Asian Journal of Research in Business Economics and Management

Asian Research consortium
www.aijsh.com

ISSN: 2249-7307
Vol. 11, Issue 10, October 2021
SJIF – Impact Factor = 8.075 (2021)
DOI: 10.5958/2249-7307.2021.00036.0

A STUDY ON CAUSES AND CONSEQUENCES OF SOIL EROSION

Shakuli Saxena*

*Department of Agricultural Sciences,
Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, INDIA
Email id: shakuli2803@gmail.com

ABSTRACT

Soil depletion refers to the wearing a way of a field's topsoil by the natural physical forces of water and wind. It may be a slow procedure. It is generally undetected or may develop at an alarming pace, causing significant loss of topsoil. Soil compaction, low organic matter, loss of soil structure, poor internal drainage, salinization and soil acidity issues are additional significant soil degradation factors that may accelerate the soil erosion process. Soil is the most fundamental and basic natural resource for all life to thrive. Water and wind erosion are two major factors that erode soils. Runoff washes away the soil particles from sloping and naked areas while wind sweeps away loose and unattached soil particles from flat and exposed lands. Geologic erosion is a typical process of weathering that usually happens at modest rates in all soils as part of the natural soil-forming processes. Magnitude and the effects of soil erosion on production depend on soil profile and horizonation, topography, soil management, and climatic factors. There are so many variables and processes are involved for soil erosion. The main goal of studying this lesson is to understand the causal causes of soil erosion and their consequences.

KEYWORDS: *Climate, Environment, Farming, Gravity Erosion Soil Erosion.*

1. INTRODUCTION

Soil erosion is a significant social and economic issue and a crucial element in evaluating ecosystem health and function. Soil erosion is one of the naturally occurring issues in soils. It will impact all landforms. Soil erosion may also happen via pressures linked with agricultural operations such as tillage. Topsoil, which is rich in organic matter, high fertility and soil life, is moved somewhere "on-site" where it builds up over time or is transported "off-site" where it fills up drainage channels. Soil erosion decreases agricultural production. Soil erosion leads to the contamination of nearby watercourses, marshes and lakes. Soil Erosion, whether it is by water, wind or tillage, includes three different processes - soil detachment, movement and deposition. Accelerated erosion is mainly the result of human activities. The main culprits are tillage, grazing, and cutting of wood. The pace of erosion may be enhanced by actions other than those of people. Fire that kills plants and causes erosion has the same impact[1]–[3].

1.1.Global Problem:

Erosion is a significant issue impacting soils all around the globe. The fast expansion of the world's population has resulted in greater cultivation of land. This puts greater strain on land and leads to soil losing its structure and cohesiveness, which means that it may be eroded more readily. Heavy agricultural equipment may also 'compact' soil, which causes water to flow right off the surface after rain, carrying soil particles with it, instead of soaking into the soil. The entire land area susceptible to human-induced soil degradation is estimated at approximately 2 billion hectares. Of this, the land area impacted by soil deterioration owing to erosion is estimated at 1100 Mha by water erosion and 550 Mha by wind erosion.

1.2.Gravity Erosion:

Mass-Wasting is the down-slope movement of rock and sediments, primarily owing to the force of gravity. Mass-wasting is an essential component of the erosional process, as it transfers material from higher altitudes to lower elevations where transportation agents like streams and glaciers may then take up the material and carry it to even lower elevations. Mass-wasting activities are happening constantly on all slopes; certain mass-wasting processes operate extremely slowly. Slumping occurs on steep slopes, happening along discrete fracture zones, typically inside materials like clay that, if freed, may flow very quickly downhill. Surface creep is the gradual movement of soil and rock debris by gravity which is generally not apparent unless via prolonged observation[4], [5].

1.3.Rainfall as well as Runoff :

The greater the intensity and length of a rainfall, the higher the erosion potential. The impact of rainfall on the soil surface may break down soil aggregates and distribute the aggregate material. Lighter aggregate elements such as extremely fine sand, silt, clay and organic matter are readily dispersed by the raindrop splash and runoff water. Soil movement by rainfall (raindrop splash) is typically largest and most apparent during short-duration, high-intensity thunderstorms. Surface water runoff happens anytime there is surplus water on a slope that cannot be absorbed into the soil. Reduced infiltration owing to soil compaction, crusting or freezing increases the surface runoff and soil erosion. Runoff from agricultural land is highest when compared with other land regions.

