6

Erosion basics

The word erosion is derived from the Latin *erodere* meaning to gnaw away. Soil erosion occurs when the soil is being ‘gnawed away’ by the forces of raindrop impact, water flow, wind and gravity. Essentially, these forces

- detach particles of soil
- carry or transport the particles
- deposit the soil particles.

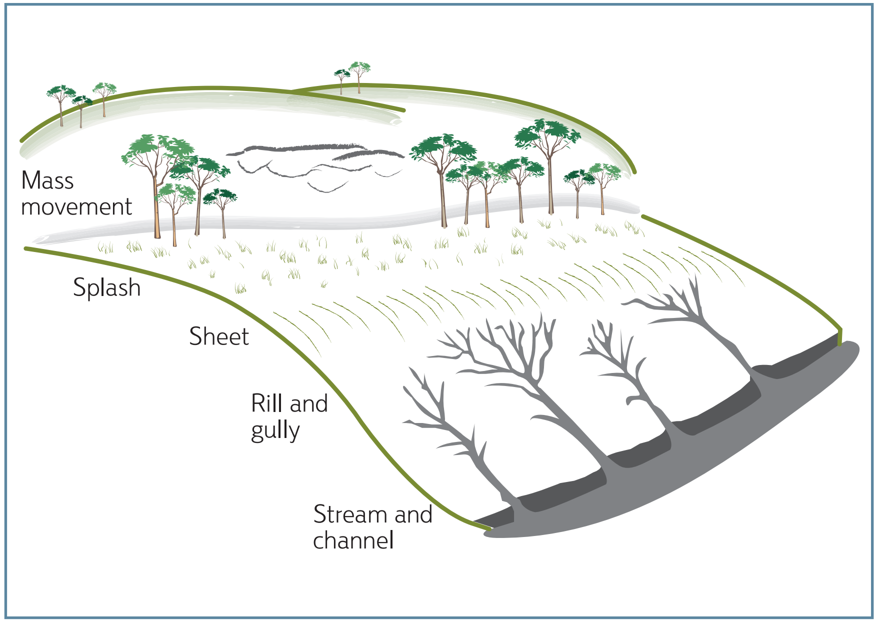
Erosion processes

When the velocity of the water or wind carrying soil particles is reduced, heavier soil particles drop out as sediment. Around 90% of sediment eroded by water is deposited on low lying land and in waterways, lakes and dams where it causes pollution and loss of aquatic habitat. The remaining 10% of sediment reaches the ocean. Sediment is the most common water pollutant in the world.

Types of erosion

Erosion takes many forms due to the effects of climate, topography, land use, groundcover and the erodibility of the soil type.

Types of erosion
Adapted from: http://www.cep.unep.org

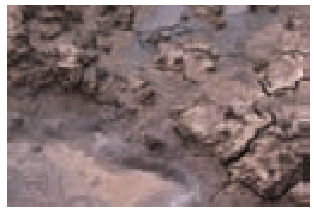


Splash erosion

Splash erosion

Splash erosion is the first stage of the water erosion process. It occurs when raindrops hit bare soil. The explosive impact breaks up soil aggregates so that individual soil particles are 'splashed' onto the soil surface. The splashed particles can rise as high as 60 cm above the ground and move up to 1.5 m from the point of impact. The particles block the spaces between soil aggregates, so that the soil forms a crust that reduces infiltration and increases runoff. Vegetation or mulch cover can reduce or prevent splash erosion.

Sheet erosion



Sheet erosion
Source: Col Begg NSW DPI

Sheet erosion is the removal of soil in thin layers by raindrop impact and shallow surface flow. It results in loss of the finest soil particles that contain most of the available nutrients and organic matter in the soil. Soil loss is so gradual that the erosion usually goes unnoticed, but the cumulative impact accounts for large soil losses. Early signs of sheet erosion include bare areas, water puddling as soon as rain falls, visible grass roots, exposed tree roots, and exposed subsoil or stony soils. Soil deposits on the high side of obstructions such as fences may indicate active sheet erosion.

Soils most vulnerable to sheet erosion are cultivated and overgrazed soils where there is little vegetation to protect and hold the soil. Vegetation cover is vital to prevent sheet erosion because it protects the soil, impedes water flow and encourages water to infiltrate into the soil. The surface water flows that cause sheet erosion may concentrate and cause rill erosion depending on the slope, soil surface and soil erodibility.

Rill erosion

Rills are shallow drainage lines less than 30 cm deep. They develop when surface water concentrates in depressions or low points through paddocks and erodes the soil. Rill erosion is common in bare agricultural land, particularly overgrazed land, and in freshly cultivated soil where the soil structure has been disturbed.

