg. Each team member has placed a significant amount of time and effort into each Working Paper and the corresponding datasets.

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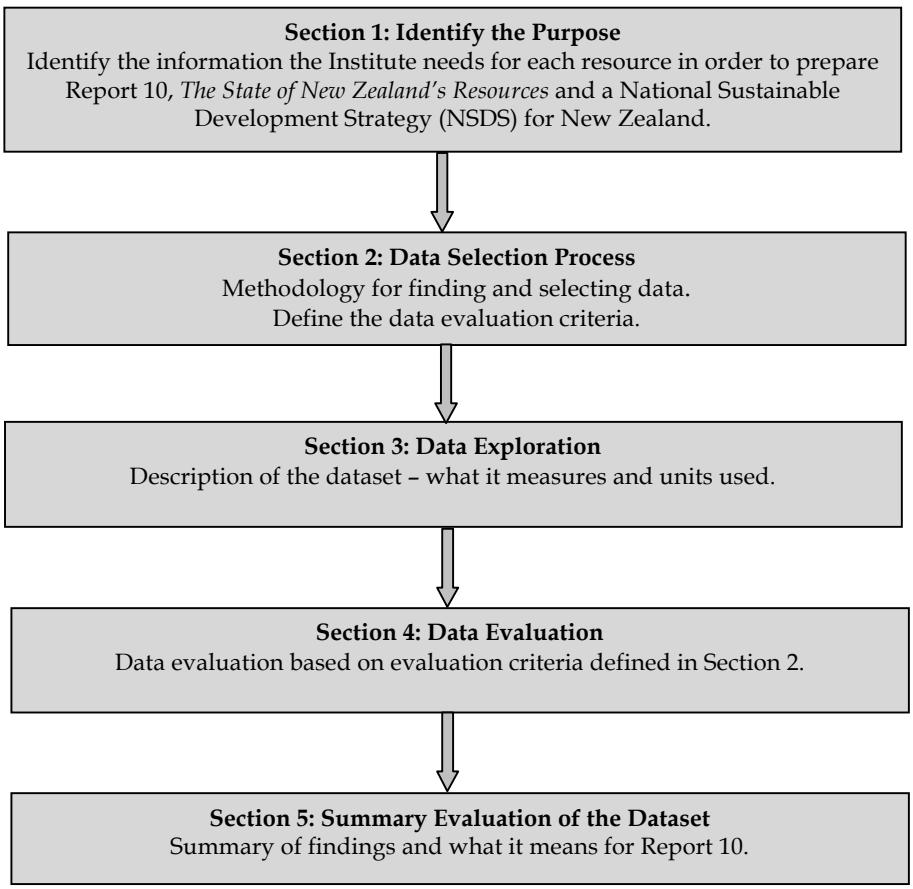
1. Purpose

This Working Paper is one of a series of 11 papers prepared as background to the Sustainable Future Institute's Report 10, *The State of New Zealand's Resources* (SFI, in press). Report 10 aims to provide an overview of available data and information covering a range of resources, and to discuss the use, availability and appropriateness of the data in the preparation of a National Sustainable Development Strategy (NSDS).

The purpose of this Working Paper is to describe the process by which the Institute collected, collated and presented a selection of data on soil health, soils not meeting health target ranges, contaminated sites and soil erosion in New Zealand. The datasets are summarised and evaluated for completeness, accuracy, relevance, appropriateness of sources and public availability. This paper discusses the purpose for which the data was collected by its custodians, and why the Institute has selected this data for it's reporting. The content of the dataset is not interpreted or analysed; rather, our purpose is to evaluate the usefulness of this dataset for the purposes of Report 10.

Following this evaluation any gaps and resulting limitations in using the selected data are assessed, as well as its relevance and reliability in relation to the Institute's purpose of using the comprehensive series of datasets to inform the development of an NSDS for New Zealand.

Figure 1 The Five-step Process for Evaluating the Institute's Datasets



1.1 The Sustainable Future Institute

The Institute is an independently funded think tank based in Wellington, New Zealand. Earlier work by the Institute has indicated that New Zealand is well behind other developed countries on its international obligations to develop and implement a National Sustainable Development Strategy (NSDS) (SFI, 2007). It is hoped that *Project 2058* will help inform ministers, policy analysts and members of the public about key events and trends in New Zealand's past, and alternative strategies for the future. With this in mind, this Working Paper is a step towards the Institute's goal of preparing an NSDS for New Zealand.

