SOIL EROSION

NZ LANDCARE TRUST

Nelson City Council
te kaunihera o whakatū

WHAT IS EROSION?

Erosion is the stripping away of soil and rock from land.

The process creates sediment which is transported – usually by water and wind – down the slope from where it came, entering waterways.

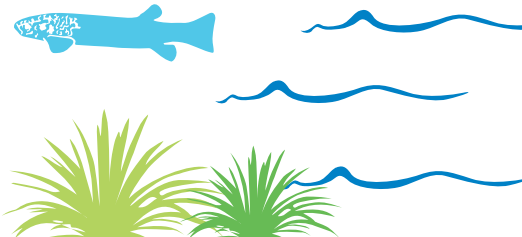
The process generally occurs only now and again and is usually associated with storm events, intense rainfall and the resulting flooding. The type of soil, climate, vegetative cover (trees versus pasture), topography and land-use practices all influence erosion. Erosion is a natural process, but removing vegetation and poor land use practices can speed it up.

- Most soil erosion happens on slopes steeper than 25 degrees.
- Tree cover significantly reduces the amount of soil erosion on steep country.
- Most erosion happens in storms where more than 250mm of rain falls in only two or three days. Smaller storms tend to clean out the debris left by larger storms.
- Slopes over 25 degrees need some tree cover to increase slope stability. Without the right level of tree cover we can expect a severe erosion event at least once every 10 years.
- Sustainable management of steep slopes needs lots of trees or much of the soil will be lost over time.
- More than 50 percent of the sediment which moves in big storms enters streams and rivers, leading to silting in coastal waters.

By controlling erosion, we prevent sediment from impacting on our rivers and seas

WHY CONTROL EROSION?

- Reducing erosion helps to reduce flooding, and protect the health and ecology of our streams, rivers and harbours.
- Eroded soils usually find their way into waterways. While soil is a natural substance, it's actually one of the most serious and common pollutants of our waterways.
- Sediment affects water quality, smothers creatures and shellfish, and silts up estuaries and harbours creating worsening flooding problems. Nutrients and bacteria carried with the soil can also be damaging in large amounts.
- For landowners, controlling and preventing erosion will maintain the amount of land available for production and also helps to retain the fertile soils and their nutrients on the farm.
- Soil erosion significantly lowers both short and long-term production and profitability. For example, where slip erosion has occurred the land will likely only ever regain 80 percent of its former production levels.
- Erosion can also impact on infrastructure – like roads or farm tracks – and result in potentially costly repairs or put farm structures at risk.



THE IMPACT OF LAND MANAGEMENT PRACTICES ON EROSION

Stocking rates

Increasing stocking rates increases the density of animals treading on pastures. Voids in the soil which allow air circulation and water drainage are compressed or eliminated. This not only lowers the infiltration rate of the soil, it also limits root transpiration and slows down pasture growth. Heavy stocking rates increase erosion risk while reducing pasture production, and these effects are more pronounced on wet soils.

Grazing pressures

High-grazing pressure may be used as a management tool to control weeds but if not managed with care will result in lost pasture production and increased erosion.

While pasture forms a continuous mat, individual plants of grass and legume species grow from a clump (crown). Where pastures are grazed hard, gaps between the plant crowns become apparent and bare soil is exposed.

Pasture recovery is also checked because removal of a high proportion of the green plant material reduces the amount of chlorophyll available to perform photosynthesis, the essential process of plant growth.

Stock tracks

Animals form regular pathways, particularly for access to water or between preferred grazing areas. Tracks are usually bare of vegetation and are recessed into the soil surface. As a result they function as drainage channels (rills) where runoff concentrates during storm events.

Cattle and deer often track along fence lines. Where fences are angled across a slope, a combination of stock-induced sheet and rill erosion can either bury fences downhill of a stock track, or undermine fences up slope of a track.

Stock camps and wallows

These are areas where stock congregate, usually to the detriment of pasture health. This generally results in bare ground, especially if a tree is present which may attract stock for shade and scratching purposes. Bare ground is frequently created around troughs. Stock may also wallow in shallow depressions or rub against embankments, also damaging the pasture layer.

