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Land degradation: Soil Conservation as a Precious Natural Resource

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ARTICLE ID: 35

Introduction:

Land degradation is defined as "a state of continuous decline in the level of ecosystem services over an extended period" (Millennium Ecosystem Assessment, 2005). The United Nations Convention to Combat Desertification (UNCCD) defines desertification as "The land degradation in dry lands (i.e Arid, Semi-Arid, and Sub-humid region), which represents loss or a reduction of biological or economic productivity" (UNCCD, 2022). Land degradation reduces the productivity of natural resources and threatens biodiversity (Shao *et al.* 2016).

Ever since agriculture was started, land degradation has been the single largest threat to soil health with productivity and has remained till date. Land degradation will be remain an important global issue for the 21st century because of its adverse impact on soil productivity, soil fauna, bio degradation, environment, and its effect on food security and the quality of life (Eswaran *et al.*, 2001). Removal of the topsoil by any means has, through research and historical evidence and has many deleterious effects on the productive capacity of the soil as well as on ecology. The impact of soil erosion in their popular term that "the thin layer of soil covering the earth's surface represents the difference between survival and extinction for most terrestrial life (Obalum *et al.,* 2012)." Although fertile top soils could be lost when scraped by heavy machineries, the key factor of topsoil loss include water erosion and wind erosion. The relative magnitude of economic losses due to productivity decline versus environmental deterioration also has created a debate. According to economists, the on-site impact of soil erosion and other gradation processes are not severe enough to warrant implementing any action plan at a national or an international level. Agronomists and soil scientists, on the other

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hand, argue that land is a non-renewable resource at a human time-scale and some adverse effects of gradation processes on land quality are irreversible, e.g. reduction in effective rooting depth (Kenneth and Spaeth, 2020). In India, Land degradation is estimated to be 97.85 million hectare or 30% of land area–as much as Rajasthan, Madhya Pradesh and Maharashtra put together (ISRO, 2019).

IPCC (2019) noted that increase in population and per capita consumption, since 1961. Increased commercial agricultural and forestry production has supported population growth and food availability (Singh *et al.,* 2022). This has led to changes in land use patterns, increase in GHG emissions, loss of natural ecosystems (forests, savannahs, natural grasslands, and wetlands), and loss of biodiversity. Anthropogenic activities and extensive use of the land have led to the degradation of 25% of the land areas (ice-free land). Various reports project different values for degraded land. As per GEF, 25% of the global land area is under degradation, as per the "World Atlas of Desertification" 75% of the global land area is under degradation (Cherlet *et al.,* 2018). However, as per the Global Land Outlook, 2022, 40% of the global land area is under degradation (UNCCD, 2022).

Fig. 1. Degraded land due to soil erosion

Factors to influencing land degradation

1. **Deforestation:** Clearing of forests for agriculture, logging, or urban development reduces vegetation cover, leading to soil erosion and loss of biodiversity.
2. **Overgrazing:** Excessive grazing by livestock can lead to the removal of vegetation, soil compaction, and erosion, negatively impacting the land's health.

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3. **Improper Agricultural Practices:** Intensive and unsustainable farming methods, such as excessive use of chemical fertilizers, pesticides, and poor irrigation practices, can degrade soil quality.
4. **Urbanization:** Expansion of urban areas often involves soil sealing, disrupting natural processes and reducing the land's ability to support vegetation.
5. **Mining:** Extractive industries can lead to soil erosion, habitat destruction, and contamination, contributing to land degradation.
6. **Climate Change:** Changes in climate patterns, such as increased temperatures and altered precipitation, can exacerbate soil erosion and degradation.
7. **Land Pollution:** Contamination from industrial activities, improper waste disposal, and the use of harmful chemicals can degrade soil quality.
8. **Soil Erosion:** Natural processes like wind and water erosion can remove the topsoil, which is crucial for plant growth and nutrient retention.

