SOIL

- Soil is the loosely bound mixture of rock debris, small particles and decayed organic matter which develops on the Earth's surface. It is the **topmost layer of the Crust**.
- Soil consists of small rock particles/minerals, humus (decayed organic matter), moisture, air and living organisms which exist in complicated and dynamic relationship with each other.

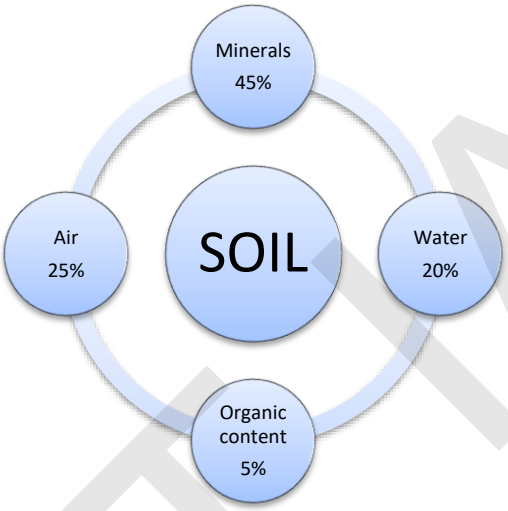

Figure 1: Soil Composition

- If we take the cross section of the soil column, it consists of four layers which are called as **Horizons**. Horizons differ physically and/or chemically with each other and the layers lie more or less parallel to the surface of the Earth.

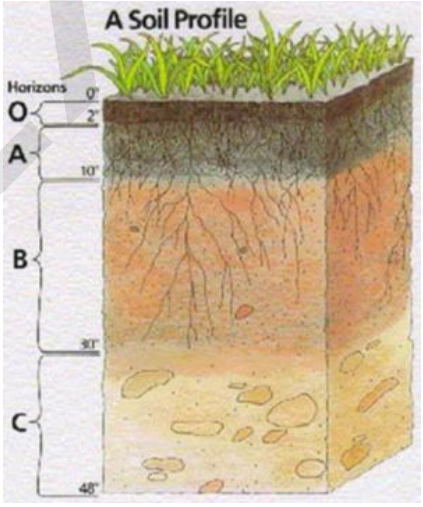

Figure 2: Soil Profile

- **Horizon O**- It covers humus on the ground surface of the Earth.
- **Horizon A**- It is composed of organic matter along with minerals, nutrients and water. It makes the top soil and also called zone of **Leaching**.
- **Horizon B**- This layer is sandwiched between Horizon A and Horizon C and is composed of some organic matter and weathered mineral matter such as Calcite in arid climates (caliche). It is also called zone of **Accumulation**.
- **Horizon C**- It is the first stage in the soil formation process and incorporates loose parent material. It forms the above layers of soil profile.

- The arrangement of these soil horizons vertically from the ground surface to the parent rock is called **Soil Profile**.
- The standard unit for the measurement of soil particles is **millimeter (mm**). Size of sand grain varies between 0.05 and 0.2 mm in diameter. Silt particles have diameter between 0.02 and 0.002mm and individual particles of clayey soil are 0.005 to 0.002 mm in diameter.
- Soil structure refers to the arrangement of these soil particles. The texture of the soil depends upon the bond of **sand, silt, clay and humus**.

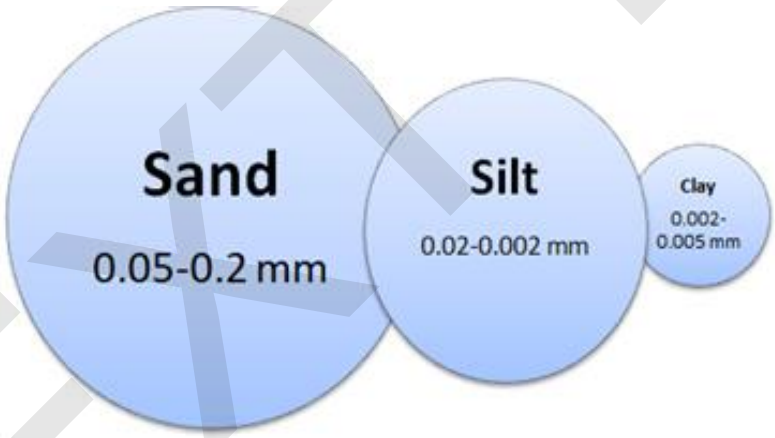

Figure 3: Soil particles' size in diameter

How Soil is formed?