GOOD MANAGEMENT PRACTICES ON PASTURELAND

Management factors can be controlled to ensure the on-farm erosion risk is minimised, while the pasture base of the farm enterprise is maintained at its most productive level. These objectives can be attained by using the following strategies.

- Maintain vigorous pasture growth, soil test regularly, apply fertilisers appropriately, and control pasture weeds.
- Oversow with improved, high yielding cultivars and/or those selected for specific site types.
- Consider oversowing rilled areas and stock camps with coarse, clump-forming grasses like Cocksfoot.
- Discourage soil compaction by stock treading, avoid high stocking rates and manage wet soils carefully.
- Monitor soil compaction with a Visual Soil Assessment kit.
- Try to avoid high grazing pressure at all times of the year. If necessary destock, provide feed supplements or seek grazing off the property.
- Site fences, troughs and gates to minimise stock tracking issues. Use deflector rails on problem fencelines.
- Situate vehicle access tracks carefully and manage their runoff.
- Site trees in paddocks with care. Avoid planting in the centre of ephemeral (runoff) channels on hill slopes or gully floors. Plant trees at five to seven metres off the centre of such channels.
- Use narrow-crown deciduous trees (eg hybrid poplar) for spaced plantings in paddocks.
- Plant several trees per paddock, but no more than 40/ha (i.e. at spacings of at least 15 metres) and prune to reduce shading.
- Retire and tree plant eroding gully floors.

PLANTING FOR EROSION CONTROL

There are several options for controlling or preventing erosion through planting of trees, depending on the land use, and the individual aspirations of each landowner.

This includes retaining pasture while planting more trees for shade and shelter to support stock, to small woodlots, or establishing native revegetation through either planting or reversion.

Dairy NZ has produced some useful resources about tree planting on farms which can be found online at dairynz.co.nz/environment/land-management/trees-on-farms/

Spaced planting of trees in pasture

Where pasture is retained and land is erosion prone, spaced planting can be used to not only address soil slip erosion, but will also provide much needed shade and shelter for animals. Trees planted for shade can reduce the amount of solar radiation impacting on stock by over 50 percent and can reduce temperature by up to 10 percent.

The lateral roots of fast-growing trees meet up throughout the top metre of soil. On flows or slumps up to five to six metres deep, they form a resistant layer – like a membrane – against outward or upward movement of the subsoil.

Where the failure plane is five to 10 metres deep, the mass of moving subsoil is greater so tree-planting alone is unlikely to suffice; it must be supplemented by drainage.

- Plant appropriate tree species on hill slopes and streambanks, either native or exotic.
- Ensure that the species you plant are not toxic to animals.
- Poplar and willow species are commonly used because they are fast growing, have extensive lateral roots, and the least canopy density. Ensure that an appropriate cultivar for the regional climate is used, and which will not become a pest problem. Good varieties for the Nelson region include Populus euramericana Veronese (Veronese Poplar) or Salix matsudana x alba Tangoio (Tangoio willow).
- Control and remove wild goats, rabbits and possums – they eat the vegetation, reducing the forest health.

For advice on planting poplars and willows, go to **poplarandwillow.org.nz**.

Close planting of trees on land retired from grazing

The root network of a close planting is much denser than that of a spaced planting, so is able to arrest a greater mass of moving subsoil. The de-watering effect of a dense coniferous planting may also help – a greater percentage of rainfall is intercepted by and evaporated from the tree canopy without ever reaching ground level.

Surveys have demonstrated that blanket afforestation does not totally prevent future movement, but reduces its area by 90 percent or more compared to an unplanted paddock.

There is an increasing interest in retiring land and returning steeper country to native forest. This has added benefits for biodiversity. While exotic species such as willows or poplars grow and produce the necessary root growth in a faster timeframe, a mixed native planting will eventually achieve the same outcome, particularly if land has not begun moving.

> “Control and remove wild goats, rabbits and possums – they eat the vegetation, reducing the forest health.”