1.2 Project 2058

The strategic aim of *Project 2058* is to promote integrated long-term thinking, leadership and capacity building so that Aotearoa/New Zealand can effectively seek and create opportunities, and explore and manage risks, over the next 50 years. In order to achieve this aim, the *Project 2058* team is working to:

1. Develop a detailed understanding of the current national planning landscape, and in particular the government's ability to deliver long-term strategic sustainability thinking;
2. Develop a good working relationship with all parties that are working for and thinking about the 'long-term view';
3. Recognise the goals of iwi and hap□, and acknowledge te Tiriti o Waitangi;
4. Assess key aspects of New Zealand's society, asset base and economy in order to understand how they may shape the country's long-term future, such as government-funded science, natural and human-generated resources, the state sector and infrastructure;
5. Develop a set of four scenarios to explore and map possible futures for New Zealand;
6. Identify and analyse both New Zealand's future strengths and weaknesses, and potential international opportunities and threats;
7. Develop and describe a desirable sustainable future in detail, and
8. Prepare a *Project 2058* National Sustainable Development Strategy. (SFI, 2009: 3)

The culmination of *Project 2058*, the creation of a National Sustainable Development Strategy, depends on having an accurate assessment of key aspects of New Zealand society. Earlier reports have dealt in particular with points 1, 3, 5 and 6 above,[1] and this Working Paper is designed to help progress the fourth point: 'Assess key aspects of New Zealand's society, asset base and economy in order to understand how they may shape the country's long-term future …'

1.3 Soil Resources within an NSDS

Below we ask six strategic questions that drive this research. These are then expanded upon to discuss the use, availability and appropriateness of the data in the preparation of an NSDS. Without accurate, comprehensive, relevant and accessible data to answer the following questions, it will be difficult to develop and execute an informed NSDS for New Zealand.

[1] For a detailed list of published and upcoming reports, see *Project 2058 Methodology: Version 3* (SFI, 2009: 7).

- **What** are the issues facing soil and soil use in New Zealand? Are New Zealanders clear on exactly what these issues are? Does New Zealand have quality data and information to enable us to understand these issues to their full extent? Are New Zealanders able to establish an informed understanding of the priorities?

- **Why** does New Zealand need to confront issues affecting our soil? Are there improvements that can be achieved; or practices that need to change? Are current indicators relevant and meaningful to benchmark changes over time? What is the purpose and the benefit in taking action?

- **When** should New Zealand start to address issues which impact on New Zealand's soil? Is now the right time? Are current economic, social and environmental conditions conducive? Would it be beneficial to wait and monitor events as they evolve? Are current measures and indicators appropriate to monitor developments? Is there a risk of rushing into short-term action when a long-term approach is needed?

- **Where** do New Zealanders most need to concentrate their efforts to address New Zealand's soil issues? Which aspects of the issue should be focused on first? Where should New Zealanders begin to ensure the most beneficial and sustainable outcome? Does New Zealand have sufficient knowledge, based on accurate and appropriate data, to assess outcomes?

- **Who** must be engaged to effectively address issues facing soil in New Zealand? Who needs to be involved if New Zealand is going to successfully tackle these issues? Is data on soil in New Zealand accessible and transparent to allow those interested to be accurately informed? Are data ownership issues affecting public involvement?

- **How** should New Zealand ensure we have effective management of our soil? What is the best approach? What skills or techniques are needed? Does New Zealand have comprehensive and accurate information to enable effective management? How can New Zealand learn from international experience to assist in n the maintenance, protection and improvement of our soil?

This working paper does not attempt to answer the above overarching questions. These overarching questions do however inform our purpose for Report 10 and in progressing an NSDS. Data collected for inclusion within this dataset has enabled us to understand the level of accuracy, relevance, comprehensiveness and issues of ownership that exist surrounding publicly available data in New Zealand. The above questions function as a bridge between the dataset, this Working Paper and Report 10; specific questions pertaining to how the selected Institute's dataset will inform the development of an NSDS are outlined in Table 1.

2. Data Selection Process

2.1 Methodology

Report 10a, Designing a Framework to Monitor New Zealand's Resources (SFI, 2010a) outlined the process through which the Institute developed the framework for collecting and presenting the data. With this framework in place, the steps towards the completion of Report 10 are: (i) building the datasets for the 11 resource types studied; (ii) evaluating the selected datasets, and (iii) reporting on the findings in relation to the Institute's aim of defining an NSDS for New Zealand. The datasets developed in Step (i) are available on our website.[2] This Working Paper is one of 11 that form Step (ii), the data evaluation. Step (iii) will be published in Report 10.

The source data for the Institute's soil dataset was reproduced from a variety of static tables extracted from the Ministry for the Environment's (MfE) and Statistics New Zealand's websites. The tables used are listed on the Institute's website under Project 2058 Publications and State of New Zealand's Resources. The Institute has taken the original data and reformatted it in an Excel spreadsheet to facilitate use and analysis. The original data values have been preserved.

