DSE3T

Soil erosion and degradation: Factor, Processes and Mitigation

Soil Erosion

Soil is the most precious gift of nature -Prime resource -for food, fodder etc. for food, fodder etc. It is the earth's fragile covering that anchors all life on Earth. It is comprised of countless species that create a dynamic and complex ecosystem and is among the most precious resources **to humans**. Human is an active agent for transforming the soil.

Increased demand for agriculture commodities generates incentives to convert forests and grasslands to farm fields and pastures. Human activities have increased by 10–50 times the rate at which erosion is occurring globally. Half of the topsoil on the planet has been lost in the last 150 years.

Excessive erosion causes both ***"on-site" and "off-site"*** problems. ***On-site impacts*** include decreases in agricultural productivity and ecological collapse, both because of loss of the nutrient-rich upper soil layers. In some cases, the eventual end result is desertification. ***Off-site effects*** include sedimentation of waterways and eutrophication of water bodies, as well as sediment-related damage to roads and houses.

Definition

Soil erosion is a gradual process of movement and transport of the upper layer of soil (topsoil) by different agents – particularly water, wind, and mass movement – causing its deterioration in the long term.

Soil erosion is the detachment, transport and deposition of soil particles on land surface. Also termed as ***Loss of soil***.

Soil erosion representing to loss of soil quantity. Measured as ***Mass/unit area***

The process of soil erosion is made up of three parts:

- **Detachment:** This is when the topsoil is actually "detached" from the rest of the ground.
- **Transport:** This is when the topsoil is relocated to another area.
- **Deposition:** Where the topsoil ends up after this process.

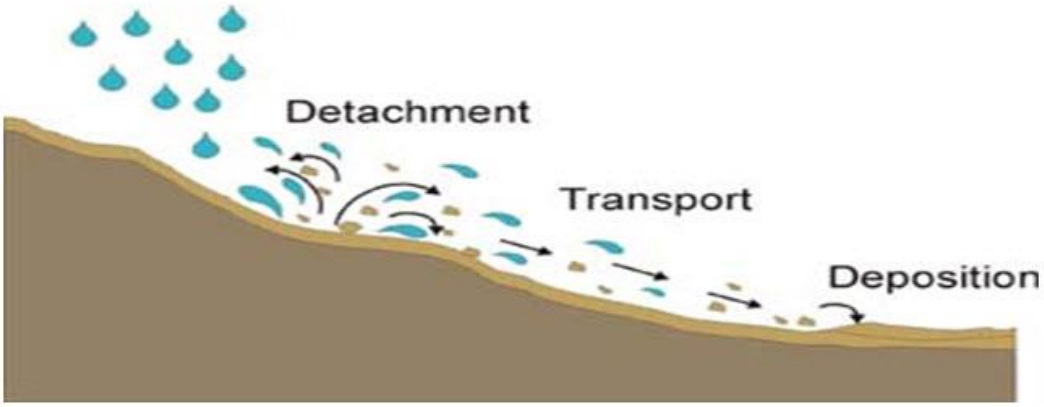


Fig. Process soil erosion

Soil erosion – function of:

- Erosivity – depends on rainfall
- Erodibility – property of soil
- Topography – property of land
- Management – contributed by man

Factors of soil erosion:

Soil erosion is the movement and transport of soil by various agents, particularly water, wind, and mass movement; hence climate is a key factor. Water and wind erosion are the two primary causes of soil erosion, land degradation; combined, they are responsible for about 84% of the global extent of degraded land. –

I. Physical factors:

A. Climate

1. **Rainfall:** frequency, intensity and duration of rainfall are fundamental factors
2. **Runoff:** Volume and velocity of runoff to detach and transport soil.
3. **Seasonal rainfall variation:** Seasonal changes of rainfall influence the erosion risk.
4. **Wind flow and storm:** Nature of wind flow and storms are frequent, intense, or of long duration, erosion risks are high.
5. **Temperature:** Seasonal changes in temperature influence the erosion risk.

B. Topography

The size, shape and slope characteristics of a watershed influence the amount and rate of runoff. As both slope length and gradient increase, the rate of runoff increases and the potential for erosion is magnified.

