Auckland
Regional Council
TE RAUHĪTANGA TAIAO

Changes in Soil State and Disturbance from 1999-2007

February TR 2009/012

Auckland Regional Council
Technical Report No.012 February 2009
ISSN 1179-0504 (Print)
ISSN 1179-0512 (Online)
ISBN 978-1-877528-19-4

Reviewed by:

Name: Amy Taylor

Position: Project Leader, Land

Organisation: Auckland Regional Council

Date: 27 February 2009

Approved for ARC Publication by:

Name: Grant Barnes

Position: Group Manager, Monitoring and Research

Organisation: Auckland Regional Council

Date: 27 February 2009

Recommended Citation:
Hicks, D. L. (2009). Changes in Soil State and Disturbance from 1999 to 2007. Prepared for Auckland Regional Council. Auckland Regional Council Document Type TR 2009/012.

Changes in Soil State and Disturbance from 1999 to 2007

D. L. Hicks

Prepared for
Auckland Regional Council

D. L. Hicks
P O Box 170, Orewa

Contents

1 Introduction

The Auckland Regional Council (ARC) has requested a comparison of current survey results (2007), with those from a previous survey carried out in 2000 (from aerial photographs taken in 1999). This report summarises changes and trends detected by the comparison.

The year 2000 survey was a point sample similar in design to the present survey, though did not cover the entire region (at ARC's request it focused on rural land). It also lacked several refinements subsequently introduced as part of the regional councils' National Land Monitoring Forum (NLMF) format for point sampling from aerial photographs. The differences do not preclude comparison of 1999 with 2007 data, but necessitate qualification of statements about change between the two dates.

1.1 Identification of comparable points between surveys (1999, 2007)

Table 5.1 (1999, 2007) contains data summaries for the region-wide point sample (5277 points). Soil disturbance (measured as bare soil) is 3.29% of the region's area in 2007, compared with 1.49% in 1999. However much of the apparent increase is due to the 2007 resurvey recording soil disturbance in parts of the region that were left unmeasured in 1999:

- 572 points within urban areas, adding bare soil equivalent to 0.21% of the region's area,
- 199 points on water bodies and coastal features with partly exposed soil (shore) or sediment (tidal), adding bare soil equivalent to 0.33% of the region's area, or
- where measurement was not possible due to lack of aerial photo cover that year; 316 points on Great Barrier and Little Barrier Islands (341 less 25 coastal points), adding bare soil equivalent to 0.15% of the region's area.

Comparison of many items in Table 5.1 is precluded by absence of 1999 data for these points. Removing them from the 2007 data summary leaves a balance of 4190 points. Some further adjustments are needed to ensure strict comparability of itemised data summaries:

- The 2007 resurvey separated 161 mainland points (plus 1 on Great Barrier) as a new category "rural buildings", consistent with current NLMF survey procedure. These 162 have now been separated as "rural buildings" in a comparable summary (Table 5.2). Doing this somewhat over-estimates the number of points with rural buildings in 1999 - clearly some of them would not have been there - but it helps ensure that comparisons for the balance of points are for land that was in rural use at both dates.

- The 2007 resurvey detected 58 points outside the 1999 urban areas that had been converted to urban use by 2007. These have now been transferred to "urban areas" in the comparable data summary.
- The 2007 resurvey observed 52 points within the 1999 urban area that were still rural in 2007. These have now been transferred to "urban areas" in the comparable data summary (less 8 points classed as rural buildings)
- The 2007 resurvey could not record data for 49 rural points on part of the Okahukura peninsula (Kaipara), where there are no aerial photographs. These points had to be removed from the 1999 rural land sub-total, and added to the "no photos or unclassified" sub-total.
- The 2007 resurvey recorded 27 points as rural, that were unmeasured in 1999 for a variety of reasons e.g. obscured by clouds on aerial photographs (9 unmeasured in 1999, are already included in the 49 above). The balance of 18 points had to be removed from the 2007 rural land sub-total, and added to the "no photos or unclassified" sub-total.

The net result of these adjustments is Table 5.2 (1999, 2007), a comparable data summary for:

- 3912 points on rural land in mainland Auckland, measured at both dates,
- 983 points in other uses use at one, other or both dates. These have partial measurements in 1999, and complete measurements in 2007, and
- 382 points lacking photo cover at one or other date. Few have 1999 measurements, but most have 2007 measurements.

2 Region-Wide Changes in Land Use 1999-2007

Table 5.1 contains sufficient information about the points un-measured in 1999, to enable some statements about region-wide changes in land use

2.1 Rural Uses

4359 points (82.6% of the region's land) was under rural uses in 1999. This total comprises 4153 measured points under rural uses, plus 316 un-measured but known to be rural (outer Gulf Islands), plus 52 within urban limits, less 162 rural buildings.

4289 points (81.3% of the region's land) was under rural uses in 2007. This total comprises all measured points under rural uses, throughout the region.

The net decline in land under rural use has been -1.3%.

2.2 Other Uses

891 points (16.9% of the region) was under other uses in 1999. This total comprises 174 recorded points on shore-lines and water bodies plus 25 un-recorded but known to be coastal (outer Gulf Islands); 402 un-measured points known to have urban buildings (within urban limits) plus 128 points with urban open space (within urban limits); but excludes 52 points known to be in rural use (within urban limits), and adds 162 points with rural buildings.

939 points (17.8% of the region) was under other uses in 2007. This total comprises all measured points, under other uses anywhere in the region (162 rural buildings + 578 urban areas + 199 water bodies and coastal features).

The net increase in land under other uses is +0.9%.

2.3 Unclassifiable Land

Land use was un-classifiable at 27 points (0.5% of the region's land) in 1999. These were points where aerial photo detail was obscured by cloud cover, deep shadow or similar.

Land use was unclassifiable at 49 points (0.9% of the region's land) in 2007. These were points on the Southern Okahukura peninsula where (despite several attempts) satisfactory aerial photos have never been supplied due to partial cloud cover.

The net change in unclassifiable land is +0.4%.

Table 5.1 (1999)

Soil state and disturbance throughout the Auckland region, 1999 (includes non-comparable points)

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		1512	28.7	1.2	0.00	0.00
S (ii) with soil disturbed by land use	grazing pressure	10	0.2	0.1	0.02	0.02
	cultivation	37	0.7	0.2	0.47	0.16
	harvest	1	0.0	0.0	<0.01	<0.01
	spraying	2	0.0	0.1	0.01	0.02
	drains	0	0.0	0.0	0.00	0.00
	tracks	16	0.3	0.1	0.03	0.02
	earthworks	10	0.2	0.1	0.05	0.04
	sub-total	76	1.4	0.3	0.59	0.17
STABLE SURFACES	total	1588	30.1	1.2		
EROSION-PRONE SURFACES						
U (i) with intact soil		1992	37.7	1.3	0.00	0.00
U (ii) with soil disturbed by land use	grazing pressure	19	0.4	0.2	0.04	0.02
	cultivation	12	0.2	0.1	0.07	0.05
	harvest	2	0.0	0.1	0.02	0.04
	spraying	2	0.0	0.1	<0.01	<0.01
	drains	7	0.1	0.1	0.01	0.01
	tracks	25	0.5	0.2	0.04	0.02
	earthworks	12	0.2	0.1	0.09	0.06
	sub-total	79	1.5	0.3	0.28	0.09
EROSION-PRONE SURFACES		2071	39.2	1.3		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.
Note 4: not measured in 2007.

Cont. Table 5.1 (1999)

Soil state and disturbance throughout the Auckland region, 1999 (includes non-comparable points)

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		276	5.2	0.6	0.00	0.00
E (ii) with soil disturbed by natural processes	landslide	84	1.6	0.3	0.16	0.07
	debris avalanche	13	0.2	0.1	0.02	0.02
	slump or earthflow	17	0.3	0.2	0.03	0.02
	tunnel gully	5	0.1	0.1	0.01	0.01
	gully	20	0.4	0.2	0.02	0.01
	streambank scour	22	0.4	0.2	0.02	0.01
	streambank deposit	16	0.3	0.1	0.10	0.06
	sandblow	26	0.5	0.2	0.28	0.13
	sheetwash	1	0.0	0.0	<0.01	<0.01
	rockfall or bare rock	14	0.3	0.1	0.00	0.00
	sub-total	218	4.1	0.5	0.63	0.16
ERODED AND ERODING SURFACES	total	494	9.4	0.8		
All land in rural use	total	4153	78.7	1.1	1.49	0.24

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.1 (1999)

Soil state and disturbance throughout the Auckland region, 1999 (includes non-comparable points)

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
EXTENSIVELY DISTURBED SURFACES						
Rural buildings	farm buildings and yards	0	0.0	0.0		
	industrial buildings and quarries	0	0.0	0.0		
	roads, railways, airfields	0	0.0	0.0		
	sub-total	0	0.0	0.0	4	4
Urban areas	residential	291	5.5	0.6		
	industrial/commercial	94	1.8	0.4		
	roads, railways, airfields	17	0.3	0.2		
	open space	128	2.4	0.4		
	urban-rural fringe	52	1.0	0.3		
	sub-total	582	11.0	0.8	5	5
Water bodies and coastal features	lake or pond	17	0.3	0.2		
	estuary	95	1.8	0.4		
	beach	28	0.5	0.2		
	coast	34	0.6	0.2		
	sub-total	174	3.3	0.5	5	5
EXTENSIVELY DISTURBED SURFACES	total	756	14.1	0.9		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.
Note 4: included in preceding categories in 1999.
Note 5: measurement not requested in 1999.

Cont. Table 5.1 (1999)

Soil state and disturbance throughout the Auckland region, 1999 (includes non-comparable points)

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
UNCLASSIFIABLE SURFACES	unclassified points in 1999	27	0.5	0.2		
	points with no photos in 1999	341	6.5	0.7		
	sub-total	378	7.2	0.7	[4]	[4]
UNCLASSIFIABLE SURFACES	total	378	7.2	0.7		
ALL SURFACES IN REGION	total	5277	100.0	0.0	1.49	0.24

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.
Note 4: not measureable in 1999.

Table 5.1 (2007)

Soil state and disturbance throughout the Auckland region, 2007 (includes non-comparable points)

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		1018	19.3	1.1	0.00	0.00
S (ii) with soil disturbed by land use	grazing pressure	110	2.1	0.4	0.06	0.01
	cultivation	65	1.2	0.3	0.52	0.16
	harvest	18	0.3	0.2	0.04	0.03
	spraying	19	0.4	0.2	0.03	0.03
	drains	20	0.4	0.2	0.02	0.01
	tracks	246	4.7	0.6	0.27	0.04
	earthworks	50	0.9	0.3	0.06	0.02
	roads	41	0.8	0.2	0.06	0.02
	sub-total	569	10.8	0.8	1.06	0.16
STABLE SURFACES	total	1587	30.1	1.2		
EROSION-PRONE SURFACES						
U (i) with intact soil		1403	26.6	1.2	0.00	0.00
U (ii) with soil disturbed by land use	grazing pressure	96	1.8	0.4	0.07	0.02
	cultivation	20	0.4	0.2	0.09	0.05
	harvest	60	1.1	0.3	0.06	0.02
	spraying	11	0.2	0.1	0.02	0.02
	drains	26	0.5	0.2	0.02	0.01
	tracks	208	3.9	0.5	0.22	0.03
	earthworks	31	0.6	0.2	0.03	0.01
	roads	30	0.6	0.2	0.03	0.01
	sub-total	482	9.1	0.8	0.54	0.05
EROSION-PRONE SURFACES	total	1885	35.7	1.3		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.
Note 4: not measured in 2007.

