KTU NOTES

The learning companion.

KTU STUDY MATERIALS | SYLLABUS | LIVE NOTIFICATIONS | SOLVED QUESTION PAPERS

MODULE 3

TYPES OF ANTHROPOGENIC DISASTERS I– SOIL AND SOIL DEGRADATION, DESERTIFICATION.

SOIL DEGRADATION

- soil degradation simply means the decline in soil quality which comes about due to aspects such as improper land use, agriculture, and pasture, urban or industrial purposes.
- It involves the decline of the soil's physical, biological and chemical state.
- Soil degradation examples include decline in soil fertility, adverse changes in alkalinity, acidity or salinity, extreme flooding, use of toxic soil pollutants, erosion, and deterioration of the soil's structural condition.
- Excessive soil degradation thus gives rise to immediate and long-term impacts which translate into serious global environmental headaches.

CAUSES OF SOIL DEGRADATION

- 1. Physical Factors
- 2. Biological Factors
- 3. Chemical Factors
- 4. Deforestation
- 5. Misuse or excess use of fertilizers
- 6. Industrial and Mining activities
- 7. Improper cultivation practices
- 8. Urbanization
- 9. Overgrazing

PHYSICAL FACTORS

- There are several physical factors contributing to soil degradation distinguished by the manners in which they change the natural composition and structure of the soil.
- Rainfall, surface runoff, floods, wind erosion, tillage, and mass movements result in the loss of fertile top spoil thereby declining soil quality.
- All these physical factors produces different types of soil erosion (mainly water and wind erosion) and soil detachment actions, and their resultant physical forces eventually changes the composition and structure of the soil by wearing away the soil's top layer as well as organic matter.
- In the long-term, the physical forces and weathering processes lead to the decline in soil fertility and adverse changes in the soil's composition/structure.

BIOLOGICAL FACTORS

- Biological factors refer to the human and plant activities that tend to reduce the quality of soil.
- Some bacteria and fungi overgrowth in an area can highly impact the microbial activity of the soil through bio-chemical reactions, which reduces crop yield and the suitability of soil productivity capacity.
- Human activities such as poor farming practices may also deplete soil nutrients thus diminishing soil fertility.
- The biological factors affect mainly lessens the microbial activity of the soil.

CHEMICAL FACTORS

- The reduction of soil nutrients because of alkalinity or acidity or water logging are all categorized under the chemical components of soil degradation.
- It comprises alterations in the soil's chemical property that determine nutrient availability.
- It is mainly caused by salt buildup and leaching of nutrients which corrupt the quality of soil by creating undesirable changes in the essential soil chemical ingredients.
- These chemical factors normally bring forth irreversible loss of soil nutrients and productivity capacity such as the hardening of iron and aluminum rich clay soils into hardpans.

DEFORESTATION

- Deforestation causes soil degradation on the account of exposing soil minerals by removing trees and crop cover, which support the availability of humus and litter layers on the surface of the soil.
- Vegetation cover primarily promotes thee binding of the soil together and soil formation, hence when it is removed it considerably affects the capabilities of the soil such as aeration, water holding capacity, and biological activity.
- When trees are removed by logging, infiltration rates become elevated and the soil remains bare and exposed to erosion and the buildup of toxicities.
- Some of the contributing activities include logging and slash and burn techniques used by individuals who invade forest areas for farming, rendering the soils unproductive and less fertile in the end.

MISUSE OR EXCESS USE OF FERTILIZERS

- The excessive use and the misuse of pesticides and chemical fertilizers kill organisms that assist in binding the soil together.
- Most agricultural practices involving the use of fertilizers and pesticides leads to excessive application, thereby contributing to the killing of soil's beneficial bacteria and other micro-organisms that help in soil formation.
- The complex forms of the fertilizer's chemicals are also responsible for denaturing essential soil minerals, giving rise to nutrient losses from the soil.
- Therefore, the misuse or excessive use of fertilizers increases the rate of soil degradation by destroying the soil's biological activity and builds up of toxicities through incorrect fertilizer use.

INDUSTRIAL AND MINING ACTIVITIES

- Soil is chiefly polluted by industrial and mining activities.
- As an example, mining destroys crop cover and releases toxic chemicals such as mercury into the soil thereby poisoning it and rendering it unproductive for any other purpose.
- Industrial activities, on the other hand, release toxic effluents and material wastes into the atmosphere, land, rivers, and ground water that eventually pollute the soil and as such, it impacts on soil quality.
- Altogether, industrial and mining activities degrade the soil's physical, chemical and biological properties.