1. Slop
2. Steepness of slop
3. Length of the slop

C. Soil Characteristics

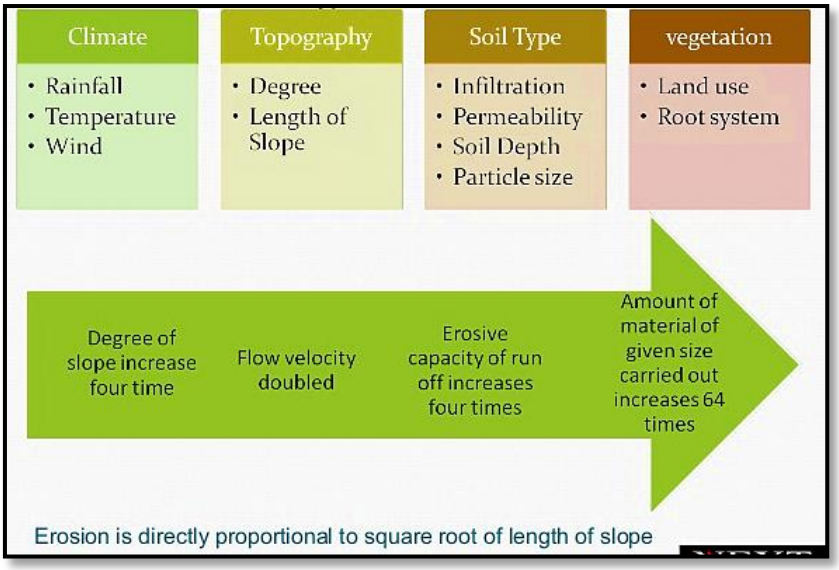
Soil characteristics influencing erosion by rainfall and runoff are those properties which affect the infiltration capacity of soil and those which affect the resistance of the soil to detachment and transport by falling or flowing water.

1. **Soil Texture:** (particle size and gradation): If soils clay and organic matter content of these soils increase, the erodibility decreases. **Clay acts as a binder for soil particles**, thus reducing erodibility.
2. **Organic Matter Content**: Organic material is the **"glue"** that binds the soil particles together and plays an important part in preventing soil erosion. It also influences the infiltration capacity of the soil.
3. **Soil Structure**: The way soil particles are held together, affects the soil's friability, the ease with which soil particles are detached by raindrops and runoff, and the resistance of the soil to the growth of roots and shoots.
4. **Soil Permeability**: Permeability is the soil's ability to transmit air and water. Soils that are least subject to erosion from rainfall and surface runoff are those with high permeability.

D. Vegetation Cover

Vegetative cover plays an important role in controlling erosion. Vegetation protect the soil erosion by:

- Shields the soil surface from the impact of falling rain
- Holds soil particles in place
- Maintains the soil's capacity to absorb water
- Reduces the velocity of runoff
- Removes subsurface water between rainfalls through the process of evapo-transpiration