Cont. Table 5.1 (2007)

Soil state and disturbance throughout the Auckland region, 2007 (includes non-comparable points)

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		424	8.0	0.7	0.00	0.00
E (ii) with soil disturbed by natural processes	landslide	93	1.8	0.4	0.08	0.03
	debris avalanche	13	0.2	0.1	0.01	0.01
	slump or earthflow	35	0.7	0.2	0.03	0.02
	tunnel gully	10	0.2	0.1	<0.01	<0.01
	gully	22	0.4	0.2	0.01	0.01
	streambank scour	49	0.9	0.3	0.03	0.01
	streambank deposit	62	1.2	0.3	0.14	0.06
	sandblow	38	0.7	0.2	0.33	0.14
	sheetwash	16	0.3	0.1	0.02	0.02
	rockfall or bare rock	53	1.0	0.3	0.20	0.07
	sub-total	393	7.4	0.7	0.84	0.17
ERODED AND ERODING SURFACES	total	817	15.5	1.0		
All land in rural use	sub-total	4289	81.3	1.1	2.45	0.24

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.1 (2007)

Soil state and disturbance throughout the Auckland region, 2007 (includes non-comparable points)

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
EXTENSIVELY DISTURBED SURFACES						
Rural buildings	farm buildings and yards	123	2.3	0.4	0.04	0.02
	industrial buildings and quarries	34	0.6	0.2	0.24	0.11
	roads, railways, airfields	5	0.1	0.1	0.02	0.03
	sub-total	162	3.1	0.5	0.31	0.11
Urban areas	residential	309	5.9	0.6	0.04	0.03
	industrial/commercial	99	1.9	0.4	0.06	0.05
	roads, railways, airfields	18	0.3	0.2	0.01	0.02
	open space	152	2.9	0.5	0.10	0.05
	urban-rural fringe	0	0.0	0.0	[5]	[5]
	sub-total	578	11.0	0.8	0.21	0.08
Water bodies and coastal features	lake or pond	16	0.3	0.1	<0.01	<0.01
	estuary	101	1.9	0.4	0.19	0.11
	beach	31	0.6	0.2	0.07	0.05
	coast	51	1.0	0.3	0.07	0.03
	sub-total	199	3.8	0.5	0.33	0.13
EXTENSIVELY DISTURBED SURFACES	total	939	17.8	1.0		
UNCLASSIFIABLE SURFACES						
	unclassified points in 2007	0	0.0	0.0		
	points with no photos in 2007	49	0.9	0.3		
UNCLASSIFIABLE SURFACES	total	49	0.9	0.3	[4]	[4]
ALL SURFACES IN REGION	total	5277	100.0	0.0	3.29	0.29

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.
Note 4: not measured in 2007.
Note 5: absorbed into other categories in 2007

3 Regional Changes in Soil State 1999- 2007

Table 5.2 (1999)

Soil state and disturbance throughout the Auckland region, 1999 (non-comparable points separated)

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		1380	26.2	1.2	0.00	0.00
S (ii) with soil disturbed by land use	grazing pressure	10	0.2	0.1	0.02	0.02
	cultivation	35	0.7	0.2	0.47	0.16
	harvest	1	<0.1	<0.1	<0.01	<0.01
	spraying	2	0.0	0.1	0.01	<0.01
	drains	0	0.0	0.0	0.00	0.00
	tracks	14	0.3	0.1	0.03	0.02
	earthworks	4	0.1	0.1	0.01	0.01
	sub-total	66	1.3	0.3	0.54	0.17
STABLE SURFACES	total	1446	27.4	1.2		
EROSION-PRONE SURFACES						
U (i) with intact soil		1918	36.3	1.3	0.00	0.00
U (ii) with soil disturbed by land use	grazing pressure	18	0.3	0.2	0.04	0.02
	cultivation	10	0.2	0.1	0.05	0.04
	harvest	2	<0.1	<0.1	0.02	0.04
	spraying	2	<0.1	<0.1	<0.01	0.01
	drains	6	0.1	0.1	0.01	0.01
	tracks	25	0.5	0.2	0.04	0.02
	earthworks	5	0.1	0.1	0.02	0.02
	sub-total	68	1.3	0.3	0.18	0.06
EROSION-PRONE SURFACES	total	1986	37.6	1.3		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.2 (1999)

Soil state and disturbance throughout the Auckland region, 1999 (non-comparable points separated)

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		269	5.1	0.6	0.00	0.00
E (ii) with soil disturbed by natural processes	Landslide	84	1.6	0.3	0.14	0.06
	debris avalanche	13	0.2	0.1	0.02	0.02
	slump or earthflow	15	0.3	0.1	0.03	0.02
	tunnel gully	5	0.1	0.1	0.01	0.01
	gully	19	0.4	0.2	0.02	0.01
	streambank scour	22	0.4	0.2	0.02	0.01
	streambank deposit	14	0.3	0.1	0.07	0.05
	sandblow	24	0.5	0.2	0.25	0.12
	sheetwash	1	<0.1	<0.1	<0.01	<0.01
	rockfall or bare rock	14	0.3	0.1	<0.01	<0.01
	sub-total	211	4.0	0.5	.55	0.14
ERODED AND ERODING SURFACES	total	480	9.1	0.8		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.2 (1999)

Soil state and disturbance throughout the Auckland region, 1999 (non-comparable points separated)

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
EXTENSIVELY DISTURBED SURFACES Rural buildings, either date	sub-total	162	3.1	0.5	0.12[4]	0.07[4]
Urban areas either date	sub-total	622	11.8	0.9	0.03[4]	0.04[4]
Water bodies and coastal features, either date	sub-total	199	3.8	0.5	0.02[4]	0.02[4]
EXTENSIVELY DISTURBED SURFACES	total	983	18.6	1.1		
UNCLASSIFIABLE SURFACES No photos or unclassified, either date	sub-total	382	7.2	0.7	0.05[4]	0.02[4]
ALL REGION	total	5277	100.0	0.0	1.49	0.24

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.
Note 4: Partial measurement – refer text)

Table 5.2 (2007)

Soil state and disturbance throughout the Auckland region, 2007 (non-comparable points separated)

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		893	16.9	1.0	0.00	0.00
S (ii) with soil disturbed by land use	grazing pressure	108	2.0	0.4	00.6	0.01
	cultivation	64	1.2	0.3	0.51	0.15
	harvest	18	0.3	0.2	0.04	0.03
	spraying	18	0.3	0.2	0.02	0.03
	drains	20	0.4	0.2	0.02	0.01
	tracks	233	4.4	0.6	0.26	0.04
	earthworks	46	0.9	0.3	0.05	0.02
	roads	34	0.6	0.2	0.05	0.02
	sub-total	541	10.3	0.8	1.02	0.16
STABLE SURFACES	total	1434	27.2	1.2		
EROSION-PRONE SURFACES						
U (i) with intact soil		1316	24.9	1.2	0.00	0.00
U (ii) with soil disturbed by land use	grazing pressure	96	1.8	0.4	0.07	0.02
	cultivation	17	0.3	0.2	0.08	0.05
	harvest	60	1.1	0.3	0.06	0.02
	spraying	11	0.2	0.1	0.02	0.02
	drains	25	0.5	0.2	0.02	0.01
	tracks	203	3.8	0.5	0.21	0.03
	earthworks	29	0.5	0.2	0.03	0.01
	roads	24	0.5	0.2	0.02	0.01
	sub-total	465	8.8	0.8	0.52	0.07
EROSION-PRONE SURFACES	total	1781	33.8	1.3		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.2 (2007)

Soil state and disturbance throughout the Auckland region, 2007 (non-comparable points separated)

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		369	7.0	0.7	0.00	0.00
E (ii) with soil disturbed by natural processes	landslide	80	1.5	0.3	0.06	0.03
	debris avalanche	8	0.2	0.1	0.01	0.01
	slump or earthflow	35	0.7	0.2	0.03	0.02
	tunnel gully	10	0.2	0.1	<0.01	<0.01
	gully	22	0.4	0.2	0.01	0.01
	streambank scour	44	0.8	0.2	0.03	0.01
	streambank deposit	52	1.0	0.3	0.11	0.05
	sandblow	35	0.7	0.2	0.27	0.12
	sheetwash	6	0.1	0.1	0.02	0.02
	rockfall or bare rock	34	0.6	0.2	0.15	0.07
	sub-total	328	6.2	0.7	0.70	0.15
ERODED AND ERODING SURFACES	total	697	13.2	0.9		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.2 (2007)

Soil state and disturbance throughout the Auckland region, 2007 (non-comparable points separated)

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
EXTENSIVELY DISTURBED SURFACES						
Rural buildings either date	sub-total	162	3.1	0.5	0.31	0.11
Urban areas, either date	sub-total	622	11.8	0.9	0.28	0.08
Water bodies and coastal features, either date	sub-total	199	3.8	0.5	0.33	0.13
EXTENSIVELY DISTURBED SURFACES	total	983	18.6	1.1		
UNCLASSIFIABLE SURFACES						
No photos or unclassified, either date	sub-total	382	7.2	0.7	0.15	0.07
ALL REGION	total	5277	100.0	0.0	3.29	0.29

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

3.1 Soil State on Land in Rural Use, Mainland Auckland and Inner Gulf Islands

There is insignificant change in stable surfaces, down from 27.4 to 27.2% of sample points (due to natural disturbance at 12 points re-classed as eroded and eroding surfaces in 2007). Intact soil on stable surfaces is drastically down, from 26.2 to 16.9%; and soil disturbed by land use proportionately up, from 1.3 to 10.3% of sample points.

Erosion-prone surfaces are down from 37.6 to 33.8% of sample points, a significant change due to natural disturbance at 205 points which have been reclassified as eroded and eroding surfaces in 2007. On the balance of erosion-prone surfaces, intact soil is down from 36.3 to 24.9%; and soil disturbed by land use up from 1.3% to 8.8%.

Declines in the proportion of sample points classed as intact, are partly real and partly an artefact of altered survey procedure. The differences can be isolated, and are discussed beneath the sub-heading Land use related soil disturbance.

Eroded and eroding surfaces are up, from 9.1% to 13.2% of sample points, a significant change. The components are eroded surfaces with revegetating soil, up from 5.1 to 7.0%; and eroded surfaces with bare soil, up from 4.0 to 6.2%.

3.2 Soil State on Land in Other Use, Mainland Auckland and Inner Gulf Islands

The increased proportion of sample points classed as eroded, is partly real and partly an artefact of altered survey procedure. The differences can be isolated, and are discussed beneath the sub-heading Natural soil disturbance.

There has been little change in extensively disturbed surfaces, 18.6% of sample points at both dates; though this sub-total conceals:

- a small number of "rural buildings" points where construction post-dates 1999,
- 52 "urban area" points that remain in rural use as of 2007, and

3.3 Soil State on Other Land (Off Shore Islands or Unclassifiable)

For 382 sample points (7.2% of the total), nothing can be said about changes in soil state 1999 - 2007 because aerial photos were not taken at one or other date.

