

# Erodible Soil Stabilisation

Ministry for the Environment Attribute Stocktake

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## Te Whakawhena Oneone ka Taea te Ngāhorohoro

Whakarārangi Āhuatanga a Te Manatū mō te Taiao



Ministry for the  
**Environment**  
*Manatū Mō Te Taiao*



**Te Kāwanatanga o Aotearoa**  
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# Introduction

This document collates existing information and has been produced by the Ministry for the Environment. It complements the Ministry's commissioned stocktake of 55 environmental attributes. The stocktake involved 43 researchers from NIWA, Manaaki Whenua Landcare Research, Cawthron Institute and Environet Limited (Lohrer et al, 2024a). The attributes covered by the stocktake are in air, terrestrial, soil, freshwater, and estuaries and coastal waters domains.

In practical terms, the 'erodible soil stabilisation' attribute aims to reduce erosion on land with high risk to mass movement (ie, marginal, unproductive land) by requiring councils to proactively plan and monitor relevant erosion mitigation, such as soil conservation. This attribute has a clear relationship to soil ecological integrity, as it aims to prevent soil degradation and ensure soil loss is reduced.

Following conversations with experts at regional councils, other government agencies and Crown research institutes, the authors are confident this attribute addresses an urgent issue (soil erosion), and the monitoring is suitable and feasible (with National Environmental Monitoring Standards now being developed).

## State of knowledge conclusion

State of knowledge of erodible soil stabilisation attribute: **Good/Established** but incomplete.

Relationships between drivers, pressures and response to mass-movement erosion are well understood.

There is a lack of national available data and standardised methods to monitor soil conservation efforts through plantings, retirement and reforestation. Therefore, no current measure exists for the stabilisation of erodible soil.

# Part A – Attribute and method

## A1: How does the attribute relate to ecological integrity or human health?

This attribute has a clear relationship to soil ecological integrity, as it aims to reduce soil degradation and soil loss. Intact soil is a key component of ecological integrity – it is an ecosystem in itself and a habitat for below-ground biodiversity. Soil also forms the basis for the above-ground terrestrial ecosystem. Intact soil thus provides essential ecosystem functions both below- and above-ground.

This attribute also protects the ecological integrity of the wider environment by minimising damage to terrestrial ecosystems from erosion, and minimising sediment impacts on freshwater, estuaries and coastal ecosystems.

Soil erosion is a natural phenomenon. In Aotearoa New Zealand, erosion rates are naturally high due to steep slopes, high rates of tectonic activity and volcanism, high rainfall and high intensity rainstorms (Basher, 2013; Hicks et al, 2011). Soil erosion has been accelerated in anthropogenically modified landscapes following the clearing of indigenous vegetation for pastoral use (Basher, 2013). Soil erosion is now a widespread and long-standing issue in New Zealand (Basher, 2013), for example, erosion rates are an order of magnitude greater under pasture than under indigenous forest (Basher et al, 2012). Further, although few studies on urban catchments exist, sediment yield from urbanising Auckland catchments was found to be an order of magnitude higher than from any other land use (Hicks, 1994).

Soil erosion can cause substantial damage to land, infrastructure and culturally significant sites, as well as primary production losses and degradation of receiving environments from excess sediment (Smith et al, 2022). Ultimately, this impacts the many ways that soil is valued (Stronge et al, 2020). The loss of soil is irreversible, with recovery possibly taking hundreds of years — under natural conditions topsoil takes 100 to 400 years to rebuild or reform to its former depth (Doran et al, 1996). For example, pasture production on slip scars is unlikely to return to the production levels of uneroded sites within human timescales (Rosser and Ross, 2011).

Erosion control mitigations via soil conservation are required to address environmental issues in these landscapes (Basher et al, 2016), and contribute towards ensuring the resilience of the land (Ministry for the Environment, 2023). As well as contributing to the avoidance of property and infrastructure damage as well as clean-up costs (Dymond et al, 2016), soil conservation measures help keep soil intact and stable, protecting its ecological integrity and the ecosystem services it provides (Ausseil et al, 2013; Dominati et al, 2010; Dominati et al, 2014).

The main forms of erosion control include space-planting of trees, afforestation, retirement from grazing (reversion), and riparian retirement and enhancement (Basher, 2013; Manderson, 2018). Recent research has also proposed low-cost, lower-density native planting methods, which are best suited for retirement of erosion-prone, marginal land, with canopy closure achieved within five to eight years (Dewes et al, 2022). Erosion control practices such as afforestation and reversion can take about 10 years to become fully effective whereas space-planted trees and gully tree planting can take about 15 years (Phillips et al, 2020).