Rill erosion Source: Terrence Hudson

The rills can usually be removed with farm machinery. Rill erosion can be reduced by reducing the volume and speed of surface water with grassed waterways and filter strips, ripped mulch lines, contour drains and graded banks. Cropping systems that use minimal cultivation and retain more than 70% groundcover will prevent rills forming. Rill erosion is often described as the intermediate stage between sheet erosion and gully erosion.

Gully erosion

Gullies are channels deeper than 30 cm that cannot be removed by normal cultivation. They can be spectacular to look at, but in the long term they stabilise and cause less soil loss than sheet and rill erosion. Gullies occur when smaller water flows concentrate and cut a channel through the soil. Most gullies extend upslope as a result of the head of the gully being continually undercut and collapsing. However, collapse and slumping of sidewalls usually contribute a greater proportion of soil loss.

Tunnel erosion

Tunnel erosion occurs when surface water moves into and through dispersive subsoils which erode easily when wet. The tunnel starts when surface water moves into the soil along cracks or channels or through rabbit burrows and old tree root cavities. Dispersive clays are the first to be removed by the water flow. As the space enlarges, more water can pour in and further erode the soil. As the tunnel expands, parts of the tunnel roof collapse leading to sinkholes and gullies. Indications of tunnel erosion include water seepage at the foot of a slope and fine sediment fans downhill of a tunnel outlet.

Tunnel erosion Source: David Morand DECC

Wind erosion

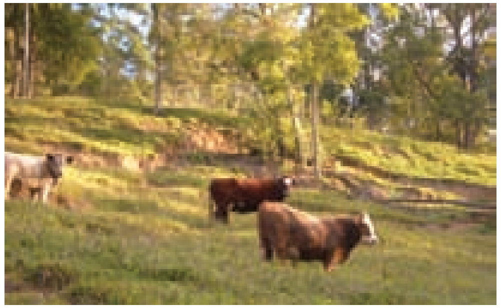
Wind erosion is the detachment and movement of soil particles by air moving at more than 20 kph. Wind moves the soil in two ways, suspension and saltation. Suspension occurs when the wind lifts finer particles into the air, leading to dust storms. Saltation occurs when the wind lifts larger particles off the ground for short distances, leading to the formation of sand drifts.

Wind erosion Source: Michel Dignand NSW DPI

Wind erosion tends to occur predominantly in low rainfall areas when soil moisture content is at wilting point or below, however all drought-stricken soils are at risk. Often the only evidence of wind erosion is an atmospheric haze of dust comprising fine mineral and organic soil particles that contain most of the soil nutrients. Actions to minimise wind erosion include improving soil structure so wind cannot lift the heavier soil aggregates, retaining vegetative cover to reduce wind speed at the ground surface and planting windbreaks. Landholders should be prepared for severe wind erosion in summers after dry autumns and winters.

Mass movement

Mass movement is the downward movement of soil and rock under the influence of gravity. It is most frequent on slopes above 25° with little vegetation and annual rainfall over 900 mm, and often occurs after heavy storms when soil becomes waterlogged and heavy.



Mass movement

Mass movement is common due to the region's geology and intense rainfall events. Factors increasing mass movement include erosion or excavation undermining the foot of a slope, weight loads of buildings or embankments, and loss of stabilising root systems and changes in soil water pressure through removal of vegetation. Remediation actions include diverting water away from slip-prone areas, fencing off suspect areas, and revegetating with trees and perennial pastures.

Streambank erosion

Erosion of streambanks can be caused by the erosive force of stream flow, which scours out the bank, or by bank collapse and slumping due to loss of vegetation and trampling of bank soil by livestock. Remediation actions include removal of livestock, revegetation and strategic bank or channel works.

Streambank erosion

Universal Soil Loss Equation

US scientists developed the Universal Soil Loss Equation in the 1950s to predict soil loss due to water erosion in agricultural fields. Using the equation, soil loss was calculated as the product of weighted factors for:

» rainfall erosivity
» soil erodibility
» slope length and gradient
» groundcover
» prevention practices.

While the first two factors are fixed for any particular situation, landholders can have a significant impact on the calculation by shortening slope length, establishing groundcover and introducing prevention practices.

The USLE has been extensively revised and is now known as the Revised USLE or RUSLE. It uses complex computer modelling to calculate erosion losses, and is the province of erosion specialists.

Erosion factors

Several factors contribute to soil erosion processes:

climate, soil erodibility, landscape, groundcover and land use.

These factors combine to determine a soil's erosion hazard. Each specific land use has its own erosion hazard.