4 Regional Changes in Soil Disturbance 1999 to 2007

4.1 Land Use Related Soil Disturbance

Numbers in this discussion are obtained by adding percentages for stable surfaces disturbed by land use (Sii in Table 5.2) to those for unstable surfaces disturbed by land use (Uii in Table 5.2).

Soil disturbance (bare soil) on land in rural use increased from 0.72% to 1.54% of the region's area between 1999 and 2007. This large and apparently significant increase must be interpreted with caution. A large part of it is actually due to a change in survey procedure between the two dates:

- The 1999 survey recorded farm tracks that were bare soil (39 points) and did not record rural roads. The 2007 re-survey recorded unsealed as well as bare farm tracks (436 points). It also recorded unsealed rural roads (58 points). This change ensures 2007 re-survey is consistent with the NLMF survey format, but has the effect that:
  - bare soil/unsealed surface exposed by tracking is measured as 0.47% of the region's area in 2007 compared with 0.07% in 1999, and
  - bare soil/unsealed surface exposed by rural roads is measured as 0.07% of the region's area in 2007 compared with 0% in 1999.

When the combined increase (+0.47%) is removed, bare soil on land in rural use is still up by 0.35%. This increase is genuine and most of it is accounted for by land use disturbance:

- grazing pressure, up from 0.06% to 0.13%,
- cultivation, up from 0.52% to 0.59%,
- harvest, up from 0.02% to 0.10%,
- spraying, up from 0.01% to 0.04%,
- drain excavation, up from 0.01% to 0.04%, and
- earthworks, up from 0.03% to 0.08%.

Increases are within sample error margins for individual disturbance types, but the collective increase for land use disturbance at 0.35% is well outside the error margins for land use disturbance sub-totals (which range from 0.08 to 0.17%).

4.2 Natural Soil Disturbance on Land in Rural Use

Numbers in this discussion are obtained from percentages for eroding surfaces disturbed by natural processes (Eii in Table 5.2).

Natural soil disturbance (bare soil) on land in rural use increased from 0.55% to 0.70% of the region's area between 1999 and 2007. The increase is right on the border of error margins. It appears entirely due to another alteration in survey procedure:

- The 1999 survey recorded presence of bare rock outcrops, but only measured them where there was evidence of fresh rockfall. The 2007 re-survey measured all bare rock outcrops as natural disturbance of soil (consistent with NLMF format). This amounted to 0.15% of the region's area, equivalent to the increase in natural soil disturbance between dates.

So there has been no real change in area of bare soil caused by natural disturbance. However results for soil state show a significant increase in number of points where fresh disturbance (bare soil) has been recorded. A closer look at types of disturbance, gives a better indication of what has been happening around the region:

- slope failures (landslides, debris avalanches, slumps, earthflows) are down from 0.19% to 0.10%,
- under-runners and gullies are down from 0.03% to 0.01%,
- streambank scour and deposits are up from 0.09% to 0.14%,
- sandblow is little changed from 0.25% to 0.27%,
- sheetwash is slightly increased from <0.01% to 0.02%, and
- rockfalls and rock outcrops are up from <0.01% to 0.15%.

So some types of natural disturbance have been healing (bare eroding surfaces in 1999 are now revegetating eroded surfaces in 2007); while others have been opening up (vegetated unstable surfaces are now bare eroding surfaces). The corresponding increases in bare soil are within sample error margins for individual disturbance types, so are not large enough to be regarded as significant. The exception is rock outcrops, where the change appears significant only because these have been measured for the first time.

4.3 Land Use Related Disturbance on Land Under Other Use

Although much of this land was excluded from the 1999 survey, enough parts were measured (land with rural buildings and yards) for some statements to be made about 1999 - 2007 changes for this category. Some statements are also possible about soil disturbance in parts that have been measured for the first time in 2007 (urban areas and shorelines). Numbers in this discussion are obtained from percentages for extensively disturbed surfaces in Table 5.2.

4.3.1 Rural Buildings

The apparent increase in soil disturbance for land where rural buildings are sited, from 0.12% to 0.31% of the region's area, has two possible causes. One is addition of unsealed tracks and yards by the 2007 re-survey. The other is a genuine increase in earthworks due to rural construction. Components of the data are:

	1999	2007
• unsealed tracks and yards	0.01%	0.04%
• unsealed roads	unmeasured	0.02%
• earthworks	0.11%	0.23%
• miscellaneous land use disturbance	<0.01%	0.02%
• miscellaneous natural disturbance	0.00%	<0.01%

so a genuine and significant increase in rural earthworks has occurred at these sites.

4.3.2 Urban Areas

The 2007 survey's first-time measurement of bare soil on sample points in urban use indicates that it is measureable but not excessive, at 0.21% of the region's area. The adjusted data summaries (Table 5.2) now include two other items:

- 0.03% bare soil in 1999 at 58 rural sample points transferred into the "urban areas and urban fringe" category i.e. now urban,
- 0.07% bare soil in 2007 at 52 rural sample points retained in the "urban areas and urban fringe" category i.e. not yet urban,

giving an "urban areas" measurement of 0.28% bare soil in 2007, compared with a partial measurement (urban fringe only) of 0.03% in 1999. Components of the urban bare soil are:

	1999	2007
• unsealed tracks and yards	0.00%	0.02%
• unsealed roads	unmeasured	0.01%
• earthworks	<0.01%	0.18%
• miscellaneous land use disturbance	0.02%	0.04%
• miscellaneous natural disturbance	0.01%	0.03%

The changes, while statistically significant, are likely to be an artefact of soil disturbance not having been measured at 572 out of 630 "urban areas and urban fringe" points in 1999.

4.4 Natural Disturbance on Land in Other Use

4.4.1 Water bodies and coastal features

The first-time measurement of bare soil/bare sediment associated with water bodies and coastal features, indicates that it collectively occupies 0.33% of the region's area. Its components are:

	2007
• sediment deposits	0.25%
• bare rock outcrops	0.07%
• landslides	<0.01%
• miscellaneous land use disturbance	0.01%

Sediment deposits were recorded where sample points fell on the banks of tidal creeks, within mangrove swamps, or on beaches. Rock outcrops were recorded where they fell on coastal rock platforms or bare cliffs. Although numerous sample points fell on vegetated coastal slopes, landslides were recorded at just two. The miscellaneous land use disturbances (six sample points) ranged from cultivation or earthworks on rural land near shore-lines, to tracking or trampling of vegetation behind urban beaches.

5 Rural Land Uses Region-Wide

The next paragraphs compare soil disturbance in 1999 and 2007, for nine broad rural land uses:

- intensive uses (vineyards, orchards, market gardens, grain and fodder crops),
- dairy farms,
- drystock farms,
- forest plantations,
- natural forest,
- natural scrub,
- exotic scrub,
- coastal grass and scrub, and
- wetlands and mangroves

Table 5.3 (1999 and 2007) gives the area in each use at both dates, expressed as a percentage of the region.

Changes in soil disturbance can be discussed for each use by comparing its 1999 and 2007 summary tables, without removing non-comparable points. Collectively these affect the region-wide summary (Table 5.1), but once distributed across land uses, there are so few of them in most tables, that they have little effect on number totals or percentages. The exceptions are tables for natural forest, natural scrub, and exotic scrub; where addition of Great Barrier and Little Barrier points is obvious and merits discussion.

Table 5.3 (1999)

Land use throughout the Auckland region, 1999

Land use	Composition	Points	Points as% of sample[1]	95% conf. lim.[2]
Intensive	vineyards incl. kiwifruit	[3]		
	orchards incl. avocado	50	0.9	0.3
	market gardens	91	1.7	0.4
	grain crops	45	0.9	0.2
	greenfeed crops	11	0.2	0.1
	sub-total	197	3.7	0.5
Dairy	improved, hard-grazed	11	0.2	0.1
	improved, lax-grazed or spelled	593	11.2	0.9
	improved, harvested	0	0.0	0.0
	sub-total	604	11.4	0.9
Drystock	improved, hard-grazed	278	5.3	0.6
	improved, lax-grazed or spelled	1446	27.4	1.2
	improved, harvested	2	0.0	0.1
	unimproved	14	0.3	0.1
	sub-total	1740	33.0	1.3
Forest plantations	open-canopy pines	178	3.4	0.5
	maturing pines	282	5.3	0.6
	harvested pines	36	0.7	0.2
	broadleaved trees	0	0.0	0.0
	sub-total	496	9.4	0.8
Natural forest	closed canopy	159	3.0	0.5
	with natural scrub	123	2.3	0.4
	with exotic grass, scrub or trees	17	0.3	0.2
	sub-total	299	5.7	0.6

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: confidence limits are not additive.
Note 3: included with orchards in 1999.

Cont. Table 5.3 (1999)

Land use throughout the Auckland region, 1999

Land use	Composition	Points	Points as% of sample[1]	95% conf. lim.[2]
Natural scrub	closed canopy	270	5.1	0.6
	with forest trees	193	3.7	0.5
	with exotic grass, scrub or trees	84	1.6	0.3
	sub-total	547	10.4	0.8
Exotic scrub	closed canopy	15	0.3	0.1
	with natural scrub or forest trees	49	0.9	0.3
	with exotic grass or trees	29	0.5	0.2
	sub-total	93	1.8	0.4
Coastal grass and scrub	undifferentiated	30	0.6	0.2
Wetland and mangrove	wetland	60	1.1	0.3
	mangrove	87	1.6	0.3
	sub-total	147	2.8	0.4
Other	rural buildings	0	0.0	0.0
	urban areas	582	11.0	0.8
	water bodies	174	3.3	0.5
	unclassified points	27	0.5	0.2
	points with no photo cover	341	6.5	0.7
All region	total	5277	100.0	0.0

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: confidence limits are not additive.

Table 5.3 (2007)

Land use throughout the Auckland region, 2007

Land use	Composition	Points	Points as % of sample[1]	95% conf. lim.[2]
Intensive	vineyards incl. kiwifruit	26	0.5	0.2
	orchards incl. avocado	33	0.6	0.2
	market gardens	66	1.3	0.3
	grain crops	34	0.6	0.2
	greenfeed crops	12	0.2	0.1
	sub-total	171	3.2	0.5
Dairy	improved, hard-grazed	133	2.5	0.4
	improved, lax-grazed or spelled	448	8.5	0.8
	improved, harvested	10	0.2	0.1
	sub-total	591	11.2	0.9
Drystock	improved, hard-grazed	422	8.0	0.7
	improved, lax-grazed or spelled	1054	20.0	1.1
	improved, harvested	20	0.4	0.2
	unimproved	146	2.8	0.4
	sub-total	1642	31.1	1.2
Forest plantations	open-canopy pines	132	2.5	0.4
	maturing pines	304	5.8	0.6
	harvested pines	39	0.7	0.2
	broadleaved trees	4	0.1	0.1
	sub-total	479	9.1	0.8
Natural forest	closed canopy	147	2.8	0.4
	with natural scrub	167	3.2	0.5
	with exotic grass, scrub or trees	58	1.1	0.3
	with other, principally houses	11	0.2	0.1
	sub-total	383	7.3	0.7

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: confidence limits are not additive.

