CORANGAMITE CMA SOIL HEALTH STRATEGY

Identification and management of soil erosion

Australian Government

Victoria The Place To Be

CORANGAMITE CMA
HEALTHY CATCHMENTS - HEALTHY WATERWAYS

Produced for the Corangamite Catchment Management Authority by the Victorian Department of Primary Industries

Cover Photos: Soil erosion presents a threat to natural and built assets in the Corangamite region.

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Introduction – Soil erosion

Soil erosion – by water or wind – is costly, with impacts on natural and built assets including infrastructure, water quality, biodiversity and in some cases, human safety.

It occurs because soils have not been protected from the forces of wind, raindrop impact or running water in sheets, rills, gullies or tunnels.

Wind erosion occurs on dry, exposed surfaces and can be aggravated by disturbance of the exposed soil surface by vehicular traffic, livestock (just walking for feed or water) or cultivation. The keys to controlling wind erosion are wet soil (not always feasible); surface cover (ideally by vegetation) and a lack of disturbance.

Erosion by water is much the more important form of erosion in the Corangamite region. Although a naturally occurring phenomenon – just one of the forces that has created the landscape – it is unwanted and uncontrolled soil erosion by water that creates costs for infrastructure managers, landholders, and local government - with a very significant but little-appreciated damage to all forms of life in streams, creeks and rivers that feed into water supplies and the wider environment.

Defining soil erosion. Soil erosion is the detachment, transportation and deposition of soil by water or wind. Eroded soil in transport is 'sediment'; sedimentation occurs when sediment is deposited. The rate of erosion depends on the climate, soil, topography, plant cover and land use.

It all starts with raindrops. Leaving wind erosion to one side, the first and most important stage in soil erosion by water is the impact of the raindrop.

Fig.1: Research has shown that rain falling at an intensity of 50mm/hr for 30 minutes generates sufficient energy to raise the top 10cm of soil to a height of 45cm.

How does erosion occur?

In simple terms, erosion occurs because the energy in water is sufficient to overcome the inertia and other forces that are holding soil particles in place.

The start – rain drops of sufficient size and/or intensity impact the soil, impart the energy they have acquired through falling, impact the soil surface and create disturbance. Water, failing to infiltrate, then starts to 'run' across the soil surface, wherever there is a gradient and gravity at work.

Step 2 – Sheet erosion – water movement across the soil surface begins sheet erosion. This can be over very small or very large areas. Generally, sheet erosion is associated with larger areas of shallow water moving across the soil surface.

Step 3 – Rill erosion – rills are small, eroding channels across the soil. They can be naturally occurring channels or indentations before erosion begins or they can be created - for instance from the ridges and valleys left by cultivation or other mechanical means. Water runs from sheets large and small into these channels. In this concentrated form, the running water now as small rivulets picks up soil particles and erosion begins.

Step 4 – Gully erosion – gullies are larger rills – sometimes many metres deep. They are generally steep-sided and can be metres deep, and cut through top soil into sub-soil layers and even bedrock. Most gullies form in natural drainage lines and are generally precipitated by clearing upstream which itself leads to sheet and rill erosion. Gullies can also be formed from the collapse of surface soil into an eroded sub-surface area.

Tunnel erosion – the most insidious form of erosion because it is generally taking place out of view, under the surface. Tunnel erosion is the subsurface erosion of soil that becomes apparent only when signs of subsoil appear on the surface or the tunnel collapses.

Impacts and Implications of soil erosion


Blocking of culverts


Blocking of flow under bridge


Loss of valuable topsoil


Reducing capacity of drainage


Tunnel erosion


Tunnel erosion

Sedimentation is a major impact of soil erosion. The implications of sedimentation include:

- Blocking of culverts with sediment reducing the flow of run-off water off site
- Blocking of flow under bridge resulting in bridge damage and failure
- Loss of valuable topsoil containing nutrients
- Reducing capacity of drainage basin causing diversion and flooding.

Tunnel erosion

The insidious nature of tunnel erosion makes it extremely dangerous when working machinery on areas affected by tunnels. Tunnels can also create structural problems if situated near building development.