The risk of erosion varies with land use and a site's position in the landscape.

Climate

Climate can be defined as the variability of weather conditions prevailing over a specific period of time for a particular region. In the region the principal climate factors influencing erosion associated with agricultural practices are rainfall, temperature and wind speed.

Rainfall factors

Rainfall erosivity is the capacity of the rainfall to cause erosion. Heavy, fast falling rain is much more erosive than gentle soft rain. Rainfall erosivity is the principal cause of soil erosion in the region where large amounts of rain can fall in a very short time. The region has the highest annual rainfall in the state. The table on page 144 shows mean monthly rainfalls in the region.

Frequency of rainfall

Rainfall frequency is defined as the number of rain days per month. If rain falls every day, and there is no sunlight to evaporate the moisture, soil becomes saturated, leading to runoff and possible surface erosion. In some cases mass movement of soil can occur, where water draining through the soil flows along a harder subsoil or rock, creating a slippery plane on which the heavy wet soil slides. In the region, the mean number of rain days per month varies from 6 in the drier months to 17 in the wet season, depending on location.

Intensity of rainfall

Rainfall intensity is measured by the amount of rain that falls within a given time. Severe storms can dump huge amounts of water in a short time, producing large volumes of fast-flowing runoff that scour the soil and carry tonnes of soil into waterways. Where there is intense rainfall over a longer period, there is much greater likelihood of erosion and mass movement. While exceptional rainfall events can occur at any time, the long term average monthly rainfall figures are the most reliable guide for planning on-ground activities that can disturb the soil or leave it devoid of groundcover for any length of time. This information helps landholders plan their activities for times when there is less potential for erosive rainfall.

Mean monthly rainfall (mm) recorded at selected weather stations since records were collected.

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alstonville	177.6	234.3	283.7	196.8	198.6	151.5	91.9	73.0	52.4	108.3	132.2	160.6
Armidale	104.5	98.6	65.0	45.9	44.4	57.1	49.2	48.4	58.7	79.6	109.6	89.2
Bellingen	180.2	199.6	217.3	153.7	119.0	108.6	79.4	57.6	56.2	96.2	111.9	137.6
Casino	134.7	158.9	149.5	95.6	79.6	66.5	58.3	42.0	42.1	69.6	85.7	114.8
Coffs Harbour	180.3	215.3	245.2	179.7	167.1	112.9	74.7	78.1	60.0	88.0	129.8	146.0
Glen Innes	112.6	92.1	71.9	43.0	48.4	55.8	54.3	50.5	55.5	79.3	86.9	107.5
Grafton	129.9	127.5	119.2	85.3	68.0	65.5	56.5	40.4	45.9	62.7	79.2	101.6
Kempsey	133.4	153.4	153.7	115.8	94.9	96.4	67.9	62.0	55.1	77.1	91.8	110.2
Lismore	155.4	183.6	188.4	129.2	115.3	97.0	80.3	54.9	50.4	73.2	94.1	121.3
Murwillumbah	189.7	234.7	223.9	170.0	150.4	88.0	70.7	50.0	39.3	84.9	124.4	158.6

Seasonal distribution of rainfall

Seasonal distribution of rainfall describes the rainfall pattern during the year. Traditionally, the region's rainfall is heaviest in the summer and autumn, and driest in the winter and spring. Landholders know that it is important to have groundcover in the summer and autumn months to protect the soil during expected periods of intense, erosive rainfall. However, the seasonal distribution is not entirely predictable, and unusually heavy falls can occur in the traditionally drier months.

Amount of runoff

Rainfall becomes runoff when the soil cannot absorb the falling rain. Once rainfall is greater than the soil's capacity to absorb it, water collects on the soil surface and runs off into drainage lines. As the water flows across the surface, the force of the flow detaches and transports soil particles. The topsoil often has greater infiltration capacity than the subsoil, so once the topsoil is saturated, runoff will increase because the rainfall cannot infiltrate the subsoil. This occurs particularly where there is a clay subsoil underneath a sandy topsoil. Continued rainfall on such a soil can cause severe erosion due to the high runoff.

Intense rainfall leads to erosive runoff. Source: Lynette Walters

Temperature and wind speed

While rainfall is the main climatic influence on erosion in the region, temperature also influences erosion. Hot dry weather dries out soils, particularly in areas further away from the coast, and makes the soils prone to wind erosion. Winds detach the dry soil particles and carry them either along the soil surface or in the air. Air haze seen in the region in dry periods is actually due to the presence of tiny suspended soil particles. The dry particles are also easily eroded by water when droughts break. Frosts can also influence erosion by killing off groundcover and making the soil more easily eroded.