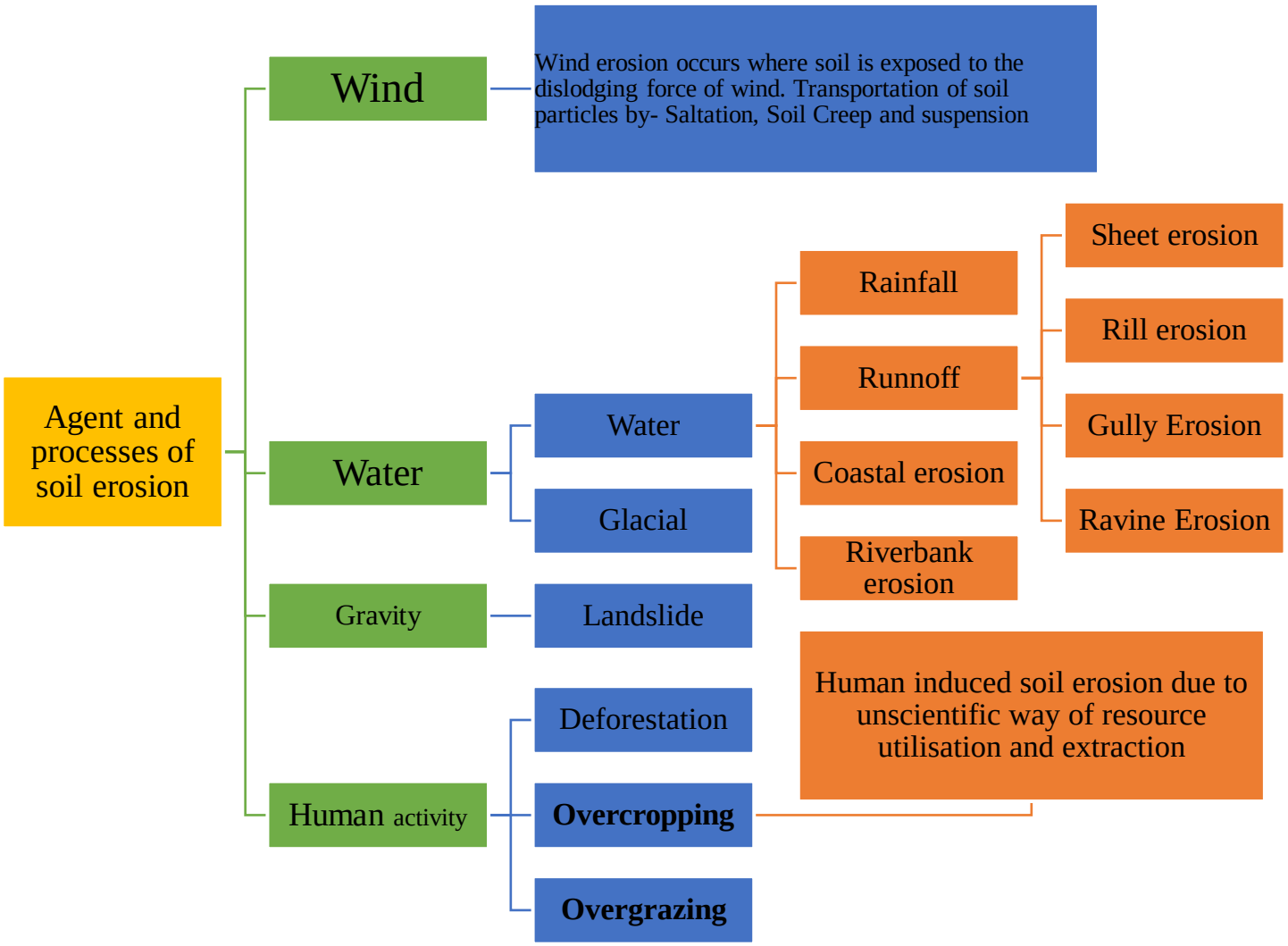


II. Human induced factors:

A. Alteration of natural land cover by deforestation, agriculture, resource extraction etc.
B. Cropping and agricultural pattern
C. Use of land and resources in unscientific manner
D. Over exploitation of land resource
E. Overgrazing of the vegetative cover and forest fires- Shifting cultivation – heavy rains wash away the bare soil from the slopes to the valleys below.

Agents and related processes of soil erosion:

Soil erosion by water is the wearing away of the earth's surface by the force of water and gravity, and consists of soil particle dislodgement, entrainment, transport, and deposition. Soil erosion occurs naturally by wind or harsh climatic conditions but human activities include overgrazing, over utilisation and deforestation.



Sheet erosion

Rill erosion

Gully Erosion

Ravine Erosion

River bank erosion

Landslide

Impact of soil erosion

A major problem with soil erosion is that there is no telling how quickly or slowly it will occur. The loss of fertile soil makes land less productive for agriculture, creates new deserts, pollutes waterways and can alter how water flows through the landscape, potentially making flooding more common. The effects of soil erosion include:

1. Loss of Arable Land- reduction in general health and productivity of the soil, reduction in the efficiency of plant nutrient use, damage to seedlings, decrease in plant rooting depth, reduction in the soil's water-holding capacity, decrease in its permeability, and increase in infiltration rate.
2. Loss of top productive soil
3. Drying of vegetation and extension of arid lands, increase in the frequency of droughts and floods
4. Soil compaction
5. Reduced organic amount and soil became infertile
6. Increase soil acidity levels
7. Water Pollution as well as Clogging of Waterways
8. Increases flood risk due to elevated river beds on account of deposition of silt carried by waters

METHODS OF CONSERVATION

Various methods of soil conservation may be broadly categorized into two types:

(1) Agronomic Practices
(2) Engineering practices

Agronomic Practices

This method involves protection of the top soil by special methods and schemes of crop cultivation. These are-

