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# Soil Stability and Disturbance in the Tararu Catchment –

# Changes from 2002 to 2007

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# Executive Summary

## Background

1. The Tararu was selected by EW staff as a representative catchment, partly because its terrain typefies the Coromandel, and also because it is one of several catchments targeted for intensive pest control from 2005 onwards. Vegetation plots have been established to ascertain whether EW's pest control initiative is resulting in measureable revegetation of erosion scars and creek beds, and a sampler has been installed near the stream mouth to find out if there is any consequential reduction in sediment yield.

2. 2 In 2006 EW requested Dr. D. Hicks (then Ecological Research Associates) to measure erosion and revegetation of scars throughout the Tararu catchment from the region's aerial photo cover. The southern Coromandel portion was fortuitously taken shortly after a storm in April 2003. Results and their interpretation are contained in a report by Hicks (2006).

3. In 2010 EW contracted Mr. A.B. Thompson (Thelton Environmental) to undertake a re-measurement of the Tararu from new aerial photo cover taken in 2007. Dr. Hicks was involved in the contract as needed for analysis procedure and comparisons.

4. The report starts with an overview of soil stability, soil disturbance, bare soil and revegetation. It then gives results from the 2007 assessment of vegetation's effectiveness as soil conservation cover. Results are split according to whether land is under natural or disturbed vegetation

## Soil stability

1) Between 2003 and 2007:

- Stable soil i.e. free from risk of erosion, remained at 16% of sample points.
- Unstable soil i.e. at risk of erosion but currently undisturbed by natural processes, went up from 39% to 47% as points that were revegetating in 2003 became completely revegetated.
- Eroded (revegetating) or eroding (bare) soil went down from 43% to 36%. Eroded points remained static at 19%, while eroding points decreased from 24% to 17%.
- Extensively disturbed soil (by building, earthworks and roadworks) was 1% of sample points at both dates.

## Soil disturbance

1) Between 2003 and 2007 :

- Soil recently or freshly disturbed by natural processes (of erosion and deposition) reduced from 43% to 36% of sample points.
- Soil recently or freshly disturbed by land use remained 2% of sample points.
- Soil extensively disturbed by building etc. remained 1% of sample points.

## Bare soil

1) Between 2003 and 2007:

- Bare soil due to fresh disturbance by natural processes went down substantially, from 1.12% to 0.54% of the Tararu catchment's area.

- Bare soil due to fresh disturbance by land use dropped slightly, from 0.13% to 0.11% of the Tararu's area.

- Bare soil due to extensive disturbance (including submerged creek beds) dropped slightly, from 0.29% to 0.12% of the Tararu's area.

## Revegetation

1) Between 2003 and 2007 :

- Revegetation on recently disturbed surfaces (erosion scars or creek-beds that were separate from and older than freshly disturbed surfaces measured by the 2006 survey) changed from 1.14%+ to 1.76% of the Tararu catchment's area. The 0.62% gain is accounted for by points recorded as revegetating in 2003 making the transition to revegetated by 2007; off-set by points that altered from bare in 2003 to revegetating in 2007
- Initial revegetation interspersed with bare soil or rock on freshly disturbed surfaces (erosion scars or creek-beds measured by the 2006 survey) went down from 1.18% to 1.14% of catchment area. The 0.04% loss is accounted for by extension of colonising plants across soil or rock at points recorded as bare at both dates; offset by points that changed from bare in 2003 to revegetating in 2007.

## Land use and its effect

1) In 2007 :

- Just one large block of grazing land remains in the middle of the catchment. Small grass paddocks also remain in the lower catchment, on several lifestyle blocks. Bare soil attributable to land use amounted to 0.04% of catchment area.

- On both slopes of the lower catchment, areas of wildling pines and reverting exotic scrub amount to 5% of catchment area. Here, bare soil attributable to land use amounted to 0% of catchment area.

- 88% of catchment area is natural vegetation, on upper slopes in mid-catchment and throughout the headwaters. Bare soil attributable to land use (tracks and roads) amounted to 0.08% of catchment area.

- The balance of land in non-rural uses is just 1% of the catchment, occupied by houses and gardens on an alluvial fan at the catchment's mouth, or on lower slopes nearby. Bare soil attributable to extensive disturbance (earthworks etc.) amounted to 0.04% of catchment area.

