

Soil State in the Marlborough Region, 2002 – 2005



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Environmental Science and Monitoring Group



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Executive summary

Regional Councils (and Unitary Councils) have a responsibility for promoting the management of the natural and physical resources of their region. One of the physical resources that we have a duty under the Resource Management Act (1991) to monitor in the region is the “life supporting capacity of soil” and whether current practices will meet the “foreseeable needs of future generations”.

In line with these monitoring requirements, one of the key objectives in the current Marlborough Regional Policy Statement is ‘Soil Productivity and the Avoidance of Soil Erosion and Degradation’. While the Council have some information about potential soil degradation in the region by way of its soil quality monitoring program, it is recognized there is a dearth of recent information about the amount and type of soil erosion in Marlborough. Specifically how well soil is being kept in place as a resource for farming, forestry and conservation and how much soil is being lost through natural erosion, deposition, or land use-related disturbance.

To gain a better understanding of soil stability across the Marlborough Region, in 2009 a survey was undertaken applying a point sample analysis technique using region-wide aerial photography taken between 2002 and 2005. The survey was undertaken in accordance with the National Land Monitoring Forum’s (NLMF) methodology for point sampling (NLMF 2009) and is similar to surveys that have been undertaken in several other regions.

The monitoring area was defined by the boundaries of the region that the Marlborough District Council has statutory responsibility for managing. Within this area, soil stability was assessed by evaluating soil state at 1844 points, distributed at 2 km intervals on a map grid. Soil state characterises whether soil at a given site is on i) stable surfaces i.e. vegetated ii) erosion-prone unstable surfaces i.e. inactive vegetated surfaces iii) eroded, unstable surfaces i.e. recently disturbed and re-vegetating iv) eroding, unstable surfaces i.e. freshly disturbed and bare. In addition various other data were collected at each sample point including landform, landuse, vegetation type and importantly a measure of the nature of disturbance i.e. natural disturbance or land use disturbance. Although spatially regular this sample design was random with respect to land use and other factors that are unrelated to map grid and represented coverage over 70% of the Marlborough region which is the total area for which ortho-photographs were available for the 2002-2005 interval.

The results of the survey indicate that:

- 52.5% of the region’s sample points are on stable surfaces of which 41% is intact soil that is well vegetated and 11.4% is soil currently disturbed by land use.
- 11.5% of the region’s sample points are on erosion-prone but inactive surfaces of which 8.8% is intact soil that is well vegetated and 2.7% is soil currently disturbed by land use.
- 36.0% of the region’s sample points are on actively eroded and eroding surfaces of which most sample points i.e. 34.1% of the region have soil freshly disturbed by natural erosion processes.

Land use related disturbance was present on 14.1% of land in the Marlborough region.

Soil actually bared equated to 1.47% of the region’s area and included contributions from:

- Farm and forest tracks which are present on 10.5% of the region’s land and expose bare soil on 0.87% of the region’s area.
- Livestock grazing pressure is present on 1.9% of the region’s land and exposes bare soil on 0.17% of the region’s area.
- Cultivation and harvest (including forest harvest) collectively represent 1.1% of the region’s land and are responsible for bare soil on 0.30 and 0.05% of the region’s area respectively.
- Earthworks occupy 0.6% of the region’s land and expose 0.08% of the region’s area.

Land disturbance by natural processes of erosion and deposition is present on 34.1% of land in the Marlborough region. Soil actually bared equates to 10.08% of the region's area and included contributions from:

- Bare rock and scree, which are by far the most widespread form of disturbance by natural processes and present on 11.3% of the region's land and equate to 6.98% of the region's area.
- Slope failures are also a major form of natural disturbance. Landslides, debris avalanches and slumps or earthflows are collectively present on 8.5% of the region's land and expose bare soil on 0.73% of the region's area.
- Sheetwash is also a major form of natural disturbance being present on 7.0% of the region's land and expose bare soil on 1.01% of the region's area.
- Riparian erosion and deposition are present on 5.6% of the region's land, with deposits of sand, silt or gravel along watercourses together with bank scour and collapse accounting for bare soil on 1.19% of the region's area.
- Tunnel gullies (under runners) and gullies are a relatively minor component accounting collectively for 1.6% of the region's land and responsible for bare soil on only 0.14% of its area.

The results of this survey have produced baseline data for soil state in the Marlborough Region that can be used for State of the Environment (SoE) reporting and can now be applied again in the future to measure any change in soil state in Marlborough when new region-wide aerial photography becomes available.

1.0 Introduction

Regional councils (and Unitary Councils) have a responsibility for promoting the sustainable management of the natural and physical resources of their region. One of the physical resources that we have a duty under the Resource Management Act (1991) to monitor is the “life supporting capacity of soil” and whether current practices will meet the “foreseeable needs of future generations”. The results of soil monitoring provide information that can be used to change or prioritise the way we manage the land environment. Furthermore, trends determined by the monitoring of soils can be used to develop policies or rules that will protect the sustainability of our land resources.

To help determine what effect land use practices are having on the health of soils in the region, in 2000 the Marlborough District Council began a soil quality monitoring program. To date soils have been sampled from 60 sites in Marlborough across a range of land use activities. However this monitoring program does not provide any indication about soil stability in our region, specifically how well soil is being kept in place as a resource for farming, forestry and conservation and how much soil is being lost through natural erosion, deposition, or land use-related disturbance.

To gain a better understanding of soil stability across the Marlborough Region, in 2009 a survey was undertaken applying a point sample analysis technique using region-wide aerial photography taken between 2002 and 2005. The survey was undertaken in accordance with the National Land Monitoring Forum’s (NLMF) methodology for point sampling (NLMF 2009) and is similar to surveys that have been undertaken in the Manawatu-Wanganui, Auckland, Gisborne, Waikato, Wellington, Tasman and Bay of Plenty regions between 1997 – 2009.

The monitoring area was defined by the boundaries of the region that the Marlborough District Council has statutory responsibility for managing. Within this area, soil stability was assessed by evaluating soil state at 1844 points, distributed at 2 km intervals on a map grid. Soil state characterizes whether soil at a given site is on i) stable surfaces i.e. vegetated ii) erosion-prone unstable surfaces i.e. inactive vegetated surfaces iii) eroded, unstable surfaces i.e. recently disturbed and re-vegetating and iv) eroding, unstable surfaces i.e. freshly disturbed and bare. Although spatially regular this sample design was random with respect to land use and other factors that are unrelated to map grid and represented coverage over 70% of the Marlborough region which is the total area for which ortho-photographs were available for the 2002-2005 interval.

1.1 Objectives

The objectives of this study are to firstly obtain an estimate of soil state in the Marlborough region that can be used for State of the Environmental (SoE) reporting. Secondly to characterise soil disturbance using factors such as land use, vegetation cover, landform and erosion type. The third objective is to establish a regional soil stability monitoring program that can be used into the future that is technically sound, statistically robust, provides easily understandable data, and can be undertaken at an acceptable cost.

2.0 Survey Method

2.1 Background

The measurement of soil state from aerial photographs was undertaken using a point sample analysis technique. This is a statistical technique that has long been applied in the natural sciences to extract sample data from field sites, maps or aerial photographs. The technique used in this survey has been designed to measure soil intactness and soil disturbance by sampling within a specific area. It does not identify all sites within a region where disturbance currently occurs, but for a range of land use it aims to:

- identify past land disturbance by assessing landform stability

- measure current soil disturbance by assessing the extent of visible soil disturbance caused by natural erosion processes e.g. landslides and land use activities e.g. tracking

The sampling method involved the use and interpretation of digital ortho-photographs (rectified aerial ortho-photographs) by on-screen viewing through GIS software, with direct entry of data into a GIS-linked database. Viewing was undertaken at a scale of 1:5000 zooming to larger scales to inspect detail at points when necessary and to smaller scales to view points in the context of surrounding terrain.

For further details about the procedure refer to the National Land Monitoring Forum Manual (2009).

2.2 Monitoring area

The monitoring was defined by the boundaries of the area that the Marlborough District Council has statutory responsibility for managing. Within this area, soil state was assessed at 1844 points, distributed at 2 km intervals on the NZTM map grid (Figure 1). Although spatially regular this sample design was random with respect to land use and other factors that are unrelated to map grid. This represents coverage over 70% of the Marlborough region which is the total area for which ortho-photographs were available for the region for the 2002-2005 interval.



Figure 1 Map grid sheet with a 1 hectare square sample point centred on each 2 km intersection overlaying an ortho-photograph

2.3 What has been recorded?

At each of the sample points, information was recorded about the following attributes. The data relate to the area delineated by a one hectare square superimposed on the ortho-photographs and centered on the sample point.

2.3.1 Point identification number

A unique reference number for each sample point, from 1 to 1844 was recorded. This was required for sample data checks and was useful when querying the database for points with specific features.

2.3.2 Grid reference

The NZTM map Grid Reference, stored as 8 figures was recorded. This is essential if the same points are to be located for a future re-survey. It also enables point data to be analysed relative to other spatial data stored in GIS such as the Land Cover Database or New Zealand Land Resource Inventory.

2.3.3 Soil state

These codes are used to show the extent and timing of past soil disturbance.