IMPROPER CULTIVATION PRACTICES

- There are certain agricultural practices that are environmentally unsustainable and at the same time, they are the single biggest contributor to the worldwide increase in soil quality decline.
- The tillage on agricultural lands is one of the main factors since it breaks up soil into finer particles, which increase erosion rates.
- The soil quality decline is exuberated more and more as a result of the mechanization of agriculture that gives room for deep plowing, reduction of plant cover, and the formation of the hardpan.
- Other improper cultivation activities such as farming on steep slope and mono-cropping, row- cropping and surface irrigation wear away the natural composition of the soil and its fertility, and prevent soil from regenerating.

URBANIZATION

- Urbanization has major implications on the soil degradation process.
- It denudates the soil's vegetation cover, compacts soil during construction, and alters the drainage pattern.
- It covers the soil in an impermeable layer of concrete that amplifies the amount of surface runoff which results in more erosion of the top soil.
- Most of the runoff and sediments from urban areas are extremely polluted with oil, fuel, and other chemicals.
- Increased runoff from urban areas also causes a huge disturbance to adjacent water sheds by changing the rate and volume of water that flows through them, and impoverishing them with chemically polluted sediment deposits.

OVERGRAZING

- The rates of soil erosion and the loss of soil nutrients as well as the top soil are highly contributed by overgrazing.
- Overgrazing destroys surface crop cover and breaks down soil particles, increasing the rates of soil erosion.
- As a result, soil quality and agricultural productivity is greatly affected.

SALINIZATION OF SOIL

- soil is rich in salts because the parent rock of the soil contains ionic substances.
- Seawater is another source of salts in low-lying area along the coast.
- Most irrigation water contains some salts. After irrigation, the water added to the soil is used by the crops or evaporates directly form the moist soil.
- The salt, however, is left behind in the soil. Therefore, unless removed, it accumulates in the soil. This phenomenon is called salinization.
- A white layer of dry salt is sometimes observed on very salty soil.
- Salty groundwater may also contribute to salinization.

CAUSES OF SALINIZATION

- The main source of salts in soil is exposed bedrock in geologic strata in the Earth's crust.
- Salts are gradually released from the bedrock after becoming soluble through physical and chemical weathering such as hydrolysis, hydration, dissolution, oxidation, and carbonation.
- The released salts dissolve into the surface water or groundwater.
- As the water with dissolved salts flows from humid regions to less humid or arid regions, salts in the water are gradually concentrated.

CAUSES OF SALINIZATION

- The most dominant ions at the place where salts become soluble by weathering are carbonate and bicarbonate of calcium, magnesium, potassium and sodium, if carbon dioxide exists.
- At first, the salinity of the water is low, but as the water flows from a humid area to a less humid area, it becomes higher as the water evaporates.
- As the salts in the water are further concentrated, salts with lower solubility start to precipitate.
- In addition, due to other mechanisms such as ion exchange, adsorption, and the difference of mobility, the concentrations of chemical substances dissolved in the water gradually shift; this always results in increased concentration of chloride and sodium ions in water and soil.

EFFECTS OF SOIL DEGRADATION

- 1. Land degradation
- 2. Drought and aridity
- 3. Loss of arable land
- 4. Increased flooding
- 5. Pollution and clogging of waterways

LAND DEGRADATION

- Soil quality decline is one of the main causes of land degradation and is considered to be responsible for 84% of the ever diminishing acreage.
- Year after year, huge acres of land lost due to soil erosion, contamination and pollution.
- About 40% of the world's agricultural land is severely diminished in quality because of erosion and the use of chemical fertilizers, which prevent land from regenerating.
- The decline in soil quality as a result of agricultural chemical fertilizers also further leads to water and land pollution thereby lowering the land's worth on earth.

DROUGHT AND ARIDITY

- Drought and aridity are problems highly influenced and amplified by soil degradation.
- that drought and aridity are anthropogenic induced factors especially as an outcome of soil degradation.
- Hence, the contributing factors to soil quality decline such as overgrazing, poor tillage methods, and deforestation are also the leading causes of desertification characterized by droughts and arid conditions.
- soil degradation may also bring about loss of biodiversity.

LOSS OF ARABLE LAND

- Because soil degradation contributes to land degradation, it also means that it creates a significant loss of arable land.
- As stated earlier, about 40% of the world's agricultural land is lost on the account of soil quality depreciation caused by agro-chemicals and soil erosion.
- Most of the crop production practices result in the topsoil loss and the damage of soil's natural composition that make agriculture possible.

