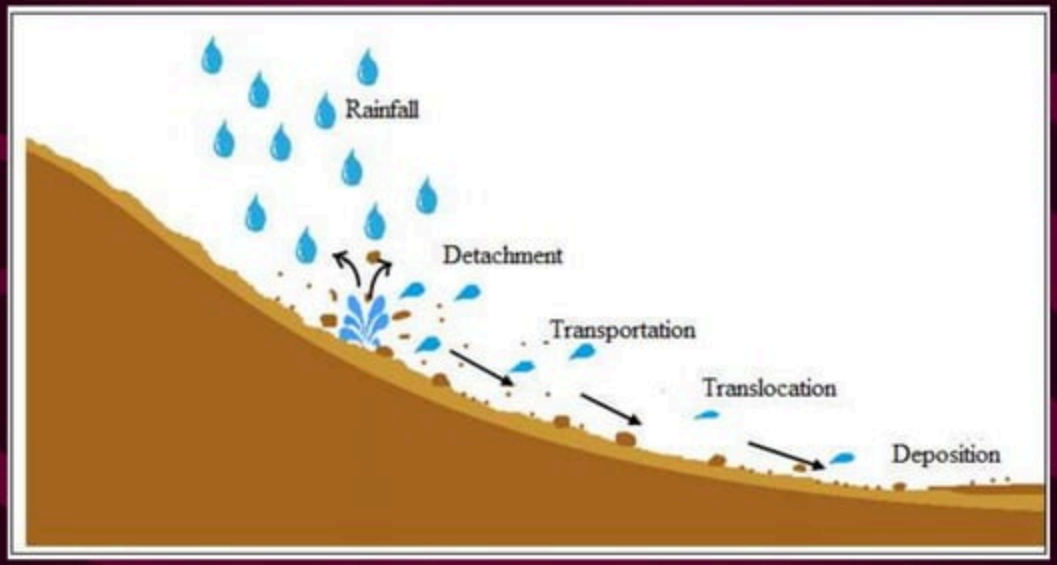
Soil Erosion

Soil erosion: Soil erosion is the detachment, transport and deposition of soil particles on land surface. Measured as Mass/unit area.

In general, soil erosion implies the physical removal of topsoil by various agents, including rain, water flowing over and through the soil profile, wind, glaciers or gravitational pull.

Land and water are the most precious natural resources that support and sustain the anthropogenic activities.

Mechanism of Soil Erosion



Harmful effects of Soil Erosion

- Top layer of soil contains most of the organic matter and nutrients, loss of this soil reducing soil fertility and affecting its structure badly.
- Soil erosion decreases the moisture supply by soil to the plants for their growth. It also affects the activity of soil micro-organisms thus deteriorating the crop yield.
- Wind erosion is very selective, carrying the finest particles - particularly organic matter, clay and loam for many kilometres. There the wind erosion causes losses of fertile soils from highly productive farming areas.
- The most spectacular forms are dunes - mounds of more or less sterile sand - which move as the wind takes them, even burying oases and ancient cities.

Soil Erosion is caused by:

- Natural Processes
  1. Water
  2. Wind
- Human Activities
  1. Over cropping
  2. Deforestation
  3. Overgrazing

Types of Soil Erosion

1. Geological Erosion 2. Accelerated Erosion

A) Wind erosion C) Ravine

B) Water Erosion D) land slide erosion

(i) Raindrop or Splash erosion,

(ii) Sheet erosion,

(iii) Rill erosion,

(iv) Gully erosion,

(v) Stream bank erosion

(vi) Costal erosion

Wind erosion

It is primary responsible for creation and maintenance of desert areas. Finer soil particles from top soil along with organic matter and nutrients are easily detachable and removed by wind velocity.

Factors of Wind Erosion

E = f (I, C, K, L, V)

I is the soil erodibility by wind (related to relative amount of particles > 0.84 mm dia.