- s Stable surfaces (vegetated).
Show no sign of past erosion. Have a smooth appearance and are completely vegetated (unless topsoil is disturbed by land use).
- u Erosion-prone unstable surfaces (inactive, vegetated).
Show signs of past erosion but are currently not eroded or eroding, erosion scars have healed and are well vegetated. Erosion has usually occurred at least a decade prior to photography.
- r Eroded, unstable surfaces (recently disturbed and re-vegetating). Show signs of recent erosion. Erosion scars are partially vegetated, surface is still rough. Erosion feature is identifiable and has usually occurred in the decade prior to photography.
- e Eroding, unstable surfaces (freshly disturbed and bare). Show signs of fresh erosion. Erosion scars are active with much bare ground. Erosion feature is easily identifiable and has usually occurred in the year prior to photography. It is important to note that recording a point as eroding does not mean that 100% of the surrounding one-hectare area is eroding. It simply denotes erosion is occurring on soil under the land use that's being practiced in the point's immediate vicinity.

2.3.4 Nature of disturbance

These codes are essential for noting where soil is currently being disturbed. The codes differentiate between soil disturbance caused by natural processes i.e. erosion or deposition and soil disturbance caused by land use activity (exposing bare soil to risk of erosion or deposition).

Topsoil disturbance is generally due to land use. It is recorded where visible for soil state categories 's' and 'u'. It is not recorded for soil state categories 'r' and 'e' as in these cases it is associated with, and often over-ridden by subsoil or other disturbance.

Topsoil

- c exposed by cultivation
- x exposed by harvest
- y exposed by spraying
- z exposed by grazing
- t exposed by farm or forest track (not sealed)
- d exposed by drain excavation, cleaning or tile drainage
- e exposed by earthworks

Subsoil and other disturbances are generally due to natural processes, but may be exacerbated by land use. They are recorded where visible for soil state categories 'r' and 'e'. These categories can be readily aggregated.

Subsoil

- l landslide
- a debris avalanche
- u slump or earthflow
- p tunnel gully
- g gully

Other

- b streambank scour
- s streambank deposit
- w sandblow

h	sheetwash
br	bare rock and scree

2.3.5 Percentage of bare ground

Bare soil due to land use is recorded for 's' and 'u' surfaces. The convention is not to record it for 'r' or 'e' surfaces, where it may be present but is over-ridden by bare soil attributed to natural disturbance. Bare soil due to natural processes is recorded for 'e' surfaces. The convention is not to record it for 'r' surfaces where it may be present but is diffuse amongst re-vegetation. Cluster sampling is used to measure the percentage of bare soil. It entails recording the incidence of bare soil at each of 100 dots set in a 10 x 10 grid within the one hectare area around the sample point. The number of dots with bare soil are recorded as an attribute.

2.3.6 Landform

The following landforms are recorded. They are not essential for ascertaining soil disturbance but may be useful for other analyses.

m	Mountains
s	Steeplands
h	Hill country
d	Downlands, plateaux
t	Raised terraces and plains
f	Floodplains
fp	Protected floodplains
w	Wetlands
wd	Drained wetlands
u	Active sand dunes
ur	Old dune ridges (vegetated)
uf	Old dune flats (vegetated)
tc	Raised coastal terraces
fc	Coastal flats

Additional landform codes need to be used at points which lack soil. For these landforms no other attributes are recorded.

l	Lake
p	Pond
a	River or stream
e	Estuary
b	Beach
r	Intertidal rock platform
c	Cliff/bluff/gorge

2.3.7 Land use

This set of land use codes is used to record the primary (dominant) vegetative cover observed at a sample point.

o	Orchards
ov	Vineyard
h	Market gardens (vegetable crops)
g	Grain and greenfeed crops
d	Dairy pasture
i	Improved drystock pasture
u	Unimproved drystock pasture
c	Exotic softwood/conifer forest
b	Exotic hardwood/broadleaf forest
f	Native (natural) forest
s	Native (natural) scrub
x	Exotic scrub
t	Tussock grass (low altitude)
a	Alpine vegetation (high-altitude tussock and herbfield)
w	wetland vegetation (rushes, sedges, raupo, flax)
m	Coastal vegetation (sand-binding or salt-tolerant plants)
e	Exotic herbaceous weeds
br	Bare rock and scree
sa	Sub-apline scrub
sd	Dryland scrub
wb	Water body
r	Exposed riverbed

To add further information to a particular land use code, where applicable a speech mark or hash symbol was used.

- For intensive uses i.e. h, o, ov, g, gf - g' etc indicates cultivated fields, including recent plantings that do not provide complete ground cover; g# indicates harvested fields.
- In grassland i.e. d, i, u - d' etc indicates sparse pasture that does not provide complete ground cover; d# indicates pasture that has been freshly harvested for hay or silage.
- In forests i.e. c, b, f - c' etc indicates young trees (not yet closed canopy); c# etc indicates trees harvested and not yet replanted. In scrubland (x, s) x# indicates recently cleared scrub.

2.3.8 Associated vegetation

The same codes as above are used to indicate when another vegetation type is intermingled with the main land use. For example, land use = u and secondary vegetation = sd denotes unimproved pasture with dryland scrub.

To add further information to the secondary vegetation code, relating to the state of the land cover in cropland or grassland:

- absence of an asterisk or the like denotes extensive secondary vegetation e.g. usd denotes unimproved dry stock pasture with clumps of dryland scrub
- a speech mark denotes scattered secondary vegetation e.g. us',
- shelterbelts are denoted by an asterisk e.g. b*; hedgerows by an ampersand e.g. b@.

In scrub or forest:

- secondary vegetation emerging through canopy (or in canopy gaps) is normally recorded without any suffix e.g. xs is exotic scrub with natural scrub emerging through canopy; sx is natural scrub with canopy gaps occupied by exotic scrub
- a speech mark may be used to denote sparse secondary vegetation in canopy gaps e.g. sx' is natural scrub where canopy gaps are occupied by sparse exotic scrub (interspersed with bare soil or rock).

Associated land use feature codes have to be used when points fall on features such as those given below

by	Farm buildings, yards, dwellings (including lifestyle homes)
bg	Indoor agriculture (glasshouses, hydroponics, poultry sheds, pig sheds)
bi	Industrial buildings on rural sites
qm	Quarries and mines
rr	Rural roads, railways and airfields
uo	Urban open space (parks, playing fields, waste ground)
ub	Urban buildings (houses, factories, shops, public buildings)
ur	Urban roads, railways and airfields
wb	Waterbodies
sl	Shorelines

2.4 Statistical analysis

Sample points were collected and stored in ArcView in an attribute table. It was duplicated into an Excel spreadsheet which enabled data sorting to check for consistency in the use of codes and to correct where necessary. Data were analyzed by sort and count operations in Microsoft Excel. Data for any particular combination of codes were copied into extra columns in an analysis spreadsheet which was set up for calculating summary statistics.

Point counts are expressed as a percentage of the regional sample for

- Landuse
- Soil state
- Type of disturbance

For percentages based on point counts, sample error has been calculated at 95% confidence level using the formula:

$$\pm 2 \text{ s.e.} = 1.96 * \text{sqrt} (p(100-p)/n)$$

Where:

s.e.	=	square error
sqrt	=	square root
p	=	percentage from point count
n	=	number of points

Bare soil at points is expressed as a percentage of regional sample area for:

- All disturbance
- Land-use related disturbance
- Natural disturbance
- Each type of disturbance.

For percentages based on cluster samples around points (bare soil) sample error has been calculated at 95% confidence level using the formula

$$\pm 2 \text{ s.e.} = 1.96 * s/\text{sqrt}(n)$$

Where:

s.e.	=	square error
s	=	standard deviation of mean percentage of clusters
sqrt	=	square root
n	=	number of clusters

2.5 Photo-interpretation accuracy

As a measure of the accuracy of the photo interpretation undertaken for the survey, 100 sample points were selected at random out of the 1844 interpreted and independently assessed by Dr Doug Hicks, the scientist who designed the technique. Points were assessed for land use, secondary vegetation, soil state, nature of disturbance, the percentage of bare ground and landform. Results show that accuracy ranged between 90 – 97% for all categories.

Categories	Classification accuracy (%)
Landuse	96
Secondary vegetation	94
Soil State	95
Nature of disturbance	93
Percentage of bare ground	97
Landform	90

This level of accuracy is at least as good, and in some cases better than other point sample surveys recently undertaken for regional council state of the environment monitoring, which typically were in the range of 85% to 95%.

3.0 Results

3.1 Soil State throughout the Marlborough Region, 2002 – 2005

Table 1 summarises the state of Marlborough's soil between 2002 and 2005, the interval of the aerial photographic survey. The results indicate that the region's sample points are:

- 52.5% on stable surfaces
- 11.5% on erosion-prone but inactive surfaces
- 36.0% on actively eroded and eroding surfaces

Table 1 Soil State throughout the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
STABLE SURFACES (S)	968	52.5	2.3		
S (i) with intact soil	757	41.1	2.2	0.00	0.00
S (ii) with soil disturbed by land use	211	11.4	1.5	1.21	0.23
EROSION PRONE SURFACES (U)	212	11.5	1.5	0.00	0.00
U (i) with intact soil	163	8.8	1.3		
U (ii) with soil disturbed by land use	49	2.7	0.7	0.26	0.11
ERODED (R) AND ERODING (E) SURFACES	664	36.0	2.2		
R (i) with re-vegetating soil	35	1.9	0.6	0.00	0.00
E (ii) with soil disturbed by natural processes	629	34.1	2.2	10.08	1.12
OTHER SURFACES	783				
Unclassified points	0				
Points with no aerals	783				
ALL SURFACES IN REGION total	1844	100.0		11.56	1.14
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

3.1.1 Stable surfaces

The stable surfaces are located on protected floodplains, elevated terraces, rolling downlands and on the ridges and spurs on parts of the hill country and steepland/mountain ranges that show no sign of past erosion and are currently well vegetated.