Gully erosion will impact on and destroy public utilities including roads, communication lines, water pipes, etc. Gullies also disrupt access across cultivation paddocks and are a hazard for stock and machinery movement. Gullies are also a major contributor of sediment to the system.

Erosion on roads can be extremely dangerous for road users and creates a high maintenance requirement.

Wind erosion removes valuable topsoil and nutrients, with impacts on healthy living and towns. Wind erosion can also become a traffic by hazard reducing visibility.

Fig. 2: Examples of impacts caused by soil erosion.

Soil erosion in the field

Fig. 3: An example of sheet erosion.
Photo: Peter Dahlhaus.

Sheet Erosion on steep hills removes the topsoil and plant nutrients and develops a hard impermeable surface which increases the rate of run-off, creating further erosion problems down-slope.

Fig.4: An example of sheet and rill erosion.
Photo: Troy Clarkson.

Sheet and rill erosion can be a major contributor of sediment to public infrastructure such as roads and streams.

Fig. 5: An example of rill erosion.

Rill erosion in a paddock situation can create problems with paddock trafficability and concentrates water flow which, if unattended, increases velocity and leads to formation of gullies.

Fig. 6: An example of gully erosion.
Photo: Laurie Norman.

Gully erosion in a paddock situation can cause disruption to cultivation, stock movement and general access across the paddock. Sediment from the gully can impact on public utilities such as roads and bridges.

Tunnel erosion can cause havoc on building blocks. There was no sign of this problem prior to its collapse.

The first sign of **tunnel erosion** is yellow clay emanating from pop-holes or formation of silt fans. The final stage is the collapse of the tunnel and formation of a gully.

Fig. 7 & 8: Examples of tunnel erosion.
Photos: Peter Dahlhaus.

Fig. 9: An example of wind erosion.
Photo: Peter Dahlhaus.

Wind erosion destroys the soil structure and fertility by blowing away the fine soil particles which also contain soil nutrients. Wind-blown soil can impact on paddock structures such as fencing and water supplies, as well as public amenities, roads, houses and road safety during a wind storm.

Formal risk assessment in the field can be purely by observation of the landscape on site. Observations that can be useful in determining the potential risk of soil erosion occurring include:

- **Light coloured subsoil** can be highly dispersible and therefore prone to erosion if not protected.
- **Topography:** Steep slopes will discharge water faster reducing infiltration and increasing potential for erosion.
- **Length of slope:** Long slopes will allow run-off to gather speed and volume, increasing the potential for erosion.
- **Vegetation cover:** Bare soil will increase erosion potential by both wind and water.

Known extent of soil erosion sites in Corangamite CMA region

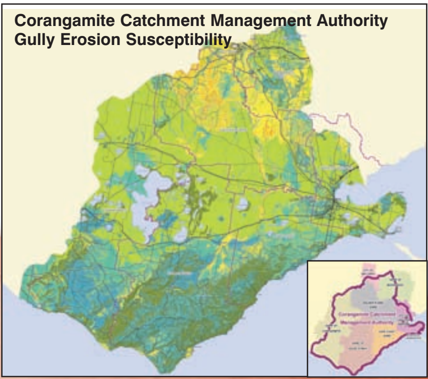
Please note: There is a series of CMA region-wide and Shire maps covering the different forms of erosion, including susceptibility maps. Shown below is a selection. Full details in the manual and from the website.

Tunnel Erosion Sites

Fig. 10: Known tunnel erosion sites in Corangamite Catchment Management Authority region.

Gully Erosion Sites

Fig. 11: Gully erosion susceptibility in in Corangamite Catchment Management Authority region.