2) Total bare soil attributable to land use was 0.16% of catchment area, down from 0.18% in 2003, but an insignificant change.

## Soil conservation cover and its effect

1) In 2007 100% of land in the Tararu had plants that can be described as "soil conservation cover", in the sense that they provide either ground cover, or root reinforcement of soil, or both :

- 59% had natural soil conservation cover as primary vegetation, ranging from closed-canopy forest remnants, through emerging trees in closed-canopy scrub,

to closed-canopy scrub. Soil bared by natural processes (of erosion or deposition) was 0.20% of catchment area.

- 13% had natural soil conservation cover in canopy gaps. This category includes scrub along old clearance lines (forest edges) and on revegetated erosion scars; also groundfern or native grasses on revegetating erosion scars. Soil bared by natural processes was 0.10% of catchment area.

- 16% had exotic soil conservation cover in canopy gaps i.e. gorse or other exotic weeds. Here soil bared by natural processes was 0.15% of catchment area.

- 5% had exotic scrub as primary vegetation with wildling pines in canopy gaps (or the reverse combination). Soil bared by natural processes was 0.06% of catchment area.

- 5% was a mix of rough pasture with exotic or natural scrub. Soil bared by natural processes was 0.03% of catchment area.

- 1% was extensively disturbed land (urban areas, rural buildings or roads and creek beds). Here, soil bared by extensive disturbance was 0.03% of catchment area.

2) Total bare soil attributable to natural processes was 0.54% of catchment area, down from 1.12% in 2003. This was a measureable and significant change.

## Conclusions

1) Area of fresh soil disturbance has decreased 2003-2007, because storms and floods have been small, and any new disturbance has been more than offset by partial revegetation of the scars that were fresh in 2003.

2) 1Area of revegetation has increased 2003-2007, due to partial revegetation on 2003 scars that are still classed fresh (measureably bare on parts of their surface), and to transition of other 2003 scars into the revegetating category (no longer measureably bare).

3) Some of the pre-2003 scars that were classed as revegetating at that date, have now moved into the revegetated category (part or all of their surface is now colonised by woody scrub).

4) The re-survey cannot conclusively attribute these changes to better pest control. However if combined with other results as they become available for the Tararu :

   - Decline in pest numbers (from residual trap rate),

   - Faster revegetation of erosion scars and depositional surfaces in absence of browsing (from pest exclosure plot measurement),

5) It can provide supporting evidence. In particular, the numbers can be used to demonstrate that disturbed surfaces are revegetating not just at the few sites where animal exclosure plots are sited, but throughout the Tararu.

# 1 Introduction

Environment Waikato has requested an assessment of the extent of erosion, and the need for soil conservation measures in a catchment that is representative of the region's Coromandel management zone. This zone encompasses all catchments including and north of the Ohinemuri, as far as Cape Colville at the tip of the Coromandel peninsula.

The assessment is intended to assist with upcoming discussions with the community as to the future promotion of catchment protection programmes in the zone.

The Coromandel management zone's catchments are numerous and individually small in area, with short steep-gradient channels descending from watersheds at the crest of the Coromandel Range towards estuaries or open coast. High annual rainfall (2000 to 4000 mm), weathered rock (ignimbrite, andesite or greywacke), and steep terrain (slopes exceeding 30 degrees) combine to cause landslides, flash floods, and rapid sediment transport through stream networks. Regenerating scrub is the most widespread vegetation, consequent from a hundred and fifty years' disturbance by logging, mining, and attempts at farming; though large stands of remnant bush persist. Farms and pine plantations are established on pockets of easy terrain, particularly in the Ohinemuri and Tairua catchments. River control works were installed by the former Hauraki Catchment Board from the 1960s through the 1980s along the larger streams where close to settlements or roads, and these works are now maintained by EW. Farther up catchments the principal soil conservation technique was designation of remaining bush and scrub as protection forest by the former New Zealand Forest Service. Its forests now form the Coromandel Forest Park administered by Department of Conservation.