Soil erodibility

Soil erodibility is the soil's susceptibility to erosion, and is determined by how easily soil particles can be detached and transported from the soil surface. Larger soil particles such as sand are more easily detached. Smaller particles such a clay are more easily transported. Highly erodible soils can be up to 10 times as susceptible to erosion as less erodible soils.

Soil location

Soils tend to erode differently in different parts of the catchment. Soil behaviour at the top of hillslopes is determined by the rocks from which the soil is derived. Soils lower down the slope comprise parent material and soil particles eroded from higher up the slope. Lowest parts of the landscape and hollows naturally tend to be wetter than other parts of the landscape. The higher soil moisture levels promote plant growth, so there is less erosion.

Tops of ridges

On the tops of ridges, soils have often eroded down to weathering rock, forming very stony soils. Soils remaining between the rocks are highly erodible due to their shallowness and to the minimal vegetation cover due to poor nutrient levels.

Upper catchments

In upper catchments where streams begin, slopes are generally steep. In times of heavy rainfall the force of water pouring down the steep slopes erodes soil in its path, often forming gullies. It is good management practice to leave vegetation intact on steep slopes to minimise erosion.

Lower slopes and floodplains

Soil eroded from the steep upper catchments settles out as the water flow slows down, depositing alluvial soils in valleys and floodplains. These soils are high in organic matter, usually fertile, sometimes poorly drained, with potential for erosion.

Soil texture

Soil texture is determined by the proportion of sand, silt and clay particles in the soil. Fine-textured soils high in clay have low soil erodibility levels because the clay particles are firmly attached to each other and not easily separated by force. However, in droughts they can dry out and be picked up by wind, creating haze. Self-mulching clays that break down naturally into small particles are highly erodible because the particles are easily detached by wind and water.

Coarse-textured soils high in sand are not easily eroded by water because rainfall can infiltrate them easily, so there is little runoff to detach and transport them. However, sandy soils are prone to wind erosion because the individual particles are easy to detach.

Medium-textured soils high in silt are the most erodible. These soils tend to produce increased runoff, and the soil particles are easily detached and transported.

Soil structure

Soil structure, the arrangement of soil particles and aggregates, has a great impact on erodibility. In soils with good structure, soil particles are bound together in aggregates by organic gums, and iron and aluminium oxides. The larger aggregates are hard to break apart into individual particles, and harder to move by water or wind. In soils with poor structure, the individual particles are held together by pressure, so are easily detached by the force of wind or water.

Well-structured soils with large aggregates like this one are less prone to erosion.

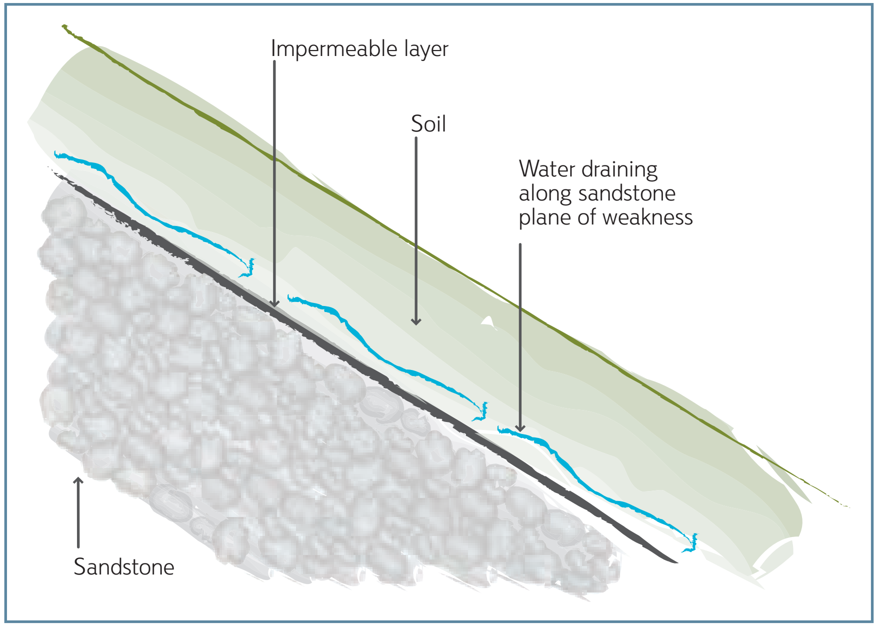
Organic matter (humus)

High humus levels in the soil helps soil particles aggregate into larger lumps that are heavier and more difficult for wind or water to move.