Protecting the ecological integrity of soil is important to Māori and aligns with their many soil principles and concepts (Stronge et al, 2020). Soil is taonga to Māori, who consider soil in a very holistic way that stresses the interconnections and strong links to sustaining life, food production and human wellbeing (Hutchings and Smith, 2020). In Māori tradition, the link between Māori and the soil was strong and reciprocal, stretching back to the time of creation (Harmsworth, 2018). Soil also has ties to whanaungatanga, as Māori have relationships and traditions with their ancestral lands that holds these ancestral connections and is the root of tūrangawaewae and whakapapa (Harmsworth, 2018).

## **A2: What is the evidence of impact on (a) ecological integrity or (b) human health? What is the spatial extent and magnitude of degradation?**

Soil erosion has been accelerated in anthropogenically modified landscapes following the clearing of indigenous vegetation (Basher, 2013). Hill-slope soils without vegetation cover are easily removed by surficial soil erosion during heavy rainfall (Baillie and Neary, 2015; Burkitt et al, 2017).

Five per cent of land in New Zealand was classified as highly erodible land at risk of mass-movement erosion in 2022, with 60 per cent of the area at risk was in the North Island. Manawatū-Whanganui had the largest area of highly erodible land at risk of erosion. Of all regions, Gisborne had the highest proportion of its area classified as highly erodible land at risk of erosion (15 per cent).<sup>1</sup>

An estimated 182 million tonnes of eroded soil entered New Zealand's rivers in 2022. Of all regions, the West Coast (48 million tonnes) and Gisborne (36 million tonnes) had the highest levels of sediment movement into waterways.<sup>2</sup>

## **A3: What has been the pace and trajectory of change in this attribute, and what do we expect in the future 10–30 years under the status quo? Are impacts reversible or irreversible (within a generation)?**

Regional estimates and trends are available for some regions where erosion through mass movement is an issue. For the Manawatū-Whanganui region, Basher et al (2020) used the sediment budget model, SedNetNZ, to estimate effects of erosion control in the region, which were undertaken under the Sustainable Land Use Initiative, and to also predict the effect of climate change on future erosion and sediment load. The model showed a 6 per cent reduction in sediment load between 2004 and 2018, with 23 per cent of the region having implemented

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<sup>1</sup> Stats NZ. *Highly erodible land: Data to 2022*. Retrieved 27 May 2025 from <https://www.stats.govt.nz/indicators/highly-erodible-land-data-to-2022/>

<sup>2</sup> Stats NZ. *Estimated long-term soil erosion: Data to 2022*. Retrieved 27 May 2025 from <https://www.stats.govt.nz/indicators/estimated-long-term-soil-erosion-data-to-2022/>

farm plans. Catchments with the highest number of farm plans tended to have the largest reductions in sediment load. Conversely, two catchments without erosion control measures did not have sediment load reductions between 2004 and 2018. With no further erosion control works, the model predicted a 15.7 per cent reduction in annual sediment load by 2038. If new farm plans continue to be implemented, a total reduction of 30.4 per cent in sediment load was predicted, offsetting sediment load increases from climate change to 2043. However, by 2090, an annual sediment load increase of between 53 per cent and 224 per cent due to climate change was predicted, and this may be beyond what can be offset by land management (Basher et al, 2020).

Nationally, a disproportionate increase in mass-movement erosion is expected in soft-rock hill country, with <1–28 per cent of North Island watersheds and <1–8 per cent of South Island watersheds estimated to experience a 100 per cent increase in sediment yield by the end of the century. This projected increase is primarily driven by the impact of increasing storm magnitude and frequency on mass-movement erosion. The result is sediment load delivered to the coast increasing regionally from 1 per cent to 233 per cent (Neverman et al, 2023).

As noted above, recovery from soil loss can take hundreds of years under natural conditions (Doran et al, 1996). However, soil conservation measures can slow the downstream impacts by stabilising remaining soil and reducing the amount of sediment in waterways.

## **A4: What monitoring is currently done and how is it reported (eg, is there a standard, and how consistently is it used; who is monitoring for what purpose)? Is there a consensus on the most appropriate measurement method?**

Some councils monitor or promote sustainable land-use initiatives to reduce erosion, for example, monitoring trees planted or area treated/reverted (Manderson, 2018).

