International Journal of Engineering and Management Research e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-9, Issue-2 (April 2019)
www.ijemr.net https://doi.org/10.31033/ijemr.9.2.36

An Assessment of Soil/Land Erosion: Management and Conservation

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ABSTRACT

Land degradation is an environmental threat to all natural ecosystems in India, including agricultural, forest, pasture, and human sustainability. It has severe impacts on agricultural and soil productivity, aquatic imbalance, damaged drainage networks, deterioration of water quality in rivers and reservoirs, infrastructure, and the environment. The soil structure, water systems, natural habitats, and ecosystem services are all adversely affected. Land degradations exacerbated by factors such as an expanding population, intensive agriculture, deforestation, overgrazing, and an increase in the need for wood for heating. Sheet and rill erosion are the primary causes of soil loss due to water erosion. Soil is a dynamic mixture of minerals and organic matter that either supports plant growth or has the ability to do so. Because of the complex interactions among parent material, climate, biology, slope, and time, soil formation is often considered a long-term endeavor in geology. The most important resource on Earth is soil, which serves as the foundation for life. The depletion and degradation of a fertile productive base are both consequences of soil erosion, which takes place at a much slower pace. Sustainable development can only be achieved through proper soil conservation and management. Identifying and describing the factors contributing to Land degradation in India is the focus of this research, which also seeks to demonstrate the severity of the problem. Third, to discuss the implications of Land degradation and actions taken in India to combat the problem of soil erosion.

Keywords-- Conservation, Land Degradation, Management, Techniques

I. INTRODUCTION

Various geomorphic processes and agents, such as flowing water, wind, coastal waves, and glaciers, contribute to soil erosion. As a result, it has been taking place since the dawn of time. However, it has grown into a major issue as the amount of anthropogenic interference has grown over time. Land degradations the separation and movement of soil particles by geomorphic processes. Essentially, the term "transportation" refers to the movement of soil particles (sediment) away from their initial location.

There is a major threat to the existence and well-being of people in India due to soil erosion. Natural or geological disturbances can cause it to occur in forest lands, semi-arid and desert lands, agricultural fields, building sites, highways, disturbed lands, surface mines, glaciated and coastal locations. A complete loss of soil may occur, exposing the bedrock. In order for soil to re-form after being fully removed, it will take tens of thousands or even millions of years. During this time, the land will be useless.

In India, water is the primary agent of erosion, accounting for 90% of the total. Soil particles are washed away by rainfall hitting the soil surface or runoff water flowing over the soil surface in the case of erosion by water. Because of the high impact speeds and vast number of drops, the hydro-dynamic force is strong enough to separate enormous quantities of soil particles. The erosive hydrodynamic forces of overland flow separate soil particles. In general, runoff is confined to a few narrow channels, but raindrop detachment is extensive. Rainfall, runoff, soil quality, topography, and cover conditions all affect the rate of detachment. Land degradation rates are determined by a combination of elements such as climate, water, structure, terrain, soil surface conditions, and interactions between these factors.

Heavy rains wash away a lot of topsoil. During splash erosion, sand and silt are washed away from the soil by raindrops striking the surface. Runoff water from the surface flows across a vast region, removing top soil from a large area. It is called "sheet erosion" when it occurs in this manner. Finger-shaped grooves may form all over an area with a high gradient and soft parent material because of the higher velocity of the runoff. Streams of water, such as those pouring down the sides of highways and embankments, can cause these channels to appear on the ground. Rill erosion is the name given to this type of erosion. If the erosion continues, these rills may deepen and expand into gullies. The Gully formation can influence large swaths of land, turning the entire region into badlands. The lateral and vertical erosion of rills causes gully erosion. Gully formation is more likely in sandy soils. This is how the Yamuna and Chambal ravines were formed. When it rains heavily or there are waves along the coast, the speed and volume of water, gradient, sediment load, rock type, and degree of vegetation cover all play a role in the rate of soil erosion. Solution or corrosion, abrasion, attrition, and hydrostatic pressure are all factors

in water erosion. Toxic waves, tidal waves, and tsunamis batter coastlines along the world's coasts. Coastal erosion, or littoral erosion, is particularly severe off the coast of Kerala. In the Himalayan region, glacial movement has a significant impact on soil erosion.