2.2 Sources of Data

The Institute supports the free availability of data relating to environmental statistics. With this in mind, we deliberately used only openly accessible data so that we were able to report on its availability and identify potential gaps. This enables us to report on the implications of using only freely available data, and to evaluate the information that can be extracted from these data sources.

We acknowledge that many sources of information exist on New Zealand soil's that may or may not be publicly available or easily discoverable. Crown Research Institutes (CRIs), universities, national and local government, and other private and public organisations also collect and hold data on soil.

For various reasons including privacy, commercial sensitivity, cost of dissemination or commercial sale price of the data, there are still many datasets on New Zealand's soil resources that are inaccessible to the public. Without extensive research, funding or expertise to assist in the interpretation of the data, many others remain unavailable. The Institute has focused on open data; therefore no efforts have been made to retrieve the other datasets. This is a limitation of this project as gaps identified by the Institute could potentially be filled by these other data sources.

For example, an extensive amount of work is being carried out by Landcare Research. Landcare Research is New Zealand's foremost environmental research organisation specialising in sustainable management of land resources including soil quality. They operate and maintain the New Zealand National Soils Database (NSD) which is described as:

[2] www.sustainablefuture.info

> [A] collection of soil profiles, site descriptions and chemical, physical and mineralogical characteristics for nearly 3000 soil profiles in New Zealand and the Pacific Islands. More than two-thirds of the data relate to New Zealand soils. (Landcare Research, 2003: 5)

It has taken many years to build up the NSD, and it represents about 15 million dollars of information (Landcare Research, 2010a).

The NSD is currently accessible to all Landcare Research staff via the company intranet and will eventually be publicly accessible via the internet, but at this stage users are required to request data each time they seek to access it (Landcare Research, 2003: 5). With Landcare Research's assistance, we have identified the following databases that are relevant to an NSDS. Further research and expert assistance are required to incorporate this data into the Institute's dataset.

Table 1 Suitable Landcare Research datasets for an NSDS

Database	Description
National Soils Database (NSD)	The NSD is a 'point' database containing descriptions of about 1500 New Zealand soil profiles, together with their chemical, physical and mineralogical characteristics (Landcare Research, 2010a).
Soil Fundamental Data Layers (FDLs)	FDLs contain spatial information for 16 key soil attributes. Each attribute is measurable and is recorded in appropriate units of measure. Because attributes have measurable values, FDLs are particularly useful in computer modelling and have enabled researchers and resource management decision-makers to make the most of rapid developments in geographic information system (GIS) technology. Regional soil databases were the key to generating the soil FDLs. New Zealand was subdivided into several geographic regions and soil scientists were allocated a region for which they developed a 'regional legend' (regional database) (Landcare Research, 2010b).
New Zealand Land Resource Inventory (NZLRI)	The NZLRI is a spatial database containing similar information to that in the NZLRI worksheets. There are about 100,000 polygons (map units) within the NZLRI, each of which describes a parcel of land in terms of five characteristics or attributes (rock, soil, slope, erosion, vegetation). These are contained on about 400 worksheets or maps covering the whole of New Zealand (Landcare Research, 2010c).
Ross Sea Soils	Soil data deposited in the Ross Sea region soils database is part of the New Zealand National Soils Database (NSD), a nationally significant database that is managed by Landcare Research. Included in the database are descriptions of over 1000 soil pits at soil sites clustered around ice-free areas, reaching as far south and east as 87° S, 150° E and as far north and west as 72° S, 170° E. For each soil

	pit, site and soil horizons are described in detail. Site descriptions include observations of the surrounding geological, topographic and climatic contexts, and local surface features, site moisture, parent material and biology (Landcare Research, 2010d) .

Due to the limited availability of information at the time of research and data collection on soil quality in New Zealand, the Institute has omitted the NSD data from the Sustainable Future Institute Soil Dataset. Data and information on soil and map layers from Landcare Research is now available through the Land Resource Information System (LRIS) Portal.[3]

Other institutions which have produced information on soil quality in New Zealand include: (i) Massey University's Soil and Earth Sciences Group, which primarily researches the importance of soil and earth processes in the global environment; (ii) The Ministry of Agriculture and Forestry, who provide detailed information on soil that directly affects farming and agriculture; and the (iii) Sustainable Land Use Research Initiative, a new government-funded research programme for maintaining and managing New Zealand soils. This data is all publicly available, but has been excluded from the Institute's soil research and presentation due to their narrow scope and alternative focus on soil quality indicators for environmental management in New Zealand.