Listed below are some of the species that might be used in the Nelson Region. These species are quick to establish and are able to do so on dry slopes.

- *Cassinia leptophylla*
  Tauhinu, Cottonwood
- *Coprosma lucida*
  Shining Karamu
- *Coprosma robusta*
  Karamu
- *Cortaderia fulvida*
  Toetoe
- *Dodonaea viscosa*
  Akeake
- *Griselinia littoralis*
  Papauma, Broadleaf
- *Griselinia lucida*
  Puka
- *Hebe stricta*
  Koromiko
- *Kunzea ericoides*
  Kanuka
- *Leptospermum scoparium*
  Manuka
- *Olearia paniculata*
  Akiraho
- *Olearia solandri*
  Coastal Tree Daisy
- *Phormium tenax*
  Harakeke, Flax
- *Pittosporum tenuifolium*
  Kohuhu

There are a number of resources available to landowners seeking to regenerate land into native forest. For more information, contact Nelson City Council.

PLANTING SMALL WOODLOTS

Many landowners are interested in planting woodlots as a means of both stabilising land, and providing income from the harvesting of diverse, and sometimes specialised, species of both broadleaved trees and conifers. If this is of interest to you, then the New Zealand Farm Forestry Association is an excellent source of information and support. You can find further information online at **nzffa.org.nz/farm-forestry-model/resource-centre**.

EROSION IN NELSON

Erosion occurs across the Nelson region, and is dependant on land use, soil type, and underlying geology. While erosion is a natural process, it is accelerated due to the change in land cover and how land is managed.

The following information outlines the different types of erosion that can occur throughout New Zealand. The most common forms of erosion in the Nelson region are sheet erosion, soil slip erosion, and streambank erosion.

Sheet erosion

This occurs when running water removes soil and organic matter from land which can be gently sloping, as well as on steeper slopes. Sheet erosion occurs particularly in areas where extended dry weather make it difficult to establish or retain pasture cover, and when it rains thin layers of soils are washed downslope in a dispersed pattern. The erosion becomes more pronounced as rainfall intensity increases.

Sheet erosion has a serious impact on crop yields and pasture growth, through the loss of topsoil and the nutrients contained within this.

Controlling Sheet Erosion

- Ensure that surface runoff water is removed safely and does not speed up or concentrate.
- Time any cultivation to when soil conditions are right and there is a low risk of erosion occurring.
- Ensure a healthy vegetative ground cover exists over the soil for as long as possible. Focus on improving soil fertility, soil organic matter, soil organisms as well as ensuring that the best match of species for your site.
- Adjust grazing pressure to match the soil conditions for example avoiding heavy stocking when risk of erosion is high.

Soil slip erosion

Soil and earth slip erosion

This is a shallow and rapid sliding or flowing movement of soil which moves downhill more or less parallel to the slope. Generally, this type of erosion is the result of an event such as an earthquake, or more often in the Nelson Region, following an intense rain event. It occurs on moderately steep to steep land formed on either ancient volcanic or sedimentary soils formed from sandstone or mudstone such as in the Stoke, Wakapauaka and Maitai catchments.

Soil slip erosion can occur on all types of terrain and under all kinds of land cover but is accelerated after the removal of native cover, which was the case following the widespread removal of native forests in the 1870's. Hillsides eventually stabilise, and are colonised by vegetation however a thick layer of mixed-up rock and soil remains beneath. Smaller slumps or earthflows may re-activate, during heavy rainfall or wet winters.

Controlling soil and earth slip erosion

Improving pasture growth by introducing deep rooting species and applying appropriate fertilisers will assist, but will not be sufficient alone. In addition:

- Space planting of trees in pasture to provide the soil with root reinforcements.
- Retire particularly susceptible areas from grazing and plant in trees or allow to revert to native cover.

Stream bank erosion

Stream bank erosion

This is a natural process as streams and rivers move and change their size and shape, transporting sediment and gravels downstream. However, as with other forms of erosion, this is accelerated due to land use and is a major contributor to sediment in rivers and estuaries.