Tararu is a small basin (15.6 square kilometres) draining to the coast north of Thames. It was selected by EW staff as a representative catchment, partly because its terrain typefies the Coromandel, and also because it is one of several catchments targeted for intensive pest control from 2005 onwards. They established vegetation plots in the Tararu to ascertain whether EW's pest control initiative was resulting in measureable revegetation of erosion scars and creek beds, and also installed a sampler near the stream mouth to find out if there would be any reduction in sediment yield.

In 2006 EW requested Dr. D. Hicks (then Ecological Research Associates) to measure erosion and revegetation of scars throughout the Tararu catchment from the region's aerial photo cover. The southern Coromandel portion was fortuitously taken shortly after a storm in April 2003. Results and their interpretation are contained in a report by Hicks (2006). In 2010 EW contracted Mr. A.B. Thompson (Thelton Environmental Ltd) to re-measure the Tararu from new aerial photo cover taken in 2007. Dr. Hicks was involved in the contract as needed for analysis procedure and comparisons.

# 2 Method

Both assessments have been undertaken as point samples from aerial photographs. This is now a standard method for assessing erosion and erosion control measures, used by EW as well as other regional councils. Interpretation and measurement procedures are described in the Land Monitoring Forum's Manual (Burton et al 2009). The advantage of a point sample, is that it can provide statistically sound measures of soil instability, vegetative soil conservation cover, and erosion's extent, without resorting to field surveys which would be time-consuming and expensive.

The 2003 survey measured fresh erosional and depositional surfaces, at a sampling density of 1 dot per 10 metres (100 dots per hectare), recording type of disturbance, area of bare soil or rock, and area of any initial revegetation. This provided baseline

data that was requested for Tararu at the time i.e. the balance between bare ground (a potential sediment source) and revegetation (whether natural or a consequence of pest control) on disturbed surfaces.

Re-survey has been carried out at 300 randomly located points, and has measured any bare or revegetating surface within a 100 dot per hectare grid centred on each sample point. It has also recorded :

- Land use (primary vegetation)
- Secondary vegetation associated with land use
- Soil stability - stable and unstable, as well as eroded (revegetating) and eroding (bare) surfaces
- Type of disturbance

This sampling strategy provides information at a density of 14 points per square kilometre and 14 dots per hectare, randomly distributed around the catchment instead of concentrated just on disturbed surfaces. The switch places Tararu on the same footing as representative catchments for other management zones, enabling comparisons with them and also with management zone sub-sets from EW's region-wide point sample (Hicks 2003, Thompson and Hicks 2009).

Three additional data items have been recorded for the Tararu in 2007, so that the two data-sets can be compared despite their differences in sampling strategy :

- Percentage of surface revegetating, for scars measured on 2003 photos (because they were fresh at that date)
- Percent of surface revegetating, for scars un-measured on 2003 photos (because they were already revegetating at that date)
- Soil stability in 2003, for sample points recorded as stable or unstable in 2007

Assessment was carried out by Mr. Thompson on Environment Waikato's Geographic Information System, using a Geomedia workspace and Manifold sampling procedure created by EW's GIS analyst Mr. D. Borman. Data analysis and report drafting were carried out jointly by Mr. Thompson and Dr. Hicks. The report will be peer-reviewed by Dr. R. Hill of EW's Resource Information Group.

# 3 Contents of the Report

The report starts with an overview of soil stability, soil disturbance and bare soil for Tararu in 2007. It then gives results from the 2007 measurement of bare and revegetating surfaces, and compares them with previous measurements from 2003. Finally it assesses the extent and effect of vegetation that functions as soil conservation cover in the Tararu. For catchments in other management zones, results are split according to whether land is farmed, planted in forest, or under natural vegetation. In the Tararu these splits have not been made, because the only farmland is a rough grazing block fast reverting to scrub; and the only forested land is an area near the catchment mouth where wildling pines emerge through gorse and kanuka. As these areas fit the LMF definitions for residual exotic plants amongst natural cover (see Burton et al 2009), they are included with natural cover in a single catchment-wide analysis.