To increase soil quality understanding in New Zealand a Sustainable Management Fund Project, *Implementing Soil Quality Indicators for Land* was initiated in 1999. The project, popularly titled and referred to in this Working Paper as the *500 Soils Project*, collected new soil quality data from approximately 500 sites selected by the various participating Regional Authorities from April 1999 to June 2001. Prior to *The 500 Soils Project* there was no nationally consistent or scientifically based soil quality monitoring data for New Zealand.

The data was compiled from *The 500 Soils Project*, a work stream administered by MfE aimed at producing recommendations to help define national soil quality monitoring policy and actions in the future (MfE, 2003). There is however no numerical data available publicly on the web; it is therefore difficult to comment on the completeness and relevance of the dataset.

The Institute searched and compiled the Soil Dataset in 2009. What we have selected and discuss in this Working Paper reflects data fitting our purpose within the environmental data landscape at the time of research.

As data availability increases rapidly on an ongoing basis, it would not be practical to include within this Working Paper all datasets relevant to soil in New Zealand. Report 10 investigates the past, present and future of the environmental data landscape in New Zealand. It also provides a list of alternative sources of information pertaining to New Zealand resources. When appropriate, we have mentioned complimentary data sources in this Working Paper.

[3] The Land Resource Information Systems Portal http://lris.scinfo.org.nz/

Data on New Zealand resources is often produced and targeted to industry experts. This makes a thorough analysis and evaluation of datasets a complex task for the uninitiated. We have referred to the original source documents to support our evaluation of the datasets.

2.3 Soil Dataset Evaluation Criteria

The Institute has developed a series of criteria to support the effective evaluation of its datasets and to consider the data in the context of our wider work programme. Each criterion is supplemented with questions to direct attention to relevant areas for consideration. The aim is to structure the analysis of each dataset in a way that is consistent and replicable across the 11 datasets. In this Working Paper, these criteria are applied to the Soil Dataset as a whole, and to the different indicators and sources that comprise the dataset.

The criteria and guiding questions are noted in Table 2 below.

Table 2 Criteria for Evaluating the Institute's Datasets

Criteria for evaluation	Guiding questions
Comprehensive time series	For how long has the data been collected? Are there gaps in the records? Are data/indicators consistent and comparable over time?
Quality data	What is the scope and range of indicators; are there any gaps? Is data comprehensive and detailed? How is data classified/categorised? Is the data local/regional/national? Is the data internationally comparable and valid? Is the data accurate – is there any sampling bias? Are error bars calculated? Is the data relevant and able to be interpreted with meaning?
Appropriate sources	How many sources are drawn on, and what are they? Who owns the data? Why, how and where is data collected/measured? Is the data original data, self-reported/obtained by survey? Is the data collection and analysis informed by sound assumptions? Is data reliable, independent, verifiable and/or of international standard? Is the data subject to (external) review?
Publicly available	Is the data easy to access? Is it located online, in publicly available reports and database, or within an institution? Is the data freely available?

2.4 Selected Sources

In order to find possible sources of data to establish a baseline portrait of soil in New Zealand, the websites of agencies and organisations with relevant links to New Zealand's soil resources were searched for publications providing information and data on soil health and erosion-prone soil areas. A search was undertaken to find online datasets and statistics, documentation on the data collection and its uses, and specific publications on soil health, quality, contamination and erosion, as well as general publications such as annual reports. The organisations whose websites were searched included, but were not limited to, Statistics New Zealand, the Ministry for the Environment and Landcare Research.

The data for soil health was obtained from the *Soil Health Environmental Snapshot* reports from the Ministry for the Environment (MfE); all other soil data was sourced from the Statistics New Zealand (2008) publication *Measuring New Zealand's Progress Using a Sustainable Development Approach: Topic 5 Land use.*

From the Statistics New Zealand tables used, the data on *soils not meeting target range* and *erosion-prone soil areas* was originally sourced from Landcare Research and the *number of identified contaminated sites by management category* was sourced from regional councils and MfE.

2.5 Purpose for which the Data was Initially Collected

MfE's *Soil Health Environmental Snapshot* reports soil health from approximately 740 sites in 12 regions, sampled by regional councils between 1995 and 2009. The samples represent soils under indigenous land cover and under selected productive land uses. Seven soil measures were monitored to provide information about the organic reserves, fertility, acidity and physical status of our soils. Collectively, these measures can tell us about the health of our soils, and allow changes in soil health due to land management to be detected (MfE, 2010a).

Statistics New Zealand (2008) publication *Measuring New Zealand's Progress Using a Sustainable Development Approach* presents a view of New Zealand's environmental, economic and social progress using a set of indicators covering a wide range of variables relating to sustainable development in New Zealand. The soil data was taken from tables used for Topic 5 of the report which focuses on land use, as land includes soil and rock, plant and animal communities in the soil, and the landforms and vegetation that cover it (ibid).