INCREASED FLOODING

- Land is commonly altered from its natural landscape when it rids its physical composition from soil degradation.
- The transformed land is unable to soak up water, making flooding more frequent.
- In other words, soil degradation takes away the soil's natural capability of holding water thus contributing to more and more cases of flooding.

POLLUTION AND CLOGGING OF WATERWAYS

- Most of the soil eroded from the land together with the chemical fertilizers and pesticides utilized in agricultural fields are discharged into waterways and streams.
- With time, the sedimentation process can clog waterways, resulting in water scarcity.
- The agricultural fertilizers and pesticides also damage marine and freshwater ecosystems and the limits the domestic uses of the water for the populations that depend on them for survival.

SOLUTIONS OF SOIL DEGRADATION

- **Reducing deforestation**
  - There is a necessity for individuals all over the world to respect forest cover and reduce some of the human-driven actions that encourage logging. With the reduction of deforestation, soil's ability to naturally regenerate can be restored.
  - Governments, international organizations, and other environmental stakeholders need to ensure there are appropriate measures for making zero net deforestation a reality so as to inhibit soil degradation.
- **Land reclamation**
  - Land reclamation encompasses activities centered towards restoring the previous organic matter and soil's vital minerals.
  - This may include activities such as the addition of plant residues to degraded soils and improving range management.
  - Salinized soils can be restored by salt level correction reclamation projects and salinity control.

SOLUTIONS OF SOIL DEGRADATION

- **Preventing salinization**
  - The costs of preventing salinization are incredibly cheaper than the reclamation projects in salinized areas.
  - Actions such as reducing irrigation, planting salt tolerant crops, and improving irrigation efficiency will have high pay offs because the inputs and the labor-demanding aspects associated with reclamation projects are zero.
- **Conservation tillage**
  - Proper tillage mechanisms hold as one of the most sustainable ways of avoiding soil quality decline.
  - This is otherwise known as conservation tillage, which means tillage mechanisms targeted at making very minimal changes to the soil's natural condition and at the same time improving the soil's productivity.
  - Examples include leaving the previous year's crop residue on the surface to shield the soil from erosion and avoiding poor tillage methods such as deep plowing.

SOIL DESERTIFICATION

- Desertification is defined as a process of land degradation in arid, semi-arid and sub-humid areas due to various factors including climatic variations and human activities.
- Desertification results in persistent degradation of dryland and fragile ecosystems due to man-made activities and variations in climate
- Overgrazing is the major cause of desertification worldwide. Other factors that cause desertification include urbanization, climate change, over drafting of ground water, deforestation, natural disasters and tillage practices in agriculture that place soils more vulnerable to wind.
- Desertification affects topsoil, groundwater reserves, surface runoff, human, animal and plant populations.
- Water scarcity in drylands limits the production of wood, crops, forage and other services that ecosystems provide to our community.

CAUSES

- Overgrazing
- Deforestation
- Farming Practices:
- Urbanization and other types of land development.
- Climate Change:
- Stripping the land of resources.
- Natural Disasters:

EFFECTS OF DESERTIFICATION

- Farming becomes next to impossible.
- Hunger
- Flooding
- Poor Water Quality
- Overpopulation
- Poverty

SOLUTIONS FOR DESERTIFICATION

- Policy Changes Related to How People can Farm.
- Policy Changes to Other Types of Land Use.
- Education:
- Technology Advances.
- Putting Together Rehabilitation Efforts.
- Sustainable practices to prevent desertification from happening.

PREVENTIVE ACTIONS INCLUDE:

- Integrating land and water management to protect soils from erosion, salinization, and other forms of degradation.
- Protecting the vegetative cover, which can be a major instrument for soil conservation against wind and water erosion.
- Integrating the use of land for grazing and farming where conditions are favorable, allowing for a more efficient cycling of nutrients within the agricultural systems.
- Applying a combination of traditional practices with locally acceptable and locally adapted land use technologies.
- Giving local communities the capacity to prevent desertification and to manage dry land resources effectively.
- Turning to alternative livelihoods that do not depend on traditional land uses, such as dryland aquaculture, greenhouse agriculture and tourism-related activities, is less demanding on local land and natural resources, and yet provides sustainable income.
- Creating economic opportunities in dryland urban centers and in areas outside of drylands

SOIL EROSION

- soil erosion is a naturally occurring and slow process that refers to loss of field's top soil by water and wind or through conversion of natural vegetation to agricultural land.
- 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.
  - Movement: This is when the topsoil is relocated to another area.
  - Deposition: Where the topsoil ends up after this process.