Cont. Table 5.3 (2007)

Land use throughout the Auckland region, 2007

Land use	Composition	Points	Points as % of sample[1]	95% conf. lim.[2]
Natural scrub	closed canopy	220	4.2	0.5
	with forest trees	287	5.4	0.6
	with exotic grass, scrub or trees	221	4.2	0.5
	with other, principally houses	30	0.6	0.2
	sub-total	758	14.4	0.9
Exotic scrub	closed canopy	12	0.2	0.1
	with natural scrub or forest trees	42	0.8	0.2
	with exotic grass or trees	60	1.1	0.3
	with other, principally houses	8	0.2	0.1
	sub-total	122	2.3	0.4
Coastal grass and scrub	undifferentiated	29	0.5	0.2
Wetland and mangrove	wetland	25	0.5	0.2
	mangrove	89	1.7	0.3
	sub-total	114	2.2	0.4
Other	rural buildings	162	3.1	0.5
	urban areas	578	11.0	0.8
	water bodies	199	3.8	0.5
	unclassified points	0	0.0	0.0
	points with no photo cover	49	0.9	0.3
All region	total	5277	100.0	0.0

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: confidence limits are not additive.

5.1 Intensive Uses

(Table 5.4 1999 compared with 5.4 2007)

The area under intensive uses - vineyards, orchards, market gardens, grain and fodder crops - declined slightly, from 3.7 to 3.2% of Auckland's land. The decline is split amongst points that have been urbanised, undergone rural building, or converted to pasture.

Bare soil due to land use disturbance increased was 0.55% of the region's area at both dates.

Most of the bare soil at both dates was due to:

- cultivation in market gardens or cropped fields, 0.53% in 1999 and 0.49% in 2007

and the balance classified as miscellaneous disturbances (harvest, spraying, drainage, tracks, earthworks).

No natural disturbance of soil was recorded on intensively used land in 1999. Slight disturbance was present in 2007, mainly streambank scour or deposition, but amounted to less than 0.01% of the region's area.

Comparisons for intensive uses are unaffected by inclusion of Great Barrier Island points in the 2007 re-survey.

Table 5.4 (1999)

Soil state and disturbance amongst intensive use in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		124	2.3	0.4	0.00	0.00
S (ii) with soil disturbed by land use	grazing pressure	1	<0.1	<0.1	<0.01	<0.01
	cultivation	36	0.7	0.2	0.47	0.16
	harvest					
	spraying					
	drains					
	tracks	2	0.0	0.1	0.01	0.01
	earthworks					
	roads					
	sub-total	39	0.7	0.2	0.47	0.16
STABLE SURFACES	total	163	3.1	0.5		
EROSION-PRONE SURFACES						
U (i) with intact soil		23	0.4	0.2	0.00	0.00
U (ii) with soil disturbed by land use	grazing pressure					
	cultivation	8	0.2	0.1	0.06	0.05
	harvest	1	<0.1	<0.1	0.02	0.04
	spraying	1	<0.1	<0.1	<0.01	<0.01
	drains					
	tracks					
	earthworks					
	roads					
	sub-total	10	0.2	0.1	0.08	0.06
EROSION-PRONE SURFACES	total	33	0.6	0.2		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.4 (1999)

Soil state and disturbance amongst intensive use in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		1	<0.1	<0.1	0.00	0.00
E (ii) with soil disturbed by natural processes	landslide					
	debris avalanche					
	slump or earthflow					
	tunnel gully					
	gully					
	streambank scour					
	streambank deposit					
	sandblow					
	sheetwash					
	rockfall or bare rock					
	sub-total	0	0.0	0.0	0.00	0.00
ERODED AND ERODING SURFACES	total	1	<0.1	<0.1		
All surfaces in land use	total	197	3.7	0.50	0.56	0.18

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Table 5.4 (2007)

Soil state and disturbance amongst intensive use in the Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		57	1.1	0.3		
S (ii) with soil disturbed by land use	grazing pressure	2	0.0	0.1	<0.01	<0.01
	cultivation	53	1.0	0.3	0.46	0.15
	harvest	3	0.1	0.1	0.01	0.02
	spraying	4	0.1	0.1	<0.01	0.01
	drains					
	tracks	16	0.3	0.1	0.02	0.01
	earthworks	2	<0.1	<0.1	<0.01	<0.01
	roads	3	0.1	0.1	<0.01	<0.01
	sub-total	83	1.6	0.3	0.51	0.50
STABLE SURFACES	total	140	2.7	0.4		
EROSION-PRONE SURFACES						
U (i) with intact soil		10	0.2	0.1		
U (ii) with soil disturbed by land use	grazing pressure					
	cultivation	7	0.1	0.1	0.03	0.02
	harvest	2	<0.1	<0.1	<0.01	<0.01
	spraying					
	drains	3	0.1	0.1	<0.01	<0.01
	tracks	4	0.1	0.1	0.01	0.01
	earthworks					
	roads	1	<0.1	<0.1	<0.01	<0.01
	sub-total	17	0.3	0.2	0.04	0.02
EROSION-PRONE SURFACES	total	27	0.5	0.2		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.4 (2007)

Soil state and disturbance amongst intensive use in the Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		1	<0.1	<0.1		
E (ii) with soil disturbed by natural processes	landslide	1	<0.1	<0.1	<0.01	<0.01
	debris avalanche					
	slump or earthflow					
	tunnel gully					
	gully					
	streambank scour	1	<0.1	<0.1	<0.01	<0.01
	streambank deposit	1	<0.1	<0.1	<0.01	<0.01
	sandblow					
	sheetwash					
	rockfall or bare rock					
	sub-total	3	0.1	0.1	<0.01	<0.01
ERODED AND ERODING SURFACES	total	4	0.1	0.1		
All surfaces in land use	total	171	3.2	0.5	0.55	0.15

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

5.2 Dairy Farms

(Table 5.5 1999 compared with 5.5 2007)

Dairy farms declined slightly, from 11.4% to 11.2% of Auckland's land. About half the decline was transfer of four points (0.1%) to the "rural buildings and yards" category in 2007.

An apparent increase in bare soil associated with land use disturbance on dairy farms - from 0.01% to 0.31% of the region's area - needs to be regarded with caution. Much of the increase is explained by inclusion of unsealed tracks (dairy races) in the 2007 re-survey. The 1999 survey just measured bare soil tracks.

Assuming most or all of the unsealed tracks were there in 1999, a more realistic comparison would be 0.19% (0.01% 1999 + 0.18% tracks 2007) compared with 0.31%. Given the 1999 and 2007 error margins, this comparison still indicates a significant increase in bare soil on dairy farms. The causes are:

- grazing pressure (not evident in 1999; 0.05% in 2007),
- cultivation (not evident in 1999; 0.02% in 2007),
- drainage and earthworks (<0.01% in 1999; 0.03% in 2007), and
- miscellaneous disturbances (<0.01% in 1999; 0.02% in 2007).

Natural disturbance of soil on dairy farms also increased from 0.02% of the region's area in 1999 to 0.03% in 2007, but the increase was statistically insignificant.

These comparisons are unaffected by inclusion of Great Barrier Island points in the 2007 re-survey.

Table 5.5 (1999)

Soil state and disturbance on dairy farms in the Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		344	6.5	0.7	0.00	0.00
S (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks					
	earthworks					
	roads					
	sub-total	0	0.0	0.0	0.00	0.00
STABLE SURFACES	total	344	6.5	0.7	0.00	0.00
EROSION-PRONE SURFACES						
U (i) with intact soil		223	4.2	0.5	0.00	0.00
U (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying	1	<0.1	<0.1	<0.01	0.01
	drains	2	<0.1	<0.1	<0.01	<0.01
	tracks	4	0.1	0.1	0.01	0.01
	earthworks					
	roads					
	sub-total	7	0.1	0.1	0.01	0.01
EROSION-PRONE SURFACES	total	230	4.4	0.6		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.5 (1999)

Soil state and disturbance on dairy farms in the Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		22	0.4	0.2	0.00	0.00
E (ii) with soil disturbed by natural processes	landslide					
	debris avalanche					
	slump or earthflow	1	<0.1	<0.1	<0.01	<0.01
	tunnel gully	2	<0.1	<0.1	<0.01	<0.01
	gully					
	streambank scour					
	streambank deposit	3	0.1	0.1	0.01	0.02
	sandblow	2	<0.1	<0.1	<0.01	<0.01
	sheetwash					
	rockfall or bare rock					
	sub-total	8	0.2	0.1	0.02	0.02
ERODED AND ERODING SURFACES	total	30	0.6	0.2		
All surfaces in land use	total	604	11.4	0.9	0.03	0.02

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Table 5.5 (2007)

Soil state and disturbance on dairy farms in the Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		173	3.3	0.5		
S (ii) with soil disturbed by land use	grazing pressure	31	0.6	0.2	0.02	0.01
	cultivation	5	0.1	0.1	0.02	0.03
	harvest	1	<0.1	<0.1	<0.01	<0.01
	spraying	3	0.1	0.1	<0.01	<0.01
	drains	11	0.2	0.1	0.01	0.01
	tracks	92	1.7	0.4	0.12	0.03
	earthworks	7	0.1	0.1	0.01	0.01
	roads	5	0.1	0.1	0.01	0.01
	sub-total	155	2.9	0.5	0.19	0.04
STABLE SURFACES	total	328	6.2	0.7		
EROSION-PRONE SURFACES						
U (i) with intact soil		98	1.9	0.4		
U (ii) with soil disturbed by land use	grazing pressure	26	0.5	0.2	0.03	0.02
	cultivation	2	<0.1	<0.1	<0.01	<0.01
	harvest					
	spraying	2	<0.1	<0.1	<0.01	<0.01
	drains	10	0.2	0.1	0.01	0.01
	tracks	47	0.9	0.3	0.06	0.02
	earthworks	1	<0.1	<0.1	<0.01	<0.01
	roads	3	0.1	0.1	<0.01	<0.01
	sub-total	91	1.7	0.4	0.12	0.04
EROSION-PRONE SURFACES	total	189	3.6	0.5		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.5 (2007)

Soil state and disturbance on dairy farms in the Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		36	0.7	0.2		
E (ii) with soil disturbed by natural processes	landslide	1	<0.1	<0.1	<0.01	<0.01
	debris avalanche					
	slump or earthflow	6	0.1	0.1	<0.01	<0.01
	tunnel gully	4	0.1	0.1	<0.01	<0.01
	gully	6	0.1	0.1	<0.01	<0.01
	streambank scour	7	0.1	0.1	<0.01	<0.01
	streambank deposit	14	0.3	0.1	0.02	0.01
	sandblow					
	sheetwash					
	rockfall or bare rock					
	sub-total	38	0.7	0.2	0.03	0.01
ERODED AND ERODING SURFACES	total	74	1.4	0.3		
All surfaces in land use	total	591	11.2	0.9	0.35	0.06

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

5.3 Drystock Farms

(Table 5.6 1999 compared with 5.6 2007)

The area classed as drystock farms declined from 32.7% to 31.1% of Auckland's land. This is due to transfer of 96 sample points with farm buildings etc. into the "rural buildings and yards" category. There has been no real change in extent of drystock farms.