2.6 Additional sources

The Institute's 11 working papers, prepared as background papers to Report 10, *The State of New Zealand's Resources,* are selective in their use of specific information and data from within a broader pool of information. The boundaries set for these working papers were tightly focused on openly accessible online data available as at February 2009, the original time of data collection for the Institute's accompanying datasets. For further reading and comparisons which fall outside of our collection strategies we suggest the following additional source. Please note that the findings of this source have not been included within this working paper due to the reasons outlined above, but that it is included in the reference list at the back of this paper.

Databases and tools

The Land Resource Information Systems Portal (LRIS) is a project supported by Landcare Research. This portal provides a map of New Zealand that can be overlaid with different national and regional datasets (LRIS, n.d.).

3. Data Exploration

The definitions relating to soil quality that have been adopted for this Working Paper and Report 10 are those used by the MfE and Landcare Research, and are as follows:

- Soil quality: The capacity of a soil to sustain biological production, maintain environmental quality, and promote plant and animal health (MAF, 1996)
- Soil health: (or soil quality) is the biological, chemical, and physical condition of different soil types under specific land uses (MfE, 2007: 225). Monitoring soil health identifies whether soils are degraded and the factors that contribute to degraded soils (MfE, 2007: 240).
- Number of identified contaminated sites by management category: A site is contaminated when hazardous substances are present in the soil and/or groundwater above background levels (at concentrations higher than would naturally occur) (ARC, 2008).
- Erosion-prone soil area: is mainly hill country with a slope of more than 21 degrees. The most erosion-prone hill-country lands are in pastoral land cover and have soils that are known as 'yellow-brown earths' situated on weakly consolidated mudstones and sandstones (MfE, 2007: 226).

A comprehensive understanding of the state of, and trends in, New Zealand's soil resources is vital for future planning. In order to gain this understanding the Soil Dataset is divided into four categories: (a) soil health; (b) proportions of soils not meeting the target range by soil health indicator; (c) number of identified contaminated sites by management category, and (d) erosion-prone soil areas.

Table 3 Soil Dataset Summary Table
Source: SFI, 2010b

Dataset Category	Data Custodian	Data Presented	Dates	Measures	Data Reporting Frequency
Soil health	Ministry for the Environment	Total carbon content Total nitrogen content pH in water Olsen phosphate Mineralisable nitrogen Macroporosity	N/A	Milligrams per cubic centimetre (mg/cm^3), pH Micrograms per cubic centimetre (□g/cm^3), Percentage of pore volume (%v/v)	N/A
Proportions of soils not meeting target range by soil	Landcare Research. Data published in Statistics New	Acidity Organic resources Fertility	One data point covering 1995–2001	Percentage	Single data point only

health indicator	Zealand (2008)	Physical composition			
Number of identified contaminated sites by management category	Regional councils and MfE. Data published in Statistics New Zealand (2008)	Cleaned sites Actively managed sites Not cleaned or actively managed	2007 and 2009	Number	Two data points only
Erosion-prone soil areas	Landcare Research. Data published in Statistics New Zealand (2008)	North Island South Island Total	1997 and 2002	Hectares (ha)	Two data points only

Soil Health

Soil health is a good measure to determine if soil is in good condition for its current land use. The soil health indicator is based on six key soil chemical, physical and biological characteristics, (i) total carbon content, (ii) total nitrogen content, (iii) pH in water, (iv) olsen phosphate, (v) mineralisable nitrogen, and (vi) macroporosity. No national data was presented in this category of the Institute's dataset, however regional data is available from MfE's *Soil Health Environmental Snapshot,* which reports soil health from approximately 740 sites in 12 regions, sampled by regional councils between 1995 and 2009.

Proportions of soils not meeting target range by soil health indicator

Data is only available for a single point from 1995 to 2001 for this category of the dataset due to the limited information in the Statistics New Zealand publication the source for this data (Statistics New Zealand, 2008). Data is assessed against guideline values, which differ depending on the land use and the type of soil. Soil health is measured in four categories; (i) acidity, (ii) organic resources, (iii) fertility, and (iv) physical composition. Soil health is assessed under the land use types of (i) crops and horticulture, (ii) pastures, (iii) production forestry, and (iv) native forests. The better the measured soil characteristic matches the guideline value for its current land use, the better the soil health. Scores for individual soil health characteristics are grouped together for each land use to give the percentage of a region's land area that meets (or fails to meet) soil health guidelines. This is expressed as either 'satisfactory' soil health or soil health that is 'of concern'. An excerpt from the Soil Dataset, 'proportions of soils not meeting target range by soil health' indicator, is provided in Figure 2 below.

