Soil erosion problems in India

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Abstract

Soil erosion is a dangerous environmental issue in India threatens the productivity of all natural ecosystems such as agricultural, forest, pasture and human sustainability inducing severe impacts on agricultural and soil productivity, aquatic imbalance, damaged drainage network, deterioration of water quality in rivers and reservoirs, infrastructure and the environment. In addition, severely affects the soil structure, hydrological systems, natural habitats and ecosystem services. Moreover, increasing population, intensive agriculture, deforestation, over grazing and higher demand of wood for fire also causes the soil erosion. Mostly soils are lost by water erosion are due to the process of sheet and rill erosion. This paper represents the extant of erosion problem in India and their mitigation practices.

Introduction

The soil erosion may be more severe in future due to climate change, increasing population pressure, faulty land use and over exploitation of natural resources (Singh and Panda, 2017). With the increasing population and land use changes, the mapping and quantitative assessment of soil has become more important for sustainable use and planning of conservation practices. Improper land utilization, unscientific cutting of hill slope, agricultural expansion, urbanization and decreasing of vegetative cover are the dominant factor leads the soil erosion. Therefore, accurate evaluation and prediction of soil erosion is more importance in order to design the appropriate erosion control and sediment management structures, given the spatial distribution of the consequences, the severity of the problem and the socio-economic impacts (Thomas et al., 2018b).

Land degradation problems in India

In India, total land degradation is estimated about 147 Mha, in which about 94,16, 14, 9, 6, and 7 Mha land is degraded by water erosion, acidification, flooding, wind erosion, salinity, and combination of these factors, respectively (Bhattacharyya et al., 2015). Water erosion is considered as one of the most serious hazards in India resulting in loss of top fertile soil and terrain formation. About 113.3 Mha of land is subjected to water erosion (Tirkey et al., 2013) and about 5334 million tonnes (16.4 tonnes ha^{-1}) of soil is being detached annually due to various reasons, in which about 29% of soil loss is carried away by the river into the sea, 10% into the reservoirs that lead to reservoir sedimentation (Singh and Panda, 2017) and remaining 61% gets displaced from one location to another (Bhattacharyya et al., 2015). Nearly, 175 Mha (53%) [in which 150 Mha is deteriorates by water and wind erosion alone, which accounts a loss of about 5.3 Mt of sub soil per year and remaining 25 Mha is degraded by various gullies, ravines, shifting cultivation, salinity, alkalinity and water logging] of total geographical area is suffering from different deteriorating effects of soil erosion and land degradation (Singh and Panda, 2017). In Northern India, deforestation, burning, clearing and dibbling of seeds alone causes about 4.1 tonnes $ha^{-1}yr^{-1}$ of soil material to roll down towards the foothills due to steep to very steep slopes (Mahapatra et al., 2018). More than 50% of total geographical area of country is degraded by soil erosion (Saha et al., 2018).

About 130 Mha (45%) of the total geographical surface area of country is affected by serious soil erosion due to gorge and gully, shifting cultivation, cultivated wastelands, sandy areas, deserts and water logging.

Nearly, 69.6% (228.3 Mha) of total geographical area of country comes under dry lands, in which 36% of area is seriously degraded (Thomas et al., 2018a). Mahapatra et al. (2018) indicated that about 48.3% area of Uttarakhand state of India is above the tolerance limit of 11.2 tonnes $ha^{-1}yr^{-1}$ of soil loss. In addition, nearly 147 Mha is degraded by erosion, in which about 94 and 9 Mha land is degraded by water and wind respectively, and remaining is degraded by acidification, salinity, flooding and combination of them etc. (Bhattacharyya et al., 2015). Moreover, about 6.6 x 10^9 tonnes of soil are lost each year (Thomas et al., 2018b). Tirkey et al. (2013) studied that maximum soil loss contributed from agricultural lands of Daltonganj watershed of Jharkhand are 10 tonnes $ha^{-1}yr^{-1}$, therefore in this regions soil conservation practices like bunding, terracing, crop rotation, agro-forestry and other biological and physical structures must be adopted for mitigating the erosion.

Bhattacharyya et al. (2015) reported that according to the National Bureau of Soil Survey and Land Use Planning about 146.8 Mha lands of India is degraded. Prasannakumar et al. (2012) studied average annual soil loss from small mountainous sub watershed in Pamba river basin, Kerala, India, of 17.73 tonnes $ha^{-1}yr^{-1}$ and resulted that the areas with high LS-factor and degraded/deciduous forest/grasslands areas were more susceptible to soil erosion. Devatha et al. (2015) observed that maximum soil loss is occurred on the main stream of Kulhan watershed of Shivnath basin, Chhattisgarh (India), because of high slope length and steepness factor value (68.16) as well as slope value ranging from 0 to 10.49%. Saha et al. (2018) revealed that if soil loss rate continues at current rate ($>$13.42 tonnes $ha^{-1}yr^{-1}$) from Kangsabati watershed, West Bengal (India), then it may lead land degradation and current land converted to unfit for agriculture. Thomas et al. (2018b) used RUSLE-SDR coupled model to estimate the soil erosion and sediment yield from Muthirapuzha River Basin of India and found that about 70% of area experienced slight erosion ($<$5 tonnes $ha^{-1}yr^{-1}$) and about 85% area has the sediment yield less than 5 tonnes $ha^{-1}yr^{-1}$.