- 52.5% of the region's sample points have stable surfaces.
- About three-quarters of these stable sample points (41.1% of the region) have intact soil that is currently well vegetated.
- About a quarter of the stable sample points (11.4% of the region) have soil currently disturbed by land use.
- Soil actually bared by land use activities e.g. farm tracks accounts for 1.21% of the region's bare area.

3.1.2 Erosion-prone surfaces

Erosion-prone surfaces are located on unprotected floodplains, terrace edges, drainage hollows or gullies through terraces and downlands and parts of the hill country and steepland/mountain ranges that show signs of past erosion but are currently not eroding.

- 11.5% of the region's sample points have erosion-prone surfaces that are currently inactive.
- About three-quarters of these erosion-prone surface points (8.8% of the region) have intact soil that is currently well vegetated.
- About a quarter of the erosion-prone surface points (2.7% of the region) have soil currently disturbed by land use.
- Soil actually bared by land use activities accounts for 0.26% of the region's area.

3.1.3 Eroded and eroding surfaces

Eroded and eroding surfaces occur along river and stream banks, tunnel gullies and gullies throughout the downlands, parts of the hill country and steeplands that are subject to mass movement (slope failure), and scree or bare rock outcrops in mountain landscapes.

- 36.0% of the region's sample points have recently active eroded surfaces and freshly active eroding surfaces.
- Only a small proportion of these eroded and eroding sample points (1.9% of the region) have soil recently disturbed by natural erosion processes that are now re-vegetating.
- In contrast, most of the eroded and eroding sample points (34.1% of the region) have soil freshly disturbed by natural erosion.
- Bare soil or rock within this category accounts for 10.08% of the region's area.

3.2 Soil disturbance through the Marlborough region, 2002 – 2005

Table 2 summarises the nature of soil disturbance for Marlborough between 2002 and 2005, be it disturbance by land use activity or by natural processes.

3.2.1 Disturbance by land use

Land use related disturbance was present on 14.1% of land in the Marlborough region (Table 2). This number corresponds with the sum of the percentage for S (ii) and U (ii) from Table 1. Soil actually bared equates to 1.47% of the region's area. It includes contributions from:

- Farm tracks and forest tracks, which are the most widespread disturbance by land use, present on 10.5% of the region's land. Bare track surfaces equate to 0.87% of the region's area.
- Livestock grazing pressure is present on 1.9% of the region's land and exposes bare soil on 0.17% of the region's area.
- Cultivation and harvest (including forest harvest) collectively represent 1.1% of the region's land and are responsible for bare soil on 0.30 and 0.05% of the region's area respectively.
- Earthworks occupy 0.6% of the region's land and expose 0.08% of the region's area.

Table 2 Soil Disturbance throughout the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
BY LAND USE					
grazing pressure	35	1.9	0.6	0.17	0.07
cultivation	14	0.8	0.4	0.30	0.18
harvest	6	0.3	0.3	0.05	0.06
spraying	0	0.0	0.0	0.00	0.00
drains	1	0.1	0.1	<0.01	<0.01
tracks	193	10.5	1.4	0.87	0.15
earthworks	11	0.6	0.4	0.08	0.06
Sub-total	260	14.1	1.6	1.47	0.26
BY NATURAL PROCESSES					
landslide	126	6.8	1.2	0.52	0.14
debris avalanche	22	1.2	0.5	0.14	0.07
slump or earthflow	10	0.5	0.3	0.07	0.06
tunnel gully	14	0.8	0.4	0.09	0.06
gully	15	0.8	0.4	0.05	0.03
streambank scour	40	2.2	0.7	0.14	0.05
streambank deposit	63	3.4	0.8	1.05	0.35
sandblow	1	0.1	0.1	0.03	0.05
sheetwash	130	7.0	1.2	1.01	0.25
bare rock and scree	208	11.3	1.4	6.98	1.05
Sub-total	629	34.1	2.2	10.08	1.12
Undisturbed (intact or re-vegetating)	955	51.8	2.3	0.00	0.00
Total	1844	100.0		11.56	1.14
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

3.2.2 Disturbance by natural processes

Land disturbance by natural processes of erosion and deposition is present on 34.1% of land in the Marlborough region (Table 2). This number corresponds with the percentage for E (ii) from Table 1. Soil actually bared equates to 10.08% of the region's area. It includes contributions from:

- Bare rock and scree, which are by far the most widespread form of disturbance by natural processes, are present on 11.3% of the region's land. Bare rock and scree equate to 6.98% of the region's area.
- Slope failures are also a major form of natural disturbance. Landslides, debris avalanches and slumps or earthflows are collectively present on 8.5% of the region's land and expose bare soil on 0.73% of the region's area.
- Sheetwash is also a significant form of natural disturbance being present on 7.0% of the region's land. This bares soil on 1.01% of the region's area.
- Riparian erosion and deposition are present on 5.6% of the region's land, with deposits of sand, silt or gravel along watercourses together with bank scour and collapse accounting for bare soil on 1.19% of the region's area.

- Surprisingly, tunnel gullies (under runners) and gullies are a relatively minor component accounting collectively for 1.6% of the region's land and responsible for bare soil on only 0.14% of its area.

3.3 Regional summary (land use related and natural processes)

51.8% of the sample points were found to be free from soil disturbance during the survey of aerial photographs 2002 – 2005.

Soil disturbance is present on 48.2% of land in Marlborough. Of this 14.1% is land use related disturbance while 34.1% is caused by natural processes of erosion or deposition. Bare soil accounts for 11.56% of the region's area of which 1.47% is attributed to land use activities and 10.08% is due to natural processes.

There is 95% confidence that sample percentages for soil intactness or disturbance are within 2.3% or better of the true regional figures. For bare soil there is a 95% confidence that sample percentages are within 1.14% or better.

4.0 Intensive Uses

4.1 Overview

It was found that 2.4 % of Marlborough's sample points were under intensive land use (Table 3). Not surprisingly this was predominantly viticulture with lesser amounts of high yielding food crops such as olives, peas, corn and cherries.

Table 3 Soil State for intensive uses in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
STABLE SURFACES (S)	36	2.0	0.6		
S (i) with intact soil	14	0.8	0.4	0.00	0.00
S (ii) with soil disturbed by land use	22	1.2	0.5	0.16	0.11
EROSION PRONE SURFACES (U)	8	0.4	0.3		
U (i) with intact soil	4	0.2	0.2	0.00	0.00
U (ii) with soil disturbed by land use	4	0.2	0.2	0.02	0.03
ERODED (R) AND ERODING (E) SURFACES	1	0.1	0.1		
R (i) with re-vegetating soil	0	0.0	0.0	0.00	0.00
E (ii) with soil disturbed by natural processes	1	0.1	0.1	0.01	0.03
ALL SURFACES IN LANDUSE Total	45	2.4	0.7	0.19	0.12
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

4.2 Soil State

4.2.1 Stable surfaces

Stable surfaces under intensive land use are mostly on protected floodplains and elevated terraces.

- 2.0% of the region's sample points are on stable surfaces under intensive use,
- 0.8% have intact soil that is well-vegetated (i.e. vine cover with a vegetated inter-row), and
- 1.2% have soil currently disturbed by land use. Bare soil within this category amounts to 0.16% of the region's area.

4.2.2 Erosion-prone surfaces

The erosion-prone surfaces are drainage hollows on terraces or protected floodplains.

- 0.4% of the region's sample points are on erosion-prone surfaces under intensive use,
- 0.2% have intact soil currently well vegetated, and
- 0.2% have soil currently disturbed by land use. Within this category bare soil amounts to 0.02% of the region's area.

4.2.3 Eroded and eroding surfaces

Only one point was measured as eroded or eroding. This was a point of streambank deposition along a stream that ran through a terrace.

- 0.1% of the region's sample points are on eroded and eroding surfaces under intensive use,
- <0.1% have soil recently disturbed by natural erosion processes, and
- 0.1% have soil freshly disturbed. Within this category bare soil amounts to 0.01% of the region's area.

4.3 Soil disturbance

4.3.1 Disturbance by land use

Numbers in this section were obtained by adding the percentage for S (ii) and U (ii) from Table 3. When stable and erosion-prone surfaces are combined, 1.4% of Marlborough's land is disturbed by intensive land use activities (Table 4). On most sites, growing crops, fruit or vines provide a good ground cover. Nonetheless, a proportion of sites did show some topsoil exposed by either:

- cultivation, on 0.09%
- harvest, on 0.01%
- tracks, on 0.07%
- earthworks, on 0.02%

These sites collectively contribute 0.19% of the region's area of exposed soil at risk of topsoil loss (Table 4).