Currently, nationally erodible soil stabilisation is not monitored in a standardised or consistent way, but a National Environmental Monitoring Standard (NEMS) is currently being developed.<sup>3</sup>

The area of land treated for soil stabilisation does not necessarily equate to the area of land actually protected, as that depends on factors such as plant survival, which will need to be considered in guidance on data standardisation/NEMS.

The inclusion of non-council initiatives – particularly those involving soil conservation on marginal, unproductive land – can be considered, but this would require councils to help support the recording of data. An alternative would be to explicitly qualify that any reporting pertains only to regional authorities (noting that regional councils are responsible for managing most erosion mitigation in New Zealand (Monaghan et al, 2021)). However, reporting should include all works that are verifiable and considered to be of a suitable standard, to help determine if the limit has been maintained or improved.

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<sup>3</sup> National Environmental Monitoring Standards. *Land Management – Soil Stability/Erosion Monitoring*. Retrieved 27 May 2025 from <https://www.nems.org.nz/documents/soil-stabilityerosion-monitoring>

**A4(i): Are there any implementation issues such as accessing privately owned land to collect repeat samples for regulatory informing purposes?**

Depending on the agreed monitoring methods, ground-truthing and auditing may require access to private land, and land-owner cooperation.

**A4(ii): What are the costs associated with monitoring the attribute? This includes up-front costs to set up for monitoring (eg, purchase of equipment) and ongoing operational costs (eg, analysis of samples).**

Costs of monitoring the attribute depend on the agreed best methods. Costs could include repeat purchasing of resourcing for light detection and ranging (LiDAR), satellite or aerial imagery, plus costs of interpreting the data and ground-truthing. However, LiDAR can serve multiple purposes beyond this attribute.

**A5: Are there examples of this being monitored by iwi/Māori? If so, by who and how?**

The authors are not aware of any current monitoring by iwi or Māori.

**A6: Are there known correlations or relationships between this attribute and other attribute(s), and what is the nature of these relationships?**

There are known relationships between this attribute and other attributes including erosion attributes, freshwater and estuary/coastal sediment attributes, and indigenous vegetation cover.



# Part B – Current state and allocation options

## **B1: What is the current state of the attribute?**

As mentioned previously at [A3](#), there is no national monitoring currently in place. Estimates (modelled) of area affected by, or at risk of, erosion are available.

Nationally, a disproportionate increase in mass-movement erosion is expected in soft-rock hill country, primarily driven by the impact of increasing storm magnitude and frequency on mass-movement erosion. This results in regional increases in sediment load delivered to the coast, ranging from 1 per cent to 233 per cent (Neverman et al, 2023).

Sediment budget modelling showed reductions in sediment load due to sustainable land-use initiatives in the Manawatū-Whanganui region (Basher et al, 2020). For more detail [see A3](#).

## **B2: Are there known natural reference states described for New Zealand that could inform management or allocation options?**

Theoretically, natural reference states could be informed by non-anthropogenically influenced natural reference areas where these exist (ie, where indigenous vegetation cover has not been removed). Such natural reference areas will vary in erodibility due to microclimate, soil type, geology, topography and the relationship of those factors with vegetation types. In practice, as suggested in the other erosion attribute background documents, the pre-human erosion rates are unknown, and the current landscape has been altered, so that natural reference state of erosion rates is not necessarily a suitable option to refer back to. Nevertheless, for the erodible soil stabilisation attribute, a canopy cover similar to a natural reference state could potentially be used.

**B3: Are there any existing numeric or narrative bands described for this attribute? Are there any levels used in other jurisdictions that could inform bands (eg, US EPA, Biodiversity Convention, ANZECC, regional council set limit)?**

No known numeric or narrative band exist in New Zealand published literature.

**B4: Are there any known thresholds or tipping points that relate to specific effects on ecological integrity or human health?**

Thresholds have been modelled for slope, above which the probability of landsliding is high (Dymond et al, 2006). Whether landsliding or other mass-movement erosion actually occurs, however, depends on further factors including weather events.

For erodible soil stabilisation, a tipping point could likely be when closed canopy cover and/or sufficient root stabilisation has occurred, as this is when the full protective effects of soil stabilisation through vegetation are expected (Phillips et al, 2020).

**B5: Are there lag times and legacy effects? What is the nature of these, and how do they impact state and trend assessment? Further, are there any naturally occurring processes, including long-term cycles, that may influence the state and trend assessments?**

The time before canopy closure is reached depends on the method and vegetation type used for soil stabilisation (Phillips et al, 2020).