Impact of land degradation

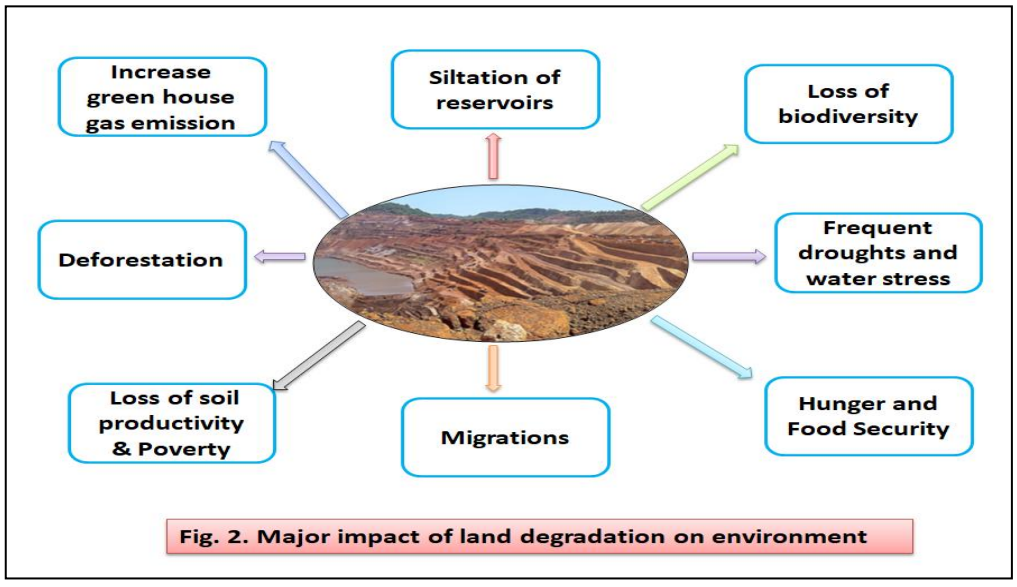

Fig. 2. Major impact of land degradation on environment

Impact of land degradation on soil fauna and bio-degradation process

- All these physical, chemical and biological characteristics of soil play an important role in survival of soil fauna or micro-organisms. Mostly micro-organisms or soil animals lives on top soil layers and microbial activity occurs in the layers.
- Land degradation decreases microbial activity and soil fauna population due to reduction in organic matter content, microbial biomass carbon, microbial biomass N and basal

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respiration. Consequently, the activity of various soil enzymes involves in the cycle of C, N, P and S decreased due to decrease in C turn-over and nutrient availability which results a death of soil fauna and decrease land biodiversity.

- Bio degradation of organic compounds by soil micro-organisms involves a process known as mineralization whereby microorganisms convert the organic molecules to obtain carbon and energy for growth and multiplication, releasing the inorganic forms of N, P, S or other elements.
- Thus, bio degradation process also depends on soil and microbial population. Land degradation process erodes top soil and herbour of microorganisms which results a reduction in bio degradation process.
- Increasing population pressure, unsustainable use of natural resources, continuing loss of farm land for non-agricultural uses and continuing destruction of ecosystems rich in biological diversity are all leading to a situation where ensuring food security may become a serious challenge. Strip mining and metal contamination are serious threats to soil microbial communities, as is the application of pesticides. Remediation of damage caused may require long time, and damaged sites that return to relatively healthy status may not return to their pristine states. Injudicious use of natural resources, mining for exploitation of earth reserves and industrialization is depleting soil organic matter which in turn may be eroding soil biodiversity and in long-term affecting soil fertility and agriculture productivity.

Ways to conserve the soil by minimizing the soil degradation

Soil degradation management helps restore soil health, turning it into a living entity. While natural causes of soil degradation are minimal and unavoidable, the more significant causes of land degradation are human-induced. However, these effects can be minimized by implementing the following measures.

- **Implement conservation tillage techniques:** Reduce or eliminate intensive tillage practices that disrupt the earth's structure and contribute to degradation. Conservation tillage methods, such as no-till or reduced tillage, aid in retaining moisture, enhancing organic matter content, and minimizing land degradation.

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- **Practice crop rotation:** Implement crop rotation by alternating the types of crops grown in your fields each season. This practice helps break pest and disease cycles, enhances soil fertility, and mitigates the risk of nutrient depletion
- **Alternate crops with strip cropping**: This strategy involves rotating crops annually from one strip to another, contributing to improved degradation management. Effective soil degradation solutions focus on strip-cropping rotations, where annual grasses and legumes are alternated with grain and row crops.
- **Avoid overuse of Water for Irrigation**: by employing efficient methods, such as drip irrigation, to prevent undesirable outcomes like secondary salinization and sodification of fields.
- **Application the right amount of fertilizer based on soil test**: Variable rate application, guided by soil diagnostics and satellite imagery analytics, can assist in determining the precise amount of fertilizer required in each zone to achieve the desired yield without causing harm to the land and the surrounding environment.
- **Organic farming/natural farming**: To prevent soil degradation, decrease reliance on chemical fertilizers and explore organic/ natural alternatives. When addressing pest issues, opt for chemical-free Integrated Pest Management (IPM) practices to minimize the risk of pesticide drift.
- **Plant cover crops and mulch the soil with crop residues:** Consider planting cover crops, such as legumes or grasses, during seasons when your cash crop isn't in rotation. Cover crops play a crucial role in protecting the land from degradation, suppressing weed growth, enhancing soil structure, and increasing organic matter content. Use the crop residue as mulch it helps to protect the soil from erosion, increase the infiltration of water, conserve the soil moisture from evaporation.
- **Contour farming**: farming across the slope and along the contour lines. It helps to reduce the runoff and allow more time for rain water for infiltration. contour farming mitigates land degradation and water runoff.
- **Practice terrace farming on high slopes area:** Terracing effective in reducing hillside grades, thereby minimizing the risk of surface water flow causing slope erosion. Additionally, terrace farming enhances pedogenetic processes, promoting better soil development and health.