Table 4 Soil disturbance amongst intensive uses in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
BY LAND USE					
grazing pressure		0.0	0.0		
cultivation	5	0.3	0.2	0.09	0.10
harvest	2	0.1	0.2	0.01	0.02
spraying		0.0	0.0		
drains		0.0	0.0		
tracks	16	0.9	0.4	0.07	0.04
earthworks	3	0.2	0.2	0.02	0.02
Sub-total	26	1.4	0.5	0.19	0.11
BY NATURAL PROCESSES					
landslide		0.0	0.0		
debris avalanche		0.0	0.0		
slump or earthflow		0.0	0.0		
tunnel gully		0.0	0.0		
gully		0.0	0.0		
streambank scour		0.0	0.0		
streambank deposit	1	0.1	0.1	0.01	0.03
sandblow		0.0	0.0		
sheetwash		0.0	0.0		
bare rock and scree		0.0	0.0		
Undisturbed (intact or re-vegetating)	18	1.0	0.4	0.00	0.00
Total	45	2.4	0.7	0.19	0.12
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

4.3.2 Disturbance by natural processes

Numbers in this section correspond with the percentage for E(ii) in Table 3. A further 0.1% of Marlborough's land is disturbed by natural processes under intensive use - by stream deposition. This makes a minimal contribution (0.01%) to the region's area of bare soil due to erosion. However, because natural disturbance has only been detected at one point, there is a large error term attached ($\pm 0.03\%$).

4.3.3 Summary for intensive uses

Under intensive uses, soil disturbance affects 1.4% of Marlborough's soil. This has been caused virtually all by land use rather than natural processes and soil actually bared accounts for only 0.19% of the entire region's area.

There is 95% confidence that sample percentages for soil disturbance are within 0.7% or better of the true regional figures. For bare soil, there is 95% confidence that sample percentages are within 0.12% or better.

5.0 Dairy Farms

5.1 Overview

It was found that only 1.1 % of Marlborough's sample points were used for dairy farming (Table 5). They are entirely on improved pasture.

Table 5 Soil State for dairy farms in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
STABLE SURFACES (S)	15	0.8	0.4		
S (i) with intact soil	5	0.3	0.2		
S (ii) with soil disturbed by land use	10	0.5	0.3	0.06	0.06
EROSION PRONE SURFACES (U)	2	0.1	0.2		
U (i) with intact soil	1	0.1	0.1		
U (ii) with soil disturbed by land use	1	0.1	0.1	<0.01	<0.01
ERODED (R) AND ERODING (E) SURFACES	4	0.2	0.2		
R (i) with re-vegetating soil	0	0.0	0.0		
E (ii) with soil disturbed by natural processes	4	0.2	0.2	0.01	0.01
ALL SURFACES IN LANDUSE Total	21	1.1	0.5	0.06	0.06
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

5.2 Soil State

5.2.1 Stable surfaces

Stable surfaces under dairying are predominantly on elevated terraces, or protected floodplains, with some on easy hill country footslopes.

- 0.8% of the region's sample points are on stable surfaces under dairying,
- 0.3% have intact soil currently well-vegetated, and
- 0.5% have soil currently disturbed by land use. Within this category, bare soil only amounts to 0.06% of the region's area.

5.2.2 Erosion-prone surfaces

The erosion-prone surfaces are on unprotected floodplains.

- 0.1% of the region's sample points are on erosion-prone surfaces dairying,
- 0.1% have intact soil, currently well vegetated, and
- 0.1% have soil currently disturbed by land use. Within this category bare soil amounts to <0.01% of the region's area.

5.2.3 Eroded and eroding surfaces

Eroded and eroding surfaces are where bank erosion or deposition occurs along streams that run through terraces or across floodplains.

- 0.2% of the region's sample points are on eroded and eroding surfaces under dairying,
- <0.1% have soil recently disturbed by natural erosion processes, and
- 0.2% have soil freshly disturbed. Within this category bare soil amounts to 0.01% of the region's area.

5.3 Soil disturbance

5.3.1 Disturbance by land use

Numbers in this section are obtained by adding the percentages for S (ii) and U (ii) from Table 5. When stable and erosion-prone surfaces are combined, it was found that 0.6% of Marlborough's land is disturbed by dairy farming (Table 6). Soil actually bared by dairy farming equates to 0.06% of the region's area. This is a fairly low percentage and is attributable to tracks, grazing pressure and cultivation.

- tracks, on 0.02%
- cultivation, on 0.03%
- grazing pressure, on 0.01%

Table 6 Soil disturbance amongst dairy farms in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
BY LAND USE					
grazing pressure	3	0.2	0.2	0.01	0.01
cultivation	1	0.1	0.1	0.03	0.05
harvest		0.0	0.0		
spraying		0.0	0.0		
drains		0.0	0.0		
tracks	7	0.4	0.3	0.02	0.02
earthworks		0.0	0.0		
Sub-total	11	0.6	0.4	0.06	0.06
BY NATURAL PROCESSES					
landslide		0.0	0.0		
debris avalanche		0.0	0.0		
slump or earthflow		0.0	0.0		
tunnel gully		0.0	0.0		
gully		0.0	0.0		
streambank scour	2	0.1	0.2	<0.01	<0.01
streambank deposit	2	0.1	0.2	0.01	0.01
sandblow		0.0	0.0		
sheetwash		0.0	0.0		
bare rock and scree		0.0	0.0		
Sub-total	4	0.2	0.2	0.01	0.01
Undisturbed (intact or re-vegetating)	6	0.3	0.3	0.00	0.00
Total	21	1.1	0.5	0.06	0.06
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

5.3.2 Disturbance by natural processes

Numbers in this section correspond with the percentage for E(ii) in Table 5. A further 0.2% of Marlborough's land is disturbed by natural processes while under dairying - all by stream deposition or scour (Table 6). Soil exposed by natural disturbance is minor, contributing only 0.01% to the region's area of exposed soil.

5.3.3 Summary for dairy farms

Under dairy farming, soil disturbance affects only 0.8% of Marlborough's soil. This has been caused more by land use rather than natural processes and exposes bare soil on only 0.06% of the entire region's area. The reason the figures are low are firstly dairy farming occupies only a small percentage of the region (1.1%) and secondly dairy farms are on the whole are located on stable or unstable but inactive landforms i.e. terraces and protected floodplains.

There is 95% confidence that sample percentages for soil disturbance are within 0.5% or better of the true regional figures. For bare soil, there is 95% confidence that sample percentages are within 0.06% or better.

6.0 Drystock farms

6.1 Overview

32.5% of Marlborough's sample points were under land use used for drystock farming (Table 7) – either improved (23.8%) or unimproved pasture (8.7%) grazed by sheep, cattle and deer.

Table 7 Soil State for drystock farms in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
STABLE SURFACES (S)	311	16.9	1.7		
S (i) with intact soil	218	11.8	1.5	0.00	0.00
S (ii) with soil disturbed by land use	93	5.0	1.0	0.52	0.15
EROSION PRONE SURFACES (U)	92	5.0	1.0		
U (i) with intact soil	61	3.3	0.8	0.00	0.00
U (ii) with soil disturbed by land use	31	1.7	0.6	0.19	0.10
ERODED (R) AND ERODING (E) SURFACES	197	10.7	1.4		
R (i) with re-vegetating soil	16	0.9	0.4	0.00	0.00
E (ii) with soil disturbed by natural processes	181	9.8	1.4	1.10	0.25
ALL SURFACES IN LANDUSE Total	600	32.5	2.1	1.81	0.29
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

6.2 Soil State

6.2.1 Stable surfaces

Stable surfaces under drystock farms are mostly on the elevated terraces, rolling downlands, and easy hillslopes with lesser amounts on floodplains, protected floodplains and steepland landforms.

- 16.9% of the region's sample points are on stable surfaces under drystock pasture,
- 11.8% have intact soil currently well-vegetated, and
- 5.0% have soil currently disturbed by land use. Within this category bare soil amounts to 0.52% of the region's area.

6.2.2 Erosion-prone surfaces

The erosion-prone surfaces are drainage hollows on downlands (including healed tunnel gullies and gullies), moderate hillslopes showing traces of past slope failure but now completely vegetated and stream banks or channels on terraces, protected floodplains and floodplains.

- 5.0% of the region's sample points are on erosion-prone surfaces under drystock pasture,
- 3.3% have intact soil, currently well vegetated, and
- 1.7% have soil currently disturbed by land use. Within this category bare soil amounts to 0.19% of the region's area.

6.2.3 Eroded and eroding surfaces

Eroded and eroding surfaces are sheetwash, landslides, slumps and gullies on moderate hill country; landslides and sheetwash on steepland sites, tunnel gullies and gullies on downlands and streambank scour or deposition along watercourses.

- 10.7% of the region's sample points are on eroded and eroding surfaces under drystock pasture,
- 0.9% have soil recently disturbed by natural erosion processes but are re-vegetating, and
- 9.8% have soil freshly disturbed. Within this category bare soil amounts to 1.10% of the region's area.

6.3 Soil disturbance

6.3.1 Disturbance by land use

Numbers in this section are obtained by adding the percentages for S (ii) and U (ii) from Table 7. When stable and erosion-prone surfaces are combined, it was found that 6.7% of Marlborough's land is disturbed by land use activities under drystock farming uses (Table 8). This is mainly attributed to farm tracks (4.4%) and grazing pressure (1.5%). Other land-use related disturbance are individually minor. Topsoil is exposed by:

- tracks on 0.36% of the region's area
- grazing pressure on 0.14%
- cultivation on 0.19%
- earthworks on 0.03%

These sites collectively contribute 0.71% to the region's area of exposed soil at risk of topsoil loss.