The main forms of erosion control include space-planting of trees, afforestation, retirement from grazing (reversion), and riparian retirement and enhancement (Basher, 2013; Manderson, 2018). Recent research has also proposed low-cost, lower-density native planting methods that are best suited for retirement of erosion prone, marginal land – with canopy closure achieved within five to eight years (Dewes et al, 2022). Erosion control practices such as afforestation and reversion can take about 10 years to become fully effective whereas space-planted trees and gully tree planting can take about 15 years (Phillips et al, 2020).

## **B6: What tikanga Māori and mātauranga Māori could inform bands or allocation options and how (eg, by contributing to defining minimally disturbed conditions, or unacceptable degradation)?**

Although the influence of tikanga and mātauranga Māori is unknown, tikanga Māori may prefer native species, and mātauranga Māori could inform place-based species decisions.

Preliminary analysis, based on the 2018 highly erodible land (HEL) layer, identifies 96 per cent, 9 per cent and 1 per cent of HEL in the North Island as private land, Māori land and Department of Conservation land, respectively. In the South Island, 54 per cent, 0.1 per cent and 44 per cent of HEL is identified as private land, Māori land and Department of Conservation land, respectively. Note that the percentages do not total 100 per cent because some land appears in multiple ownership.

# Part C – Management levers and context

## **C1: What is the relationship between the state of the environment and stresses on that state? Can this relationship be quantified?**

Soil erosion has been accelerated in anthropogenically modified landscapes following the clearing of indigenous vegetation for pastoral use (Basher, 2013). Erosion rates can be an order of magnitude greater under pasture than under indigenous forest (Basher et al, 2012). From a sediment yield perspective, studies in urbanised catchments have been relatively sparse, but yields from urbanising Auckland catchments have been shown to be an order of magnitude higher than any other land use, with a high proportion of bare ground attributed to sheet and rill erosion (Hicks, 1994). Erosion control mitigations via soil conservation are required to address environmental issues in these landscapes (Basher et al, 2016) and help contribute towards ensuring the resilience of the land (Ministry for the Environment, 2023).

Soil conservation measures help keep soil intact and stable, which protects its ecological integrity, and the ecosystem services it provides (Ausseil et al, 2013; Dominati et al, 2010; Dominati et al, 2014). The main forms of erosion control include space-planting of trees, afforestation, retirement from grazing (reversion), and riparian retirement and enhancement (Basher, 2013; Manderson, 2018). Recent research has also proposed low-cost, lower-density native planting methods that are best suited for retirement of erosion prone, marginal land – with canopy closure achieved within five to eight years (Dewes et al, 2022). Erosion control practices such as afforestation and reversion can take about 10 years to become fully effective whereas space-planted trees and gully tree planting can take about 15 years (Phillips et al, 2020).

## **C2: Are there interventions/mechanisms being used to affect this attribute? What evidence is there to show that they are/are not being implemented and being effective?**

### **C2(i): Local government driven**

A survey in 2018 (Manderson, 2018) found that nine councils reported soil conservation indicators. There was a high level of commonality in the use of six indicators:

- number of poles planted (8 councils)
- number of soil conservation plans prepared (7 councils)
- length of fencing (7 councils)

- area of land treated (7 councils)
- area of forestry established (7 councils)
- area of land retired from grazing (7 councils).

A follow-up Ministry for the Environment survey to the Manderson report (Manderson, 2018) found that nine regions monitor soil erosion conservation, predominantly as part of the Hill Country Erosion Programme.

Regional council initiatives exist, such as the Sustainable Land Use Initiative in Manawatū-Whanganui. However, because these initiatives are non-regulatory, some of the most erodible land is not included (Dymond et al, 2016). The development and implementation of voluntary management plans is a tool used by Horizons Regional Council to promote erosion mitigation actions such as space-planting poplars and willows, retirement and afforestation (Horizons Regional Council, 2014).

## **C2(ii): Central government driven**

Current management interventions and approaches relevant to this attribute include managing sediment in freshwater under the National Policy Statement for Freshwater Management 2020 (NPS-FM) and policies relating to water quality. The NPS-FM has provisions that could enforce behavioural change to actively target the use and management of land and soils. This attribute would take a more proactive approach than the NPS-FM, by deliberately targeting areas of land requiring urgent treatment, and by promoting standardised data collection by councils. There is also potential to leverage from freshwater farm plans, which will also require capture of land management mitigations. These mitigations may include interventions for erodible soil stabilisation on land with high risk of mass-movement erosion, which will present an additional method for capturing aggregated private contributions to soil conservation. As local authorities oversee the use and management of land, including through freshwater farm plans, such management interventions will need to be considered and developed further given the complementarity.