Report tables 1 to 6 contain key numbers which may be useful for staff discussions and public presentations. They have been extracted from more detailed analyses, which appear as four spreadsheets in Appendix A :

- Soil stability and disturbance
- Bare soil
- Land use's extent and effect

- Soil conservation cover's extent and effect

# 4 Soil Stability, Soil Disturbance and Bare Soil

## 4.1 Soil stability

**Table 1 Soil stability in Tararu catchment**

| | As percent of catchment : | | | |
|---|---|---|---|---|
| | **Stable** | **Unstable** | **Eroded & eroding** | **Extensively disturbed** |
| Tararu 2003 | 16.3 | 39.0 | 43.4 | 1.3 |
| Tararu 2007 | 16.3 | 46.7 | 35.7 | 1.3 |

In 2003, 16% of sample points in the Tararu catchment had soil that was stable i.e. free from risk of erosion (this includes less than 1% where recent or fresh land use disturbance was present). In 2007 16% of sample points remained stable (including less than 1% where recent or fresh land use disturbance was present).

In 2003, 39% of sample points in the Tararu had soil that was unstable i.e. at risk of erosion but currently undisturbed by natural processes (this includes 2% where recent or fresh land use disturbance was present). In 2007 47% of sample points were unstable (including 2% where recent or fresh land use disturbance was present). The change is mostly a result of re-classification of surfaces from eroded and eroding.

In 2003, 43% of sample points in the Tararu had soil that was eroded (revegetating) or eroding (bare scars). In 2007 36% of sample points were eroded or eroding. The change is a corollary of re-classification of points from eroded and eroding to unstable,

In 2003, just over 1% of sample points in the Tararu had soil that was extensively disturbed i.e. partly covered by buildings and pavements, or partially removed by road-works or earthworks. In 2007 just over 1% of sample points remained extensively disturbed.

## 4.2 Soil disturbance

**Table 2: Soil disturbance in the Tararu catchment**

| | Percent of catchment with : | | | |
|---|---|---|---|---|
| | **recent land use disturbance** | **fresh land use disturbance** | **recent natural disturbance** | **fresh natural disturbance** |
| Tararu 2003 | - | 1.6 | 18.7 | 24.7 |
| Tararu 2007 | - | 2.0 | 18.7 | 17.0 |

Recent disturbance by land use (surfaces revegetating after land use-related disturbance) was not recorded for sample points in the Tararu catchment. Its omission is consistent with now-standard LMF procedure (Burton et al 2009). In 2003 2% of sample points had bare soil freshly disturbed by land use. The percentage remained 2% in 2007.

Recent disturbance by natural processes (surfaces revegetating after erosion or deposition) was recorded at both dates. In 2003 19% of sample points in the Tararu had patches of revegetating soil recently disturbed by natural processes of erosion or deposition, and 25% had bare scars where soil was freshly disturbed. In 2007, recent natural disturbance was recorded at 19% of sample points, and fresh disturbance was recorded at 17%. Although the same proportion of sample points was recorded as recently disturbed, this masks a transition at 19 points from eroded (revegetating) to unstable (completely revegetated), and a transfer at 19 points from eroding (bare) to eroded (revegetating), off-set by 3 points that deteriorated from eroded to eroding. The net decline in eroding (bare) points is due to minimal erosion as a result of less intense storm events between 2002 and 2007, allowing previously eroded areas to revegetate.

## 4.3 Bare soil

**Table 3: Bare soil in the Tararu catchment**

| | Percent of catchment with bare soil due to : | |
|---|---|---|
| | **fresh land use disturbance** | **fresh natural disturbance** |
| Tararu 2003 | 0.13 | 1.12 |
| Tararu 2007 | 0.11 | 0. 54 |

In 2003, 0.13% of the Tararu catchment's area had bare soil due to fresh disturbance by land use. In 2007 bare soil was 0.11%. New bare soil was counter-balanced by revegetation at some of the points recorded as freshly disturbed in 2003. A small area of bare soil extensively disturbed by building, earthworks or roadworks, is excluded from land use-related disturbance.

In 2003 1.12% of the Tararu catchment's area had bare surfaces (soil or rock) due to fresh disturbance by natural processes. In 2007 bare surfaces were 0.54% i.e. new natural disturbance (at just 3 points) was far outweighed by a net drop of 0.74%, caused by partial or complete revegetation at many points recorded as freshly disturbed in 2003 (see next section). A small area of submerged creek-bed is excluded from natural disturbance.