There is a high risk of wind erosion in arid and semi-arid environments that lack vegetation. Wind erosion is the process through which soil particles are removed by the wind. Wind erosion takes place by deflation and abrasion. It is important to note that the rate of wind erosion is influenced by factors such as wind velocity, soil moisture, and the size of surface soil particles. The faster the wind, the more soil will be blown away. Land degradations more likely in areas with bare or sparsely vegetated soils. Fine-textured soils, on the other hand, are more vulnerable to erosion than coarser soils. Rajasthan, as well as the neighbouring states of Haryana, Punjab, and Gujarat, is prone to wind-driven soil erosion.

Aside from natural forces like water, wind, and glaciers, other human and animal activities also contribute to soil erosion. Erosion of soil is exacerbated by factors such as logging, overgrazing, and inefficient agricultural practises. Soil is protected from erosion by trees and plants because they link the soil structure and continuously add moisture to it. During heavy rains, vegetation and tree litter act as a buffer to prevent soil erosion. Land degradation and flooding are inevitable consequences of deforestation. Deforestation has led to large-scale rill and gully erosion in Punjab's Siwalik foothills, resulting in chos and ravines in Madhya Pradesh, Rajasthan, and Uttar Pradesh, all of which were eroded as a result of gully erosion. Wischmeier and Smith (1978) established the Universal Soil Loss Equation to quantify long-term soil loss based on extensive study data (USLE). The USLE is an empirical erosion model that is used to forecast long-term average yearly losses of soil per unit area due to sheet and rill erosion under a specific cropping and management system.

II. INDIA'S LAND DEGRADATION ISSUES

In India, there is an issue with land degradation. Water erosion, acidity, flooding, wind erosion, salinity, and combinations of these variables erode approximately 94,16, 14, 9, 6, and 7 Mha of land in India. In India, one of the most important risks is water erosion, which causes the loss of valuable topsoil and alters the shape of the landscape. Water erosion affects approximately 113.3 Mha of land, and approximately 5334 million tonnes (16.4 tonnes ha^{-1}) of soil are detached annually for a variety of reasons, with approximately 29 percent of soil loss being carried away by the river into the sea, 10 percent into reservoirs, resulting in reservoir sedimentation, and the remaining 61 percent being displaced from one location to another (Bhattacharyya et al., 175 Mha (53%) of the total area is affected by Land degradationand land degradation; 150 Mha is deteriorated by water and wind erosion alone, which accounts for a loss of about 5.3 Mt of sub soil per year; the remaining 25 Mha is degraded by a variety of gullies and ravines; shifting cultivation; salinity; alkali; and water logging (Singh and Panda, 2017). As a result of the steep to very steep slopes in Northern India, deforestation, burning, clearing, and dibbling of seeds cause around 4.1 tonnes of soil material to roll down each year. Land degradationhas degraded more than half of the country's land area.

More than half of the country's land surface is subject to substantial Land degradationas a result of gorges and gullies, changing cultivations, agricultural wastelands, sand dunes, and water logging, among other factors. 1. Published on Authorea under the terms of a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License. There has been no formal peer review of this preprint. It's possible that these results are preliminary. Nearly 69.5 percent (228.3 Mha) of the country's total land area is classified as dry land, with 36.5 percent of that area being considered significantly degraded or otherwise negatively impacted (Thomas et al., 2018a). According to Mahapatra et al. (2018), around 48.3% of Uttarakhand state in India is beyond the 11.2 tonnes ha-1 yr-1 soil loss tolerance level. Emissions of carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), sulphur dioxide (SO2), and other pollutants contribute to the degradation of about 147 million hectares (147 million acres) of land. A staggering 6.6 x 10^9 metric tonnes of soil are lost annually. Agricultural lands in Jharkhand's Daltonganj watershed contribute 10 tonnes of soil loss per acre per year. As a result, soil conservation techniques like bunding, terracing, crop rotation, agroforestry, and other biological and physical structures must be implemented in this area in order to reduce soil erosion.

