Why Is My Forest the Way It Is:
Soil Erosion

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The forest you currently see on your property is the way it is because of a combination of factors that shaped it as it was growing. The most important forest shaping factors are soil, climate, and human actions.

Soil Erosion

The single most important resource on your property is the soil that has built up over time. Soil is the basis of all plants and the wildlife they support on your land. Soil building is a long-term process, and effects of having soil lost or displaced through management activities can be so devastating that you must consider the impact of all activities on the soil. The soil present on your property is a vital component of its productivity and ability to grow trees. Loss of that soil through erosion reduces a site's productivity through loss of nutrients and the ability to hold water. Soil erosion negatively impacts down-slope ecosystems.

Although erosion is a natural process, it can accidentally be accelerated by forest management actions. The soil that erodes washes into streams, rivers, and lakes and creates water quality problems for people, fish, and wildlife.

In order to prevent excess soil loss, it's necessary to first understand how erosion occurs and what makes a forested area vulnerable to erosion.

Soil Erosion Mechanics

Soil erosion is the most common natural landscape forming process. Over thousands of years, erosion wears down mountains and deposits soil elsewhere to form plains, plateaus, valleys, river flats, and deltas. This type of erosion is known as natural erosion.

Erosion occurring at a rate that exceeds the rate of natural erosion is called accelerated erosion. Accelerated erosion can result from certain human land use practices. For soil to erode requires a combination of two factors - loose soil and a physical force that can transport the soil to a new location.

Soil particles are loosened in several ways. The impact of raindrops on exposed soil can detach soil particles as can soil freezing and thawing. Soil particles may be detached from a stream bank during high water. Detached soil particles are then transported to a new location by some physical force, including water, wind, ice, or gravity. On forested lands, this force is flowing water. Wind is also an important force for soil transport on agricultural lands as in the 1930s Dust Bowl.

Both the likelihood of soil particles coming loose and the amount and timing of flowing water determine how high the rate of natural erosion is in a given area.

Natural Factors Influencing Soil Detachment

Several factors influence whether soil particles are likely to be loosened or detached and, thus, become vulnerable to erosion. These factors include:

- precipitation
- vegetation and litter

- soil texture
- slope stability

Precipitation

The way in which precipitation falls on a forest determines the force it has to loosen the soil. Areas with low annual precipitation which comes in a few torrential downpours are extremely prone to erosion because the rain falls with great force. This is why there is a high rate of natural erosion in semi-arid and arid regions. Also, arid regions usually have less vegetation cover. Areas with high annual rainfall which falls in many gentle rains are less prone to erosion. High rainfall areas are usually well vegetated.

Vegetation and Litter

Soil with sparse vegetation is more susceptible to erosion. This is because the roots of plants, especially trees, bind soils and rocks together. Vegetation cover, leaves, and branches plus the top layer of organic matter covering the ground, known as litter, also acts to protect the soil from the force of intense rains.

Soil Texture

The texture of a soil describes the size of the particles within it. Soils with high silt and sand contents will detach most easily. Conversely, those with a high clay content are very dense and may repel water even when exposed. This is because the small clay particles have a lot of stickiness which binds them and the larger particles together.

Slope Stability

Soil at the top end of a slope is naturally susceptible to the force of gravity trying to pull it downhill. At one extreme, a landslide occurs when a large mass of soil becomes detached at the same time. Areas with highly unstable slopes typically have abundant landslides and high rates of mass erosion.

Slope stability is affected by:

- steepness
- shape
- water content of the slope
- slope modification

Slope Steepness: The steepness of a slope is a major factor in determining its potential for erosion. Generally, the steeper a slope the more susceptible it is to erosion and landslides. The existence of steep slopes may actually be a good indication of previous landslides. Very steep slopes, however, may be relatively stable because they are solid rock.

The amount of erosion that occurs is a response to the balance between gravity, which tends to move soil down slope, and the resistance of soils, rock and, vegetation, which tends to hold the materials in place. Activities such as road building and timber harvesting can affect the ability of soils, rock, and vegetation to resist movement.

Slope steepness is expressed as the angle of the slope in degrees (0 is flat; 90° is vertical) or a percentage (0 is flat; 100% is a 45° angle). See Figure 1. Since both are used, conversions are given in Table 1.

