

Degraded Soils: Introduction, Causes, and Types

Land Degradation:

Degradation means undesirable and unwanted changes brought about by human activities along with natural phenomenon. Soil degradation is among serious prevailing issues in our modern era. It is badly affecting soil's natural fertility to enhance our economic values along with ecological issues. It is being caused due to natural and anthropogenic activities. The level of degradation depends on degree of degradative processes; duration of usage of such degraded land and its management. Land degradation causes exploitation of soil resources, reduces soil productivity and alters composition of vegetation's; thus influencing billions of people around the globe directly or indirectly.

Degradation of soils can considerably decrease the soil's capacity to produce food and consequently about 66 % of the total world's population is malnourished. To feed the ever increasing population of world, food production needs to be enhanced. It is important to reverse the land degradation to achieve this modest goal as 99.7 % of our human diet calories are fulfilled by our land resources and only 0.3 % is being contributed by aquatic ecosystems. To overcome our basic food demands it is most important to maintain productivity and quality of our land. Generally, soil formation process is 10 to 40 times slower compared to soil lost. It is pertinent that we should look for alternative means of intensification specially use of sustainable land management techniques (SLM). It is said that utilization of land resources is to use the water, land, plants and animals resources to fulfill our present day human demands along with enhancing their productive potential and environmental functions. SLM focus on four land sustaining techniques, improved irrigation management, rehabilitation of degraded soil, enhance pasture and grazing processes along with maintenance of our organic soil all these steps without further degradation of our resources come to meet our present food demands (World Bank 2006). Not only to maintain but also to enhance soil natural fertility it is important to increase its carbon sequester capacity along with ability to overcome climate change (FAO 2009 ; FAO 2010). By using SLM technologies we meet our human food demands without further degradation of our land and water resources. It is evident that allowing land degradation is expensive because it has long term effects on society as well as on land owners.

Causes of Land Degradation

The cause of land degradation for a particular area can be one or combined effects of many. There are two categories i.e proximate causes (biophysical) & overlying causes (anthropogenic). Biophysical have direct effect on all ecosystems like drought, soil salinity, soil acidity, metal contamination, related to extreme climatic conditions while on the other hand anthropogenic causes have indirect effect on ecosystem like intensive cropping, deforestation, overgrazing or poverty, urbanization and industrialization. Among the proximate causes, agriculture is most contributing source of land degradation but its effect on land is aggravated by inter-related relations with other causes. Severe land degradation is observed in combination like the effect of extreme climatic changes is augmented along with poor man management.

Processes of Land Degradation

Following are the some processes discussed which alone or in combination effect land quality.

Saline Soils

Saline soil means soils with excessive soluble salts that retards seed germination and plant growth. Soil erosion is one of major factor causing land degradation. Erosion not only removes upper fertile layer but also causes soil crusting or sealing, soil compaction, poor soil structure, low organic matter, poor drainage and run-off. There are two agents of soil erosion i.e. wind and water, each loss significant amount of soil and reduces its productivity and 12 % of total land area is affected by erosion globally.

Soil Salinization

Land Degradation occurs due to high concentration of soluble salts, exchangeable sodium or both in such amount that decline the plant growth and soil productivity. According to (FAO 2000), of the world's cultivated land; 3.97×10^8 ha is affected by salinity and 4.34×10^8 ha of land is affected by sodicity, thus making 6 % of total land area.

Water Logging

Water logging is the rise of ground water in root zone, thus having adverse effects on plant growth. According to GLASOD assessment, 4.6 M ha area of irrigated land of Pakistan and India is affected by water logging.

Decline in Soil Fertility

According to FAO (1994), decline in soil fertility causes land degradation by (i) lowering soil organic matter, (ii) deteriorating soil physical properties, (iii) imbalance in soil nutrient status and (iv) accumulation of toxic metals.

Degraded Soils: Origin, Types

It is said that these processes are caused by natural (erosion, salinity etc), institutional factors (improper land policies, inadequate planning) and socio-economic activities (improper land use, exploitation of forests, contamination of resources etc. These phenomenon's have devastating impacts on human-beings and on environment.

Types of Land Degradation

Land degradation can be divided into different categories like soil erosion, soil salinity and soil acidity.

Soil Salinity: salt-affected soils can be divided into three different categories depending upon the nature of salts. Saline soil means soils with excessive soluble salts that retards seed germination and plant growth

Sodic Soils have high exchangeable sodium concentration but low total soluble salts are called sodic soils. Such soils are characterized by having electrical conductivity $< 4 \text{ dS m}^{-1}$ soil reaction (pH s) > 8.5 , sodium adsorption ration (SAR) $> 13 (\text{mmol L}^{-1})^{1/2}$ and exchangeable sodium percentage (ESP) > 15 .

Origin of Salt Effectuated Soils

There are various interconnected sources behind the origin of salt-affected soils; nevertheless weathering of minerals and rocks is the most predominant one in accumulating soluble salts in soils. Though the salts in ocean at present occur mainly due to the weathering process of earth crust, ocean now serves as important role in distribution of salts. Soil salinization originates from one or combination of following;

Soil Weathering Process

Weathering of soils and minerals leads to the accumulation of soluble salts in soil. Under humid conditions, salts leached down in the soil due to heavy rainfall. Thus in humid regions the formation of salt affected soils is rare while in arid and semi- arid regions there is not sufficient water available to leach down these salts and consequently more salts accumulate in soil surface

and result in soil salinity development. This process of accumulation of salts in soil by weathering is known as primary salinization.

Accumulation on the Surface Due to Irrigation Under Inadequate Drainage

Improper irrigation system transports the salt on the surface of soil profile and on evaporation this salt is left behind. So, the water build up more salt on surface compared to evenly distribution of salt in the soil profile. This leads to the formation of saline soil.

Shallow Water Table

Inadequate water management and unsuitable drainage system are the reason behind the rise in water table of command area. In some lands it is reported that water table rises at rate of 1–2 m per year. To some extent this water is mineralized and due to increase in water table, water continues to rise upward by capillary action and on evaporation leave the salt behind. Shallow water table is the foremost reason behind developing salty soils.

Fossil Salts

In arid regions, salt accumulation is also derived from fossil salts, involve some entrapped solution or some former deposits in marine. Salt release is either natural or due to anthropogenic activities. Example of naturally salt release is rise in saline ground water through impermeable layer overlying saline band. Example of human induced salt release is the construction of canals or water channels in saline strata that leads to development of salinity in the area because of using this ground water for irrigation.

2.2.5 Seepage from the Upslope Containing Salts

Salinity of downslope areas is commonly observed due to water infl ux in the upslope areas particularly, under certain conditions when water movement in subsurface takes place through those regions which are salts rich.

Ocean

Soil near coastal areas usually has high salt concentration from the ocean in the course of:

- Flooding of soil surface by sea water when waves are high;
- Entrance of sea water through rivers, inlets, etc.
- Flow of groundwater
- Aerosols generated by salt-affected areas are transported many kilometers in coastal areas. It is reported that 20–100 kg/ha NaCl in land while 100–200 kg/ha NaCl in coastal areas are deposited every year. Continuous addition of this small amount of salts in soils leads to soil salinity.

Chemical Fertilizer and Waste Materials

Excessive use of chemical fertilizers in fields also contributes augmentation of salts in soil, yet there input in salinity development is insignificant. ~~Nevertheless~~ addition of some manures like sewage sludge, cow dung or slurry and industrial material like pyrites or pressmud influence the build-up of certain ions in soil that has negative effect on soil productivity