Soil permeability

Soil permeability affects how well water can move through the soil. Soils with low permeability increase runoff. In the region this is a particular problem where heavy clay subsoils underlie sandy topsoils because the movement of the water accumulating at the subsoil surface erodes the sandy layer above. It is also a problem in soils lying over clay or rock where the water flows along the underlying subsoil or rock, creating a slippery plane along which the heavy, saturated soil can 'slide'. Permeability is also reduced in soils with compacted layers caused by animal or machinery, or in soils with surface crusts.

Soil permeability



Seasonality

Soils vary in erodibility during the year. Soils are more erodible by water when soil moisture is high, because runoff is greater. They are more erodible by wind in dry seasons, because soils are drier and lighter, and particles are more easily detached.

Erodibility of Northern Rivers soil types

Dermosol

Source: David Morand DECC

Dermosols

These are well-structured soils commonly formed on basalts, but not restricted to them. They vary in depth up to 1 m, with a topsoil of clay loam to light clay and a subsoil of light medium to heavy clay. They are often dark and include the soils also known as chocolate soils. They are found west of Dorrigo, at Ebor, and east and northwest of Lismore including Kyogle and up to the McPherson Range. They are common soils of the steeper basaltic and sedimentary country, but also occur within alluvial plains.

Erosion hazard: Moderate to high depending on slope and groundcover.

Ferrosol

Source: David Morand DECC

Ferrosols

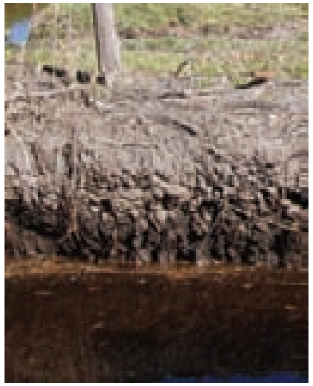
Ferrosols are friable red soils generally derived from basalt. As the name suggests, these soils are high in iron. Their red colour is due to high iron oxide content, which promotes good structure. The soil profile grades from a clay loam topsoil to a medium clay subsoil. These soils are often very friable and crumbly.

Erosion hazard: Prone to water erosion if left bare.

Hydrosols

These are wet soils of coastal and inland swamps. Those on the coastal floodplains often contain potential acid sulfate soils. These wet soils are generally characterised by a bluish grey subsoil, a reflection of the lack of oxygen available.

Erosion hazard: Given their location and high clay content, they are highly unlikely to erode. However, acid scalds may be subject to wind erosion.



Hydrosol

Source: David Morand DECC

Kandosols

These soils generally uniform throughout the profile and lack structure. They are usually loamy with a gradual increase in clay content at depth. Freshly turned, they are dull and dusty rather than shiny like clay soils. Differences in subsoil colour are due to several factors, including drainage and parent material.

Kandosol

Source: David Morand DECC

Red Kandosols occur in several isolated patches underlain by igneous, sedimentary and metamorphic rocks. The topsoil is sandy clay loam, changing to light clay at depth. They are generally very permeable, well-drained and highly erodible. In the region, they are found north west of Dorrigo, west of Sawtell, Bostobrick, and Round Mountain.

Yellow Kandosols are yellow due to poorer drainage, but the colour may only reflect that of the parent material. The topsoil is grey brown to brown and below that yellowish. They are found in the Macleay and Hastings valleys, and on alluvium derived from metamorphic rocks.

Erosion hazard: Highly erodible.

Kurosol

Source: David Morand DECC

Kurosols

These strongly acid soils generally have a marked textural difference between the topsoil (usually a sandy loam) and the subsoil (a heavy clay). They are also known as duplex soils because of this texture difference. They develop from sedimentary and metamorphic rocks. These soils are extremely erodible once vegetation is removed so are best left under natural forest cover.

Erosion hazard: Highly erodible once cleared.

Podosol

Source: David Morand DECC

Podosols

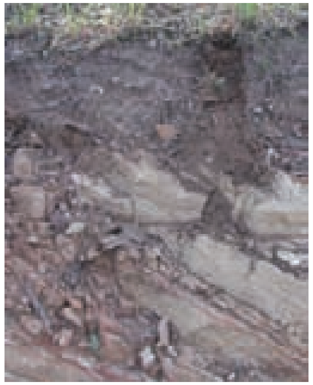
Podosols are sandy soils with a bleached horizon overlying subsoils that have accumulated organic matter or iron oxides. They are typical of older coastal sand dunes and sand plains, but can also be found inland, derived from granites and sandstones.

Erosion hazard: Erodible when dried out.