Figure 1. Degrees and percent slope

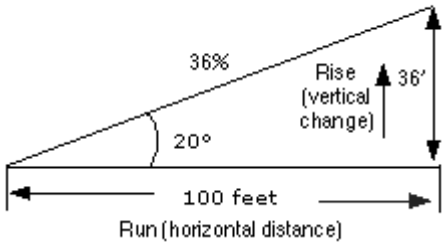


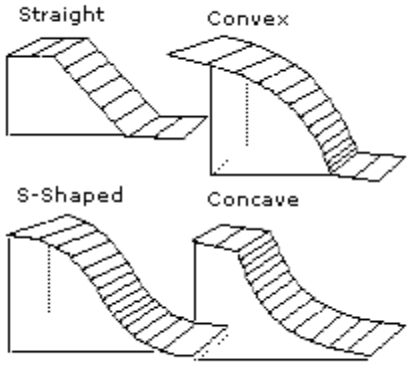
Table 1. Degree and percent slope

Degrees	%
0	0
5	9
10	18
15	27
20	36
25	47
30	58
35	70
40	84
45	100

Percent slope is defined as the change in elevation as measured over a 100-foot distance, sometimes called the rise over the run. For example, a one-foot vertical change over 100 feet of horizontal distance is a 1% slope. A rise of 36 feet over 100 feet is a 36% slope which equals 20°. Generally, slopes of 0-10% are considered gentle; slopes of 10-30% are moderate; and slopes >30% are steep.

Shape: The shape of a slope is a good sign of how stable it is. Straight and S-shaped slopes tend to be more stable than concave or convex slopes (Figure 2).

Figure 2. Slope Shapes



Water Content of the Slope: Slopes saturated with water due to precipitation or human activities like irrigation or removal of vegetation can be too heavy to withstand down-slope movement.

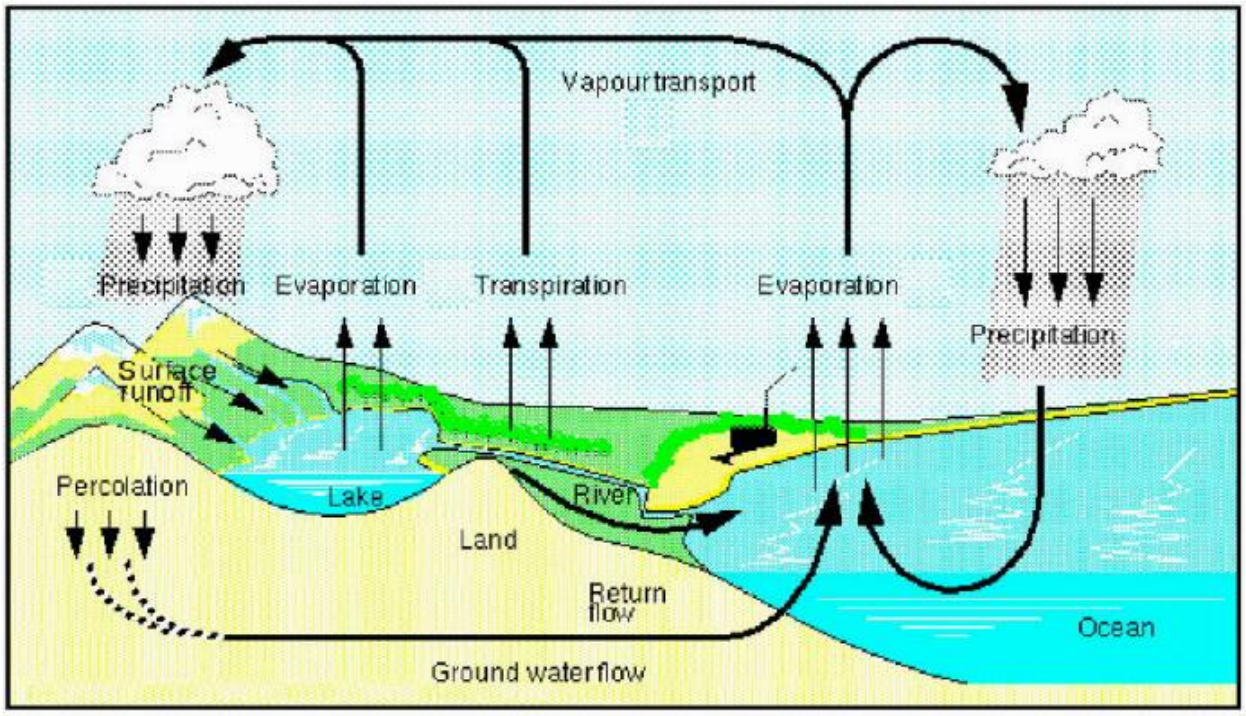
Slope Modification: Slopes that are undercut by human activities, such as roads and excavation, may be unstable. Steep canyon slopes may be undercut by the erosive actions of streams. Structures or material deposited on the top of slopes may contribute to an overloading that encourages down-slope movement.

Natural Factors Influencing Soil Transport

Once a soil particle is detached, it must then be transported some distance for erosion to take place. On forested lands, water is the primary transporting force. Preventing water from eroding the productive capacity of your land requires an understanding of how water flows.

Water flowing in streams or culverts on forest lands is in the midst of a continuous cycle from the atmosphere, to the land, and out to sea, which is called the hydrologic cycle (Figure 3). Simply, water evaporates into the atmosphere from the seas and condenses in the form of clouds. Water then returns to the earth as rainfall or snow.