Colac-Otway Shire Gully erosion Susceptibility

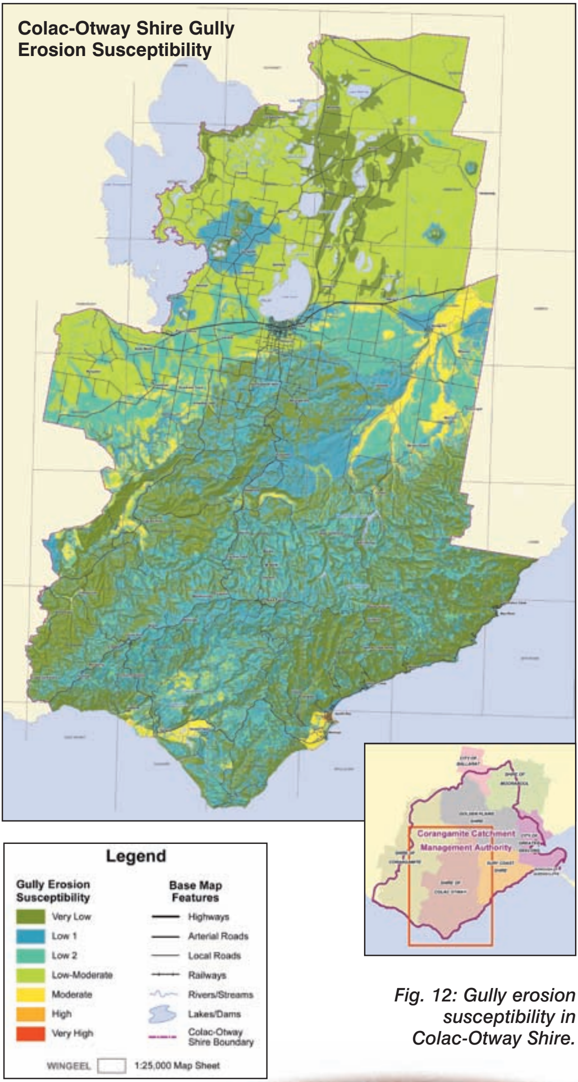
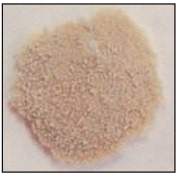


Fig. 12: Gully erosion susceptibility in Colac-Otway Shire.

Field recognition and on-the-spot tests

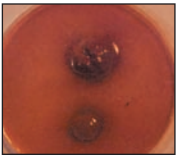
Soil Stability Test:

This is a simple test used to determine if the soil is dispersive and if it slakes. This is a modification of the laboratory-based Emerson Dispersion Test.You can carry out the test simply with rainwater or distilled water. Full details in the manual.

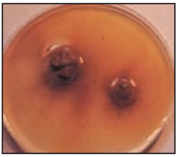


Unlike dispersion, **slaking** is a mechanical process and occurs when the soil structure is weak. When a dry soil is wet rapidly, water moves into pores within the aggregate and forces air out. The force of the escaping air causes the aggregate to burst. The soil microaggregates are washed into the soil and block soil pores and form a crust on the soil surface. In the field, soil crusting can be caused by slaking or dispersive soils.

Organic matter is important as a treatment for holding soil particles together and preventing them from slaking.



Complete dispersion
A cloud of dispersed clay covers the bottom of the dish and the aggregate has almost disappeared.



Incomplete dispersion
The dispersed clay spreads in thin streaks and crescents on the bottom of the container.

What does this mean for treating the soil?
In the field, a dispersible soil may suffer from severe crusting, erosion and poor drainage. When wet, the soil loses all structure with the clay particles dissolving in water. This means the soil can be easily transported, leading to all types of water erosion - including tunnel erosion – and high impact on water quality.

Fig. 13: Soil aggregates dispersing and slaking in water.

Road construction and soil erosion

Roads are a major source of erosion and sediment. Gravel roads have an inherent potential for causing erosion. They have a surface, batters and table drains of subsoil material which is frequently erodible and exposed to splattering action of raindrops.

Fig. 14: Gully erosion forming along a road side. Photo: Peter Dahlhaus.

Roads have a surface, batters, and tabledrains of subsoil material which is frequently erodible and continually exposed to erosion by rain and surface run-off. Note that this road has no apparent opportunity to divert run-off away from the road.

Location of roads

Careful location of a road can significantly reduce its construction, drainage and maintenance costs.
Where the velocity of water is doubled, its capacity to erode and transport sediment increases 64 times. It is therefore important to provide more drains and use gentle gradients wherever possible.