Table 8 Soil disturbance amongst drystock farms in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
BY LANDUSE					
grazing pressure	27	1.5	0.5	0.14	0.06
cultivation	8	0.4	0.3	0.19	0.14
harvest		0.0	0.0		
spraying		0.0	0.0		
drains	1	0.1	0.1	<0.01	<0.01
tracks	81	4.4	0.9	0.36	0.09
earthworks	7	0.4	0.3	0.03	0.03
Sub-total	124	6.7	1.1	0.71	0.18
BY NATURAL PROCESSES					
landslide	42	2.3	0.7	0.13	0.06
debris avalanche	1	0.1	0.1	0.06	0.03
slump or earthflow	6	0.3	0.3	0.03	0.02
tunnel gully	13	0.7	0.4	0.08	0.06
gully	7	0.4	0.3	0.02	0.02
streambank scour	14	0.8	0.4	0.13	0.07
streambank deposit	22	1.2	0.5	0.06	0.03
sandblow		0.0	0.0		
sheetwash	70	3.8	0.9	0.58	0.21
bare rock and scree	6	0.3	0.3	0.07	0.07
Sub-total	181	9.8	1.4	1.16	0.25
Undisturbed (intact or re-vegetating)	295	16.0	1.7	0.00	0.00
Total	600	32.5	2.1	1.81	0.29
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

6.3.2 Disturbance by natural processes

Numbers in this section correspond with the percentage for E(ii) in Table 7. A further 9.8% of Marlborough's land is disturbed by natural processes while under drystock farm use. Soil bared by natural processes in drystock pasture contributes to 1.16% to the region's area of exposed soil. This has occurred from:

- mass movements (landslide etc) on 0.22%
- tunnel gullies and gullies on 0.10%
- streambank scour and deposits on 0.19%
- surface erosion (sheetwash etc) on 0.65%

6.3.3 Summary of drystock farms

Under drystock farming, soil disturbance affects 16.5% of Marlborough's soil. This has been caused more by natural processes (9.8%) than land related activities (6.7%). Drystock farms contribute to 1.81% to the entire region's area of bare soil, which 1.1% is attributable to natural processes and 0.71% due to land use activities.

There is 95% confidence that sample percentages for soil disturbance are within 2.1% or better of the true regional figures. For bare soil, there is 95% confidence that sample percentages are within 0.29% or better.

7.0 Natural forest

7.1 Overview

Natural forest remains on 20.6 % of Marlborough's sample points (Table 9). Very little is podocarp or hardwood forest. Most of what has been recorded is beech, either in the Marlborough Sounds or the Richmond Range, or lower slopes of high county south of the Wairau.

Table 9 Soil State for natural forest in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
STABLE SURFACES (S)	293	15.9	1.7		
S (i) with intact soil	280	15.2	1.6	0.00	0.00
S (ii) with soil disturbed by land use	13	0.7	0.4	0.05	0.03
EROSION PRONE SURFACES (U)	44	2.4	0.7		
U (i) with intact soil	43	2.3	0.7	0.00	0.00
U (ii) with soil disturbed by land use	1	0.1	0.1	<0.01	<0.01
ERODED (R) AND ERODING (E) SURFACES	42	2.3	0.7		
R (i) with re-vegetating soil	6	0.3	0.3	0.00	0.00
E (ii) with soil disturbed by natural processes	36	2.0	0.6	0.28	0.12
ALL SURFACES IN LANDUSE Total	379	20.6	1.8	0.33	0.12
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

7.2 Soil State

7.2.1 Stable surfaces

Stable surfaces under natural forest are predominantly on hillslopes, spurs and ridges in steepland ranges and to a lesser extent in mountains.

- 15.9% of the region's sample points are on stable surfaces under natural forests,
- 15.2% have intact soil currently well-vegetated, and
- 0.7% have soil currently disturbed by land use. Within this category bare soil only amounts to 0.05% of the region's area.

7.2.2 Erosion-prone surfaces

The erosion-prone surfaces are slopes showing sign of past slope failure (now completely revegetated) in hill country, steeplands or mountains. A small number of erosion-prone forest sites are adjacent to watercourses.

- 2.4% of the region's sample points are on erosion-prone surfaces under natural forest,
- 2.3% have intact soil, currently well vegetated, and

- 0.1% have soil currently disturbed by land use. Within this category bare soil amounts to <0.01% of the region's area.

7.2.3 Eroded and eroding surfaces

The eroded and eroding surfaces are landslides and debris avalanches in steep land ranges, or sheetwash or bare rock and scree in the mountains, plus a few gullies or stream deposits in valley bottoms.

- 2.3% of the region's sample points are on eroded and eroding surfaces under natural forest,
- 0.3% have soil recently disturbed by natural erosion processes but are re-vegetating, and
- 2.0% have soil freshly disturbed. Within this category bare soil amounts to 0.28% of the region's area.

7.3 Soil disturbance

7.3.1 Disturbance by land use

Numbers in this section are obtained by adding the percentages for S (ii) and U (ii) from Table 9. When stable and erosion-prone surfaces are combined, only 0.8% of Marlborough's land is disturbed by land use-related activities within natural forest (Table 10). These are entirely access tracks or unsealed roads which contribute 0.05% to the region's area of exposed soil.

Table 10 Soil disturbance amongst natural forest in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
BY LAND USE					
grazing pressure		0.0	0.0		
cultivation		0.0	0.0		
harvest		0.0	0.0		
spraying		0.0	0.0		
drains		0.0	0.0		
tracks	14	0.8	0.4	0.05	0.03
earthworks		0.0	0.0		
Sub-total	14	0.8	0.4	0.05	0.03
BY NATURAL PROCESSES					
landslide	11	0.6	0.4	0.05	0.10
debris avalanche	3	0.2	0.2	0.01	0.01
slump or earthflow		0.0	0.0		
tunnel gully		0.0	0.0		
gully	2	0.1	0.2	0.01	0.01
streambank scour		0.0	0.0		
streambank deposit	4	0.2	0.2	0.02	0.02
sandblow		0.0	0.0		
sheetwash	5	0.3	0.2	0.02	0.02
bare rock and scree	11	0.6	0.4	0.16	0.10
Sub-total	36	2.0	0.6	0.28	0.12
Undisturbed (intact or re-vegetating)	329	17.8	1.7	0.00	0.00
Total	379	20.6	1.8	0.33	0.12
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

7.3.2 Disturbance by natural processes

Numbers in this section correspond with the percentage for E(ii) in Table 9. It was found that 2.0% of Marlborough's land is disturbed by natural processes within natural forests (Table 10). Bare soil on disturbed surfaces is attributable to:

- Rock outcrops and scree on 0.16% of the region's area
- Slope failure on 0.06%
- Sheetwash on 0.02%
- Streambank desposition on 0.02%
- Gully on 0.01%

This only amounts to 0.28% of the region's area of bare soil due to erosion. The reason for the small contribution is that the region's remaining forest is mainly in steep land ranges or mountains, which for the most part it is underlain by relatively stable greywacke and schist geology.

7.3.3 Summary of natural forests

Under natural forests, soil disturbance affects only 2.8% of Marlborough's soil. This has been caused more by natural processes (2.0%) than land related activities (0.8%). Natural forests contribute only 0.33% to the entire region's area of bare soil, which is low considering that 20.6% of the region is covered by natural forest.

There is 95% confidence that sample percentages for soil disturbance are within 1.8% or better of the true regional figures. For bare soil, there is 95% confidence that sample percentages are within 0.12% or better.

8.0 Forest plantations

8.1 Overview

Forest plantations were found on 9.8% of Marlborough's sample points (Table 11). 3.6 % are young pines (prior to canopy closure), 4.8% are maturing pines (closed canopy), 0.4% are harvested pines, not yet re-planted and 1% are either broadleaved species or other exotics.

Table 11 Soil State for forest plantations in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
STABLE SURFACES (S)	149	8.1	1.2		
S (i) with intact soil	108	5.9	1.1	0.00	0.00
S (ii) with soil disturbed by land use	41	2.2	0.7	0.26	0.10
EROSION PRONE SURFACES (U)	15	0.8	0.4		
U (i) with intact soil	8	0.4	0.3	0.00	0.00
U (ii) with soil disturbed by land use	7	0.4	0.3	0.03	0.03
ERODED (R) AND ERODING (E) SURFACES	16	0.9	0.4		
R (i) with re-vegetating soil	2	0.1	0.2	0.00	0.00
E (ii) with soil disturbed by natural processes	14	0.8	0.4	0.12	0.10
ALL SURFACES IN LANDUSE Total	180	9.8	1.4	0.41	0.14
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

8.2 Soil State

8.2.1 Stable surfaces

Stable surfaces under forest plantations are on moderate hillslopes and spurs and ridges in the hill country or steep-land ranges, and to a lesser extent on downlands and terraces.

- 8.1% of the region's sample points are on stable surfaces under forest plantations,
- 5.9% have intact soil currently well-vegetated, and
- 2.2% have soil currently disturbed by land use. Within this category bare soil amounts to 0.26% of the region's area.