Figure 3. The Hydrologic Cycle



Some of the rain that falls to the earth is retained in or on plants, soil, and surface water bodies. It then evaporates or is transpired by plants back to the atmosphere. Transpiration is the water evaporated by plants to cool their leaves.

Some rain seeps into the ground. This process is called infiltration. The remainder, called runoff, is carried to streams and eventually, returned to the seas. From here the cycle starts all over again.

When rain lands on the forest floor, some water infiltrates immediately into the soil. From here it is taken up by plant roots or is stored. The water which does not seep into the soil flows over the land down slope until it reaches a

stream, river, pond, or lake. It is this overland flow which has the ability to pick up detached soil particles and transport them off your property, leading to soil erosion.

Several factors influence whether soil particles are likely to be picked up by flowing water. These factors include the following:

- precipitation pattern
- soil litter layer
- slope steepness and length

Precipitation Pattern: The pattern of rainfall determines how much power it will have both to dislodge and to transport soil. Intense rains have more power to transport soil off site than gentle rain does. The seasonal distribution of rainfall is also an important factor. Heavy rains that fall in the winter when the ground is frozen will not find much loose soil available to transport. Those same rains falling in the summer will detach and transport quite a bit of soil.

Soil Litter Layer: The top layer of dead organic matter covering the ground, known as litter, acts to slow and hold falling rain. With a thick litter layer, more falling rain will be able to infiltrate into the soil, and there will be less runoff to erode soil particles.

Slope Steepness and Length: The greater the steepness of the slope, the more likely it is that rain will run off rather than infiltrate. In addition, the steeper the slope, the faster the water running over it will travel. Water with more speed has more power and can move more soil. The longer the slope before there is a change in the slope or barrier to water flow, the more potential the rain runoff has to gather speed and, thus, erosive power.

Amount of Natural Erosion on Forest Lands

In general, natural erosion from forested lands is quite small because of the protective influence of the soil litter layer, which increases infiltration and, thus, minimizes overland flow to streams. Working in opposition to this, however, is the fact that many forests are growing in rugged areas with extremely steep ground. In steep areas, slope instability produces a significant amount of erosion from landslides.

Another large contributor to soil erosion in California is flooding. Flood waters typically move very fast and so have a lot of power to scour their stream banks and beds. In some areas, the majority of erosion from forested lands happens in the winter during one or two large floods when stream banks collapse.

Amount of Accelerated Erosion on Forest Lands

Even forests which are being actively managed for timber harvest typically have low rates of erosion compared to agricultural lands if adequate vegetation is left to protect the soil and stream courses and to prevent slope instability. However, even a small amount of accelerated erosion can have a very harmful effect on fish and wildlife in forest streams. One important example of the consequences of soil erosion on wildlife is salmon.

Many species of salmon are in trouble today in part due to excess sediment in streams which has eroded from California's forest and agricultural lands. This is because salmon have evolved as a species in streams with natural rates of erosion. Accelerated erosion produces excess sediment which clogs up the gravels where salmon lay their eggs, depriving the eggs of oxygen and lowering their survival rate.

Preventing Soil Erosion

There are a number of steps that landowners can take to reduce their land's vulnerability to erosion and so safeguard its productivity and the fish and wildlife that depend on forest streams. Principally, accelerated erosion occurs from roads. Building roads well in the right location and maintaining them will go a long way towards reducing erosion.

Most of the California Forest Practice Act is designed to reduce the soil erosion from timber harvests. Erosion hazard ratings, buffer strips along water courses, and seasonal closures all help ensure that erosion is reduced.

Definitions

ACCELERATED EROSION: Erosion which occurs much more rapidly than normal, natural, geological erosion; primarily as a result of human activities.
HYDROLOGIC CYCLE: The cycle of water movement from the atmosphere to the Earth and back to the atmosphere through the various stages of precipitation, infiltration, transpiration, evaporation, and runoff.
INFILTRATION: The entry of water into the soil. Water not infiltrating the soil will runoff the soil surface as over-land flow.
LANDSLIDE: An event in which a large amount of soil and rock moves down a slope.
NATURAL EROSION: Wearing away of the Earth's surface by water, ice, or other natural agents under natural environmental conditions of climate, vegetation, and so on, undisturbed by humans.
PRECIPITATION: Water condensing from the atmosphere and falling to the ground as rain or snow.
RUNOFF: That part of precipitation that does not infiltrate the soil but runs off over the soil surface into stream channels.
SLOPE: The degree of deviation of a surface from horizontal, expressed as a numerical ratio, percent, or degrees.
SOIL EROSION: The detachment and movement of soil or rock by water, wind, ice, or gravity.
TRANSPIRATION: The water that plants absorb through their roots and evaporate through their leaves to cool them.

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