Bare soil associated with land use disturbance on drystock farms shows an apparent increase, from 0.22% to 0.48% of the region's area. Although statistically significant, some caution must be exercised interpreting this increase, because part of it is due to inclusion of unsealed farm tracks in the 2007 re-survey. However such tracks are not widespread on drystock farms (where except for farm driveways, most tracks are bare earth). The increase is caused by bare soil associated with:

- farm tracks, up from 0.05% to 0.19%,
- grazing pressure, up from 0.06% to 0.08%
- cultivation of pasture, up from 0.01% to 0.07%
- drainage and earthworks, down from 0.11% to 0.08%
- miscellaneous disturbances, up from <0.01% to 0.06%

Even if all the unsealed tracks are regarded as present in 1999, the balance of increase due to other disturbances, at 0.12%, is still significant relative to error margins.

Natural disturbance of soil on drystock farms was similar at both dates: 0.20% of the region's area in 1999 compared with 0.19% in 2007.

These comparisons are just slightly affected by adding 21 drystock pasture points on Great Barrier Island (recorded in the 2007 re-survey) to the drystock total which is now 1642.

Table 5.6 (1999)

Soil state and disturbance on drystock farms in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		693	13.1	0.9	0.00	0.00
S (ii) with soil disturbed by land use	grazing pressure	9	0.2	0.1	0.02	0.01
	cultivation	1	<0.1	<0.1	<0.01	<0.01
	harvest	1	<0.1	<0.1	<0.01	<0.01
	spraying	2	<0.1	<0.1	0.01	0.02
	drains					
	tracks	11	0.2	0.1	0.03	0.02
	earthworks	8	0.2	0.1	0.04	0.04
	sub-total	32	0.6	0.2	0.09	0.05
STABLE SURFACES	total	725	13.7	0.9		
EROSION-PRONE SURFACES						
U (i) with intact soil		704	13.3	0.9	0.00	0.00
U (ii) with soil disturbed by land use	grazing pressure	18	0.3	0.2	0.04	0.02
	cultivation	4	0.1	0.1	0.01	0.01
	harvest					
	spraying					
	drains	4	0.1	0.1	0.01	0.01
	tracks	12	0.2	0.1	0.02	0.01
	earthworks	9	0.2	0.1	0.06	0.04
	sub-total	47	0.9	0.3	0.13	0.05
EROSION-PRONE SURFACES	total	751	14.2	0.9		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.6 (1999)

Soil state and disturbance on drystock farms in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		149	2.8	0.4	0.00	0.00
E (ii) with soil disturbed by natural processes	landslide	40	0.8	0.2	0.04	0.02
	debris avalanche	4	0.1	0.1	0.01	0.02
	slump or earthflow	16	0.3	0.1	0.03	0.02
	tunnel gully	3	0.1	0.1	<0.01	<0.01
	gully	19	0.4	0.2	0.02	0.01
	streambank scour	14	0.3	0.1	0.01	0.01
	streambank deposit	11	0.2	0.1	0.06	0.05
	sandblow	7	0.1	0.1	0.03	0.02
	sheetwash rockfall or bare rock	1	<0.1	<0.1	<0.01	<0.01
	sub-total	115	2.2	0.4	0.20	0.07
ERODED AND ERODING SURFACES	total	264	5.0	0.6		
All surfaces in land use	total	1740	33.0	1.3	0.42	0.10

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Table 5.6 (2007)

Soil state and disturbance on drystock farms in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		411	7.8	0.7		
S (ii) with soil disturbed by land use	grazing pressure	76	1.4	0.3	0.04	0.01
	cultivation	7	0.1	0.1	0.03	0.03
	harvest	2	<0.1	<0.1	<0.01	<0.01
	spraying	10	0.2	0.1	0.02	0.02
	drains	9	0.2	0.1	0.01	0.01
	tracks	106	2.0	0.4	0.10	0.02
	earthworks	33	0.6	0.2	0.04	0.02
	roads	15	0.3	0.1	0.02	0.01
	sub-total	258	4.9	0.6	0.27	0.05
STABLE SURFACES	total	669	12.7	0.9		
EROSION-PRONE SURFACES						
U (i) with intact soil		398	7.5	0.7		
U (ii) with soil disturbed by land use	grazing pressure	61	1.2	0.3	0.04	0.01
	cultivation	11	0.2	0.1	0.04	0.04
	harvest	2	<0.1	<0.1	<0.01	<0.01
	spraying	6	0.1	0.1	0.01	0.01
	drains	13	0.2	0.1	0.01	<0.01
	tracks	95	1.8	0.4	0.09	0.02
	earthworks	22	0.4	0.2	0.02	0.01
	roads	9	0.2	0.1	0.01	0.01
	sub-total	219	4.2	0.5	0.21	0.05
EROSION-PRONE SURFACES	total	617	11.7	0.9		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.6 (2007)

Soil state and disturbance on drystock farms in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		189	3.6	0.5		
E (ii) with soil disturbed by natural processes	landslide	50	0.9	0.3	0.03	0.01
	debris avalanche	4	0.1	0.1	0.01	0.01
	slump or earthflow	28	0.5	0.2	0.03	0.02
	tunnel gully	6	0.1	0.1	<0.01	<0.01
	gully	14	0.3	0.1	0.01	<0.01
	streambank scour	21	0.4	0.2	0.01	0.01
	streambank deposit	15	0.3	0.1	0.02	0.01
	sandblow	10	0.2	0.1	0.01	0.01
	sheetwash	5	0.1	0.1	0.01	0.02
	rockfall or bare rock	14	0.3	0.1	0.05	0.04
	sub-total	167	3.2	0.5	0.19	0.05
ERODED AND ERODING SURFACES	total	356	6.7	0.7		
All surfaces in land use	total	1642	31.1	1.2	0.67	0.08

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

5.4 Forest Plantations

(Table 5.7 1999 compared with 5.7 2007)

Forest plantations dropped slightly, from 9.4% to 9.1% of Auckland's land. The drop is statistically insignificant (margins of error are +-0.8% at both dates). However this is a real trend observed at 16 sample points which had either reverted to scrub or been converted to pasture following timber harvest.

Bare soil attributed to land use disturbance within forest plantations increased from 0.02% (1999) to 0.13% (2007) of the region's area. Part of the increase is due to inclusion of unsealed forest tracks and roads in the 2007 re-survey, boosting the track-and-road component from 0.01% to 0.06%. Additionally there is a significant increase (outside the error margins of 0.03% and 0.02%) in bare soil caused by:

- timber harvest, up from <0.01% to 0.07%.

Natural disturbance of soil in plantation forests also increased, from 0.02% to 0.04% of the region's area. Though the increase is statistically insignificant, it masks a real trend for landslides in plantation forest to decline (down from 22 to 17 sample points), and sandblows in plantation forests to increase (up from 0 to 4). Other types of natural disturbance e.g. debris avalanches, streambank scour and deposition, are present but minor (<0.01% of the region's area at both dates).

These comparisons are unaffected by the addition of Great Barrier Island points, only two of which are plantation forest.

Table 5.7 (1999)

Soil state and disturbance in forest plantations in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		95	1.8	0.4	0.00	0.00
S (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks	1	<0.1	<0.1	<0.01	<0.01
	earthworks					
	roads					
	sub-total	1	<0.1	<0.1	<0.01	<0.01
STABLE SURFACES	total	96	1.8	0.4		
EROSION-PRONE SURFACES						
U (i) with intact soil		340	6.4	0.7	0.00	0.00
U (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest	1	<0.1	<0.1	<0.1	0.1
	spraying					
	drains					
	tracks	4	0.1	0.1	0.01	0.01
	earthworks	1	0.0	0.0	0.02	0.03
	roads					
	sub-total	6	0.1	0.1	0.02	0.03
EROSION-PRONE SURFACES	total	346	6.5	0.7		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.7 (1999)

Soil state and disturbance in forest plantations in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		27	0.5	0.2		
E (ii) with soil disturbed by natural processes	landslide	22	0.4	0.2	0.02	0.01
	debris avalanche	4	0.1	0.1	<0.01	<0.01
	slump or earthflow					
	tunnel gully					
	gully					
	streambank scour	2	<0.1	<0.1	<0.01	<0.01
	streambank deposit					
	sandblow					
	sheetwash					
	rockfall or bare rock					
	sub-total	28	0.5	0.2	0.02	0.01
ERODED AND ERODING SURFACES	total	55	1.0	0.3		
All surfaces in land use	total	497	9.4	0.8	0.05	0.03

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Table 5.7 (2007)

Soil state and disturbance in forest plantations in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		59	1.1	0.3		
S (ii) with soil disturbed by land use	grazing pressure	1	<0.1	<0.1	<0.01	<0.01
	cultivation					
	harvest	11	0.2	0.1	0.02	0.02
	spraying					
	drains					
	tracks	8	0.2	0.1	0.01	<0.01
	earthworks					
	roads	8	0.2	0.1	0.01	0.01
	sub-total	28	0.5	0.2	0.04	0.02
STABLE SURFACES	total	87	1.6	0.3		
EROSION-PRONE SURFACES						
U (i) with intact soil		232	4.4	0.6		
U (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest	50	0.9	0.3	0.05	0.02
	spraying	1	<0.1	<0.1	<0.01	<0.01
	drains					
	tracks	29	0.5	0.2	0.03	0.01
	earthworks	1	<0.1	<0.1	<0.01	<0.01
	roads	4	0.1	0.1	0.01	0.01
	sub-total	85	1.6	0.3	0.09	0.02
EROSION-PRONE SURFACES	total	317	6.0	0.6		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.7 (2007)

Soil state and disturbance in forest plantations in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		42	0.8	0.2		
E (ii) with soil disturbed by natural processes	landslide	17	0.3	0.2	0.01	0.01
	debris avalanche	6	0.1	0.1	<0.01	<0.01
	slump or earthflow					
	tunnel gully					
	gully					
	streambank scour	4	0.1	0.1	<0.01	<0.01
	streambank deposit	2	<0.1	<0.1	<0.01	<0.01
	sandblow	4	0.1	0.1	0.02	0.03
	sheetwash rockfall or bare rock					
	sub-total	33	0.6	0.2	0.04	0.03
ERODED AND ERODING SURFACES	total	75	1.4	0.3		
All surfaces in land use	total	479	9.1	0.8	0.17	0.04

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

5.5 Natural Forest

(Table 5.8 1999 compared with 5.8 2007)

Points classed as natural forest are up from 5.7% of Auckland's land to 7.3%. The increase is almost entirely due to inclusion of 77 forested points (1.4%) on Great Barrier and Little Barrier Islands. The balance of increase appears to be a net change of 10 in the balance between sample points classed as forest compared with scrub. This could indicate emergence of successional forest through scrub canopy; or might merely be a change in observer perception.

Bare soil attributed to land use disturbance within natural forest has increased from <0.01% of the region's area in 1999, to 0.01% in 2007. The change, which is statistically insignificant, has been caused by measurement of:

- unsealed tracks and roads passing through forest, cumulatively 0.01%,
- plus a small area of earthworks (house sites) <0.01%

so is due to inclusion of tracks and roads in 2007 re-survey and is not a genuine increase in bare soil. Most of the track and road points are on Great Barrier, though a few are in the Waitakere and Hunua Ranges.