- The exposed parent material/rock is worked upon by various elements of the natural environment i.e. water, wind, sunlight etc called **weathering** and other agents of erosion like human and animal activities. Thus the parent material disintegrates and makes the upper layers containing the same soil characteristics, including the chemical constituents.
- Organisms like bacteria, mosses, lichens, vegetation etc occupy this small unconsolidated material. The dead remains of these organisms lead to the accumulation of organic matter like humus into the soil.
- The process of soil formation is called **Pedogenesis** which takes thousands of years in its making.

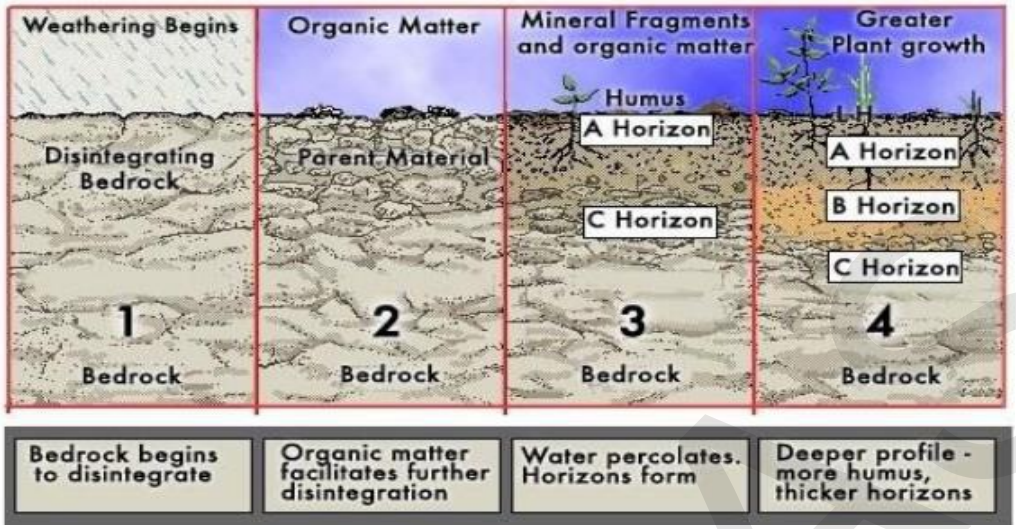

Figure 4: Process of soil formation

- Major factor which affect the formation of the soil are:

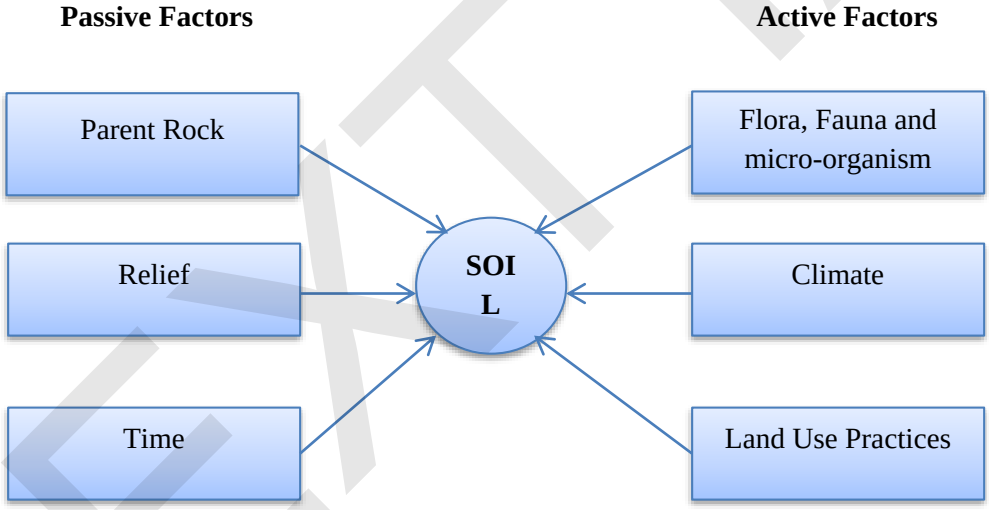

Figure 5: Factors affecting formation of the soil

- **Parent rock**- The type of parent material and the conditions under which they break down by weathering and erosion determine the **colour, texture, chemical properties, mineral content, permeability**. Example- Soils formed from Granite are often sandy and infertile whereas Basalt under moist conditions breaks down to form fertile clay soils.
- **Relief**- The **altitude and slope** which determine the accumulation of soil, exposure to sunlight, degree of erosion and rate of run-off of water. Example- Soils are thick on flat areas and thin on steep slopes.
- **Time**- It determines thickness of soil profile. Soil properties may vary depending on how long the soil has been weathered.