The erosion of stream banks can be the result of the frequency and intensity of flooding, the type of subsoil in the stream banks, the amount and type of vegetation on stream banks, and the presence of stock which tread the banks of streams.

Controlling stream bank erosion

- Shrubs and trees with extensive fibrous root systems stabilise streambanks. Bank collapse is greatly reduced, and channel migration largely controlled, thereby protecting adjacent farmland and buildings.
- Dense vegetation, for instance rank grass or low shrub cover, traps silt and stores it temporarily on banks. Eventually, the build-up is scoured away and transported out to sea by a large flood.
- Exclude stock, particularly cattle, from streams.

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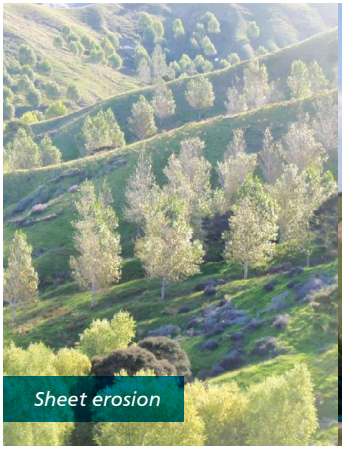
SURFACE EROSION

Surface erosion involves the movement of a thin layer of particles across the ground by water, wind or gravity.

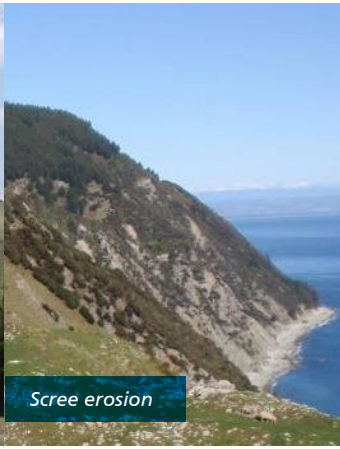
Sheet erosion (Sh): There is potential for sheet erosion on the steep to very steep slopes where there is very limited vegetation or on the soil slip erosion scars. Sheet erosion occurs where running water washes soil or organic material from the surface. The primary control of sheet erosion is by maintaining a vegetative cover through grazing management and soil fertility.

Wind erosion (W): Wind erosion is the detachment and transportation of soil particles by wind when the air-stream passing over a surface generates sufficient lift and drag to overcome the forces of gravity, friction and cohesion. Once a particle has been dislodged from the surface, it may be transported in suspension or by saltation or by surface creep.

Scree erosion (Sc): scree can develop in grassland where sheet and or wind erosion has removed the finer particle-sized components of the regolith . This exposes residual fragments of weathered bedrock, or it may result from rock falls where angular debris accumulates in an area of lower slope angle below disintegrating rock outcrops.


Sheet erosion


Wind erosion


Scree erosion

MASS MOVEMENT

Mass movement erosion includes a wide range of erosion types where material moves down slope as a more or less coherent mass under the influence of gravity.

Soil slip erosion (Ss): Slip erosion is a shallow and rapid sliding or flowing movement of soil and subsoil, exposing a slip surface which is approximately parallel to the slope. Debris comes to rest in the area from the base of the exposed slip to the toe of the slope. There can be some rotational movement, leaving a concave slip plane. The slip plane is usually less than onemetre (but sometimes up to two metres) below the original surface.

Soil slip erosion is most evident during or immediately after heavy rain. This is due to saturation of the soil, which increases the soil mass, lubricates the slip plane, and turns pore water pressure positive. The resisting forces are shear strength of the soil, cohesion of the material, and tensile strength of the plant roots in the soil.

The severity of the potential for slip erosion dictates effective control measures. Space planted trees will effectively control slip erosion where the potential is only slight to moderate. Higher potential requires closed canopy plantings such as afforestation or retirement.

Riparian slip (Rs): The rapid sliding of soil material off the steepened sides of streambanks or gorge faces. Often undercut by streambank or gully erosion.

