Gully Erosion

Gully erosion is a highly visible form of soil erosion that affects soil productivity and restricts access to and use of land. Soil eroded from a gully can impact on water quality and damage infrastructure.

Sediments generated by an eroding gully usually carry nutrients and pesticides (attached to the small clay particles). When these enter waterways, they can pollute waterways, threaten aquatic flora and fauna, and negatively impact on groundwater quality.

Infrastructure can be damaged due to sediments burying fence lines, silting up waterways, clogging road culverts and filling dams and reservoirs.

There are three aspects to gullies—gully head, gully sidewall and the gully floor. It is critical to understand which aspect you are addressing before implementing control works. Controlling gully erosion can be difficult and costly and for this reason prevention is the best strategy.

How Gullies Develop

Gullies are steep-sided watercourses that flow only during heavy or extended rainfall. Gully erosion is caused when runoff concentrates and flows fast enough to detach and transport soil particles. As runoff plunges over the gully head, it picks up energy and may form a waterfall. Splashback at the base of this waterfall erodes the subsoil at the gully head and causes the gully to eat its way up the slope.

Gullies generally have the capacity to accommodate far more runoff than they are likely to carry under normal circumstances. A watercourse is usually in a state of balance where its size, shape and gradient are matched to the flows it carries. If this balance is disturbed, for example by a larger than normal flow, a gully may start to form.

Gullies may also become wider due to slumping and scouring of the sides. This occurs most commonly on the outside curve of meanders when scouring of the toe-slope of the bank weakens the gully side and leads to soil falling away under gravity. Soil deposited in the bed as a result of this process is then washed away in subsequent flows.

When gullies are still active the sides are usually vertical. However, the sides generally become more sloping once the gully starts to stabilise. This process may occur naturally, but can also be sped up by gully treatment measures.

Image 1: Gully erosion.

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Secondary gullies or branches can be created by runoff entering a gully from the sides. This can result in what is known as a 'badlands' effect. The gully floor may cut down further as these secondary gullies advance up the channel. When this occurs, sediment deposits below the gully head will result in a 'step and stairs' pattern in the bed.

While high flows from intense rainfall are the biggest cause of gully erosion, prolonged low flows can also cause significant issues. Constant low flows through a drainage line can saturate the soil which structurally weakens it and makes it very susceptible to erosion. The wet conditions created by constant flows may also retard the growth of vegetation and reduce its ability to resist erosion.

The depth of the gully is often limited by the depth of soil to the underlying rock. On some erosion prone land in Queensland, soils are quite shallow and gullies are usually less than two metres deep. However, on deep alluvial and colluvial soils, gullies may reach depths of 10 to 15 metres.

Image 2: This gully has eroded to the depth of underlying rock.

Dispersive subsoils

Areas with dispersive subsoils are especially vulnerable to gully erosion, especially when the topsoil is disturbed. Dispersive subsoils are very common throughout Queensland. The topsoil in these areas is characteristically shallow, light textured and relatively stable with an abrupt change to a highly erodible clay subsoil that has a high exchangeable sodium percentage. When saturated by seepage flows or subject to splashback, dispersive subsoils will slump, leaving the topsoil unsupported. The topsoil then collapses and the process is repeated.

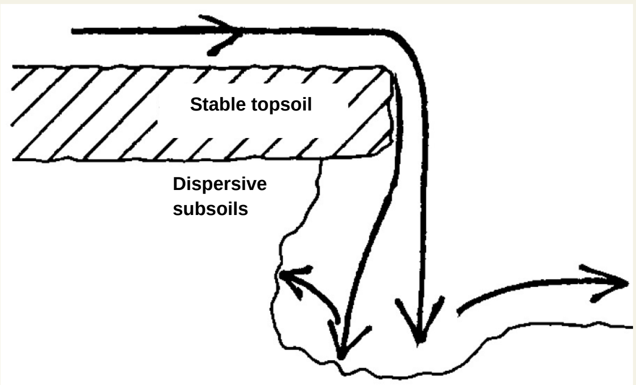

Figure 1: The process of gully formation in a dispersive subsoil.