8.2.2 Erosion-prone surfaces

The erosion-prone surfaces are next to watercourses on floodplains and downlands, or on slopes showing signs of past erosion (now re-vegetated) in the hill country and steep-land ranges.

- 0.8% of the region's sample points are on erosion-prone surfaces under forest plantations,
- 0.4% have intact soil, currently well vegetated, and
- 0.4% have soil currently disturbed by land use. Within this category bare soil amounts to 0.03% of the region's area.

8.2.3 Eroded and eroding surfaces

The eroded and eroding surfaces in forest plantations are either landslide scars or sheetwash and rock outcrops on hillslopes; also streambank deposits along watercourses.

- 0.9% of the region's sample points are on eroded and eroding surfaces under forest plantations,
- 0.1% have soil recently disturbed by natural erosion processes but are re-vegetating, and

- 0.8% have soil freshly disturbed. Within this category bare soil amounts to 0.12% of the region's area.

8.3 Soil disturbance

8.3.1 Disturbance by land use

Numbers in this section are obtained by adding the percentages for S (ii) and U (ii) from Table 11. When stable and erosion-prone surfaces are combined 2.6% of Marlborough's land is disturbed by land use-related activities within forest plantations (Table 12). 2.3% of the land-use related disturbance is tracking which includes access tracks for silviculture and planting as well as roads for harvest. 0.1% is earthworks associated with forest harvest – landing stages and skid sites which are largely protected by slash while 0.3% is harvest sites. Bare soil exposed to risk of topsoil loss by forestry is:

- tracking 0.24%
- harvest 0.03%
- earthworks 0.02%

Collectively there equate to 0.29% of the region's area.

Table 12 Soil disturbance amongst forest plantations in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
BY LANDUSE					
grazing pressure	1	0.1	0.1	<0.01	<0.01
cultivation		0.0	0.0		
harvest	3	0.2	0.2	0.03	0.05
spraying		0.0	0.0		
drains		0.0	0.0		
tracks	43	2.3	0.7	0.24	0.08
earthworks	1	0.1	0.1	0.02	0.03
Sub-total	48	2.6	0.7	0.29	0.10
BY NATURAL PROCESSES					
landslide	3	0.2	0.2	0.01	0.01
debris avalanche		0.0	0.0		
slump or earthflow	1	0.1	0.1	0.01	0.01
tunnel gully		0.0	0.0		
gully		0.0	0.0		
streambank scour		0.0	0.0		
streambank deposit	5	0.3	0.2	0.06	0.09
sandblow		0.0	0.0		
sheetwash	3	0.2	0.2	0.02	0.03
bare rock and scree	2	0.1	0.2	0.01	0.02
Sub-total	14	0.8	0.4	0.12	0.10
Undisturbed (intact or re-vegetating)	118	6.4	1.1	0.00	0.00
Total	180	9.8	1.4	0.41	0.14
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

8.3.2 Disturbance by natural processes

Numbers in this section correspond with the percentage for E(ii) in Table 11. It was found that a further 0.8% of Marlborough's land is disturbed by natural processes in forest plantations (Table 12). Bare soil on disturbed surfaces is attributable to:

- streambank deposition on 0.06% of the region's area
- rock outcrops and scree on 0.01%
- slope failure on 0.01%
- sheetwash on 0.02%
- slump on 0.01%

These amount to only 0.12% of the region's area. This is proportionately a small contribution to regional soil erosion given the area in forest plantation (i.e. 9.8% of the region), and suggests there is a degree of stabilising by tree roots in soil irrespective of whether the exotic forest is mature, harvested, or replanted.

8.3.3 Summary of forest plantations

Under forest plantations, soil disturbance affects 3.4% of Marlborough's soil. This has been caused more by land related activities (2.6%) than natural processes (0.8%). Forest plantations contribute only 0.41% to the entire region's area of bare soil.

There is 95% confidence that sample percentages for soil disturbance are within 1.4% or better of the true regional figures. For bare soil, there is 95% confidence that sample percentages are within 0.14% or better.

9.0 Tussock and dryland scrub

9.1 Overview

10.1% of Marlborough's sample points were under tussock and dryland scrub (Table 13). This is low altitude tussock mixed with dryland scrub (e.g. matagouri, broom, briar) scattered through it. Also the tussock is grazed, not intact - really a mix of short tussock with some introduced grasses.

9.2 Soil State

9.2.1 Stable surfaces

Stable surfaces under tussock and dryland scrub are on moderate hillslopes, spurs and ridges in the steepland ranges and mountains.

- 2.2% of the region's sample points are on stable surfaces under tussock and dryland scrub,
- 1.8% have intact soil currently well-vegetated, and
- 0.3% have soil currently disturbed by land use. Within this category bare soil only amounts to 0.02% of the region's area.

Table 13 Soil State for tussock and dryland scrub in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
STABLE SURFACES (S)	40	2.2	0.7		
S (i) with intact soil	34	1.8	0.6	0.00	0.00
S (ii) with soil disturbed by land use	6	0.3	0.3	0.02	0.02
EROSION PRONE SURFACES (U)	24	1.3	0.5		
U (i) with intact soil	21	1.1	0.5	0.00	0.00
U (ii) with soil disturbed by land use	3	0.2	0.2	0.01	0.01
ERODED (R) AND ERODING (E) SURFACES	122	6.6	1.1		
R (i) with re-vegetating soil	5	0.3	0.2	0.00	0.00
E (ii) with soil disturbed by natural processes	117	6.3	1.1	1.24	0.29
ALL SURFACES IN LANDUSE Total	186	10.1	1.4	1.27	0.29
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

9.2.2 Erosion-prone surfaces

The erosion-prone surfaces under tussock and dryland scrub are on moderate hillslopes, spurs and ridges in the steepland ranges and mountains and to a lesser extent on downlands.

- 1.3% of the region's sample points are on erosion-prone surfaces under tussock and dryland scrub,
- 1.1% have intact soil, currently well vegetated, and
- 0.2% have soil currently disturbed by land use. Within this category bare soil amounts to 0.01% of the region's area.

9.2.3 Eroded and eroding surfaces

The eroded and eroding surfaces under tussock and dryland scrub are on predominantly the steepland ranges and mountains and to a lesser extent on moderate hillslopes.

- 6.6% of the region's sample points are on eroded and eroding surfaces under tussock and dryland scrub,
- 0.3% have soil recently disturbed by natural erosion processes but re-vegetating, and
- 6.3% have soil freshly disturbed. Within this category bare soil amounts to 1.24% of the region's area.

9.3 Soil disturbance

9.3.1 Disturbance by land use

Numbers in this section are obtained by adding the percentages for S (ii) and U (ii) from Table 13. When stable and erosion-prone surfaces are combined, only 0.5% of Marlborough's land is disturbed by land

use related activities within tussock and dryland scrub (Table 14). Exposed topsoil equates to 0.03% of the region's area contributed either by access tracks (0.02%) or grazing (0.01%).

9.3.2 Disturbance by natural processes

Numbers in this section correspond with the percentages for E(ii) in Table 13. It was found that a further 6.3% of Marlborough's land is disturbed by natural processes in tussock and dryland scrub (Table 14).

Bare rock or soil on disturbed surfaces is attributable to:

- rock outcrops and scree on 0.66% of the region's area
- slope failure 0.21%
- sheetwash 0.20%
- streambank deposition 0.10%
- streambank scour 0.06%
- gully <0.01%

which collectively contribute 1.24% to the region's area of exposed soil.

Table 14 Soil disturbance amongst tussock and dryland scrub in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
BY LANDUSE					
grazing pressure	2	0.1	0.2	0.01	0.02
cultivation		0.0	0.0		
harvest		0.0	0.0		
spraying		0.0	0.0		
drains		0.0	0.0		
tracks	7	0.4	0.3	0.02	0.02
earthworks					
Sub-total	9	0.5	0.3	0.03	0.02
BY NATURAL PROCESSES					
landslide	28	1.5	0.6	0.17	0.10
debris avalanche	6	0.3	0.3	0.03	0.03
slump or earthflow	1	0.1	0.1	0.01	0.01
tunnel gully		0.0	0.0		
gully	1	0.1	0.1	<0.01	0.01
streambank scour	8	0.4	0.3	0.06	0.04
streambank deposit	11	0.6	0.4	0.10	0.07
sandblow		0.0	0.0		
sheetwash	27	1.5	0.5	0.20	0.10
bare rock and scree	35	1.9	0.6	0.66	0.24
Sub-total	117	6.3	1.1	1.24	0.29
Undisturbed (intact or re-vegetating)	60	3.3	0.8	0.00	0.00
Total	186	10.1	1.4	1.27	0.29
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

9.3.3 Summary for tussock and dryland scrub

Under tussock and dryland scrub, soil disturbance affects 6.8% of Marlborough's soil. This has been caused mainly by natural processes (6.3%) rather than land related activities (0.5%). Tussock and dryland scrub contribute 1.27% to the entire region's area of exposed soil and rock; proportionately about what would be expected given the area under these vegetation cover (10.1 % of the region).

There is 95% confidence that sample percentages for soil disturbance are within 1.4% or better of the true regional figures. For bare soil, there is 95% confidence that sample percentages are within 0.29% or better.