## 4.4 Revegetation

**Table 4: Revegetation in the Tararu catchment**

| | Percent of catchment with revegetating soil after : | |
|---|---|---|
| | **Recent natural disturbance** | **fresh natural disturbance** |
| Tararu 2003 | 1.14 | 1.18 |
| Tararu 2007 | 1.76 | 1.14 |

In 2003, 1.14% of the Tararu catchment's area had advanced revegetation (dense weed and fern regrowth) on recently disturbed surfaces that were separate from, and older than freshly disturbed surfaces. In 2007, the percentage was 1.76% of catchment area. The change is accounted for by a 0.30% loss (19 points recorded as revegetating in 2003 making the transition to revegetated by 2007); off-set by a 0.92% gain (22 points that changed from bare in 2003 to revegetating in 2007). Nature of the revegetation on these surfaces was colonizing natural cover such as ground fern or exotic weeds such as gorse.

In 2003, 1.18% of the Tararu catchment's area had initial revegetation (sparse weed and fern regrowth) interspersed with bare soil or rock on freshly disturbed surfaces. In 2007, the corresponding percentage was 1.14% of catchment area. The change is accounted for by a 0.74% gain (extension of colonising plants across soil or rock at 48 points recorded as bare at both dates); offset by a 0.92% loss (22 points that changed from bare in 2003 to revegetating in 2007). The 0.14% discrepancy is attributed to use of a somewhat different point sampling technique in 2003 cf. 2007 (see Methods section), and is contained within the error margins of 2007 percentages (see Appendix). Nature of the revegetation on the eroding surfaces was mosses and ferns to sparse exotic weeds such as pampas and gorse seedlings.

# 5 Land Uses' Extent and Effect

**Table 5: Land uses and their effect in Tararu catchment, 2007**

| ***Land Use*** | ***% of catchment's area*** | ***Bare soil due to land use as % of catchment's area*** |
|---|---|---|
| Rough grazing land | 5.3 | 0.04 |
| Exotic scrub with wildling pines | 5.3 | 0.00 |
| Natural vegetation | 88.4 | 0.08 |
| Non-rural uses | 1.3 | 0.04 |

Areas of land in the Tararu, originally cleared by logging or for mining, have been intermittently brought into rough pasture, but never developed as viable farms. Most have reverted to scrub. Today just one large block of grazing land remains on a lower slope in the middle of the catchment. After about five years' de-stocking when owned by the Tararu Forest Restoration Trust, cattle have been re-introduced by its new owner. The block is now more fern and gorse than grass. Small grass paddocks also remain in the lower catchment, on several lifestyle blocks which are mostly scrub and wildling pines. Collectively the rough grazing land is 5% of catchment area, and bare soil due to land use amounts to 0.04% of catchment area.

Both slopes of the lower catchment are former grazing land which has long since reverted to a mix of exotic and natural scrub, with many wildling pines of mixed age. Two patches of closed-canopy pine, younger than the rest, appear to have been planted. These areas of wildling pines and reverting scrub are 5% of catchment area, and bare soil due to land use is presently 0%.

88% of the Tararu is natural vegetation, on upper slopes in mid-catchment and throughout the headwaters. Vegetation ranges from patches of undisturbed kauri and podocarp-hardwood forest, through young second-growth forest where land was cleared in the 19th century, to kanuka scrub and broadleaf scrub on land that was intermittently cleared through the 20th century (until about 20 years ago on some of the lower slopes). Bare soil due to land use (tracks and roads) here amounts to 0.08% of the catchment's area.

The balance of land in non-rural uses is just 1% of the catchment, occupied by houses and gardens on an alluvial fan at the catchment's mouth, and nearby lower slopes. Bare soil due to extensive disturbance (earthworks, driveways etc) amounts to 0.04% of the catchment's area.

Total bare soil attributable to land use is 0.11% of the Tararu's area, down from 0.13% in 2003, but an insignificant change.