1.4.Cropping as well as Vegetation:

The risk for soil erosion rises if the soil has no or very little vegetative cover of plants and/or agricultural leftovers. Plant and residue cover shields the soil from raindrop impact and splash, tends to slow down the flow of runoff water and enables surplus surface water to enter. The erosion-reducing efficacy of plant and/or agricultural leftovers relies on the kind, area and amount of cover. The efficacy of any protective cover also relies on how much protection is provided at different times throughout the year, compared to the quantity of erosive rainfall that occurs during these periods. Crops that provide a full protective cover for a major portion of the year (e.g., alfalfa or winter cover crops) can reduce erosion much more than can crops that leave the soil bare for a longer period of time (e.g., row crops), particularly during periods of highly erosive rainfall such as spring and summer.

1.5.Forms of Water Erosion:

The major forms of water-borne soil erosion are:

- Sheet Erosion
- Rill Erosion
- Gully Erosion
- Bank Erosion

1.5.1. Sheet Erosion:

Sheet erosion is the movement of soil by raindrop splash and runoff water. It usually develops uniformly across a uniform slope and remains undetected until much of the fertile topsoil has been gone. Deposition of the eroded soil happens near the bottom of the slope or in low regions. Lighter-colored soils on knolls, changes in soil horizon thickness and poor crop yields on shoulder slopes and knolls are additional indications[6], [7].

1.5.2. Rill Erosion:

Rill erosion is the loss of soil by concentrated water flowing via tiny streamlets, or head cuts. Detachment in a rill happens if the sediment in the flow is below the amount the load can carry and if the flow exceeds the soil's resistance to detachment. As separation continues or flow increases, rills will grow broader and deeper. Rill erosion usually occurs as a consequence of concentrated overland flow of water leading to the formation of tiny well-defined channels. These canals serve as sediment sources and transport routes, resulting to soil loss.

1.5.3. Gully Erosion:

Gully erosion is "the removal of soil or soft rock material by water, creating separate narrow channels, bigger than rills, which typically transport water only during and shortly after rains". Gully erosion is an advanced stage of rill erosion. A gully is a separate watercourse, formed into a hillslope or valley bottom by intermittent or transitory runoff. Such channels are cut when the force produced by flowing water – a function of its mass and velocity – surpasses the subsoil's resistance. Gully erosion results in large areas of land being taken out of production and creates dangerous circumstances for the users of agricultural equipment[8].

1.5.4. Bank Erosion:

Bank erosion is the wearing away of the banks of a stream or river. This is differentiated from erosion of the bed of the watercourse, which is referred to as scour. Natural streams and manmade drainage channels serve as outlets for surface water runoff and subsurface drainage systems. Bank erosion is the gradual undercutting, scouring and slumping of these drainage channels. There are three major mechanisms that produce bank erosion (scour, mass collapse and slumping), and it is important to identify which are functioning at any given site since the management needed to delay or prevent them may vary. Bank scour is the direct removal of bank materials by the physical action of flowing water and is typically dominant in smaller streams and the upper sections of bigger streams and rivers. Mass failure, which includes bank collapse and slumping, occurs when huge sections of bank material become unstable and fall into the stream or river in single occurrences. Mass failure is frequently prevalent in the lower sections of big streams and often occurs in conjunction with scouring of the lower banks.

1.6.Effects of Water Erosion on site:

The main on-site impact is the reduction in soil quality which results from the loss of the nutrient rich upper layers of the soil, and the reduced water-holding capacity of many eroded soils. The breakdown of aggregates and the removal of smaller particles or entire layers of soil or organic matter can weaken the structure and even change the texture. Textural changes can in turn affect the water-holding capacity of the soil, making it more susceptible to extreme conditions such as drought. Crop emergence, growth and yield are directly affected by the loss of natural nutrients and applied fertilizers. Seeds and plants can be disturbed or completely removed by the erosion. Organic matter from the soil, residues and any applied manure, is relatively lightweight and can be readily transported off the field, particularly during spring thaw conditions. Pesticides may also be carried off the site with the eroded soil. Soil quality, structure, stability and texture can be affected by the loss of soil[9]–[11].