- **Climate**- The **temperature, rainfall, moisture** influence rate of weathering and humus formation. With a colder and drier climate, these processes can be slow but with heat and moisture they are relatively rapid.
- **Flora, Fauna and Micro-organism**- It directly affects the rate of **humus** formation. Dead remains of them are directly added to the soil. **Bacteria, fungi, worms** and other **burrowers** break down plant litter and animal wastes and remains to eventually become organic matter. This may take the form of **peat, humus or charcoal**.
- **Land use practices**- How the land is used determine the soil characteristics. There are various cultivation practices which are followed in different terrains which affect the soil characteristics. Example- **Slash and burn agricultural practice or Jhum cultivation** in hilly dense forested areas of Mizoram, Nagaland and Manipur.

- All the factors which affect the formation of the soil work in close association with each other.

Difference between Weathering and Erosion

- Weathering is **in-situ** breaking down of rocks which are exposed. There is no movement involved in the weathering process. It involves two processes-
  - **Chemical weathering** – It involves chemical change in all or some of the minerals present in the rock.

Figure 6: Chemical Weathering

  - **Mechanical/ Physical weathering**- It involves breaking down of rocks into pieces and fragments due to alternate freezing and thawing of water or air action.

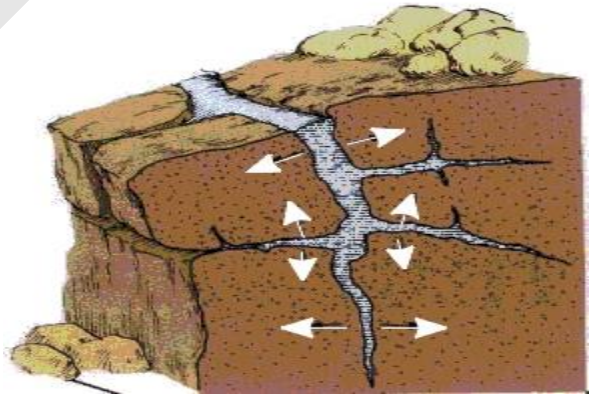

Figure 7: Mechanical weathering

- When the loosely bound weathered rock particles move from its parent rock by some flowing agent i.e. air, ice or water, it is called **Erosion**.
    - **Splash erosion**- Detachment of soil particles by rain drop splash is called the splash erosion.
    - **Sheet erosion**- When upper soil sheet is flown away by water or wind action, it is called Sheet erosion.
    - **Rill erosion**- It is the removal of soil by heavy flow of water and small channels are formed due to this.
    - **Gully erosion**- It is the removal of soil along the drainage lines by surface water run-off.
    - **Ravine erosion-** It is the result of high degree of gully erosion. Example- **Chambal valley**.

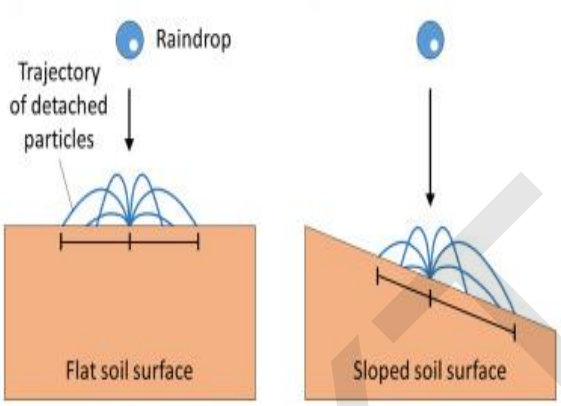

Figure 8: Splash erosion

Figure 9: Sheet erosion

Figure 10: Rill erosion

Figure 11: Gully erosion

Figure 12: Ravine erosion

Classification of soils

- On the basis of origin, colour, composition and location, **Indian Council of Agricultural Research (ICAR)** has classified Indian soil in 8 major types-
  - **I.** Alluvial soils
  - **II.** Black soils
  - **III.** Red and yellow soils
  - **IV.** Laterite soils
  - **V.** Arid soils
  - **VI.** Saline soils
  - **VII.** Peaty soils
  - **VIII.** Forest soils

