

Soil erosion by water

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While a low level of soil erosion is essential for soil and landscape development, accelerated rates deplete soil and damage downstream lands, habitats, roads, dams and ports and estuaries. Accelerated rates result from inappropriate land use, or ill-considered disturbance of soil.

This Note describes the process of soil erosion and outlines some control principles for land managers.

What is erosion?

Erosion (the word) is derived from the latin *erodere*; to gnaw. And that's what it is, the steady chewing away and removal of soil material.

What are the consequences of erosion?

- Loss of physical material reduced depth for plant roots, less soil moisture stored for plant use, and depletion of nutrients and organic material
- Lowered plant growth and less organic cycling
- Erosion products moving down the catchment and accumulating on lower lands, reducing stream health, and damaging public utilities such as roads, dams and ports.

Why does erosion occur?

It very much depends on the power balance between the rainfall (or the runoff) and the soil.

Rain and its runoff provides the force to drive water erosion. If the force applied to the soil is greater than the resistance of the soil, then particles will detach and move away in either splash or in surface flows. As the force increases so does the rate of detachment.

This gives the first clue to keeping erosion down to acceptable limits. We can do very little about reducing the force applied by the rain, but we can work at dissipating its energy before it reaches the soil surface.

How does erosion occur?

Gravity drives the erosion system. It does this by giving the power to falling raindrops or running water to detach soil particles and carry them away down the catchment.

Rain drops

Raindrops usually about 2-5mm in diameter. Figure 1 gives a representation of a drop at full speed.



Figure 1. A raindrop about to hit unprotected soil

The bigger the drop, the faster it falls. The larger drops can strike soil at about 30 km per hour.

If a 50 mm storm was all composed of 5mm raindrops, each square metre of soil would be hit by 1000 0.5g drops each traveling at 30 km per hour.

When a drop hits bare soil energy is transferred directly to the soil. This energy breaks bonds between soil particles and splashes small detached particles up to 150mm from the impact point.

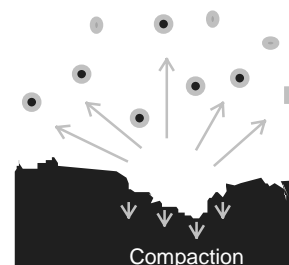


Figure 2. A raindrop hitting unprotected soil

This illustration assumes that the raindrop has direct access to exposed soil.

If the soil surface is covered with plants or mulch the raindrop energy will be intercepted and absorbed before reaching the soil and the detachment and splash illustrated in Figure 2 will not occur.

Runoff

Where the rain falls faster than the ability of the soil to absorb it, water builds up at the surface and runoff starts.

The compacting effect of rain impact will often speed this up by partly sealing the soil surface.

If the land is relatively flat water moves at a leisurely rate and will either shear off soil particles, or carry those splashed up as a result of rain impact.

However, if the land slopes, gravity causes runoff to move rapidly down hill.

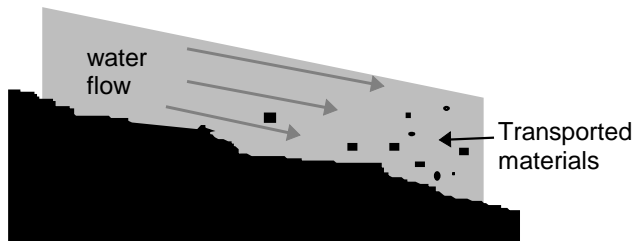


Figure 3. A flow of water applying stress to the soil surface

It will follow grooves and depressions and form itself into little channels. The faster the flow the more potential for scour and transport. The more channelised the route the faster the flow. The steeper the slope the faster the flow.

Scouring

Water flowing across a soil has the potential to scour materials from the surface. The faster the water flows the more potential there is for scour.

A clay loam is susceptible to scour by water moving about 800mm/second and above while a fine sand will be susceptible from about 400mm/second.

Doubling the velocity will increase the scouring potential by 16 times.

Transport

Flowing water transports detached soil particles. The smaller the particles the more readily they are transported. Doubling the velocity increases the transport capacity by 32 times.

A simple representation

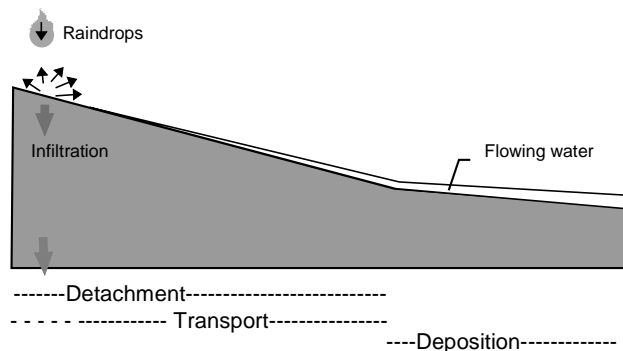


Figure 4. A simple model of hillside erosion

The role of vegetation and mulch cover

If raindrops (or runoff) do not have direct access to physical soil, the power can be dissipated on the covering materials and the water then passed to the soil with low energy levels. This can effectively eliminate erosion if cover rates are high

Additionally, vegetative cover will cycle organic decomposition products into the soil increasing the health and structure of the soil.

Erosion control principles

As a consequence of the above discussion there are four basic principles for erosion control:

1. Dissipate the power of the rain, by intercepting with vegetation, mulch or other materials
2. Minimize the rate of runoff by increasing infiltration the soil and by maximizing the use of water by plants
3. Prevent runoff generating excessive power by controlling slope, and stopping the accumulation and concentration of flows, and
4. Increase the resistance of the soil by increasing its structural strength by raising fertility (via organic cycling) and incorporating sound tillage practices.

Approach to erosion control

These principles translate into the following:

- Infiltrate and transmit rain through the soil where it falls
- Use as much water as is possible on site
- Maximize soil cover by controlling the total grazing pressure or tillage and weed control practices.
- Maximize organic activity
- Use cultivation sparingly
- Match land use with the capability of the land type to support that use.

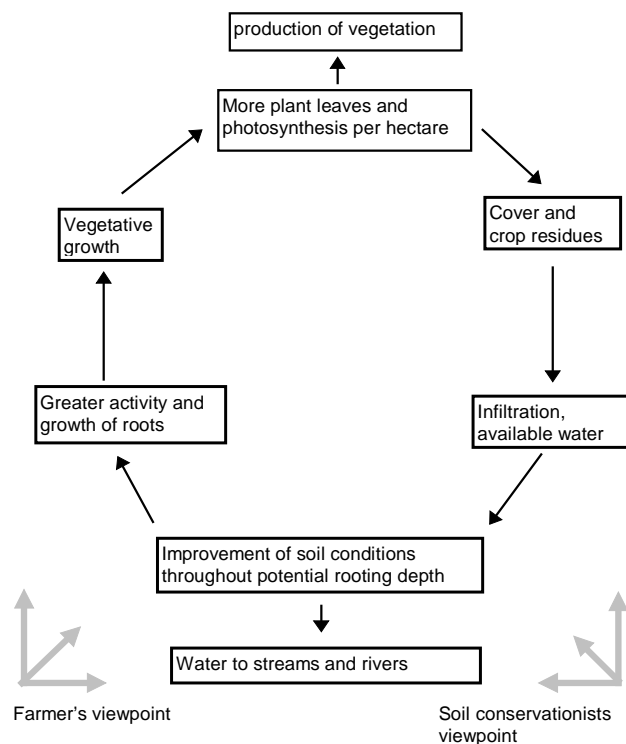


Figure 5. Soil erosion control and property productivity

Further information

Consult your local office of the Department of Natural Resources and Environment

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