C is the local wind erosion climatic factor (product of average wind velocity and average moisture of soil surface)

K is the soil surface roughness (expressed in height of ridges; more roughness increases resistance to wind erosion)

L is the unprotected width of the field (protection provided by wind breaks)

V is the equivalent quantity of vegetative cover (includes quantity, kind, and orientation of vegetative cover

Factors Affecting Wind Erosion

Several factors relating to soil, landscape and climate that affects wind erosion are

- soil texture: Erosion works on loosely held soil particles at the soil surface.
- soil structure Silty and very fine sandy soils are particularly vulnerable to erosion. Poorly structured soils whose aggregates (clumps) have been broken down into fine particles by tillage and other forces are also easily eroded

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- surface relief Surface relief (shape and slope) affects the direction and rate of erosion. It also affects the location of soil deposition, because eroded soil tends to accumulate at the base of slopes and in depressions.
- soil protection by plants or plant residues Exposed soils suffer greater erosion than soils well protected by standing plants or plant residues•). Soils are most vulnerable to wind erosion when the soil surface dries out rapidly during periods of low or no rainfall, such as the drought during the "dirty thirties" in the prairiesor in early spring when the soil is not protected by vegetation.
- rainfall Climate affects erosion mainly through the moisture conditions of the soil and specific climatic events (wind and rainstorms
- wind force. Wind speed and the length of time the wind blows are major factors in wind erosion.

Causes of Wind Erosion

- Bare, unprotected soil is extremely vulnerable to wind erosion
- Erosion occurs with strong, turbulent winds blowing across a soil surface that is smooth, loose, dry and finely granulated.
- Slightly larger soil particles bounce or roll along the soil surface.
- Loose particles drift along, bombarding and dislodging still more particles with the same effect on clods or growing plants as

Forms of Wind Erosion

Saltation : lifting and bouncing of a particle, most important for particles 0.1 - 0.5 mm dia.

Creep: coarse and very coarse sand grains rolled on ground surface.

Suspension: Lifting of silt- and clay-sized particles(<0.1 mm) high into the air and can thus be carried long distances

Damages of Wind Erosion

- Losing topsoil has a direct effect on the productivity of the land. A loss of 2.5 cm of soil can reduce wheat yields by 5-10% while a loss of 20 cm can reduce yields to 1/3 of their previous levels.
- Estimated soil loss by wind erosion on the is 160 million tones per year.•
- As soil productivity decreases due to a decrease in topsoil, soil fertility becomes less.•
- Organic material is reduced and hence, less plant growth occurs.

How to control wind erosion?

- ✓Planting shelterbelts (trees may be obtained from the Tree Nursery) to help reduce the velocity of the wind
- ✓Increasing the organic content of the soil
- ✓ Using fertilizers to increase soil productivity.
- ✓Alternating narrow strips of summer fallow and crop perpendicular to the prevailing winds (strip cropping)
- ✓Leaving stubble barriers

✓Using trash cover and green manure.
✓Reducing tillage.
✓Using marginal land for livestock rather than crop production.
✓Reducing the speed of tillage• Planting of fall cover crops (winter wheat or rye) in areas of light, sandy soil which are particularly prone to wind erosion
✓Using marginal land for livestock rather than crop production
✓Reducing the speed of tillage• Planting perennial grass or legumes on grazing lands.
✓Zero tillage - planting crops in to last years stubble

Continued….