(a) Crop Rotation - It is a method of growing a series of dissimilar crops in an area sequentially. Here different crops are grown in the same area by rotation, that is, one after another. Crop rotation also helps in the improvement of soil structure and fertility.
(b) Strip Cropping – In this method, the cultivated crops and the cover crops are sown in alternate strips during the same peroid in the same field.

c. Contour farming- the practice of tilling sloped land along lines of consistent elevation in order to conserve rainwater and to reduce soil losses from surface erosion.

d. Terrace Farming- On hilly slopes, terraces act as bunds and prevent the soil from being washed away.

e. Shifting or Jhuming or slash and burn type of agriculture should be banned

f. Mulching- is a practice of covering the topsoil surface with organic materials like straw, grass, stones inorganic materials like plastics, etc. Reasons for applying mulch include conservation of soil moisture, improving fertility and health of the soil, reducing weed growth.

Engineering practices

a. Excavation of ditches – These are artificially created channel to divert the excess water. Two types of ditches are commonly made-
    1. Diversion ditches
    2. Interception ditches
b. Terraces construction – Terraces are large steps cut into a hillside. This reduces slope length and steepness to control the energy of running water and its ability to carry soil away.

c. Check Dams – Small(sometimes temporary) check dams are constructed out of various materials like stones,, timber, steel etc. to control erosion by reducing the velocity of water flow.

d. Windbreaks / Shelter Belts - Barriers formed by trees and plants with many leaves to control the wind velocity.

e. Contour Ploughing- Ploughing along contours on a slope prevents soil being washed away by rainwater or by surface run off. Contours act like bunds. Terraces are levelled into step like small fields with even slope.

f. Afforestation: planting of trees along the edges of the fields, the waste land and on steep slopes to prevent soil erosion as well as to enhance the capacity of the soil to retain water. increase area under forests and indiscriminate felling of trees must stop.

Soil degradation

Soil erosion has been considered as the primary cause of soil degradation because soil erosion leads to the loss of topsoil and soil organic matter, which are essential for the growing of plants. Soil erosion is a form of land degradation that accounts for 83 percent of the global degraded land. As much as 56 percent of the degraded land is affected by water erosion alone (Oldeman, 1991). **Most dominant soil degradation processes are soil erosion and organic matter decline.**

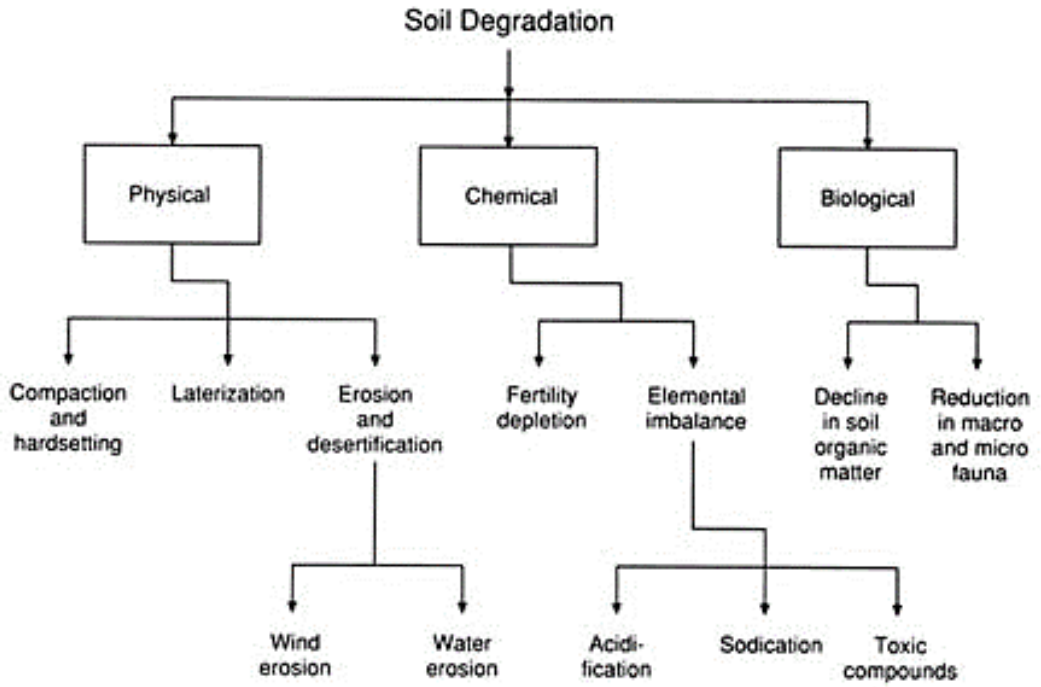
- Soil degradation is the inability of soil to support the growth of crops.
- Soil degradation is the **decline in soil quality** caused by its improper use, usually for agricultural, industrial or urban purposes.
- It is a serious environmental problem.