10.0 Mountain vegetation

10.1 Overview

8.9% of Marlborough's sample points were under mountain vegetation, scree and rock outcrops (Table 15). Mountain vegetation comprise sub-alpine scrub, high altitude tussock (alternating with scrub or above the scrub-line) and alpine herbfield. These covers are typically sparse, and interspersed with shingle scree or rock outcrops. Although not strictly a land use, it is such a significant land cover in Marlborough it was considered reasonable to assign its own category.

Table 15 Soil State for mountain vegetation in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
STABLE SURFACES (S)	1	0.1	0.1		
S (i) with intact soil	1	0.1	0.1	0.00	0.00
S (ii) with soil disturbed by land use	0	0.0	0.0		
EROSION PRONE SURFACES (U)	2	0.0	0.0		
U (i) with intact soil	2	0.1	0.2	0.00	0.00
U (ii) with soil disturbed by land use	0	0.0	0.0		
ERODED (R) AND ERODING (E) SURFACES	161	0.0	0.0		
R (i) with re-vegetating soil	0	0.0	0.0		
E (ii) with soil disturbed by natural processes	161	8.7	1.3	6.16	0.97
ALL SURFACES IN LANDUSE Total	164	8.9	1.3	6.16	0.97
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

10.2 Soil State

10.2.1 Stable surfaces

There are very few stable surfaces under mountain vegetation, typically vegetated spurs and ridges.

- 0.1% of the region's sample points are on stable surfaces under mountain vegetation,
- This 0.1% (just one point) has intact soil currently well-vegetated, and
- 0% have soil currently disturbed by land use.

10.2.2 Erosion-prone surfaces

Few erosion-prone but inactive sites are recorded under mountain vegetation

- 0.1% of the region's sample points are on erosion-prone surfaces under mountain vegetation and scree,
- 0.1% have intact soil, currently well vegetated (just two points), and
- 0% have soil currently disturbed by land use.

10.2.3 Eroded and eroding surfaces

Eroded and eroding surfaces under mountain vegetation are for the most part bare rock outcrops and shingle scree slopes. A few eroded or eroding points are recorded where debris avalanches, gullies and streams have out through vegetated slopes or along valley bottoms and scree are not surprisingly in mountain landscapes.

- 8.7% of the region's sample points are on eroded and eroding surfaces under mountain vegetation
- 0% have soil recently disturbed by natural erosion processes but re-vegetating, and
- 8.7% have soil freshly disturbed. Within this category bare soil amounts to 6.16% of the region's area.

10.3 Soil disturbance

10.3.1 Disturbance by land use

Numbers in this section are obtained by adding the percentages for S (ii) and U (ii) from Table 15. When stable and erosion-prone surfaces are combined, none are currently distributed by land use amongst mountain vegetation.

10.3.2 Disturbance by natural processes

Numbers in this section correspond with the percentage for E(ii) in Table 15. It was found that all the disturbance under mountain vegetation is the result of natural processes of erosion and deposition, present on 8.7% of Marlborough's land (Table 16). Bare soil and rock on disturbed surfaces is attributable to:

- rock outcrops and scree on 6.00% of the region's area
- streambank deposition 0.07%
- debris avalanche 0.05%
- sheetwash 0.04%
- landslide 0.01%

collectively contributing 6.16% to the region's area of exposed soil and rock.

Table 16 Soil disturbance amongst mountain vegetation in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
BY LANDUSE					
grazing pressure		0.0	0.0		
cultivation		0.0	0.0		
harvest		0.0	0.0		
spraying		0.0	0.0		
drains		0.0	0.0		
tracks		0.0	0.0		
earthworks		0.0	0.0		
Sub-total	0	0.0	0.0	0.00	0.00
BY NATURAL PROCESSES					
landslide	1	0.1	0.1	<0.01	<0.01
debris avalanche	6	0.3	0.3	0.05	0.04
slump or earthflow		0.0	0.0		
tunnel gully		0.0	0.0		
gully	1	0.1	0.1	0.01	0.01
streambank scour		0.0	0.0		
streambank deposit	3	0.2	0.2	0.07	0.08
sandblow		0.0	0.0		
sheetwash	5	0.3	0.2	0.04	0.04
bare rock and scree	145	7.9	1.2	6.00	0.96
Sub-total	161	8.7	1.3	6.16	0.97
Undisturbed (intact or re-vegetating)	3	0.2	0.2	0.00	0.00
Total	164	8.9	1.3	6.16	0.97
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

10.3.3 Summary for mountain vegetation

Under mountain vegetation, soil disturbance affects 8.7% of Marlborough's soil. This has been caused all by natural processes. Mountain vegetation contributes 6.16% to the entire region's area of bare soil and rock, which is the greatest amount for any one land use/land cover.

There is 95% confidence that sample percentages for soil disturbance are within 1.3% or better of the true regional figures. For bare soil, there is 95% confidence that sample percentages are within 0.97% or better.

11.0 Woody Scrub

11.1 Overview

13.2% of Marlborough's sample points were under woody scrub (Table 17). This includes native scrub species such as mahoe, fuchsia and tree fern; narrow leaved species such as kanuka and manuka; and exotic species such as gorse and blackberry. The category excludes dryland species (matagouri, broom, briar etc) which are interspersed with tussock.

11.2 Soil State

11.2.1 Stable surfaces

Stable surfaces under scrub are on moderate hillslopes, spurs and ridges in the hill country and steepland ranges. Pockets of scrub are also present on some downlands (also terraces and floodplains).

- 6.5% of the region's sample points are on stable surfaces under woody scrub,
- 5.0% have intact soil currently well-vegetated, and
- 1.4% have soil currently disturbed by land use. Within this category bare soil only amounts to 0.12% of the region's area.

Table 17 Soil State for woody scrub in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
STABLE SURFACES (S)	119	6.5	1.1		
S (i) with intact soil	93	5.0	1.0	0.00	0.00
S (ii) with soil disturbed by land use	26	1.4	0.5	0.12	0.05
EROSION PRONE SURFACES (U)	21	1.1	0.5		
U (i) with intact soil	21	1.1	0.5	0.00	0.00
U (ii) with soil disturbed by land use	0	0.0	0.0	0.00	0.00
ERODED (R) AND ERODING (E) SURFACES	103	0.0	0.0		
R (i) with re-vegetating soil	5	0.3	0.2	0.00	0.00
E (ii) with soil disturbed by natural processes	98	5.3	1.0	0.69	0.22
ALL SURFACES IN LAND USE Total	243	13.2	1.5	0.81	0.22
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

11.2.2 Erosion-prone surfaces

The erosion-prone surfaces are predominantly on hill country or steepland sites showing signs of past erosion (now re-vegetated) with minor amounts on floodplains, downlands, coastal cliffs and watercourses.

- 1.1% of the region's sample points are on erosion-prone surfaces under woody scrub,
- 1.1% have intact soil, currently well vegetated, and
- There are no points where soil is being currently disturbed by land use.

11.2.3 Eroded and eroding surfaces

Eroded and eroding surfaces are predominantly slopes disturbed by landslides and sheetwash in hill country or steeplands, with minor amounts of gully and streambank scour or deposition on floodplains, downlands, cliffs and watercourses.

- 5.6% of the region's sample points are on eroded and eroding surfaces under woody scrub,
- 0.3% have soil recently disturbed by natural erosion processes but are re-vegetating, and

- 5.3% have soil freshly disturbed. Within this category bare soil amounts to 0.69% of the region's area.

11.3 Soil disturbance

11.3.1 Disturbance by land use

Numbers in this section are obtained by adding the percentages for S (ii) and U (ii) from Table 17. When stable and erosion-prone surfaces are combined 1.4% of Marlborough's land is disturbed by land use-related activities within woody scrub (Table 18). Bare soil is exposed by:

- by tracking on 0.11% of the region's area
- by harvest on 0.01%

and amount to 0.12% of the region's area.

Table 18 Soil disturbance amongst woody scrub in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
BY LAND USE					
grazing pressure		0.0	0.0		
cultivation		0.0	0.0		
harvest	1	0.1	0.1	0.01	0.02
spraying		0.0	0.0		
drains		0.0	0.0		
tracks	25	1.4	0.5	0.11	0.05
earthworks		0.0	0.0		
Sub-total	26	1.4	0.5	0.12	0.05
BY NATURAL PROCESSES					
landslide	41	2.2	0.7	0.15	0.06
debris avalanche	6	0.3	0.3	0.04	0.04
slump or earthflow	3	0.2	0.2	0.03	0.04
tunnel gully		0.0	0.0		
gully	4	0.2	0.2	0.01	0.01
streambank scour	8	0.4	0.3	0.03	0.02
streambank deposit	9	0.5	0.3	0.22	0.17
sandblow		0.0	0.0		
sheetwash	20	1.1	0.5	0.15	0.08
bare rock and scree	7	0.4	0.3	0.06	0.06
Sub-total	98	5.3	1.0	0.69	0.22
Undisturbed (intact or re-vegetating)	119	6.5	1.1	0.00	0.00
Total	243	13.2	1.5	0.81	0.22
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

11.3.2 Disturbance by natural processes

Numbers in this section correspond with the percentage for E(ii) in Table 17. It was found that a further 5.3% of Marlborough's land is disturbed by natural processes in woody scrub. Bare soil on disturbed surfaces is attributable to:

- slope failure on 0.22% of the region's area
- streambank deposition on 0.22%
- streambank scour on 0.03%
- sheetwash on 0.15%
- bare rock and scree on 0.06%
- gully on 0.01%

11.3.3 Summary for woody scrub

Under woody scrub, soil disturbance affects 6.7% of Marlborough's soil. This has been caused more by natural processes (5.3%) than land use activities (1.4%). Woody scrub contributes 0.81% to the entire region's area of exposed soil. This somewhat less than would be expected, given the area occupied by this land cover (13.2% of the region), indicating that woody scrub helps keep soil intact, by providing a dense canopy cover and root reinforcement.