Figure 2 Excerpt from Soil Dataset: proportions of soils not meeting target range by soil health indicator
Source: SFI, 2010b

Indicator	Attribute			1995-2001	Data source table #
1.2 proportions of soils not meeting target range by soil health indicator	acidity	crops and horticulture	%	1	11g
		pastures		0	
		production forestry		8	
		native forests		9	
	organic resources	crops and horticulture		14	
		pastures		36	
		production forestry		30	
		native forests		26	

Number of identified contaminated sites by management category

Data is only available for two years, 2007 and 2009, for this category of the dataset. Data is measured in a number of sites in the three categories of: (i) cleaned sites, (ii) actively managed sites, and (iii) not cleaned or actively managed sites. Statistics New Zealand (2008: 55) notes that the 10 regions with data for 2006–07 were Auckland, Waikato, Bay of Plenty, Hawke's Bay, Taranaki, Wellington, Tasman, Marlborough, Canterbury, and Otago. In 2009, data for Manawatu-Wanganui was also included. Data is collected by the regional councils with assistance from MfE. The Resource Management (RMA) Act has included the following definition of contaminated land since 2005:

> contaminated land means land that has a hazardous substance in or on it that—
> (a) has significant adverse effects on the environment; or
> (b) is reasonably likely to have significant adverse effects on the environment.[4]

However, there is no national environmental standards that set maximum levels for contaminants in soil, and as such councils may have used different guidelines for reporting (Statistics New Zealand, 2008: 57). An excerpt from the number of identified contaminated sites by management category dataset is provided in Figure 3 below, only values from 2009 have been included for representation purposes.

Figure 3 Excerpt from Soil Dataset: Number of identified contaminated sites by management category
Source: SFI, 2010b

Indicator	Attribute		2009	Data source table #
1.3 number of identified contaminated sites by management category	cleaned sites	number of sites	663.00	11h
	actively managed sites		760.00	
	not cleaned or actively managed		472.00	

Erosion-prone soil areas

Data is only available for two years, 1997 and 2002, for this category of the dataset. Data is measured in hectares (ha) under the two categories of: (i) North Island, and (ii) South Island.

[4] Resource Management Act 1991 No 69 (as at 16 December 2010), Public Act, Part 1 Interpretation and application.

Erosion-prone land is mainly hill country with a slope of more than 21 degrees. The most common erosion-prone hill country lands are in pastoral land cover, where soils are known as 'yellow-brown earths', and are situated on weakly consolidated mudstones and sandstones (MfE, 2007:226). Land cover is used to assess the soil intactness of erosion-prone soil areas. Landcare Research identifies hill-country pasture from the national Land Cover Databases (LCDB), and its erosion potential is graded as 'severe', 'very severe', or 'extreme' depending on its slope, the underlying soils, and any limits to land-use capability (ibid.). While potential erosion will remain the same irrespective of time, an extreme weather event of land cover change may influence actual erosion. Other forms of soil erosion, such as wind erosion, are not included within the statistics. An excerpt from the erosion-prone soil areas dataset is provided in Figure 4 below, only values from 2002 have been included for representation purposes.

Figure 4 Excerpt from Soil Dataset: Erosion-prone soil area
Source: SFI, 2010b

Indicator	Attribute		2002	Data source table #
1.4 erosion-prone soil area	north island	ha	799,154.00	11i
	south island		341,213.00	
	total		1,140,367.00	

4. Data Evaluation

In this section we evaluate the data presented in the Soil Dataset based on the criteria set in Table 2.

4.1 Comprehensive Time Series

Lack of consistent or scientifically based soil quality monitoring data for New Zealand
Soils can take thousands of years to develop and mature. Production levels are directly affected by soil health, and land management activities affect the biological, physical and chemical composition of soils (Landcare Research, 2010b). It is necessary to have an up-to-date dataset that accurately records the decline or increase in the quality of our soil health indicators. The data provided by Statistics New Zealand and MfE in their reports is not comprehensive enough to make a thorough assessment of soils. Other sources need to be consulted to fill this gap.

Lack of time series data
A consistent problem across all the indicators is the absence of data over a significant duration to allow time series analysis and to assess changes over time. For each category, data is only either unavailable or available for one or two points in time. Original data sources and further research is necessary to establish time series analysis for all selected variables. It is also important to note that the inherent soil variability may be greater than soil variability with time.

Approaching issues of sustainability and change over time where data is predominantly viewed as relatively static spatial information.