TYPES OF SOIL EROSION

- **1. Sheet erosion**
- Rainfall on an artificially prepared soil especially on gently sloping fields, generally results in sheet erosion. In this process, many soil grains are pounded loose and made free to float away during the initial stages of rainfall.
- This process starts simultaneously over a large area so that after some time during the rains, a huge thick sheet of water flows down the slope and hence it cause erosion of the top soil i.e. uniform skimming of the top soil.
- Sheet erosion has been described as dangerous because this erosion cannot recognized easily and thus it may continue for years without being realized.

TYPES OF SOIL EROSION

- **2. Gully erosion**
- This signifies formations and evolution of down slope valleys that develop on sloping soil due to continued soil erosion.
- Gullying is a consequence of sheet erosion.
- Uniform sheet erosion over any surface for longer periods is impossible even on perfectly smooth surfaces because neither the flow velocities over the entire surface could be uniform nor the surface could be 'absolutely' perfect. Hence, rate of erosion along different paths would be different creating conditions for excessive concentrated erosion along some paths.
- These paths of excessive erosion eventually develop into gulleys with the passage of time

CAUSES OF SOIL EROSION

- 1. Erosion by Water
- 2. Erosion by Wind
- Erosion by Water
  - Rainfall Intensity and Runoff:
  - Distribution of rainfall and landscape:
  - Soil Erodibility:
  - Ground Slope:.
  - Vegetation:
  - Deforestation:.
  - Mismanaged utilization of soil resources

- 2. Erosion by Wind
  - Erodibility of Soil
  - Soil Surface Roughness:
  - Climate:
  - Un-Sheltered Distance:
  - Vegetative Cover:.

CAUSES OF SOIL EROSION

- **Natural Causes**
  - Rain and rainwater runoff:
  - Farming
  - Slope of the land
  - Lack of vegetation
  - Wind
- **Human-Induced Causes of Soil Erosion**
  - Mining
  - Deforestation
  - Recreational activities
  - Climate change

EFFECTS OF SOIL EROSION

- **On-Site Effects of Erosion**
- Loss of topsoil:
- Soil compaction:
- Reduced organic and fertile matter:
- Poor drainage:
- Issues with plant reproduction:
- Soil acidity levels:
- Long term erosion:
- Water pollution:

EFFECTS OF SOIL EROSION

- **Off-Site Effects of Erosion**
- Water pollution and sedimentation:
- Flooding
- Airborne dust pollution
- Damage to infrastructure:

PREVENTION AND CONTROL OF SOIL EROSION

- Methods adopted for prevention and control of soil erosion fall under two categories: agronomic practices and engineering practices.
- Agronomic Practices - it means the protection of the top soil by special methods and schemes of crop cultivation.
- These include:

- (i) Crop Rotation
  - In which different crops are grown in the same area by rotation, that is, one after another.
  - A sequence commonly followed is, for example, a cultivated crop, a small grain and then grass. After this, cultivated crop may again be sown.
- (ii) Strip Cropping
  - In which the cultivated crops and the cover crops are sown in alternate strips during the same period in the same field.

ENGINEERING PRACTICES

- Excavation of ditches
- These can be described as artificially created channels excavated at suitable locations to divert the excess of water from approaching the affected areas, especially in steeply sloping regions.
- Two types of ditches commonly made for controlling soil erosion are:
- (a) Diversion Ditches which are excavated above the cultivated portion of a sloping area with a view of diverting the run off away from the field.
- (b) Interception Ditches – These are made at regular and suitable intervals across the cultivated field. By draining water from small strips, these ditches do not allow the formation of thick sheets of water capable of doing soil erosion.

TERRACE CONSTRUCTION

- These are constructed along suitable locations across the slope of hillsides with essential function of collecting and conducting the run-off to an erosion-proof outlet.
- Spacing of terraces along the slope requires careful consideration. First terrace is generally built near enough to the upper limit of the slope.
- This prevents the initiation of erosion. Terraces should always be uniformly graded as to prevent ponding of water on the one hand and development of erosional velocities on the other hand.

CHECK DAMS.

- Small check dams constructed out of various materials like stones, timber and steel etc. prevent gullying.
- Such dams serve the purpose of reducing the velocity of run-off and cause deposition of the material which may ultimately support vegetation. This may contribute positively for controlling gullying, especially when vegetation is re-established.