# 6 Soil Conservation's Extent and Effect

**Table 6: Soil conservation's extent and effect in the Tararu catchment, 2007**

| ***Soil conservation cover*** | ***% of catchment's area*** | ***Bare soil due to natural processes as % of catchment's area*** |
|---|---|---|
| Natural vegetation | 58.7 | 0.20 |
| Natural vegetation with natural cover in canopy gaps | 13.0 | 0.10 |
| Natural vegetation with exotic cover in canopy gaps | 16.3 | 0.15 |
| Exotic scrub and wildling pines | 5.3 | 0.06 |
| Rough grazing land | 5.3 | 0.03 |
| Non-rural uses | 1.3 | 0.08 |

In 2007 100% of land in the Tararu had plants that can be described as "soil conservation cover", in the sense that they provide either ground cover, or root reinforcement of soil, or both.

59% of unstable land had natural soil conservation cover, as primary vegetation, ranging from closed-canopy forest remnants, through emerging trees in closed-canopy scrub, to closed-canopy scrub. Soil bared by natural processes of erosion or deposition was 0.20% of catchment area.

13% had natural soil conservation cover in canopy gaps. It includes scrub along old clearance lines (forest edges) and on revegetated erosion scars; also groundfern or native grasses on revegetating erosion scars. Soil bared by natural processes was 0.10% of catchment area.

Another 16% had exotic soil conservation cover in canopy gaps within natural vegetation i.e. gorse or other exotic weeds colonizing erosion scars or stream beds. Here soil bared by natural processes was 0.15% of catchment area.

5% had exotic scrub as primary vegetation with wildling pines in canopy gaps (or the reverse combination). This was land formerly cleared for farming or mining. Soil bared by natural processes was 0.06% of catchment area.

5% was a mix of rough pasture with exotic or natural scrub. This is land that has been grazed within recent years but not farmed intensively. Soil bared by natural processes was 0.03% of catchment area.

1% was extensively disturbed land (urban areas, rural buildings or roads) and submerged creek-beds. Here, soil bared by extensive disturbance was 0.08% of catchment area.

Total bare soil attributable to natural processes was 0.54% of catchment area, down from 1.12% in 2003. This was a measureable and significant change.

# 7 Conclusions

Area of fresh soil disturbance has decreased 2003-2007, because storms and floods have been small, and any new disturbance has been more than offset by partial revegetation of the scars that were fresh in 2003.

Area of revegetation has increased 2003-2007, due to partial revegetation on 2003 scars that are still classed fresh (measureably bare on parts of their surface), and to transition of other 2003 scars into the revegetating category (no longer measureably bare).

Some of the pre-2003 scars that were classed as revegetating at that date, have now moved into the revegetated category (part or all of their surface is now colonised by woody scrub).

One of the reasons for the original Tararu survey (and for the re-survey) has been to find out whether the Coromandel watersheds pest control programme (a joint DOC-EW initiative) is improving revegetation of past erosion scars or reducing the present rate of erosion.

Hicks (2006) pointed out that the Tararu has a high natural rate of erosion, so the erosion scars measured in 2003 cannot be attributed solely - or principally - to browsing by animal pests. The report showed that over half the freshly or recently disturbed surfaces were already colonised by ground cover (grasses, weeds and ferns), but commented that the absence of woody scrub (tree fern, mixed broadleafs, kanuka and gorse) from these surfaces indicated that animal pests may have been suppressing secondary colonisation; and postulated that when the catchment is re-photographed, the effect of better pest control might be detected as :

- a decrease in the extent of disturbed surfaces - because some of the revegetating proportion may progress to successional scrub,

- an increase in the revegetating proportion - because of faster initial colonisation by ground cover.

The 2007 re-survey has confirmed both trends. One would expect plant colonisation to progress somewhat in the space of four years, particularly if the surfaces are not unduly disturbed by fresh storms meanwhile. So the re-survey cannot conclusively attribute the trends to better pest control. However if combined with other results as they become available for the Tararu :

- Decline in pest numbers (from residual trap rate),

- Faster revegetation of erosion scars and depositional surfaces in absence of browsing (from pest exclosure plot measurement),

it can provide supporting evidence. In particular, the numbers can be used to demonstrate that disturbed surfaces are revegetating not just at the few sites where animal exclosure plots are sited, but throughout the Tararu.