- **Alluvial Soils**
  - These cover mainly the Sutlej-Ganga-Brahmaputra plains, river valleys of Narmada and Tapi, Eastern and Western coastal plains and East Coast delta. **More than 40%** of the Indian soil is alluvial type and covers states like **Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal, Assam** etc.
  - Alluvial soils are formed by river action through transportation and deposition of sediments, so called **Depositional soils**.
  - The texture varies from **sandy loam to clay** and colour from **light grey to ash grey**.
  - These soils are **rich in Potash, humus, lime, organic matter** but **poor in Phosphorous.**
  - It is subdivided in upper and middle Ganga plain in two types i.e. **Khadar** and **Bhangar**.
    - Khadar is the new alluvium, low lying and frequently inundated by floods during rainy season. It incorporates fine silt.
    - Bhangar is the older alluvium and lies above the flood plain.
  - It is quite fertile and most suitable for crops like **wheat, rice, maize, sugarcane, pulses, oilseeds, fruits, vegetables and fodder** etc.

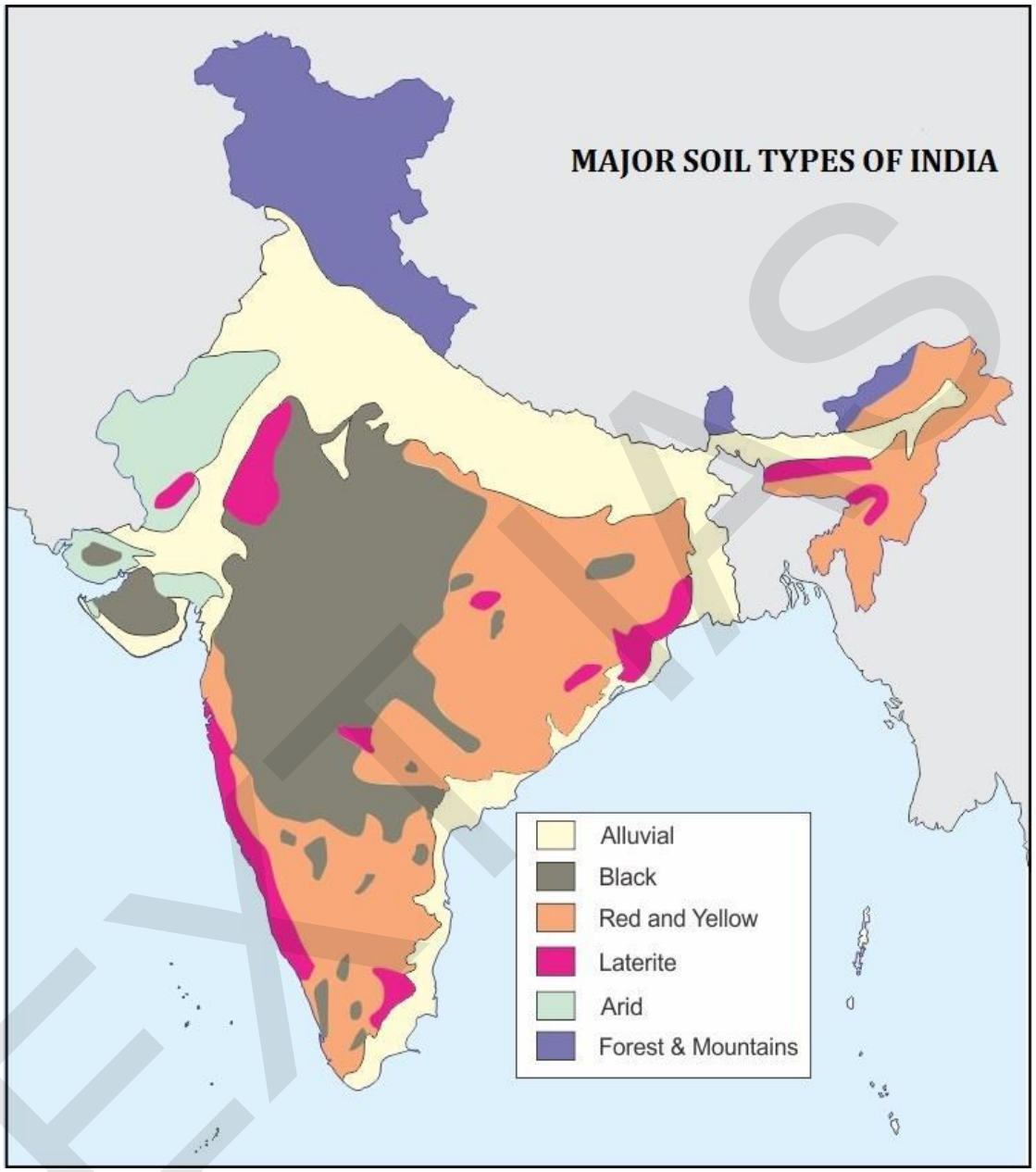

Figure 13: Soil distribution in India

- **Black soils**
  - These soils cover most of the Deccan Plateau which includes **Maharashtra, Madhya Pradesh, Gujarat, Telangana, Andhra Pradesh and North-Western Tamilnadu**.
  - These soils are also known as **Regur soil** or **Black Cotton Soil** or **Tropical Chernozems**.
  - Their parent material is weathered rocks of Cretaceous Lava.
  - These soils have **clayey texture** and are **rich in iron, lime, calcium, potash, aluminium and magnesium** but **deficient in phosphorous, nitrogen and organic matter**.
  - They have high water retaining capacity and when wet they swell greatly and become sticky and develop wide cracks when dry.

- These soils are well suited for cultivation of **cotton, pulses, millets, linseed, castor, tobacco, sugarcane, vegetables and citrus fruits**.

- **Red and Yellow soils**
  - The red soil develops on crystalline igneous rocks in low rainfall areas in Eastern and Southern part of Deccan Plateau.
  - They are found mainly over the peninsula from Tamilnadu in the South to Bundelkhand in the North, Rajmahal in the East to Kathiawad and Kachchh in the west.
  - Red colour of the soil is mainly due to the presence of **Ferric oxides**. The top layer of the soil is generally red while the layer under it is yellow in colour.
  - The texture of red soils varies from **sand to clay and loam**.