1.7.Effects of Water Erosion Off-Site:

The primary on-site effect is the decrease in soil quality which comes from the loss of the nutrient rich top layers of the soil, and the reduced water-holding capacity of many eroded soils. The breakup of aggregates and the removal of smaller particles or whole layers of soil or organic materials may weaken the structure and potentially alter the texture. Textural changes may in turn alter the water-holding capacity of the soil, making it more vulnerable to severe circumstances such as drought. Crop emergence, growth and yield are directly influenced by the loss of natural nutrients and applied fertilizers. Seeds and plants may be damaged or entirely eliminated by the erosion. Organic matter from the soil, residues and any added manure, is very lightweight and may be easily moved off the field, especially during spring thaw conditions. Pesticides may potentially be transported from the site with the eroding soil. Soil quality, structure, stability and texture may be altered by the loss of soil.

1.8.Wind-borne soil Erosion:

Wind erosion is the separation and movement of soil particles by wind when the airstream flowing over a surface produces sufficient lift and drag to overcome the forces of gravity, friction and cohesion. Once a particle has been dislodged from the surface, it may be carried in suspension or by saltation or by surface creep. Loss of topsoil by wind erosion over a very short time period may substantially reduce soil fertility and crop production.

The pace and amount of soil erosion by wind is influenced by the following factors:

- Soil Erodibility
- Soil Surface Roughness
- Climate(wind patterns, precipitation, frost action)
- Unsheltered Distance
- Vegetative Cover
- Topography
- Cultural practices

1.9.Effects of Wind Erosion:

Wind erosion affects crops via sandblasting of young seedlings or transplants, burying of plants or seed, and exposing of seed. Crops are destroyed, resulting in expensive delays and making reseeding essential. Plants injured by sandblasting are susceptible to the entrance of disease with a consequent reduction in production, loss of quality and market value. Soil drifting is a fertility-depleting process that may lead to poor crop development and yield decreases in regions of fields where wind erosion is a recurrent issue. Continual drifting of an area eventually produces a textural change in the soil. Loss of fine sand, silt, clay and organic particles from sandy soils helps to decrease the moisture-holding capacity of the soil. Also, soil nutrients and surface-applied pollutants may be transported along with the soil particles, leading to off-site effects. In addition, flying dust may damage human health and cause public safety concerns.

1.10. Tillage Erosion:

Tillage erosion is the redistribution of soil via the action of tillage and gravity. It results in the gradual down-slope movement of soil, producing significant soil loss on upper-slope locations and buildup in lower-slope ones. This type of erosion is a key delivery method for water erosion. Tillage action transports soil to convergent regions of a field where surface water runoff accumulates. Also, uncovered subsoil is extremely erodible to the effects of water and wind. Tillage erosion has the greatest potential for the "on-site" movement of soil and in many instances may cause more erosion than water or wind.

- The rate and magnitude of soil erosion by tillage is controlled by the following factors:
- Type of Tillage Equipment
- Direction
- Speed and Depth
- Number of Passes

1.11. Conservation Measures:

Soil conservation is the prevention of soil loss from erosion or decreased fertility caused by over use, acidification, salinization or other chemical soil pollution. Soil conservation is about addressing the issues of land degradation, especially soil erosion. Soil conservation is essentially a question of selecting a proper type of land use and management. Soil conservation may be described as the combination of the proper land use and management techniques that promotes the productive and sustainable use of soils and, in the process, reduces soil erosion and other kinds of land degradation. Slash-and-burn and other unsustainable techniques of subsistence farming are used in certain lower developed regions. A sequel to the deforestation is usually wide scale erosion, loss of soil nutrients and occasionally complete desertification. Techniques for better soil conservation include crop rotation, cover crops, conservation tillage and planted windbreaks and impact both erosion and fertility.