Soil degradation is the physical, chemical and biological decline in soil quality. It can be the loss of organic matter, decline in soil fertility, and structural condition, erosion, adverse changes in salinity, acidity or alkalinity, and the effects of toxic chemicals, pollutants or excessive flooding.

Types of Soil Degradation

Following are the Main types of Soil Degradation:

- Chemical Degradation
- Physical Degradation
- Biological Degradation



Causes of soil Degradation

Soil physical, biological, chemical and hydrological properties are degraded in different ways:

Key processes that result in degradation of soil physical properties include:

- Surface crusting and compaction through the impact of raindrops, animal hooves and farm machinery;
- Loss of topsoil structure through excessive tillage and loss of soil organic matter;
- Sub-soil compaction due to the passage of heavy farm machinery and/or ploughing to a constant depth.

Key processes that result in degradation of soil hydrological properties include

- Waterlogging involving a rise in the water table close to the soil surface due to poor irrigation practices, or loss of deep rooted vegetation whose water needs would have kept the water table low; and
- Aridification involving a decrease in soil moisture availability, typically due to reduced rain water infiltration following deterioration in the soil‟s physical structure.

Key processes that result in degradation of soil chemical properties include:

- Decline in the number and availability of soil nutrients (N,P,K, secondary and trace elements) e.g. through leaching, gaseous losses, removal in harvested products etc.
- Chemical imbalances and toxicities e.g. through application of inappropriate types and quantities of fertiliser, pesticides etc.;
- Changes in soil pH (acidification or alkalinisation);

- Salinisation (build up of salts through poor irrigation practices in crop lands and poor grazing practices in grasslands);
- Chemical pollution from over use of agro-chemicals, plastic mulches or poor management of industrial and mining wastes.

Key processes that result in degradation of soil biological properties include:

- Reduction in the numbers or activity of beneficial soil organisms such as bacteria, rhizobia, mycorrhiza, earth worms, termites etc;
- Increase in the numbers and activity of harmful soil organisms such as nematodes, parasitic weeds etc.

Consequence of soil degradation:

The effect of soil degradation is detected as a serious global problem. Its directly impacted on human society and their production system.

- Decline in the productive capacity of the soil (temporary or permanent)
- Decline in the soil "usefulness".
- Loss of biodiversity
- Increased vulnerability of the environment or people to destruction or crisis
- Accelerated soil erosion by wind and water
- Soil acidification and the formation of acid sulphate soil resulting in barren soil
- Soil alkalinisation owing to irrigation with water containing sodium bicarbonate leading to poor soil structure and reduced crop yields
- Soil salinization in irrigated land requiring soil salinity control to reclaim the land
- Soil water logging in irrigated land which calls for some form of subsurface land drainage to remediate the negative effects.
- Destruction of soil structure including loss of organic matter.

Mitigation

Mitigation is intervention intended to reduce ongoing degradation. This comes in at a stage when degradation has already begun. The main aim here is to halt further degradation and to start improving resources and their functions. Prevention implies the use of conservation measures that maintain natural resources and their environmental and productive:

1. Soil Erosion Control by- changing agricultural practices and engineering practices.
2. Water Harvesting (Watershed Approach), Terracing and Other
3. Engineering Structure like, Contour ploughing, Terracing, wind barrier etc
4. Landslide and Mine-spoil Rehabilitation
5. River Bank Erosion Control
6. Intercropping and crop divarication
7. Integrated Nutrient Management and Organic Manuring
8. Reclamation of Acid and Salt Affected Soils and Drainage (Desalinization)
9. Water Management and Pollution Control
10. Vegetative Barriers and Using Natural Geotextiles, Mulching and Diversified Cropping

11. Agro forestry
12. Conservation diversified agriculture practices