Rudosols

Rudosols are stony soils with no real soil horizons. They are found on steeper slopes where much of the soil has eroded away, and on dunes, and are also formed on recent sediment within floodplains. The soils saturate rapidly in heavy rain, leading to early runoff. They are highly erodible, particularly on slopes where there is minimal vegetation due to poor nutrient levels. These soils are best left under natural cover to reduce the erosion hazard.

Erosion hazard: Highly erodible.



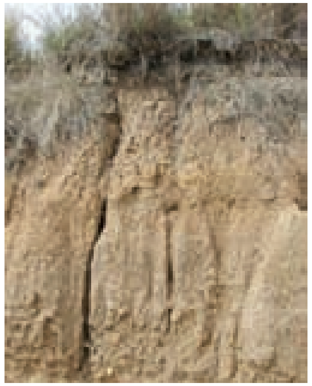
Rudosol

Source: David Morand DECC

Sodosols

Sodosols are mildly acidic to alkaline duplex soils with high levels of exchangeable sodium cations in the subsoil. When sodic soils are wet, each clay particle becomes surrounded by a significant water film which forces the particles away from each other. When this happens, the clay particles are said to have dispersed. The dispersed particles are seen as cloudy water in runoff. Dispersible soils are of concern to farmers because they are easily eroded by water. Erosion in sodic soils is often in the form of gully and tunnel erosion.

Erosion hazard: Extremely high.



Sodosol

Source: David Morand DECC

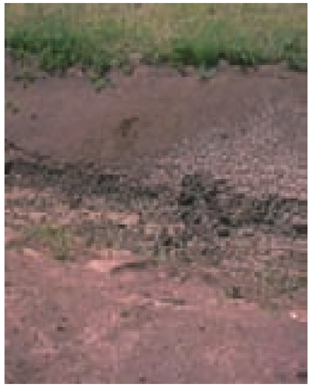
Tenosol

Source: David Morand DECC

Tenosols

Tenosols are shallow, stony soils similar to Rudosols, but with some soil formation evident (eg a colour change with depth).

Erosion hazard: Highly erodible.



Vertosol

Source: David Morand DECC

Vertosols

These soils are also known as cracking clays. The Richmond River floodplain between Casino and Coraki is dominated by Vertosols that are generally derived from basalt. Montmorillonite is the main clay mineral in these soils; leading to significant shrinking and swelling with changing soil moisture contents. Vertosols are often described as self-mulching due to the development of a fine aggregate assemblage on the surface.

Erosion hazard: Very low given its high clay content and low position in the landscape, but sheet erosion is common when groundcover is removed.

Soil tests for high risk soils

Sodicity and the dispersible soils that result increase the risk and extent of soil erosion. It is important to understand if your soils have these problems, especially when planning earthworks and constructing dams.

Field test for dispersion

- Place a small lump of soil in a dish of rainwater (not chlorinated tap-water).
- If a milky cloud appears around the lump as it breaks down, the soil is probably sodic.
- Avoid constructing any structures in these soils if possible.
- If construction is necessary, get the soil laboratory tested.

Laboratory tests will provide information of the extent of the problem, the possibility of and appropriate strategies for successful amelioration to reduce the risk of major erosion. Check with the laboratory to which you will send your soil sample about the information you need to provide and instructions on how to collect the soil sample.

Emmerson Aggregate Test (EAT)

This test is used to determine gypsum requirements to reduce crusting in cultivated soils, or to assess the suitability of subsoils for constructing water holding embankments.

The EAT test is based on observations of a soil crumb placed in distilled water. The soil is classified on a scale of 1 to 8, where class 1 soils are completely dispersible and class 8 the most stable.

The best result for dam construction is in the middle range, classes 3–5. This is because dam walls built from soils that disperse too much may fail due to piping and tunnelling, while those built from soils with too little dispersion will not compact and reform sufficiently to produce a seal.

Class 1 soils have a high susceptibility to tunnelling and should be avoided for the construction of embankments. Class 2 soils may be acceptable if treated with an ameliorant such as gypsum to reduce dispersion. At the other end of the scale, embankments constructed from soils with a score of 6–8 are unlikely to hold water without extra efforts to achieve compaction and an ameliorant such as sodium tripolyphosphate (STPP) to induce some dispersion.

Exchangeable sodium percentage (ESP)

Soils are considered sodic when the ESP is >6%. Soils with an ESP between 6–14% are moderately dispersive, and have been associated with dam walls failing due to tunnelling. Soils with an ESP >14% are highly dispersible and are highly susceptible to tunnelling, and also to surface sealing which makes them difficult to revegetate.