Identification of spatial soil erosion prone areas and quantitative information of soil loss are helpful for designing and implementing of conservation planning, erosion control and management of the environment. Many researchers prepared soil erosion map by dividing the entire watershed area into different erosion classes such as slight, moderate, high, very high, severe and very severe, respectively (Bhattacharyya et al., 2015; Singh and Panda, 2017; Mahapatra et al., 2018). About 91% of total geographical area of India is comes under these five erosion classes ranging from $<$5 to 40 tonnes $ha^{-1}yr^{-1}$ and requires immediate soil conservation practices (Thomas et al., 2018a). Saha et al. (2018) found that about 45% area of upper Kangsabati watershed, West Bengal (India) was under high to very high erosion prone zone. Karthick et al. (2017) found that 68.95% area of Perambalur Taluk, Tamil Nadu (India) comes under low erosion classes and remaining areas are moderate (16.80%), high (7.48%), very high (4.52%) and severe (2.26%) erosion classes, respectively. The different forms of soil erosion and extent of land degradation in the country are shown in Fig.1 and Table 1, respectively.

Application of soil and water conservation practices

Soil and water conservation practice plays an important role to control the soil loss and sediment mobilization. The soil conservation techniques such as strip cropping, contour cropping, terracing, rotational cropping system, conservation tillage, zero tillage, mulching and hedgerow systems reduces the runoff and soil losses by intercepting the rainfall and runoff energy. The land cover influences the soil erosion in terms of rate of runoff generation, protection of soil, action of falling rainfall and degree of infiltration. Higher gross and net soil loss occurred in natural vegetation belt as compared to anthropogenic signatures of plantation and crops lands (Thomas et al., 2018a). No-till practices are also considered the best management practices to reduce the soil erosion. Moreover, Forest, shrubs and dense grassland provided the best protection of soil erosion. Saha et al. (2018) found that dense forest and plantation area of Kangsabati watershed of India has low soil loss rate ($<$1 tonnes $ha^{-1}yr^{-1}$).

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Table 1. Extant of land degradation in India

Organizations	Assessment Year	Degraded Area (Mha)
National Commission on Agriculture	1976	148.1
Ministry of Agriculture-Soil and Water Conservation Division	1978	175.0
Department of Environment	1980	95.0
National Wasteland Development Board	1985	123.0
Society for Promotion of Wastelands Development	1984	129.6
National Remote Sensing Agency	1985	53.3
Ministry of Agriculture	1985	173.6
Ministry of Agriculture	1994	107.4

Organizations	Assessment Year	Degraded Area (Mha)
NBSS & LUP	1994	187.7
NBSS & LUP (revised)	2004	146.8

(Source: Bhattacharyya et al., 2015)

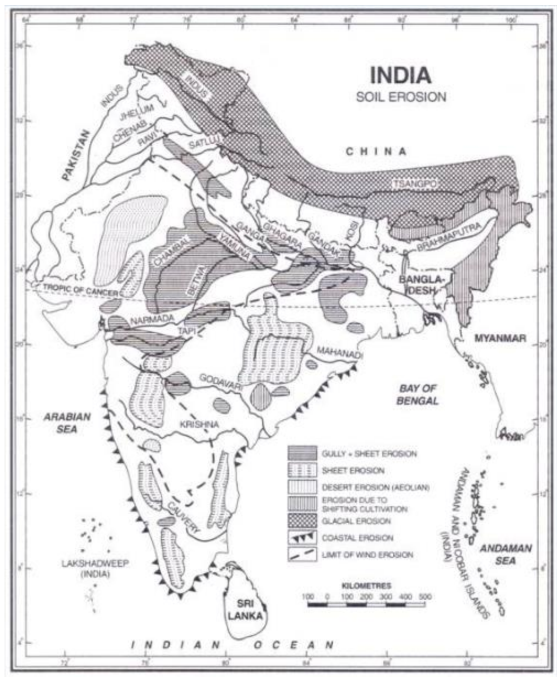

Fig.1. Different forms of soil erosion in India

(Source: http://www.yourarticlelibrary.com/soil/soil-erosion-paragraphs-on-soil-erosion-in-india/13895)