The Soil Conservation and Rivers Control Act 1941 was intended to conserve soil and prevent erosion. However, its only current use is for flood mitigation infrastructure. It is unclear how effective this has been for soil conservation, given the ongoing and substantial soil erosion issues. Since the demise of the agencies that implemented the Act, soil conservation functions have deteriorated, resulting in a fragmented, inconsistent landscape of soil conservation operations.

The erodible soil stabilisation attribute also has relevance to existing policies and initiatives, including the National Environment Standards for Commercial Forestry and its erosion susceptibility classification, and the New Zealand Emissions Trading Scheme.

This attribute would also complement Action 6.6 of the national adaptation plan: “Implement the Sustainable Land Management Hill Country Erosion Programme,” which aims to support regional planning for, and treatment of, erosion-prone land (and, in turn, contribute to afforestation). Ultimately, and among other things, the attribute could formalise a policy framework and coordinate a range of soil conservation initiatives that adopt national data standards for aggregation purposes.

### **C2(iii): Iwi/hapū driven (eg, rāhui)**

Impact on this attribute by iwi and hapū is unknown, but this is likely to be part of community and catchment groups (see C2(iv) below).

### **C2(iv): NGO, community driven**

Community, and particularly catchment, groups are likely to affect this attribute by planting or retiring erodible land, but these efforts are not monitored or reported on regionally or nationally.

### **C2(v): Internationally driven (eg, obligations to Convention on Biological Diversity, Kunming-Montreal Global Biodiversity Framework)**

No monitoring or reporting on this attribute is directly driven by international obligations. However, New Zealand is a signatory to a United Nations Convention to combat desertification, which reports on land degradation (including erosion) neutrality (United Nations Convention to Combat Desertification Performance Review and Assessment of Implementation System Seventh Reporting Process Report from New Zealand, 2024).

# Part D – Impact analysis

## **D1: What would be the environmental and/or human health impacts of not managing this attribute?**

This attribute is urgent and important, because there is clear evidence that highly erodible land is vulnerable to irreversible soil loss. This contributes to soil degradation and can be detrimental to receiving environments, an issue that is predicted to be exacerbated by climate change (Basher et al, 2012; Neverman et al, 2023). Extreme events in the past decades – and particularly in recent decades (eg, Cyclone Bola in 1988, Manawatū-Whanganui storm in 2004, Cyclones Hale and Gabrielle in 2023) – have demonstrated the real urgency needed for soil conservation. These extreme events saw critical infrastructure damaged and significant crop and stock losses as a result of mass-movement erosion (McMillan et al, 2023). Considering the potential for more extreme events due to climate change, urgent reassessment is needed on whether existing soil conservation management has been sufficient.

## **D2. Where and by whom would the economic impacts likely be felt (eg, horticulture in Hawke’s Bay, electricity generation, housing availability and supply in Auckland)?**

Soil erosion can cause substantial damage to land, infrastructure and culturally significant sites, as well as primary production losses and degradation of receiving environments from excess sediment (Smith et al, 2022). Ultimately, this impacts the many ways soil is valued (Stronge et al, 2020).

The soft-rock hill country in the North Island is at particularly high risk of erosion, and this affects the receiving environments where eroded sediment can cause damage to infrastructure and croplands (Basher et al, 2012; Neverman et al, 2023).

Clean-up costs of extreme events should also be considered – that is, the cost of doing nothing. The annual expenditure on preventing erosion was estimated to be \$24 million in 2001, whereas the damage from erosion was (conservatively) estimated to be \$103 million (Krausse et al, 2001). More recently, the costs associated with landslides have been estimated to be at least \$250 million to \$300 million a year (Page, 2015; Rosser et al, 2017).

In the Manawatū catchment, the cost of implementing farm plans to promote soil conservation was estimated to be \$20 million (in total), with benefits of avoided sedimentation estimated to be \$4.5 million per year (Barry et al, 2014; Dymond et al, 2016). A case study in the Manawatū-Whanganui region estimated marginal costs of surficial and mass-movement erosion. It showed higher relative marginal costs associated with surficial erosion for all farm types (Soliman and Walsh, 2020).

### **D3: How will this attribute be affected by climate change? What will mitigating that require, in terms of management response?**

Climate change is expected to exacerbate the issue of soil erosion (Ministry for the Environment, 2018), with increasing storm magnitude and frequency contributing to large projected increases in soil loss and sediment yield (Basher et al, 2020), particularly in North Island soft-rock hill country (Basher et al, 2012; Neverman et al, 2023).



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