2. DISCUSSION

Soil erosion is a complicated process that relies on soil characteristics, ground slope, vegetation, and rainfall quantity and severity. According to Montgomery, changes in land use are one of the most significant methods of increasing soil erosion. These changes subsequently have a cascading effect as the loss of rich topsoil cover pushes millions of tons of sediments into lakes and reservoirs, altering ecosystems and harming agricultural output and water quality. The key to controlling and decreasing soil erosion is to repair already-damaged land, halt future deterioration and place erosion-preventative measures at the heart of land management strategy. In this manner, we can assist avoid famine and alleviate the climate catastrophe. Many farmers have already made considerable progress in dealing with soil erosion issues on their properties. However, because of continuous improvements in soil management and crop production technologies that have maintained or improved yields in spite of soil erosion, some have not been aware of the growing issue on farms. Awareness typically comes only after property is destroyed and fertile patches of soil are gone.

3. CONCLUSION

Soil depletion may be a gradual process that goes largely undetected, or it may occur at an alarming pace causing significant loss of topsoil. The loss of soil from farms may be reflected in decreased agricultural production potential, poorer surface water quality and impaired drainage network. Soil erosion is a major problem for agriculture in many nations. Proper management of this precious resource is essential to maintain long-term agricultural production. Soil conservation techniques are tools the farmer may employ to avoid soil deterioration and increase organic matter. These techniques include: crop rotation, decreased tillage, mulching, and cover cropping and cross-slope farming.

REFERENCES

1. A. Orgiazzi and P. Panagos, “Soil biodiversity and soil erosion: It is time to get married: Adding an earthworm factor to soil erosion modelling,” *Glob. Ecol. Biogeogr.*, 2018, doi: 10.1111/geb.12782.

2. T. G. Pham, J. Degener, and M. Kappas, “Integrated universal soil loss equation (USLE) and Geographical Information System (GIS) for soil erosion estimation in A Sap basin:

Central Vietnam," *Int. Soil Water Conserv. Res.*, 2018, doi: 10.1016/j.iswcr.2018.01.001.

3. Z. Nigussie *et al.*, "Farmers' Perception about Soil Erosion in Ethiopia," *L. Degrad. Dev.*, 2017, doi: 10.1002/ldr.2647.

4. X. Z. Xu *et al.*, "Gravity erosion on the steep loess slope: Behavior, trigger and sensitivity," *Catena*, 2015, doi: 10.1016/j.catena.2015.08.005.

5. X. Z. Xu *et al.*, "Avalanche in Tuban: a hazard with no defense," *Nat. Hazards*, 2015, doi: 10.1007/s11069-015-1946-9.

6. D. Wang, Z. Wang, Q. Zhang, Q. Zhang, N. Tian, and J. Liu, "Sheet erosion rates and erosion control on steep rangelands in loess regions," *Earth Surf. Process. Landforms*, 2018, doi: 10.1002/esp.4460.

7. B. Wu, Z. Wang, Q. Zhang, N. Shen, and J. Liu, "Modelling sheet erosion on steep slopes in the loess region of China," *J. Hydrol.*, 2017, doi: 10.1016/j.jhydrol.2017.07.017.

8. M. Zabihi *et al.*, "Spatial modelling of gully erosion in Mazandaran Province, northern Iran," *Catena*, 2018, doi: 10.1016/j.catena.2017.10.010.

9. Y. Yue *et al.*, "Lateral transport of soil carbon and land-atmosphere CO2 flux induced by water erosion in China," *Proc. Natl. Acad. Sci. U. S. A.*, 2016, doi: 10.1073/pnas.1523358113.

10. R. S. Van Pelt *et al.*, "The reduction of partitioned wind and water erosion by conservation agriculture," *Catena*, 2017, doi: 10.1016/j.catena.2016.07.004.

11. H. Yang, Y. Gao, D. Lin, X. Zou, J. Wang, and P. Shi, "An experimental study on the influences of wind erosion on water erosion," *J. Arid Land*, 2017, doi: 10.1007/s40333-017-0004-8.