  - Fine grained red and yellow soils are fertile whereas coarse-grained soils found in dry uplands are poor in fertility.
  - Red soils are **deficient in Lime, phosphate, magnesia, nitrogen, humus, potash**. Intense **leaching** is dangerous to this soil.
  - This soil is devoted to **cotton, pulses, tobacco, millets, oilseed (linseed), potato and orchards**.

- **Laterite soils**
  - The name of this soil is derived from the **Latin word 'Later'** which means '**brick'**. It is soft when wet but becomes very hard on drying.
  - This soil is found in the areas with high temperature and heavy rainfall. Heavy rainfall leads to the **leaching** of the siliceous matter of the rocks.
  - Colour of the soil is red and grey due to the **presence of iron and aluminium**. It is coarse in its texture.
  - Laterite soils are **poor in nitrogen, potash, lime and organic matter** which lead to low fertility.
  - It is found mainly in **Western Ghats, Eastern Ghats, Rajmahal hills, Satpura, Vindhyas, Odisha, Chattisgarh, Jharkhand, Cachar hills of Assam and Garo hills of Meghalaya**.
  - It is well suited for the cultivation of **rice, ragi, sugarcane and cashewnuts**.

- **Arid soils**
  - Arid soils as the name suggests are developed under dry and semi-dry conditions and are deposited mainly by wind action.
  - They are found mainly in **Rajasthan, Northern Gujarat, Saurashtra, Kuchchh, West of the Aravallis, Western Haryana**.
  - It ranges from **Red to Brown** in colour and **sandy** in its texture.
  - Salinity in this soil is high. It is **deficient in humus, moisture, nitrogen** with varying percentage of Calcium Carbonate.
  - Less water requiring crops are suited for this soil such as bajra, pulses, guar, fodder etc.

- **Saline soils**
  - Salts of **Sodium, Potassium and Magnesium** in this soil are in excess which leads to infertility.
  - It is found in dry, semi-dry climatic areas and swaps so called **Usara** soils. It covers western Gujarat, deltas of East Coast, Sunderban area of West Bengal and Runn of Kuchchh.

- Their texture ranges from **Sandy to Sandy-Loam**.
- Seawater comes in the deltaic areas and promotes the existence of Saline soils. Additionally, in the areas where excessive irrigation is done the soil there is converting into saline. Due to capillary action salts come on the surface of the Earth.
- Saline soils are **deficient in nitrogen, calcium and lime** and it is advised to apply **gypsum** to solve the problem of fertility.