Particle Size Analysis (PSA)

PSA is used to classify the texture of the soil. Knowing the texture of a soil is very useful in predicting its behaviour in different conditions, its susceptibility to erosion and its permability – the speed at which water moves through the soil. The texture grade is a more specific classification than the soil types described on page 150.

In a PSA test soil aggregates are physically broken up and agitated into water, so that the laboratory can separate the particles into different fractions based on the size of the particles.

20–20000μm	sand
2–20 μm	silt
0–2 μm	clay

Particle size analysis is essential to determine the dispersion percentage of the soil.

Dispersion percentage

This test is used to identify whether earthworks in this type of soil are likely to fail due to tunnelling. The test estimates the percentage of the soil material (clay and fine silt) which is easily mobilised in water. Highly dispersible soils have a high dispersion percentage.

A PSA test must be undertaken first. A sample of the soil is shaken in water, the liquid drained off and the PSA analysis performed again on the remaining soil. The dispersion percentage is the ratio of the percentage of soil particles <5 μm remaining after the shaking in water test compared to the original PSA result.

The critical values for dispersion percentage in terms of a soil's suitability for earthworks depend on the proportion of clay (particles <5 μm) in the soil (table below). Earthworks and embankments constructed in soils with higher than critical dispersion percentage values are likely to fail due to erosion.

The critical dispersion percentage for soils depends on the proportion of small particles in the soil.

Total % of soil particles <5μm	Critical dispersion percentage
25	20%
30	33%
35	42%
40	50%
50	60%

Landscape

Land uses appropriate for the landscape with cropping on the river flats, a well-vegetated riparian corridor, grazing on lower slopes and forest on the steeper slopes. Source: Natalie Moore NSW DPI

Land use

Choosing an appropriate land use is the main consideration for landholders in preventing and managing soil erosion. In the first instance, this means choosing a land use appropriate to the slope. The more level the land, the more land use options are available. As the land becomes steeper, fewer land use options are practicable, particularly bare soil cultivation as cultivated soil is extremely vulnerable to erosion.

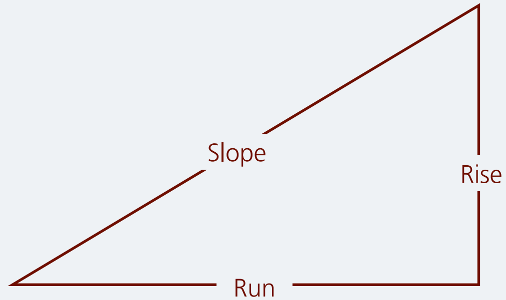
Slope length and gradient

Water erosion increases with steepness and slope length. The steeper the slope, the faster and more forceful the runoff. The longer the slope, the greater the volume of water in the runoff. Doubling the slope percentage approximately doubles the soil loss on slopes that are likely to erode. Slope has a much greater effect on rill and gully erosion than on sheet erosion.

Slope percentage and slope degree

Slope percentage is calculated as the rise of the slope divided by the run times 100.

For instance, the slope percentage of a slope that rises 1 metre for every metre of run is calculated as (1÷1) × 100 = 100%, which is equivalent to a 45° angle.



The table below gives some slope percentages and angle equivalents. In NSW slopes greater than 18° or 33% are defined as protected lands.

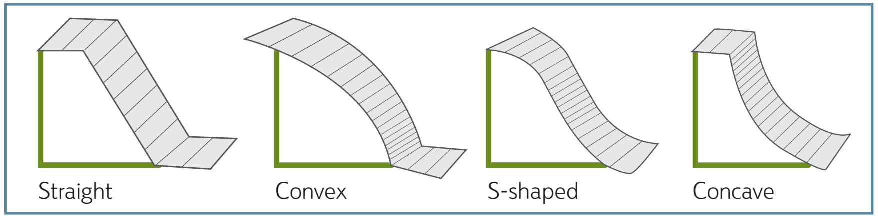
Slope percentage and slope degree

Slope (%)	5	10	15	20	25	30	33	36	58	100
Slope degrees	2.5	5.7	8.5	11.3	14	17	18	20	30	45
1 in	20	10	6.6	5	4	3.3	3	2.8	1.6	1

Slope shape

The shape of a slope indicates how stable it is. Straight slopes and S-shaped slopes tend to be more stable than concave or convex slopes. Erosion at a specific location on a slope depends on its distance from the origin of the surface runoff and the steepness at the location. If the location is far down the slope and runoff has accumulated from above, soil will erode quickly.