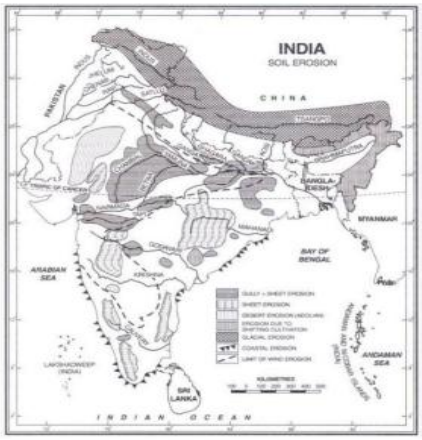

Figure 1: Soil-erosion in India takes a variety of types
Source: http://www.yourarticlelibrary.com/soil/soil-erosion-paragraphs-on-soil-erosion-inindia/13895

To put that number in perspective, the National Bureau of Soil Survey and Land Use Planning estimates that around 146.8 million hectares of Indian land have been degraded. There is an average annual soil loss of 17.73 tonnes ha^{-1} yr^{-1} in the Pamba river basin, Kerala, India, and the places with high LS-factor and degraded/deciduous forest/grassland areas are more prone to soil erosion, according to Prasanna kumar and colleagues (2012). According to Devatha et al. (2015), the major stream of the Kulhan watershed in the Shivnath basin in Chhattisgarh (India) suffers the most soil loss due to the steepness factor (68.16) and length of the slope (0 to 10.49 percent). According to Saha et al. (2018), if soil loss rates in the Kangsabati watershed, West Bengal (India), continue at their current rate (>13.42 tonnes $ha^{-1}yr^{-1}$), the area could degrade and become unusable for agriculture. According to Thomas et al. (2018b), approximately 70% of the area in India's Muthirapuzha River Basin experienced only minor erosion (5 tonnes ha^{-1} yr^{-1}) and approximately 85% of the region has a sediment yield of less than 5 tonnes ha^{-1} yr^{-1}.

Conservation planning, erosion control, and environmental management can be improved with the use of spatial Land degradationprone areas and quantitative data on soil loss. In order to create an accurate Land degradation map, researchers divided the entire watershed region into various categories, such as light, moderate, moderately high, and extremely high, respectively (Bhattacharyya et al., 2015; Singh and Panda, 2017; Mahapatra et al., 2018). Nearly ninety percent of India's landmass falls under one of the five categories of soil erosion, ranging from five to forty tonnes ha^{-1} yr^{-1} (Thomas et al., 2018a). According to Saha et al. (2018), approximately 45 percent of the upper Kangsabati watershed in West Bengal (India) is in an erosion-prone zone. About 69% of Perambalur Taluk's land is classified as low erosion, with the rest falling into one of four categories: moderate (16.80%), high (7.48%), very high (4.52%), or severe (2.26%). This information was gleaned from a study conducted by Karthick and colleagues in 2017. Images and tables demonstrate the various forms of Land degradation and land degradation throughout the country.

III. MANAGEMENT OF LAND DEGRADATION PREVENTION

All life on Earth is dependent upon the existence of soil, which is nature's most valuable resource. Economic growth and a better standard of life in society can only be achieved through a strong agricultural sector, which relies on a healthy soil base. Therefore, soil conservation and management are required for sustainable economic development. Soil conservation includes any and all methods used to protect the soil from erosion and depletion. The preservation of this precious resource can be accomplished through a variety of means. In order to counteract soil erosion, different actions must be taken in different parts of the country because of the different sources of the problem. Crop rotation and mulching are some of the most significant methods to consider. Other key ones are contour tillage, contour bunding, check dam construction, terrace farming, and the monitoring of the extension of gullies.

Contour tillage is the process of ploughing the fields along the contours rather than the hill slope. As a result, ridges and furrows emerge in the opposite direction of the flow, slowing the water down. As a result, more water may be absorbed by the plants in the soil. As a result, less water is discharged into the environment. Similar principles apply to contour bunding as well. Check dams assist in reducing runoff volume while also slowing

the rate of flow. As a result, it aids in the conservation of both soil and water.