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# Appendices

# Appendix A

**Table 1 Changes in soil stability & disturbance, Tararu Catchment 2003 - 2007**

| | Points : | | Points as % of sample | | Significant change? : |
|---|---|---|---|---|---|
| | **2003** | **2007** | **2003** | **2007** | |
| | | | | | |
| **Stable surfaces** | | | | | |
| with intact soil | 48 | 48 | 16.0 | 16.0 | |
| 95% conf. limit | | | 4.1 | 4.1 | N |
| with soil disturbed by land use | 1 | 1 | 0.3 | 0.3 | |
| 95% conf. limit | | | 0.7 | 0.7 | N |
| | | | | | |
| **Erosion-prone surfaces** | | | | | |
| with intact soil | 113 | 135 | 37.7 | 45.0 | |
| 95% conf. limit | | | 5.5 | 5.6 | N |
| with soil disturbed by land use | 4 | 5 | 1.3 | 1.7 | |
| 95% conf. limit | | | 1.3 | 1.4 | N |
| | | | | | |
| **Eroded and eroding surfaces** | | | | | |
| with revegetating soil | 56 | 56 | 18.7 | 18.7 | |
| 95% conf. limit | | | 4.4 | 4.4 | N |
| with soil disturbed by natural processes | 74 | 51 | 24.7 | 17.0 | |
| 95% conf. limit | | | 4.9 | 4.3 | N |
| | | | | | |
| **Extensively disturbed surfaces** | | | | | |
| rural buildings etc. | 2 | 2 | 0.7 | 0.7 | |
| 95% conf. limit | | | 0.9 | 0.9 | N |
| urban areas etc. | 2 | 2 | 0.7 | 0.7 | |
| 95% conf. limit | | | 0.9 | 0.9 | N |
| creek-beds etc. | 0 | 0 | 0.0 | 0.0 | |
| 95% conf. limit | | | 0.0 | 0.0 | - |
| | | | | | |
| **All surfaces** | | | | | |
| as percentage of sample | 300 | 300 | 100.0 | 100.0 | |

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

**Table 2 Changes in bare soil, Tararu Catchment 2003-2007**

| | Disturbed points | | Bare soil as % of region : | | Significant change? : |
|---|---|---|---|---|---|
| | **2003** | **2007** | **2003** | **2007** | |
| | | | | | |
| **By land use :** | | | | | |
| | | | | | |
| grazing pressure | undifferentiated | | undifferentiated | | |
| 95% conf. | in 2003 | | in 2003 | | |
| cultivation | | | | | |
| 95% conf. | | | | | |
| harvest | | | | | |
| 95% conf. | | | | | |
| spraying | | | | | |
| 95% conf. | | | | | |
| drains | | | | | |
| 95% conf. | | | | | |
| tracks | | 6 | | 0.11 | |
| 95% conf. | | | | 0.09 | |
| earthworks | | | | | |
| 95% conf. | | | | | |
| roads | | | | | |
| 95% conf. | | | | | |
| | | | | | |
| **All rural land use disturbance** | **5** | **6** | **0.13** | **0.11** | |
| 95% conf. | | | 0.12 | 0.09 | N |
| | | | | | |
| **By natural processes :** | | | | | |
| | | | | | |
| landslide | undifferentiated | 9 | undifferentiated | 0.08 | |
| 95% conf. | in 2003 | | in 2003 | 0.06 | |
| debris avalanche | | 10 | | 0.10 | |
| 95% conf. | | | | 0.06 | |
| slump or earthflow | | | | | |
| 95% conf. | | | | | |
| tunnel gully | | | | | |
| 95% conf. | | | | | |
| gully | | | | | |
| 95% conf. | | | | | |
| streambank scour | | 1 | | <0.01 | |
| 95% conf. | | | | <0.01 | |
| streambank deposit | | 26 | | 0.30 | |
| 95% conf. | | | | 0.13 | |
| sandblow | | | | | |
| 95% conf. | | | | | |
| sheetwash | | | | | |
| 95% conf. | | | | | |
| rockfall or bare rock | | 5 | | 0.05 | |
| 95% conf. | | | | 0.05 | |
| geothermal | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 95% conf. | | | | | |
| | | | | | |
| **All rural natural disturbance** | **74** | **51** | **1.12** | **0.54** | |
| 95% conf. | | | 0.32 | 0.16 | Y |
| | | | | | |
| **Extensive disturbance :** | | | | | |
| | | | | | |
| rural buildings etc. | undifferentiated | 2 | undifferentiated | 0.04 | |
| | in 2003 | | in 2003 | 0.05 | |
| urban areas etc. | | 0 | | | |
| | | | | | |
| creek-beds etc : | | 0 | | 0.08 | |
| | | | | 0.06 | |
| | | | | | |
| **All extensive disturbance** | **3** | **2** | **0.29** | **0.12** | |
| | | | 0.17 | 0.05 | N |
| | | | | | |
| **All disturbance :** | **82** | **59** | **1.54** | **0.76** | |
| 95% conf. | | | 0.38 | 0.18 | N |