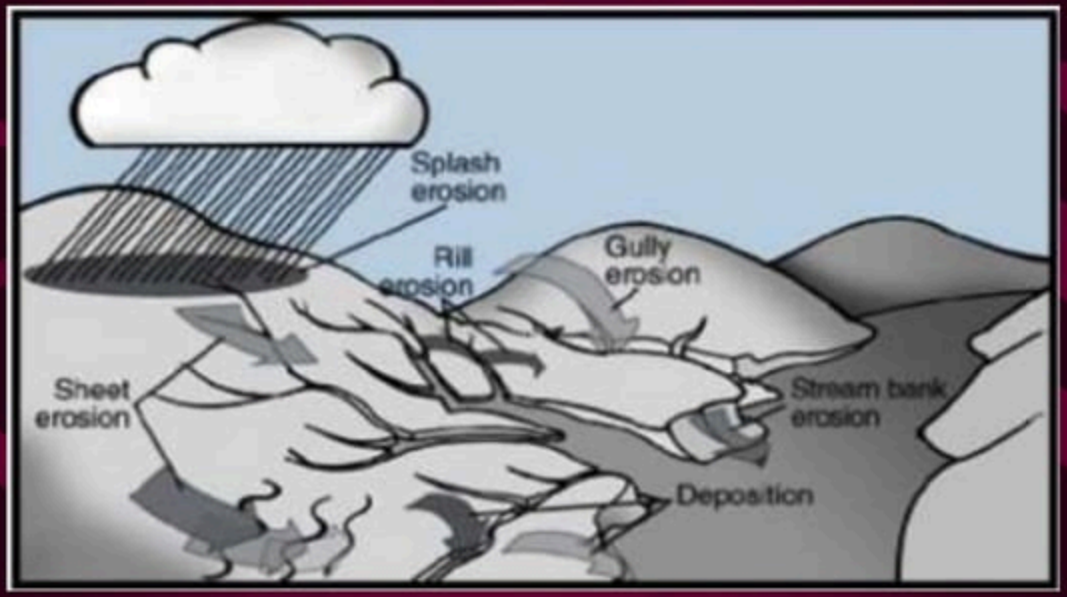
✓The more organic material present in the soil, the greater the resistance of the soil to be broken into particles small enough to be carried away by wind or water, and the more moisture the soil will hold.

✓Adding fertilizers to the soil aids in making the soil more productive, which protects it against the effects of erosion.

✓Mulching

✓ Strip Cropping

Forms of Water Erosion



Different Forms of Water Erosion

(i) Raindrop or Splash erosion,
(ii) Sheet erosion,
(iii) Rill erosion,
(iv) Gully erosion,
(v) Stream bank erosion
(vi) Costal erosion

(i) Splash Erosion

- It results from soil splash caused by the impact of falling torrential rain.
- If raindrops strikes on the land covered with thick blanket of vegetation the drop breaks into a spray of clear water which slowly finds its way into soil pores Splash/ Raindrop Erosion.

Continued… Splash erosion

If the raindrop strikes bare soil considerable splashing occurs. These splashes gradually remove fine materials from the soil and leave the land infertile by leaving behind sand and gravel particles. Splashes as much as 60 cm. high and 150 cm. away Splash/ Raindrop Erosion.

(ii) Sheet Erosion

- It is the removal of fairly uniform layer of soil from land surface by the action of rainfall and runoff water
- Sloping land having a shallow loose topsoil overlying a compact subsoil are the most susceptible to sheet erosion
- detected by the muddy colour of the run-off from the fields.

(iii) Rill Erosion

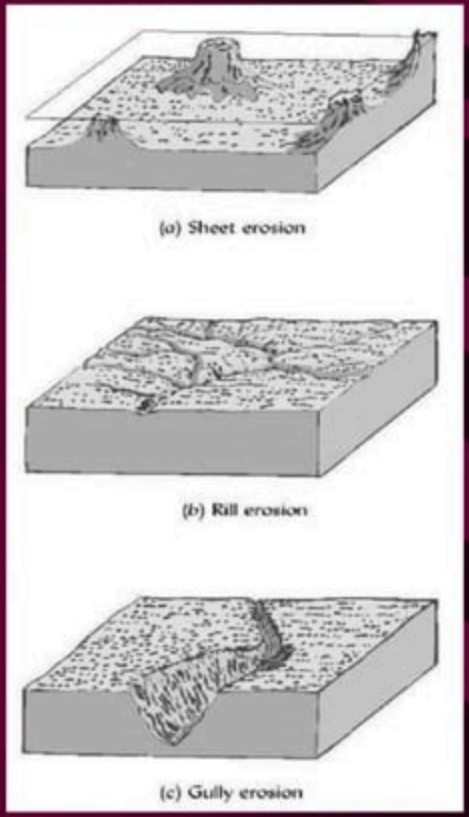
- These The advance form of the rill is initial stage of gully formation.
- The rills are shallow drainage lines less than 30cm deep and 50 cm wide.
- They develop when surface water concentrates in depressions or low points through paddocks and erodes the soil.

- Rill erosion is common in bare agricultural land, particularly overgrazed land, and in freshly tilled soil where the soil structure has been loosened.

- Rills will increase not only in number but also in shape and size.
- Rill erosion is more serious in soils having shallow top soil.