- **Peaty soils**
  - Peaty soils are found in areas where rainfall and humidity are very high.
  - The amount of vegetation is high in these areas so as the dead organic matter in the soil which may go up to 40-50%.
  - Colour of the soil is **black** and it is **deficient in phosphate and potash**.
  - It is found mainly in some districts of **Kerala, Sunderban delta, riverine deltas of Mahanadi, Godavari, Krishna, Cauvery and Rann of Kutchchh**.

- **Forest soils**
  - Forest soils are found in the areas of forests where **ample amount of rainfall** is present.
  - These are of varying texture depending upon the area where it is found. These are **loamy and silty** on valley sides and **coarse-grained** in the upper slopes.
  - In the mountain areas it is **dark brown** in colour and is **acidic in character** with **low humus** content on high altitude and relatively more humus in low altitude forest soils.
  - Forest soils are found in hill slopes of Himalayas and valleys and Terai region of the sub-montane stretch from Jammu and Kashmir to Assam in the form of belt.

Soil Degradation

- Soil degradation is directly linked to the fertility of the soil. The minerals and nutrients of the soil are reduced due to various natural and human as well as animal activities, this is called soil degradation.

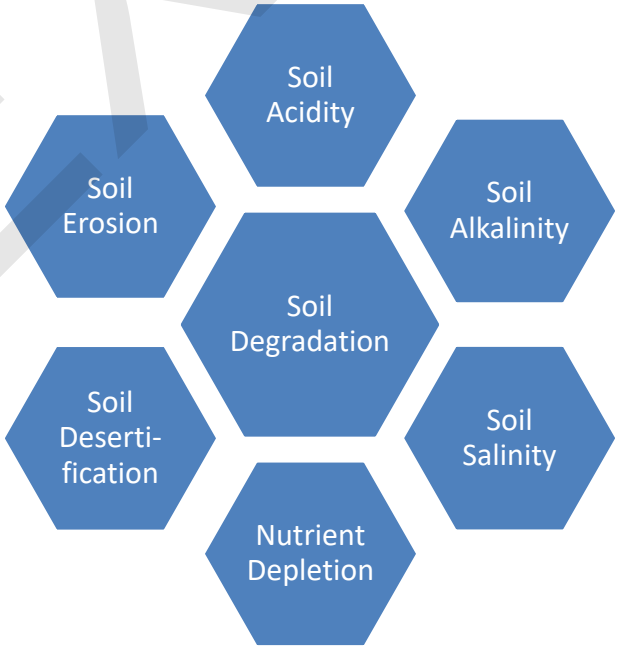

Figure 14: Soil Degradation

- **Soil Acidity**
  - It happens due to heavy rainfall and lime leaching. Regular addition of lime is done to maintain the fertility of the soil.
  - Over-use of **Urea ($CO(NH)_2$)** can also lead to soil acidity so judicious use of Urea is required to be followed.
  - Industrial effluent containing **Sulphur** can also increase the acidity of the soil if it is discharged in open fields, so it is mandated not to discharge it in open.

- **Soil Alkalinity**
  - It is caused due to more use of Sodium Carbonate and fertilizers.
  - Pollution by industries is also a main reason for the increase of soil alkalinity.
  - **Gypsum** is advised to add in the soil to deter soil alkalinity.

- **Soil Salinity**
  - It is caused due to over irrigation of the soil like flood irrigation and from canals.
  - **Sea water intrusion** is also a main cause in the coastal areas for the soil salinity and land degradation.
  - Proper drainage of the ground water is required for avoiding soil salinity in the fields.

- **Nutrient Depletion**
  - Reduction in the amount of micro and macro nutrients of the soil causes ill-effect to the crops.
    - **Micro nutrients**- Boron (B), Zinc (Zn), Manganese (Mn), Iron (Fe), Copper (Cu), Molybdenum (Mo), Chlorine (Cl)
    - **Macro nutrients**- Nitrogen (N), Potassium (K), Carbon (C), Hydrogen (H), Oxygen (O), Phosphorous (P)

- **Soil Desertification**
  - Conversion of cultivable land into desert due to deforestation is called soil desertification. Other factors which are responsible for it are erosion of the soil and moisture loss.
  - Conservative agricultural practices can be the remedy for it.

- **Soil erosion**
  - Soil erosion is caused due to various natural elements like air, water, glaciers etc as well as due to some anthropogenic causes like deforestation, mining activity, construction works, unsustainable agricultural practices and overgrazing.
  - It can be contained by afforestation, contour farming, terrace farming, mulching and Mangrove forestation etc.