Bare soil due to natural disturbance has increased, from <0.01% in 1999 to 0.03% in 2007. The increase is statistically insignificant (within error margins). It is entirely caused by:

- streambank scour and deposits within bushed areas, up from 0% to 0.03%.

These were observed at 11 sample points mainly in the Hunua Ranges.

Natural disturbance of forested areas by landslides and debris avalanches has decreased (down from 7 to 4 sample points), but the decrease is insignificant as regards error margins for point numbers, and has produced no net change in area of bare soil (<0.01% at both dates).

Table 5.8 (1999)

Soil state and disturbance in natural forest in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		63	1.2	0.3	0.00	0.00
S (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks					
	earthworks					
	roads					
	sub-total	0	0.0	0.0	0.00	0.00
STABLE SURFACES	total	63	1.2	0.3		
EROSION-PRONE SURFACES						
U (i) with intact soil		206	3.9	0.5	0.00	0.00
U (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks	1	<0.1	<0.1	<0.01	<0.01
	earthworks					
	roads					
	sub-total	1	<0.1	<0.1	<0.01	<0.01
EROSION-PRONE SURFACES	total	207	3.9	0.5		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.8 (1999)

Soil state and disturbance in natural forest in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		22	0.4	0.2	0.00	0.00
E (ii) with soil disturbed by natural processes	landslide	5	0.1	0.1	<0.01	<0.01
	debris avalanche	2	<0.1	<0.1	<0.01	<0.01
	slump or earthflow					
	tunnel gully					
	gully					
	streambank scour					
	streambank deposit					
	sandblow					
	sheetwash					
	rockfall or bare rock					
	sub-total	7	0.1	0.1	<0.01	<0.01
ERODED AND ERODING SURFACES	total	29	0.5	0.2		
All surfaces in land use	total	299	5.7	0.6	<0.01	<0.01

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Table 5.8 (2007)

Soil state and disturbance in natural forest in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		89	1.7	0.3		
S (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks	3	0.1	0.1	<0.01	<0.01
	earthworks					
	roads	3	0.1	0.1	<0.01	<0.01
	sub-total	6	0.1	0.1	<0.01	<0.01
STABLE SURFACES	total	95	1.8	0.4		
EROSION-PRONE SURFACES						
U (i) with intact soil		221	4.2	0.5		
U (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks	4	0.1	0.1	<0.01	<0.01
	earthworks	1	<0.1	<0.1	<0.01	<0.01
	roads	1	<0.1	<0.1	<0.01	<0.01
	sub-total	6	0.1	0.1	0.01	<0.01
EROSION-PRONE SURFACES	total	227	4.3	0.5		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.8 (2007)

Soil state and disturbance in natural forest in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		43	0.8	0.2		
E (ii) with soil disturbed by natural processes	landslide	2	<0.1	<0.1	<0.01	<0.01
	debris avalanche	2	<0.1	<0.1	<0.01	<0.01
	slump or earthflow					
	tunnel gully					
	gully					
	streambank scour	3	0.1	0.1	<0.01	<0.01
	streambank deposit	8	0.2	0.1	0.03	0.03
	sandblow					
	sheetwash					
	rockfall or bare rock	3	0.1	0.1	<0.01	<0.01
	sub-total	18	0.3	0.2	0.03	0.03
ERODED AND ERODING SURFACES	total	61	1.2	0.3		
All surfaces in land use	total	383	7.3	0.7	0.04	0.03

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

5.6 Natural Scrub

(Table 5.9 1999 compared with 5.9 2007)

Points classed as natural scrub have increased from 10.3% to 14.4% of Auckland's land. 3.5% of the increase is due to inclusion of 186 scrubland points on Great Barrier Island. The balance of 0.6% is mostly genuine increase in area of natural scrub reversion on Auckland's mainland, (recorded at 26 sample points), plus 4 sample points on scrub remnants in the urban-rural fringe (these points were within the metropolitan

growth area defined by ARC's Regional Policy Statement, so were excluded from survey in 1999).

Bare soil associated with land use disturbance in natural scrub has increased from 0.02% of the region's area to 0.09%. The increase is due to measurement of tracks and roads in 2007:

- tracks, up from <0.01% to 0.04%, and
- roads, not measured in 2000, now 0.03%,

A little of this is new tracking in scrub on the mainland, but the bulk is attributed to addition of Great Barrier points, plus extant tracks and roads at sample points in the Waitakere and Hunua ranges:

- earthworks (mainly house sites) in scrub remain the same at 0.02%
- scrub clearance by harvest or spraying is up from 0% to <0.01%,

but these changes are statistically insignificant.

Soil bared by natural disturbance is up from 0.10% to 0.20%, but the change is an artefact of altered survey procedure. During 1999 survey, bare rock outcrops were recorded but not measured. Consistent with current NLMF procedure, their area was measured and included with bare soil in the 2007 re-survey. This boosted the total by 0.14%.

If bare rock outcrops are regarded as present but unmeasured in 1999, net change in natural disturbance is downwards, from 0.24% (0.10% +0.14%) to 0.20% of the region's area. However this decline of 0.04% is statistically insignificant (within error margins at both dates).

It does however appear to be a real change; partly a reduction in slope failures (landslides, debris avalanches, slumps), and partly a reduction in streambank scour and deposition. Given that Great Barrier points have added an extra 0.03% bare soil to these categories in 2007, declines in slope failure and streambank disturbance in mainland scrub are likely to be 0.07% of regional area. Bare soil attributable to sandblow remains unchanged at 0.01%, while there is a measureable increase in sheetwash to 0.01%; the latter due to addition of Great Barrier points.

Table 5.9 (1999)

Soil state and disturbance in natural scrub in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		158	3.0	0.5	0.00	0.00
S (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks	2	<0.1	<0.1	<0.01	<0.01
	earthworks	2	<0.1	<0.1	0.01	0.02
	roads					
	sub-total	4	0.1	0.1	0.01	0.02
STABLE SURFACES	total	162	3.1	0.5		
EROSION-PRONE SURFACES						
U (i) with intact soil		312	5.9	0.6	0.00	0.00
U (ii) with soil disturbed by land use	grazing pressure	1	<0.1	<0.1	<0.01	<0.01
	cultivation					
	harvest					
	spraying					
	drains					
	tracks	2	<0.1	<0.1	<0.01	<0.01
	earthworks	1	0.0	0.0	0.01	0.01
	roads					
	sub-total	4	0.1	0.1	0.01	0.02
EROSION-PRONE SURFACES	total	316	6.0	0.6		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.9 (1999)

Soil state and disturbance in natural scrub in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		33	0.6	0.2	0.00	0.00
E (ii) with soil disturbed by natural processes	landslide	14	0.3	0.1	0.08	0.05
	debris avalanche	3	0.1	0.1	<0.01	<0.01
	slump or earthflow					
	tunnel gully					
	gully					
	streambank scour	3	0.1	0.1	<0.01	<0.01
	streambank deposit	1	<0.1	<0.1	<0.01	<0.01
	sandblow	1	<0.1	<0.1	0.01	0.03
	sheetwash					
	rockfall or bare rock	14	0.3	0.1		
	sub-total	36	0.7	0.2	0.10	0.06
ERODED AND ERODING SURFACES	total	69	1.3	0.3		
All surfaces in land use	total	547	10.4	0.8	0.12	0.07

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Table 5.9 (2007)

Soil state and disturbance in natural scrub in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		199	3.8	0.5		
S (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest	1	<0.1	<0.1	<0.01	<0.01
	spraying					
	drains					
	tracks	18	0.3	0.2	0.02	0.01
	earthworks	6	0.1	0.1	0.01	0.01
	roads	7	0.1	0.1	0.01	0.01
	sub-total	32	0.6	0.2	0.04	0.01
STABLE SURFACES	total	231	4.4	0.6		
EROSION-PRONE SURFACES						
U (i) with intact soil		335	6.3	0.7		
U (ii) with soil disturbed by land use	grazing pressure	3	01	01	<0.01	<0.01
	cultivation					
	harvest	1	0.0	0.0	<0.01	<0.01
	spraying	1	0.0	0.0	<0.01	<0.01
	drains					
	tracks	20	0.4	0.2	0.02	0.01
	earthworks	5	0.1	0.1	0.01	0.01
	roads	12	0.2	0.1	0.02	0.01
	sub-total	42	0.8	0.2	0.05	0.02
EROSION-PRONE SURFACES	total	377	7.1	0.7		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.9 (2007)

Soil state and disturbance in natural scrub in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		69	1.3	0.3		
E (ii) with soil disturbed by natural processes	landslide	21	0.4	0.2	0.03	0.03
	debris avalanche	2	<0.1	<0.1	<0.01	<0.01
	slump or earthflow					
	tunnel gully					
	gully					
	streambank scour	8	0.2	0.1	0.01	<0.01
	streambank deposit	5	0.1	0.1	<0.01	<0.01
	sandblow	3	0.1	0.1	0.01	0.01
	sheetwash	5	0.1	0.1	0.01	0.01
	rockfall or bare rock	37	0.7	0.2	0.14	0.06
	sub-total	81	1.5	0.3	0.20	0.05
ERODED AND ERODING SURFACES	total	150	2.8	0.4		
All surfaces in land use	total	758	14.4	0.9	0.28	0.07

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

5.7 Exotic Scrub

(Table 5.10 1999 compared with 5.10 2007)

Points classed as exotic scrub increased from 1.8% of Auckland's area to 2.3%. The increase is entirely attributable to addition of 27 sample points in exotic scrub on Great Barrier Island.

Bare soil associated with land use disturbance in exotic scrub is up, from 0.01% to 0.03% of the region's area. The increase appears real i.e. is not an artefact of

including the Great Barrier Island points (where land use-related disturbance is <0.01%). The causes are:

- scrub clearance by harvest or spraying, up from 0 to 0.01%,
- tracks through scrub, up from <0.01% to 0.01%, and

mostly at mainland points. Although small, this change is statistically significant relative to error margins at both dates.

Earthworks in exotic scrub (house sites) appear to have declined slightly from 0.01% to <0.01% but the change is insignificant; as is the appearance of grazing pressure (<0.01%) in 2007.

Bare soil attributed to natural disturbance is down slightly, from 0.02% to 0.01% of the region's area. It is due to a decline in landslides from 0.02% to <0.01% (entirely in exotic scrub on the mainland), slightly off-set by a rise in sheetwash from 0% to <0.01% (new measurements on Great Barrier Island). However the changes are statistically insignificant.