Landcare Research is responsible for a number of national, regional and local scale soil data sets. These include both point data sets (e.g. the NSD and 500 soils) often with complex and rich attribute information pertaining to single locations in space and time. Landcare Research also maintains a number of polygon and raster data sets which contain spatial representations of soils data and knowledge with varying degrees of precision, accuracy and spatial extent. In many cases, particularly where data of national extent is involved, these spatial representations have been derived by modelling and spatial interpolation of the rich attribute data held in the point data sets, along with knowledge derived from detailed scientific research. This is the process by which the Fundamental Soil Layers were derived from the NSD and the New Zealand Land Resource Inventory. The same process could possibly be used to derive spatio-temporal views of parameters such as soil health. While not as effective as extensive and comprehensive long-term monitoring programs, a best estimate can be derived by leveraging existing data and research to minimise expensive and time-consuming collection of new data.

No public data available for the sites sampled for soil health and only single or two data points for other indicators

There was no data publicly available for soil health at the time of research due to the limited publicly available information and statistics at time of research and the proportions of soils not meeting target range by soil health indicator dataset has only a single data point reported. Both the 'number of identified contaminated sites by management' category, and the 'erosion-prone soil area' category in the dataset only report data for two years. Such a time frame cannot be representative of soil quality, especially in regards to contaminated sites as contamination can vastly affect soil health in a rapid space of time.

The lack of data renders the establishment of trends over time impossible without additional information. This does not necessarily represent a lack of monitoring, but more likely difficulties in synthesising and summarising data for public use.

The lack of data can be clearly shown through the changes to the number of contaminated sites. In 2007, 10 of the regional councils in New Zealand reported that 1,238 sites had been confirmed as contaminated, with 545 of these having been cleaned and 301 being managed to ensure they do not significantly affect the environment. In 2009, 11 councils reported a total of 1,895 contaminated sites, with 663 having been cleaned and 760 being actively managed (Statistics New Zealand, 2008: 55). More accurate and consistent data is required or needs to be made available to effectively manage the remediation of soils and track progress achieved over time.

A measure of our knowledge of contaminated sites

The past use of chemicals in industry, agriculture and horticulture in New Zealand has left a legacy of soil contamination in New Zealand (MfE, 2010a: 7). It is widely accepted that many sites of soil contamination remain unidentified and it therefore uncertain how many sites are potentially affected. As more historically contaminated sites are identified and our knowledge increases additional contaminated sites are likely to be identified. Data selected represents the state of our knowledge of contaminated sites in New Zealand at the time the

data was collected and within the methodological parameters rather than the actual number of contaminated sites. With an increase in the identification of contaminated sites the number is likely to rise in the medium term. Thus, even if data were available to complete a time series analysis it would not provide information on the actual state of contaminated soil in New Zealand. There is currently a lack of clarity over soil contamination standards. In 2010 MfE released a discussion document titled *Proposed National Environmental Standard: for Assessing and managing contaminants in soil*. This document proposes a system to 'appropriately identify' and assess soil contamination (MfE, 2010b).

4.2 Quality Data

Incomplete dataset
The Soil Dataset as a whole is incomplete. Further research by the Institute is necessary to fill the gaps in the Soil Dataset and consultation with Landcare Research, MfE and other organisations involved in soil health work will be essential to fill the gaps

Data only suitable for a basic overview of soils in New Zealand
The limited amount of publicly available data on soil health makes it difficult to assess whether the soil dataset is consistent, accurate or comparable for future analysis and planning. As a result, the Institute was unable to construct a complete soil health dataset. The MfE website provided some background information on soil, based on selected environmental indicators, but the complete source data was not included; rather, only a data summary was presented (MfE, 2010a).

Overall, the figures and analysis provided on the MfE website were useful to users who were seeking a general overview of the state of New Zealand's soil. For those with a more specific purpose the information was somewhat ineffective due to the lack of the quantitative and measurable raw data required to allow independent assessment and analysis.

Sampling methodology for erosion-prone soils (Statistics New Zealand, 2008) not provided
The methodology for this measure was not provided in the report.

Sampling methodologies provided for the *Soil Health Environmental Snapshot* (MfE, 2010a), *Soils not meeting target range* (Statistics New Zealand, 2008) and *Contaminated soil sites* (Statistics New Zealand, 2008)
Basic sampling methodology overviews were provided for most of the reports used to obtain data for the Institute's Soil Dataset. The sampling methodology for MfE's *Soil Health Environmental Snapshot* appeared comprehensive; however the raw data is not publicly available with only key points and summary figures and trends provided (MfE, 2010a). The sampling methodology for soils not meeting target range is summarised but not sufficiently defined to make any informed assessment (Statistics New Zealand, 2008: 57).