**Table 3 Land uses' extent and effect, Tararu Catchment 2007**

| | 2003 | 2007 | 2003 | 2007 | | 2003 | 2007 | |
|---|---|---|---|---|---|---|---|---|
| **Sample points** | - | 300 | Land in category | | | Bare soil caused by land use | | |
| | | | as % of catchment | | Signif. change? | as % of catchment | | Signif. change? |
| | | | | | | | | |
| **Natural vegetation** | undifferentiated | 264 | **-** | **88.0** | | **-** | **0.08** | |
| 95% c.i. | | | - | 3.7 | - | - | 0.08 | - |
| | | | | | | | | |
| **Disturbed land (exotic scrub with wildling or planted pines)** | undifferentiated | 16 | **-** | **5.3** | | **-** | **0.00** | |
| 95% c.i. | | | - | 2.5 | - | - | 0.00 | - |
| | | | | | | | | |
| **Disturbed land (rough pasture with exotic scrub)** | undifferentiated | 16 | **-** | **5.3** | | **-** | **0.04** | |
| 95% c.i. | | | - | 2.5 | - | - | 0.05 | - |
| | | | | | | | | |
| **Roads, rural buildings, urban areas, etc.** | undifferentiated | 4 | **-** | **1.3** | | **-** | **0.00** | |
| 95% c.i. | | | - | 1.3 | - | - | 0.00 | - |
| | | | | | | | | |
| **All land in catchment** | - | 300 | **-** | **100.0** | | **0.13** | **0.11** | |
| 95% c.i. | | | | - | - | 0.12 | 0.09 | N |

**Table 4** **SOIL CONSERVATION COVER'S EXTENT AND EFFECT, TARARU CATCHMENT 2007**

| | 2003 | 2007 | 2003 | 2007 | | 2003 | 2007 | |
|---|---|---|---|---|---|---|---|---|
| **Sample points** | **-** | **300** | **Land in category** | | | **Bare soil caused by erosion or deposition** | | |
| | | | **as % of catchment** | | **Signif. change ?** | **as % of catchment** | | **Signif. change ?** |
| | | | | | | | | |
| **Natural vegetation** | - | 176 | - | 58.7 | | - | 0.20 | |
| 95% c.i. | | | - | 5.6 | - | - | 0.10 | - |
| | | | | | | | | |
| **Natural vegetation with natural cover in canopy gaps** | - | 39 | - | 13.0 | | - | 0.10 | |
| 95% c.i. | | | - | 3.8 | - | - | 0.06 | - |
| | | | | | | | | |
| **Natural vegetation with exotic cover in canopy gaps** | - | 49 | - | 16.3 | | - | 0.15 | |
| 95% c.i. | | | - | 4.2 | - | - | 0.09 | - |
| | | | | | | | | |
| **Disturbed land (exotic scrub with wildling or planted pines)** | - | 16 | - | 5.3 | | - | 0.06 | |
| 95% c.i. | | | - | 2.5 | - | - | 0.06 | - |
| | | | | | | | | |
| **Disturbed land (rough pasture with exotic scrub)** | - | 16 | - | 5.3 | | - | 0.03 | |
| 95% c.i. | | | - | 2.5 | - | - | 0.05 | - |
| | | | | | | | | |
| **Roads, rural buildings, urban areas, etc.** | - | 4 | - | 1.3 | | - | 0.00 | |
| 95% c.i. | | | - | 1.3 | - | - | 0.00 | - |
| | | | | | | | | |
| **All land in catchment** | - | 300 | - | 87.0 | | 0.12 | 0.54 | |
| 95% c.i. | | | - | - | - | 0.32 | 0.16 | Y |