- transition stage between sheet and gully erosion Rill Erosion.

- Rill erosion is mostly occurs in alluvial soil and is quite frequent in Chambal river valley in India.



(iv) Gully Erosion

- The advance stage of rills is transformed into initial stage of gully.
- Gully formation are initiated when the depth and width of the rill is more than 50 cm.
- Gullies are deeper channels that cannot be removed by normal cultivation.
- Hillsides are more prone to gullying when they cleared of vegetation, through deforestation, over-grazing or other means.
- The eroded soil is easily carried by the flowing water after being dislodged from the ground, normally when rainfall falls during short, intense storms

Gully Erosion

Classification of Gullies

- **Based on shape**

(U shape, V shape)

- **Based on nature of gully flow** (Active, Inactive)
- **Based on size** (depth, width and side slopes)

U shape and V shape Gullies

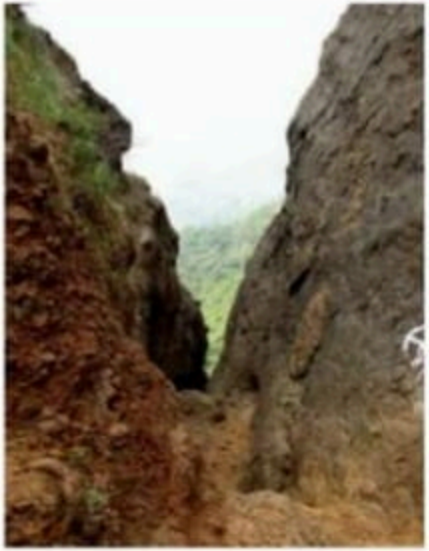
U shaped Gullies

- It is formed in areas where surface and subsurface soils are weak and susceptible to erosion.
- The flow velocity is less and this causes a continuous process of caving in of the gully sides, forming U shape.
- It is common in plains

V shaped Gullies

- It is formed in areas where the subsoil is more resistant to erosion.
- The flow through this gullies is low, but velocity is very high due to steep slope.
- These gullies are formed in hilly areas with steep faces

U - Shape and V- Shape Gullies



Classification of Gullies based on Depth

S. No.	Symbol	Description	Specification
1.	G_1	Very small gullies	Upto 3 m deep, bed width not more than 18 m, side slopes vary
2.	G_2	Small gullies	Upto 3 m deep, bed width more than 18 m and side slopes 8-15%
3.	G_3	Medium gullies	Depth 3-9 m, bed width more than 18 m, sides uniformly sloping between 8-15%
4.	G_4	Deep and narrow gullies	(a) 3-9 m deep, bed width less than 18 m, side slopes vary (b) Depth more than 9 m, bed width varies and the side slopes vary.

(v) Stream bank erosion

- Stream bank erosion occurs where streams begin cutting deeper and wider channels as a consequence of increased peak flows or the removal of local protective vegetation.
- Stream bank erosion is common along rivers, streams and drains where banks have been eroded, sloughed or undercut.
- Generally, stream bank erosion becomes a problem where development has limited the meandering nature of streams, where streams have been channelized, or where stream bank structures (like bridges, culverts, etc.) are located in places where they can actually cause damage to downstream areas.
- Stabilizing these areas can help protect watercourses from continued sedimentation, damage to adjacent land uses, control unwanted meander, and improvement of habitat for fish and wildlife.

Examples of Stream bank Erosion

(vi) Coastal erosion

- The waves, geology and geomorphology are the three major factors that affect the coastal erosion.
- Waves are the cause of coastal erosion. Wave energy is the result the speed of the wind blowing over the surface of the sea, the length of fetch and the wind blowing time.
- The geology of the coastline also affects the rate of erosion

(C) Ravine

A ravine is generally a slope landform (larger than a gully) of relatively steep (cross-sectional) sides, on the order of 20 – 70 % in gradient.

(D) Landslides

- Landslides are simply defined as the mass movement of rock, debris or earth down a slope.
- They often take place in conjunction with earthquakes, floods and volcanoes. Landslides are caused when the stability of a slope changes from a stable to an unstable condition.
- A change in the stability of a slope can be caused by a number of factors, acting together or alone.