Table 5.10 (1999)

Soil state and disturbance in exotic scrub in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		29	0.5	0.2	0.00	0.00
S (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks					
	earthworks					
	roads					
	sub-total	0	0.0	0.0	0.00	0.00
STABLE SURFACES	total	29	0.5	0.2		
EROSION-PRONE SURFACES						
U (i) with intact soil		48	0.9	0.3	0.00	0.00
U (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks	2	<0.1	<0.1	<0.01	<0.01
	earthworks	1	0.0	0.0	0.01	0.01
	roads					
	sub-total	3	<0.1	<0.1	0.01	0.01
EROSION-PRONE SURFACES	total	51	1.0	0.3		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.10 (1999)

Soil state and disturbance in exotic scrub in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		8	0.2	0.1	0.00	0.00
E (ii) with soil disturbed by natural processes	landslide	3	0.1	0.1	0.02	0.03
	debris avalanche					
	slump or earthflow					
	tunnel gully					
	gully	1	<0.1	<0.1	<0.01	<0.01
	streambank scour	1	<0.1	<0.1	<0.01	<0.01
	streambank deposit					
	sandblow					
	sheetwash					
	rockfall or bare rock					
	sub-total	5	0.1	0.1	0.02	0.03
ERODED AND ERODING SURFACES	total	13	0.2	0.1		
All surfaces in land use	total	93	1.8	0.4	0.03	0.03

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Table 5.10 (2007)

Soil state and disturbance in exotic scrub in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		29	0.5	0.2		
S (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying	2	<0.1	<0.1	<0.01	<0.01
	drains					
	tracks	2	<0.1	<0.1	<0.01	<0.01
	earthworks	2	<0.1	<0.1	<0.01	<0.01
	roads					
	sub-total	6	0.1	0.1	0.01	0.01
STABLE SURFACES	total	37	0.7	0.2		
EROSION-PRONE SURFACES						
U (i) with intact soil		42	0.8	0.2		
U (ii) with soil disturbed by land use	grazing pressure	2	<0.1	<0.1	<0.01	<0.01
	cultivation					
	harvest	5	0.1	0.1	0.01	0.01
	spraying	1	<0.1	<0.1	<0.01	<0.01
	drains					
	tracks	7	0.1	0.1	0.01	<0.01
	earthworks	1	<0.1	<0.1	<0.01	<0.01
	roads					
	sub-total	16	0.3	0.1	0.02	0.01
EROSION-PRONE SURFACES	total	58	1.1	0.3		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.10 (2007)

Soil state and disturbance in exotic scrub in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		20	0.4	0.2		
E (ii) with soil disturbed by natural processes	landslide	1	<0.1	<0.1	<0.01	<0.01
	debris avalanche					
	slump or earthflow	1	<0.1	<0.1	<0.01	<0.01
	tunnel gully					
	gully	1	<0.1	<0.1	<0.01	<0.01
	streambank scour					
	streambank deposit	1	<0.1	<0.1	<0.01	<0.01
	sandblow					
	sheetwash	5	0.1	0.1	<0.01	<0.01
	rockfall or bare rock					
	sub-total	9	0.2	0.1	0.01	0.01
ERODED AND ERODING SURFACES	total	29	0.5	0.2		
All surfaces in land use	total	122	2.3	0.4	0.03	0.01

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

5.8 Coastal Grass and Scrub

(Table 5.11 1999 compared with 5.11 2007)

There has been little change in the area of coastal grass and scrub, from 0.6% to 0.5% of Auckland's land. This change is within the error margins for sample points at both dates.

Bare soil due to land use disturbance has not been recorded amongst coastal grass and scrub at either date. It is likely to have occurred, but in Auckland's exposed

coastal environment, any land use-induced vegetation breach is rapidly converted into a mobile - and often large - sandblow.

Bare soil or sand attributed to natural disturbance is up slightly, from 0.24% to 0.28% of the region's area. It is classed entirely as natural disturbance by sandblow at both dates. The increase is statistically insignificant (error margins for sandblows are rather large because of their variable size). However it reflects a genuine increase in sample points where sandblow is recorded, from 18 to 23.

The comparison is unaffected by Great Barrier Island points. Just one is on a sandblow amongst coastal vegetation, and its addition is outweighed by disappearance of two mainland points where young pines have been planted into marram.

Table 5.11 (1999)

Soil state and disturbance in coastal grass and scrub in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		1	<0.1	<0.1	0.00	0.00
S (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks					
	earthworks					
	roads					
	sub-total	0	0.0	0.0	0.00	0.00
STABLE SURFACES	total	1	<0.1	<0.1		
EROSION-PRONE SURFACES						
U (i) with intact soil		10	0.2	0.1	0.00	0.00
U (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks					
	earthworks					
	roads					
	sub-total	0	0.0	0.0	0.00	0.00
EROSION-PRONE SURFACES	total	10	0.2	0.1		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.11 (1999)

Soil state and disturbance in coastal grass and scrub in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		1	<0.1	<0.1	0.00	0.00
E (ii) with soil disturbed by natural processes	landslide					
	debris avalanche					
	slump or earthflow					
	tunnel gully					
	gully					
	streambank scour					
	streambank deposit					
	sandblow	18	0.3	0.2	0.24	0.12
	sheetwash					
	rockfall or bare rock					
	sub-total	18	0.3	0.2	0.24	0.12
ERODED AND ERODING SURFACES	total	19	0.4	0.2		
All surfaces in land use	total	30	0.6	0.2	0.24	0.12

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Table 5.11 (2007)

Soil state and disturbance in coastal grass and scrub in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		0	0.0	0.0		
S (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks					
	earthworks					
	roads					
	sub-total	0	0.0	0.0	0.00	0.00
STABLE SURFACES	total	0	0.0	0.0		
EROSION-PRONE SURFACES						
U (i) with intact soil		5	0.1	0.1		
U (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks					
	earthworks					
	roads					
	sub-total	0	0.0	0.0	0.00	0.00
EROSION-PRONE SURFACES	total	5	0.1	0.1		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.11 (2007)

Soil state and disturbance in coastal grass and scrub in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		1	<0.1	<0.1		
E (ii) with soil disturbed by natural processes	landslide					
	debris avalanche					
	slump or earthflow					
	tunnel gully					
	gully					
	streambank scour					
	streambank deposit					
	sandblow	23	0.4	0.2	0.28	0.13
	sheetwash					
	rockfall or bare rock					
	sub-total	23	0.4	0.2	0.28	0.13
ERODED AND ERODING SURFACES	total	24	0.4	0.2		
All surfaces in land use	total	29	0.5	0.2	0.28	0.13

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

5.9 Wetlands and Mangrove Swamps

(Table 5.12 1999 compared with 5.12 2007)

Wetlands and mangrove swamps have declined from 2.8% to 2.2% of Auckland's land between 1999 and 2007. Although error margins for points overlap, this is a genuine decline mainly caused by ongoing conversion of partly drained, sparse wetland into pasture. This has occurred at 27 out of 35 lost wetland points.

Bare soil associated with land use disturbance amongst wetlands and mangrove swamps is the same at both dates. Though there is no net change, disturbance types have slightly altered:

- drain excavation down from 0.01% to 0, and
- tracks and grazing pressure, collectively up from 0 to 0.01%.

Although the change in bare soil is statistically insignificant, it reflects a genuine increase in disturbance, recorded at 7 points in 2007 compared with 1 in 1999.

Bare soil attributed to natural disturbance is up, from 0.01% of the region's area in 1999, to 0.07% in 2007. This increase is on the edge of error margins, so may be a significant change. It is entirely due to:

- streambank deposits through wetlands, plus tidal creek/estuarine deposits through mangroves.

The comparison is almost unaffected by Great Barrier points (which add an extra 3 wetland and 2 mangrove points to the total. Minor stream deposition was detected at one wetland point.

Table 5.12 (1999)

Soil state and disturbance in wetlands and mangrove swamps in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		5	0.1	0.1	0.00	0.00
S (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks					
	earthworks					
	roads					
	sub-total	0	0.0	0.0	0.00	0.00
STABLE SURFACES	total	5	0.1	0.1		
EROSION-PRONE SURFACES						
U (i) with intact soil		127	2.4	0.4		
U (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains	1	<0.1	<0.1	0.01	0.01
	tracks					
	earthworks					
	roads					
	sub-total	1	<0.1	<0.1	0.01	0.01
EROSION-PRONE SURFACES	total	128	2.4	0.4		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.12 (1999)

Soil state and disturbance in wetlands and mangrove swamps in Auckland region, 1999

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		13	0.2	0.1	0.00	0.00
E (ii) with soil disturbed by natural processes	landslide					
	debris avalanche					
	slump or earthflow					
	tunnel gully					
	gully					
	streambank scour					
	streambank deposit	1	<0.1	<0.1	0.01	0.02
	sandblow					
	sheetwash					
	rockfall or bare rock					
	sub-total	1	<0.1	<0.1	0.01	0.02
ERODED AND ERODING SURFACES	total	14	0.3	0.1		
All surfaces in land use	total	174	2.8	0.4	0.02	0.02

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Table 5.12 (2007)

Soil state and disturbance in wetlands and mangrove swamps in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
STABLE SURFACES						
S (i) with intact soil		0	0.0	0.0		
S (ii) with soil disturbed by land use	grazing pressure					
	cultivation					
	harvest					
	spraying					
	drains					
	tracks					
	earthworks					
	roads					
	sub-total	0	0.0	0.0	0.00	0.00
STABLE SURFACES	total	0	0.0	0.0		
EROSION-PRONE SURFACES						
U (i) with intact soil		63	1.2	0.3		
U (ii) with soil disturbed by land use	grazing pressure	4	0.1	0.1	<0.01	<0.01
	cultivation					
	harvest					
	spraying					
	drains					
	tracks	3	0.1	0.1	<0.01	<0.01
	earthworks					
	roads					
	sub-total	7	0.1	0.1	0.01	0.01
EROSION-PRONE SURFACES	total	70	1.3	0.4		

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

Cont. Table 5.12 (2007)

Soil state and disturbance in wetlands and mangrove swamps in Auckland region, 2007

		points	points as % of sample[1]	95% conf. lim.[3]	bare soil as % of area[2]	95% conf. lim.[3]
ERODED AND ERODING SURFACES						
R (i) with revegetating soil		23	0.4	0.2		
E (ii) with soil disturbed by natural processes	landslide					
	debris avalanche					
	slump or earthflow					
	tunnel gully					
	gully					
	streambank scour	5	0.1	0.1	<0.01	<0.01
	streambank deposit	16	0.3	0.1	0.07	0.05
	sandblow					
	sheetwash					
	rockfall or bare rock					
	sub-total	21	0.4	0.2	0.07	0.05
ERODED AND ERODING SURFACES	total	44	0.8	0.4		
All surfaces in land use	total	114	2.2	0.4	0.07	0.05

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.
Note 3: confidence limits are not additive.

6 Summary

6.1 Changes in Land Use region-wide

The net decline in land under rural use has been 1.3% (from 82.6% to 81.3%).

The net increase in land under other uses (farm buildings, urban areas, water bodies and coastal features and water bodies) has been 0.9% (from 16.9% to 17.8% of the region)

The balance of change has been an increase of 0.4 % in un-classifiable land (from 0.5% to 0.9%) where aerial photos are obscured by cloud cover or deep shadow.

Changes in area for individual land uses are summarised later in Chapter 6.

6.2 Changes in Soil State

Stable surfaces have declined slightly from 27.4% to 27.2% of the land in rural use (mainland Auckland and inner Gulf Islands). The change is due to natural disturbance at points re-classed as eroded or eroding surfaces in 2007 and is statistically insignificant.

Erosion-prone (but inactive) surfaces have declined from 37.6% to 33.8% of land in rural use. The change is due to natural disturbance at 205 sample points which have been re-classified as eroded or eroding surfaces in 2007; and is statistically significant.

There has been a corresponding increase in eroded and eroding surfaces up from 9.1% to 13.2% of land in rural use. Of the 4.1% increase, 1.9% was land revegetating at date of survey and 2.2% land with measureable areas of bare soil.