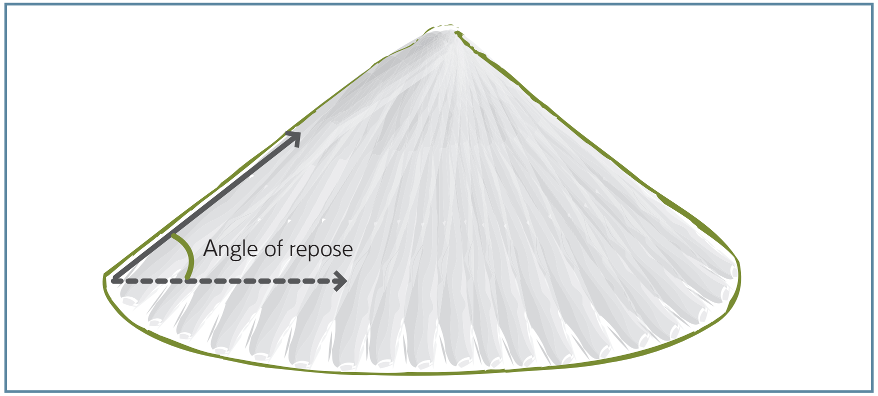
Slope shapes



Angle of repose

The angle of repose is the angle a pile of soil forms naturally with the ground. The maximum angle of a stable slope is determined by the shapes of the particles, their cohesion and friction. Soil that is steeper than its angle of repose is more likely to erode.

Angle of repose



Slope management recommendations

The following table indicates the standard land use for different slopes in the landscape. However, erosion potential also increases with soil erodibility and slope length and these factors must be taken into account. In the more western parts of the region, it is general practice not to cultivate areas with slopes greater than 10% (5.7°).

Erosion hazard and management practices for different slopes.

Slope (%)	Landscape	Erosion hazard	Runoff rate	Management
0	Level	Very low		
1	Nearly level			
2				
3	Very gentle slope	Not severe		Cultivation normally practised and erosion control readily achieved by conventional management and simpler control practices
4		Increasing erosion		
5				Cultivation practised but may need a range of erosion control practices including contour banks
6	Gentle slope			
7				
8			peaks ~ 8%	
9	Moderate slope	Rapid increase in erosion		Cultivation should be periodic with the protection of a full range of control practices including graded banks. Contour banks should be avoided as they tend to pond water. Pasture or forestry preferable.
10				
11				
12				
13				
14				
15				
16	Steep slope			
17				On slopes >16% native vegetation is preferable with carefully controlled grazing, if at all. Bench terraces allow cultivation.
18				
19				
20-25		Erosion rate peaks and levels off		
26-30				
>30	Very steep slope			

Legislation

The control of soil erosion in New South Wales is administered under several Acts. Current versions of all Acts are available through the Internet.

Soil Conservation Act 1938

This Act aims to protect catchment areas, rivers, lakes, lagoons, creeks, swamps and marshes from the effects of soil erosion, land degradation, siltation and sedimentation.

Native Vegetation Act 2003

This Act provides for the identification and mapping of areas that are vulnerable to soil erosion, sedimentation and landslip. The Vulnerable Land Natural Resource Management Plan, made under this Act, identifies three categories of such areas (known as 'vulnerable land'). The three categories are steep or highly erodible land, protected riparian land, and special category land. Clearing of native vegetation on these mapped lands requires approval except in particular situations specified under this Act. This Act includes provisions in Property Vegetation Plans to require work to prevent adverse impact on soils when clearing takes place.

Water Management Act 2000

This Act provides for the integration of the management of water with soils and other aspects of the environment. Water activities, works and use should avoid or minimise land degradation impacts.

The Act now incorporates provisions that were formerly included in the Rivers and Foreshores Improvement Act 1948 relating to permits under Part 3A of that Act.

Protection of the Environment Operations Act 1997

Part 5.3 of this Act prohibits the pollution of waters.

Fisheries Management Act 1994

Part 7 of this Act protects fish habitat, and prevents blocking of fish passage by construction of a dam, floodgate, causeway or weir, or otherwise causing an obstruction.

Environment Planning and Assessment Act 1979

This Act requires conditions of consent for erosion controls as part of development consent. Check with the local council before undertaking any work that disturbs soils.

Common Law

English common law recognises that the landowners have the sole right to possess natural resources on their land, and manage them how they wish, as long as exercising that right does not impact on the rights of adjacent landholders. This means landholders whose soil erosion impacts on adjacent land may be liable for the damage caused to the neighbour (Bates 2002)[1].

1 Bates, G., 2002. Environmental Law in Australia, 5th edition. Reed International Books. Chatswood