There is 95% confidence that sample percentages for soil disturbance are within 1.5% or better of the true regional figures. For bare soil, there is 95% confidence that sample percentages are within 0.22% or better.

12.0 Miscellaneous vegetation

12.1 Overview

1.1 % of Marlborough's sample points were in wetlands, coastal vegetation, river beds or water bodies (Table 19).

12.2 Soil State

12.2.1 Stable surfaces

There was only one site, a terrace, that was recorded as stable under miscellaneous vegetation

- 0.1% of the region's sample points are on stable surfaces under miscellaneous vegetation
- 0% have intact soil currently well-vegetated, and
- 0.1% have soil currently disturbed by land use. Within this category bare soil only amounts to 0.02% of the region's' area (just one point, so the error margin is large).

Table 19 Soil State for miscellaneous vegetation in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
STABLE SURFACES (S)	1	0.1	0.1		
S (i) with intact soil	0	0.0	0.0	0.00	0.00
S (ii) with soil disturbed by land use	1	0.1	0.1	0.02	0.04
EROSION PRONE SURFACES (U)	3	0.2	0.2		
U (i) with intact soil	2	0.1	0.2	0.00	0.00
U (ii) with soil disturbed by land use	1	0.1	0.1	0.01	0.01
ERODED (R) AND ERODING (E) SURFACES	17	0.9	0.4		
R (i) with re-vegetating soil	0	0.0	0.0	0.00	0.00
E (ii) with soil disturbed by natural processes	17	0.9	0.4	0.48	0.27
ALL SURFACES IN LANDUSE Total	21	1.1	0.5	0.51	0.27
Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.					
Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.					
Note 3: confidence limits are not additive.					

12.2.2 Erosion-prone surfaces

The erosion-prone surfaces are under two old dune ridges and a single wetland site.

- 0.2% of the region's sample points are on erosion-prone surfaces under miscellaneous vegetation
- 0.1% have intact soil, currently well vegetated, and
- 0.1% have soil currently disturbed by land use. Within this category bare soil amounts to 0.01% of the region's area.

12.2.3 Eroded and eroding surfaces

Eroded and eroding surfaces were predominantly in rivers or streams.

- 0.9% of the region's sample points are on eroded and eroding surfaces under miscellaneous vegetation,
- 0 % have soil recently disturbed by natural erosion processes but are re-vegetating, and
- 0.9% have soil freshly disturbed. Within this category bare soil amounts to 0.48% of the region's area.

12.3 Soil disturbance

12.3.1 Disturbance by land use

Numbers in this section are obtained by adding the percentages for S (ii) and U (ii) from Table 19. When stable and erosion-prone surfaces are combined 0.1% of Marlborough's land is disturbed by land use-related activities within miscellaneous vegetation (Table 20). Soil is bared by:

- grazing pressure on 0.01% of the region's area
- earthworks on 0.02%

These equate to 0.03% of the region's area.

12.3.2 Disturbance by natural processes

Numbers in this section correspond with the percentage for E(ii) in Table 19. It was found that a further 0.9% of Marlborough's land is disturbed by natural processes in miscellaneous vegetation. Bare soil on disturbed surfaces is attributable to:

- streambank deposition on 0.43% of the region's area
- sheetwash on 0.03%
- bare rock and scree on 0.02%

contributing 0.48% to the region's are of exposed soil.

Table 20 Soil disturbance amongst miscellaneous vegetation in the Marlborough Region, 2002 - 2005

	points	points as % of sample ¹	95% Confidence limit ²	Bare soil as % of area ²	95% Confidence limit ³
BY LANDUSE					
grazing pressure	1	0.1	0.1	0.01	0.01
cultivation		0.0	0.0		
harvest		0.0	0.0		
spraying		0.0	0.0		
drains		0.0	0.0		
tracks		0.0	0.0		
earthworks	1	0.1	0.1	0.02	0.04
Sub-total	2	0.1	0.2	0.03	0.04
BY NATURAL PROCESSES					
landslide		0.0	0.0		
debris avalanche		0.0	0.0		
slump or earthflow		0.0	0.0		
tunnel gully		0.0	0.0		
gully		0.0	0.0		
streambank scour		0.0	0.0		
streambank deposit	14	0.8	0.4	0.43	0.26
sandblow		0.0	0.0		
sheetwash	1	0.1	0.1	0.03	0.05
bare rock and scree	2	0.1	0.2	0.02	0.04
Sub-total	17	0.9	0.4	0.48	0.27
Undisturbed (intact or re-vegetating)	2	0.1	0.2	0.00	0.00
Total	21	1.1	0.5	0.51	0.27

Note 1: '% of sample' sub-totals/totals may differ by 0.1% due to rounding.

Note 2: '% of area' sub-totals/total may differ by 0.01% due to rounding.

Note 3: confidence limits are not additive.

12.3.3 Summary for miscellaneous vegetation

Under miscellaneous vegetation, soil disturbance affects 1.0% of Marlborough's soil. This has been caused more by natural processes (0.9%) than land use activities (0.1%). Miscellaneous vegetation contributes 0.48% to the entire region's area of exposed soil; a high contribution relative to the area under these land covers (1.1% of the region). This may be because these land covers are present on or are next to unstable sites such as coastal cliffs, riverbeds and lakes.

There is 95% confidence that sample percentages for soil disturbance are within 0.5% or better of the true regional figures. For bare soil, there is 95% confidence that sample percentages are within 0.27% or better.

13.0 References

Burton, A.S. Taylor, A. and Hicks, D.L. (2009). "Assessing Soil Stability" in Land and Soil Monitoring: A guide for SoE and Regional Council Reporting; New Zealand.

Appendix A - Glossary of terms

Bare soil

Soils that does not have a vegetation cover

Dense (primary cover)

Vegetation that provides complete ground cover (in the case of grassland or intensive uses) or has closed canopy (in the case of trees or scrub).

Disturbed soil

Soil that is no longer intact, as a consequence of land use or natural processes.

Eroded surfaces

Unstable land surfaces, recently disturbed. Contain re-vegetating erosion scars that have usually occurred in the decade prior to photography.

Eroding surfaces

Unstable land surfaces, freshly disturbed. Contain bare erosion scars that have usually occurred in the year prior to photography.

Erosion-prone surfaces

Unstable land surfaces. Show signs of past erosion but are currently not eroded or eroding, erosion scars have healed and are well vegetated. Has usually occurred at least a decade prior to the photography.

Extensively disturbed surfaces

Areas of land where soil has been removed in whole or part, re-contoured or covered by building, pavement or water.

Extensive

Patches of other vegetation which are widespread amongst a dominant vegetation (primary cover).

Harvested (primary cover)

Vegetation that has been removed from a site e.g. the felling of trees or scrub; vegetable, grain or forage crops from land under intensive use; hay and silage cutting in grassland.

Intact soil

Soil free from disturbance by natural processes or land use (including machine disturbance in the course of land use)

Land use disturbance

Where soil is disturbed through human activity, for example cultivation, grazing, tracking.

Natural Disturbance

Where soil is disturbed through erosion and deposition, for example by mass movement, running water, wind or coastal processes.

Primary vegetative cover

The dominant vegetation observed at a sample point

Scattered (secondary cover)

Patches of other vegetation which are infrequent amongst dominant vegetation (primary cover)

Secondary vegetative cover

The next most prevalent vegetation observed at a sample point after primary vegetative cover (dominant vegetation)

Soil accumulation

Addition of soil particles by decomposition of organic matter, weathering of regolith, deposition of soil from upslope erosion, deposition of sediment transported from upriver, deposition of wind-blown dust around growing plants or deposition from air-fall volcanic ash.

Soil disturbance

The concept of whether soils are at risk of moving from their place of formation. Disturbance may be by rural land uses such as farming or forestry; or re-contouring/removal of soil by machinery; or by natural movement of soil on-site or natural removal of soil off-site.

Soil erosion

Removal of soil particles by wind, overland flow of runoff, rills and gullies, stream bank scour and collapse and mass movement (landslides, earthflows, slumps and debris avalanches)

Soil intactness

The concept of whether soils are staying in their place of formation. How well a region's soil is being kept in place as a resource for farming, forestry and conservation. A decrease in soil intactness occurs when a soil is disturbed by land use or by natural processes of erosion and deposition or by re-contouring/removal.

Soil state

Whether soil is stable, erosion-prone, eroded or eroding

Sparse (primary cover)

Vegetation that does not provide complete ground cover (in the case of grassland or intensive uses) or does not have closed canopy 9in the case of trees or scrub)

Stable surfaces

Land surfaces that show no signs of past erosion, have a smooth appearance and are completely vegetated (unless topsoil is disturbed by land use)

Urban areas

Areas that are occupied by urban infrastructure, housing and amenities (including urban open space)

Vegetated soil

Soil that has a vegetative cover i.e. not bare