6.3 Changes in Soil State on Land in Other Use, Mainland Auckland

There appears to have been little change in extensively disturbed surfaces, recorded as 18.6% of sample points at both dates. However because this category was defined as including a large number of urban points and shoreline points (measured in 2007 but not 1999) the percentage masks:

- A small number of "rural buildings" points where construction post dates 1999
- 44 urban points within urban limits that remain in rural use as of 2007.

6.4 Changes in Soil Disturbance on Land in Rural Use, Mainland Auckland

The pattern of change which emerges from comparison of points measured at both dates (Table 5.2) is, firstly a genuine increase in land use-related disturbance of Auckland's soil in rural areas. It has risen from 0.72% of the region's area in 1999, to 1.07% in 2007.

This increase (0.35%) accounts for somewhat less than half of the change in soil state (from intact to disturbed) on stable and erosion-prone surfaces (Table 5.2).

Secondly, altered survey technique (inclusion of unsealed tracks and roads) has measured an extra 0.47% of the region where soil though not bare is disturbed and devegetated. It is not a change between survey dates, but a new measurement of something not detected by the 1999 survey.

This new measurement accounts for the balance of change in soil state on stable and erosion-prone surfaces (Table 5.2).

Natural disturbance has been ongoing between 1999 and 2007, with fresh exposure of bare soil but also rapid revegetation. Consequently bare soil induced by natural disturbance remains 0.55% of the region's area at both dates.

The apparent increase for 2007 is due to altered survey technique (inclusion of rock outcrops), adding an extra 0.15% of the region where soil is absent or incipient.

This pattern is confirmed by changes in soil state for eroded and eroding surfaces (Table 5.2) i.e. a considerable increase in number of points where natural disturbance is recorded. However there has been no net change in area of bare soil, because bare (Eii) points are counterbalanced by revegetating (Ri) points.

6.5 Changes in Soil Disturbance on Land in Other Use, Mainland Auckland

Land in other use encompasses rural buildings; urban areas including urban open space and water bodies and coastal features. This category corresponds with extensively disturbed surfaces (Table 5.2).

Soil disturbance amounting to 0.17% of the region's area was measured at 220 out of 983 sample points in other use at 1999. However the difference between this figure and the 2007 figure cannot be regarded as a genuine change, because ARC did not request measurement of 3 urban or coastal 821 sample points in 1999 (though partial measurement was carried out at few such points).

In 2007, other uses collectively account for a large chunk of soil disturbance in the Auckland region - an additional 0.92% of the region's area - on top of the 2.38% (2.23% mainland + 0.15% Great Barrier/Little Barrier) on rural land. This is something that did not emerge from the 1999 survey, due to its focus on rural land, but is now apparent from extending re-survey to all land in the region. Of the additional 0.92%:

- 0.31% of the region's area is bare soil due to land use disturbance amongst rural buildings and yards.

- 0.28% is due to disturbance (mainly by land use; also a small natural component) in urban areas including urban open space, and areas within urban limits that are still in rural use for the time being.
- Finally, 0.33% of the region's area is bare soil, sediment or rock due to natural disturbance of land along water bodies and coastal features.

6.6 Change under Intensive Land Uses

There has been no change in bare soil due to land use disturbance, 0.55% of the region's area, in 1999 and 2007.

No natural disturbance was measured in 1999 and less than 0.01% of regional area in 2007.

Intensive uses - vineyards, orchards, market gardens, grain and fodder crops - declined slightly, from 3.7 to 3.2% of Auckland's land. The decline is split amongst points that have been urbanised, undergone rural building, or converted to pasture.

6.7 Change on Dairy Farms

There has been a significant increase in bare soil due to land use disturbance, from 0.19% to 0.31% of the region's area, between 1999 and 2007.

Both figures include unsealed tracks and roads passing through dairy farms, 0.18% of the region's area, measured for the first time in 2007.

Bare soil due to natural disturbance has increased from 0.02% to 0.03% of the region's area, but the increase is insignificant.

Dairy farms declined slightly, from 11.4% to 11.2% of Auckland's land. Half the decline was transfer of four points (0.1%) to the rural buildings category in 2007.

6.8 Change on Drystock Farms

There has been a significant increase in bare soil due to land use disturbance, from 0.36% to 0.48% of the region's area, between 1999 and 2007.

Both figures include unsealed tracks and roads passing through drystock farms, 0.17% of the region's area, measured for the first time in 2007.

Bare soil due to natural disturbance has decreased from 0.20% to 0.19% of the region's area, but the decrease is insignificant.

Drystock farms declined from 32.7% to 31.1% of Auckland's land. This is due to transfer of 96 sample points with farm buildings etc. into the rural buildings category (see 6.15). Otherwise there has been no real change in extent of drystock farms.

6.9 Change in Forest Plantations

There has been a significant increase in bare soil due to land use disturbance, from 0.06% to 0.13% of the region's area, between 1999 and 2007.

Both figures include unsealed tracks and roads passing through forest plantations, 0.05% of the region's area, measured for the first time in 2007.

Bare soil due to natural disturbance has increased slightly from 0.02% to 0.04% of the region's area. Though the increase is insignificant, it masks a real change in pattern of disturbance. Slope failures in plantation forests have declined, while sandblows have expanded.

Forest plantations dropped slightly, from 9.4% to 9.1% of Auckland's land. The drop is statistically insignificant (margins of error are +-0.8% at both dates).

6.10 Change in Natural Forest

There has been a slight and insignificant increase in bare soil due to land use disturbance, from <0.01% to 0.01% of the region's area, between 1999 and 2007.

It is due to first-time measurement of unsealed tracks and roads passing through natural forest. Many of these are on Great Barrier Island, included in the point sample for the first time in 2007.

Bare soil due to natural disturbance has increased slightly from <0.01% to 0.03% of the region's area. It is somewhat affected by inclusion of forested points on Great Barrier and Little Barrier, a few of which have fresh natural disturbance (0.02%); more due to deposition than mass movement. The balance of increase, while insignificant, is also due to streambank scour and deposits at mainland points particularly in the Hunua Ranges.

Points classed as natural forest are up from 5.7% of Auckland's land to 7.3%. The increase is almost entirely due to inclusion of 77 forested points (1.4%) on Great Barrier and Little Barrier Islands (land use on these islands could not be measured for 1999, as no aerial photo cover was taken).

6.11 Change in Natural Scrub

There has been a slight apparently significant increase in bare soil due to land use disturbance, from 0.02% to 0.09% of the region's area, between 1999 and 2007.

However the increase is entirely due to 0.07% disturbance by unsealed tracks and roads, measured for the first time in 2007; including many on Great Barrier.

Bare soil due to natural disturbance has decreased, from 0.24%% to 0.20% of the region's area. Both figures include 0.14% bare rock outcrops, measured for the first time in 2007.

The net decrease in other types of natural disturbance, while insignificant, masks real changes in pattern of disturbance within scrub. Slope failures and streambank scour/deposit have both declined in scrub on the mainland, to an extent that is not offset by inclusion of natural disturbance in scrub on Great Barrier (0.03%) or Little Barrier (0.01%).

Points classed as natural scrub have increased from 10.3% to 14.4% of Auckland's land. 3.5% of the increase is due to inclusion of 186 scrubland points on Great Barrier and Little Barrier Islands. The balance of 0.6% is mostly genuine increase in area of natural scrub reversion on Auckland's mainland.

6.12 Change in Exotic Scrub

There has been a significant increase in land use disturbance between 1999 and 2007, up from <0.01% to 0.03% of the region's area.

The increase is just slightly affected by recording unsealed tracks and roads (0.01%) for the first time, and is unaffected by including Great Barrier Island points (where added land use disturbance is <0.01%).

Bare soil due to natural disturbance has decreased from 0.02% to 0.01% of the region's area. While insignificant, this is a real decline in slope failure amongst exotic scrub on the mainland between 1999 and 2007, and is not offset by inclusion of natural disturbance on Great Barrier (<0.01%).

Points classed as exotic scrub increased from 1.8% of Auckland's area to 2.3%. The increase is entirely attributable to addition of 27 sample points in exotic scrub on Great Barrier Island.

6.13 Change amongst Coastal Grass and Scrub

No land use disturbance has been recorded at either date. Although it occurs e.g. from grazing pressure, it swiftly transforms into moving sandblows which are recorded as natural disturbance.

Natural disturbance has increased bare soil and sand from 0.24% of the region's area in 1999 to 0.28% in 2007. The increase, while statistically insignificant, results from recording sandblows at an increased number of sample points, so it appears to be a genuine change.

There has been little change in the area of coastal grass and scrub, from 0.6% to 0.5% of Auckland's land. This change is within the error margins for both dates.

6.14 Change amongst Wetland and Mangroves

There is no change in bare soil due to land use disturbance, measured as 0.01% of the region's area at both dates.

Bare soil or sediment due to natural disturbance has increased significantly, from 0.01% in 1999 to 0.07% in 2007. It takes the form of streambank deposits through wetlands, siltation along tidal creek banks, and exposed sandflats or mudflats in the midst of sparse mangroves.

Wetlands and mangrove swamps have declined from 2.8% to 2.2% of Auckland's land between 1999 and 2007. Although within the error margins this is a genuine decline, caused mainly by ongoing conversion of partly drained, sparse wetland into pasture (27 out of 35 lost wetland points).

6.15 Change on Land associated with Rural Buildings

3.1% of Auckland's land, under various rural uses in 1999, has been re-classed as rural buildings in 2007. This figure includes land in immediate vicinity of the buildings and associated with their use i.e. yards, tracks, gardens and shelter plantings.

Bare soil attributed to land use disturbance at these sites has increased, from 0.17% to 0.31% of the region's area.

Both figures include unsealed tracks and yards associated with rural buildings, 0.05% of the region's area, measured for the first time in 2007.

Bare soil due to natural disturbance of land associated with rural buildings was less than 0.01% of the region's area at both dates.

6.16 Change on Land in Urban Areas

10.0% of Auckland's land was under urban use in 1999 (including 2.4% that was urban open space). The percentage increased to 11.0% in 2007 (including 2.9% urban open space).

Land use disturbance was not recorded on urban land in 1999 (apart from a few points within urban limits that were still in rural use). The 2007 re-survey measured bare soil attributed to urban land use disturbance, affecting 0.19% of the region's area (plus another 0.05% on the land still in rural use)

In 2007 bare soil due to natural disturbance of urban land was 0.02% of the region's area (plus another 0.02% on the land still in rural use).

6.17 Change on Land along Water Bodies and Coastal Features

3.8% of Auckland's land was water bodies and coastal features at both dates.

The 1999 survey did not record soil disturbance on water bodies and coastal features. In 2007, bare soil attributed to land use disturbance was 0.01% of the region's area.

In 2007 exposure of soil, sediment or bare rock by natural disturbance along water bodies and coastal features amounted to 0.32% of the region's area.

6.18 Change on Unclassifiable Land

Land use could not be classified on 0.4% of Auckland's land (27 sample points) in 1999 and on 0.9% (49 sample points) in 2007, due to cloud cover or deep shadow on aerial photos.

Land use disturbance and natural disturbance of soil could not be recorded for these sites at either date.