Strip cropping refers to the practise of planting crops in long rows that are spaced closely together. While some strips may be left fallow for a period of time, others may be planted with a different crop at the same time. Tree crops can also be grown on some of the strips. Wind breaks or shelter belts are provided by trees or tall crop strips. Land degradationis minimised since crops are harvested at different times, leaving just a small area exposed. Even the barren strip of land adjacent to these regions is protected from eroding due to the presence of a crop or tree cover.

Lands that have suffered from severe Land degradationand a reduction in soil depth should also be reclaimed. The ecological regeneration of the degraded areas can be aided by planting the right kinds of plants in these locations. Gully stabilisation can also benefit from this method, and some of the badlands can be reclaimed in this way.

When the period of planned development began in India, the government realised the importance of conserving land and water. A network of Soil Conservation, Research, Demonstration, and Training Centers was built under the First and Second Five Year Plans. Soil and Water Conservation Research and Training Institute (CSWCRTI) was founded in 1974 with its headquarters in Dehradun after being transferred to ICAR in 1967.

In India, watershed management is the primary strategy for preventing and controlling soil erosion. When the RVP (Soil Conservation in River Valley Project Catchments) began in 1962, it was a groundbreaking initiative. An integrated watershed planning approach is used to prevent reservoir siltation and increase productivity in catchment areas by means of appropriate interventions such as vegetative hedges, contour/graded bunding, agricultural planting, silvi-pastoral development, and pasture development. A limited number of watersheds from the All India Soil and Land Use Survey Organization (AISLUSO) have been selected for treatment under the programme.

Watershed Management in Flood-Prone River Catchments (FPR) is a programme that began in 1982-83 and is currently being implemented in 291 watersheds throughout eight catchment areas in eight states. Land degradation reduction in flood-prone river catchments is the goal here in order to lessen the frequency and magnitude of floods. The watershed concept was used to implement the Fifth Drought Prone Area Program (DPAP) and the Desert Development Programme (DDP), which both focused on soil and water conservation. The Integrated Wasteland Development Project (IWDP, 1995) and the National Watershed Development Programme for Rainfed Areas (NWDPRAs, 1990-91) both focused on sustainable use of soil and other resources. Several organisations are working together to create Land degradation maps at watershed, state, national, and international levels in order to adequately address the issue of Land degradation and its management.

IV. SOIL AND WATER CONSERVATION TECHNIQUES

Conservation practises in the fields of water and soil play a vital role in preventing soil loss. Runoff and soil loss can be reduced by using techniques like strip cropping, contour planting and rotational cropping. These strategies intercept rainfall and runoff energy to reduce soil loss and runoff, which is why they are important. Runoff generation, protection of soil, rainfall action, and degree of infiltration are all influenced by the land cover, which affects soil erosion. Higher levels of gross and net soil loss were recorded in areas of natural vegetation than in areas affected by man-made plantations and crops (Thomas et al., 2018a). Reduced Land degradation can also be achieved by the use of no-till practises. In addition, thick grassland, bushes, and forests provided the best protection against soil erosion. Forested and planted areas in the Kangsabati watershed, India, have modest soil loss rates (1 tonne ha^{-1} yr^{-1}), according to Saha et al. (2018).

V. CONCLUSION

There is a complex interplay between natural and human-caused erosion in India. Changes in land use and land cover, as well as hydrology and other major factors such as these; all interact to determine how quickly soils erode. Wind erosion predominates in the western half of the country, whereas water erosion is common across the country. Annual soil loss averages up to roughly 16 metric tonnes per hectare, which equates to about 5 billion metric tonnes. Land degradation has both immediate and long-term effects on the economy, both on and off the property. Land degradation causes the siltation of reservoirs, tanks, and rivers. Due to soil erosion, agricultural yields and productivity are lower. More frequent and standard data collection is needed to assess the degree of Land degradation throughout time and place. In India, watershed management is the most popular method for preventing and controlling soil erosion. Soil conservation and management are essential to achieving sustainable development.

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