Road maintenance

A considerable amount of careful planning and work goes into construction of a stable road free of accelerated erosion, but this continued state is often destroyed by poor maintenance.

The four most common problems are:

- Failing to re-open mitre or cut-off drains blocked by road surface grading
- Leaving an unnecessary ridge or bank of graded earth or gravel along the outside edge of the road so that the water cannot flow freely off the road but concentrates instead to scouring volumes and velocities
- Removing the toe of the cut-off batters whilst clearing out table drains with a grader. This often upsets the whole stability of the cut batter, leading to further undercutting by water in the table drains, causing either slumps or the onset of rill erosion
- Dumping unwanted sediment from drains, or material from cut batter slumps, where the table drain and other drains discharge at the end of the cut section.

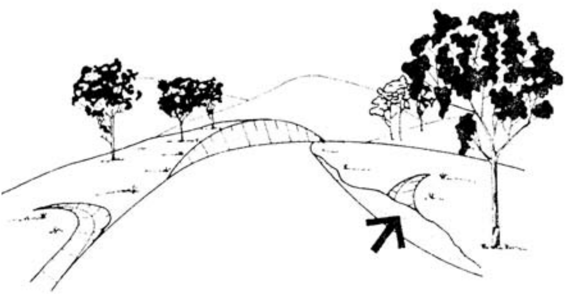


Fig. 15: A cut off drain blocked by road grading must be re-opened for effective road drainage.

Fig. 16: Removal of the toe of the cut batter during grading upsets the stability of the batter leading to slumping or rilling and blocking of table drains.

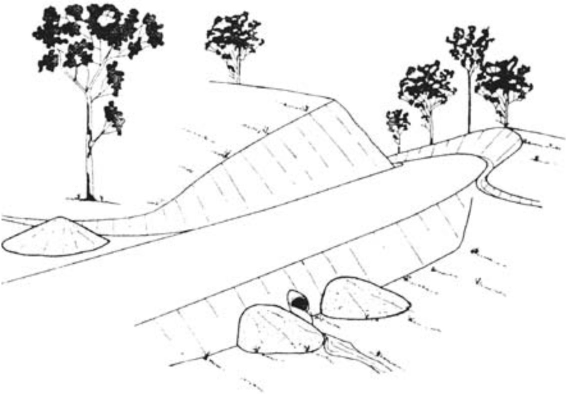


Fig. 17: Soil from the slumped cut batters or silted table drains should not be dumped near culvert or table drain outlets.

Key points to remember about SOIL EROSION

- As at April 2007 there are 5659 mapped erosion sites in the CCMA Region
- As a guide, positional accuracy may range from +/- 25m to +/-200m
- Also as a guide, there may be many more incipient or potential soil erosion that have not been identified by the surveying techniques used so far
- Many of the mapped sites intersect roads, railways or other infrastructure where human activity has created predisposing factors
- Further human activity may create triggering factors; climatic factors may also create 'triggers'.

Whilst the capture and collation of information and data is ongoing, the current number of mapped occurrences (as of April 2007) of erosion and landslide by municipality within the CCMA region is shown in the following table.

Municipality	Gully & Streambank Erosion	Sheet & Rill Erosion	Landslides
City of Ballarat	93	228	20
City of Geelong	178	288	117
Colac Otway	153	139	3,189
Corangamite	49	27	931
Golden Plains	1,603	777	48
Moorabool	709	1,125	379
Surf Coast	128	119	224
Other shires adjacent to the CCMA region	11	32	36
Totals	**2,924**	**2,735**	**4,944**
Overall total of erosion & landslide features = 10,603			

Individual erosion inventory maps have been produced by Corangamite Catchment Management Authority for each shire at both local government area scale and at 1:25,000 scale for individual map sheets.

Further Information

Contact your Supervisor who will have access to more detailed information on soil erosion from the Corangamite Catchment Management Authority. Additional information also available on the CCMA Soil Health Web site at **www.ccma.vic.gov.au/soilhealth**

Acknowledgement: Much of this information has been sourced from other documents and full reference is given in the accompanying training manual.

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For further information on Soil Health in the Corangamite region:
www.ccma.vic.gov.au/soilhealth

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