Subsurface flow in dispersive soils can saturate gully sides, causing the walls to slump and the gully to expand. Under these circumstances the gully head can continue to advance with little or no surface flow. This process is comparable to the way a hole dug to the depth of the watertable in sand at the beach expands as the sides slump away. A simple way to test for dispersive soils is explained in the *Understanding Dispersive Soils* fact sheet.

Image 3: Dispersive subsoils are very vulnerable to gully erosion.

Tunnelling

Tunnelling can increase the rate of headwater and lateral expansion of gullies in dispersive soils. When dispersive subsoils are exposed, the amount of water flowing into cracks in the soil increases. This causes water to seep more rapidly into the soil and the cracks to enlarge. Cracks enlarged through this process can develop into tunnels. These tunnels (which carry a suspension of soil and water) eventually collapse causing the gully head to progress rapidly.

Image 4: Tunnelling is common in dispersive soils.

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Cracking clay soils

Cracking clay soils, such as those found on the Darling Downs and the Central Highlands are less prone to erosion than the dispersive clay soils described above. However, gullies can still develop in these soils.

Cracking clay soils characteristically develop cracks as they dry out. In very dry weather, cracks of up to 2 metres deep and 100 mm wide may develop. This may allow large slabs of soil to fall into the gully leaving vertical (or near vertical) sides. The cracks are interconnected laterally and when storm rainfall occurs, water penetrates the soil through the cracks and moves downslope. Eventually the soil will swell and the cracks close up, however this may not happen quickly enough to prevent large volumes of water from accumulating in cracks in the subsoil. If the water finds an outlet, the hydraulic head this creates may result in subsurface flow and cause tunnelling.

Image 5: Gully erosion in a cracking clay soil.

Saline areas

Saline areas are very susceptible to gullying. Salt in soil inhibits the growth of protective vegetation and increases dispersibility of some soils. On the positive side, the presence of an eroding gully may help to drain the area which could help reduce the impacts of salinity by lowering the watertable. For this reason, when controlling gullies in a situation such as this, it may be most appropriate to aim to stabilise the gully but not to fill it in.

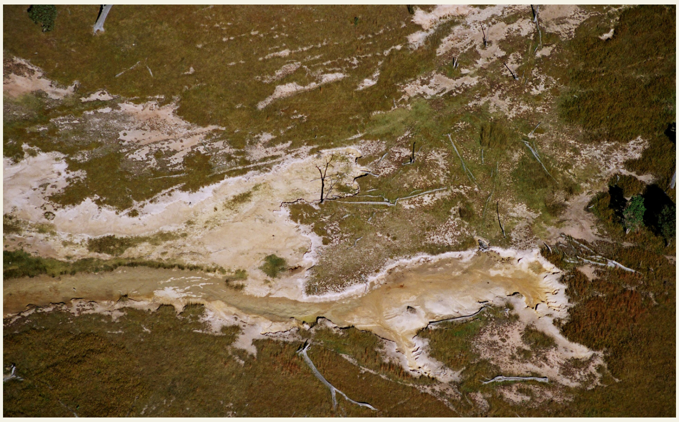

Image 6: Aerial view of gully erosion in a saline, scalded area.

Triggers of Gully Development

Gullies may be triggered by:

- Cultivation, grazing, fires or salinity exposing susceptible soils to raindrop action and runoff.
- Increased runoff due to changed land cover such as tree clearing in a catchment or construction of new residential areas.
- Concentration of runoff due to furrows, contour banks, waterways, dam by-washes, stock pads, fences, tracks or roads.
- Poor design, construction or maintenance of waterways or diversion of a drainage line to an area of high erosion risk (for example, a steep creek bank or highly erodible soils in cropping areas).
- Low flows or seepage over a long period.
- ‘Down-cutting’ in a creek causing gullies to advance up the drainage lines.

Image 7: Runoff from roads may cause gully erosion.

For more information on gully erosion, refer to *Gully Erosion: Options for Prevention and Rehabilitation* and Chapter 13 of the *Soil Conservation Guidelines for Queensland*.

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