Different guidelines used by councils when assessing contaminated soil sites
Data collected by the regional councils who contributed to the national statistics on contaminated soil sites (Statistics New Zealand, 2008) were not working under national guidelines as mentioned above in Section 3. Inconsistencies in reporting standards can cause sampling and reporting bias.

4.3 Appropriate Sources

Inaccessibility of original sources

The Institute has used data reported by third party organisations and not the original sources of data for all of the variables included within the Institute's Dataset. Original sources were cited, but not published freely and openly, or could not be found at the time without further extensive research. This prevents the methods and purposes of data collection being examined with extra detail.

4.4 Public Availability

All data publicly available and well documented

It is the aim of this project to assess publicly available data, i.e. data that is able to be accessed by parties independent of those who collect or present it. Both MfE's and Statistics New Zealand's reports fit this criterion; the reports are freely available to the public via each agency's website.

General overview of soil data provided but detailed and comprehensive soil information held by MfE and Landcare Research not available

Although the MfE and Statistics New Zealand reports were easily accessible on the internet, the original data and accompanying comprehensive methodologies were not. Referencing and cross-referencing for the data was also unclear in places which made it difficult to trace data sources at times. Further research and expert advice from MfE and Landcare Research is necessary to provide complete information for the Institute dataset.

5. Summary Evaluation of the Dataset

The Institute chose data on soil in New Zealand from MfE and Statistics New Zealand reports to inform its upcoming Report 10 and an NSDS. However these sources are incomplete and only provide snap-shots of information. The source data, particularly pertaining to all the sites sampled, was not publicly available at the time of research. Additional information, in particular from Landcare Research and MfE, is required to complete the Institute's Dataset and to provide a comprehensive overview of soil health in New Zealand. Table 4 below summarises the Institute's evaluation of the dataset.

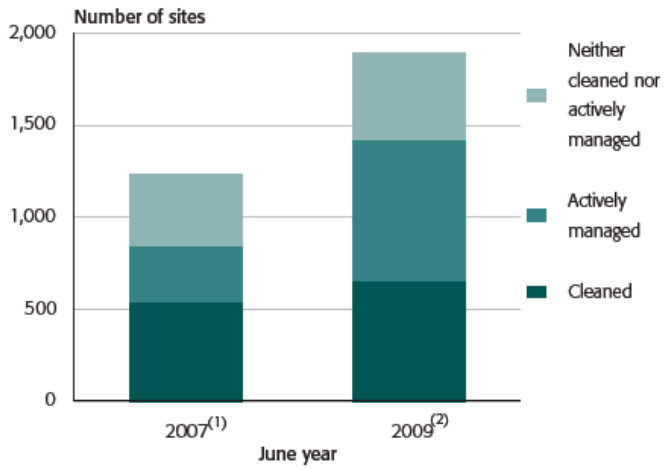
Table 4 Summary of Soil Data Evaluation

	Strengths	Weaknesses
Comprehensive time series		▪ Lack of consistent or scientifically based soil quality monitoring data for New Zealand ▪ Incomplete sources of information from the MfE and Statistics New Zealand reports ▪ Lack of time series data ▪ No public data available for the sites sampled for soil health ▪ One or two data points available for the 'soils not meeting target range', 'contaminated sites' and 'erosion-prone soils' indicators ▪ A measure of our knowledge of contaminated sites
Quality Data	▪ Data only suitable for a basic overview of soils in New Zealand ▪ Basic sampling methodology overviews were provided for most of the reports	▪ Incomplete dataset ▪ Data not suitable for a comprehensive portrait of New Zealand soils ▪ Sampling methodology for erosion-prone soils not provided ▪ Sampling methodology for MfE's *Soil Health Environmental Snapshot* appeared comprehensive but raw data not available ▪ Sampling methodology for soils not meeting target range summarised but not well defined ▪ Different guidelines used by councils when assessing contaminated soil sites
Appropriate Sources		▪ Inaccessibility of original sources
Publicly available	▪ All data reported was publicly available and well documented	▪ General overview of soil data provided but detailed and comprehensive soil information held by MfE and Landcare Research not available

The Institute acknowledges that other sources will need to be consulted in order to gain a complete and comprehensive overview of soil in New Zealand. The Institute's dataset does not answer the questions outlined in Section 1.3, but can provide limited background statistics to support analysis, reporting and argumentation. An example of how the data may be used is presented in Figure 5.

Figure 5 Identified Contaminated Sites by Management Category, 2007 and 2009 June Years

Source: Statistics NZ, 2008: 55



(1) Four regions combined the categories 'cleaned' and 'actively managed'; these are classified as 'cleaned'.

(2) Two regions combined the categories 'cleaned' and 'actively managed'; one of these is classified as 'cleaned' and one as 'actively managed'.

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