Soil slip erosion

Riparian slip

MASS MOVEMENT (CONTINUED)

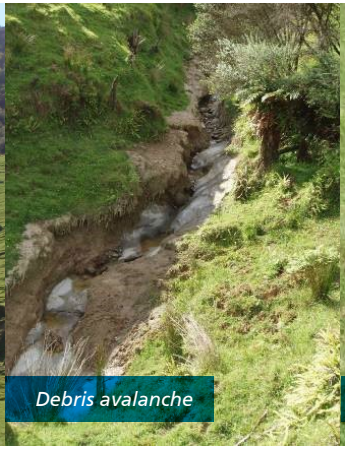
Earth-flow erosion (Ef) and Slump Erosion (Sl): Flows move across the surface rather than in an arc like slump erosion. The surface breaks into hundreds of hummocks, roughly aligned as arcuate ridges transverse to the direction of flow, and separated by tension Earthflow erosion is most common in conjunction with slump erosion and occur at the bottom of the slope where the watercourse continues to take out the toe. Control is by dewatering, space plantings and forestry. The key for stabilisation is to stabilize the toe.

Debris Avalanche (Da): Debris avalanche occurs when there is a sudden massive avalanche of material from above and it scours out a trail over which it crosses to the regolith.

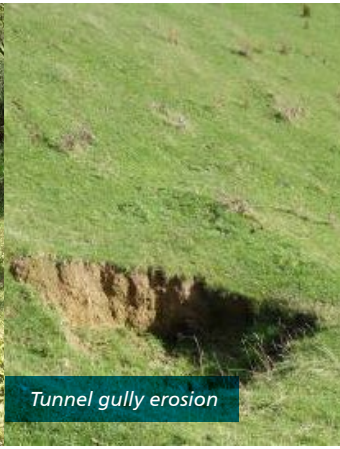
Tunnel Gully Erosion (T): Tunnel gully erosion is a compound erosion form initiated by the subsurface concentration and flow of water, resulting in scouring and the formation of narrow conduits, tunnels or pipes. Soluble, dispersive or low strength material is removed, ultimately resulting in collapses, visible either as holes in the land surface, or as gullies developed by collapse of pipes – followed by continued erosion.

When tunnel gully erosion problems are only slight to moderate, and occur as holes or depressions, remedial works can be undertaken by pole planting using poplars or willows planted directly into the tunnel gully hole. Where the erosion feature has formed collapsed gullies, pair plant poles or staggered pole planting can be carried out.

Earth-flow / slump erosion



Debris avalanche



Tunnel gully erosion

FLUVIAL EROSION

Fluvial erosion involves the removal of material by channelized running-water.

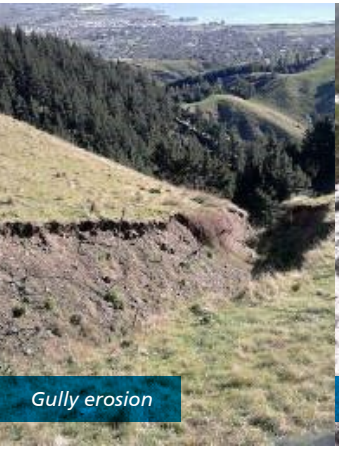
Gully erosion (G): Gully erosion is the removal of soil or soft rock material by water, forming distinct narrow channels which usually carry water during and immediately after rains. The main control of gully erosion is by controlling storm water run-off over the gully head and through the gully floor. The control techniques include drop structures over the gully head, plantings (space plantings of critical points or retirement), and reducing peak runoff rates with coffer dams.

Streambank erosion (Sb): Erosion occurs by the removal of soil or soft rock material by water, typically on bends where the water is undercutting the toes of the slope/bank. The main control of stream bank erosion is to amour these actively eroding bends with spaced planted willows, to reduce the undercut of the toe. The exclusion of stock from these areas will help to reduce the bare soil exposed to high water flows.

DEPOSITION

Deposition is a special category concerning the accumulation of waterborne material across large areas (e.g. silt deposition after flooding).

Deposition (D): Results from the inundation of flood waters which deposit flood silt/sediment onto a flood plain.


Gully erosion


Streambank erosion


Deposition

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