Soil erodibility of Jorhat and Sibsagar districts of Assam

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Abstract

Soil erodibility of Jorhat and Sibsagar districts in the Brahmaputra valley of Assam was evaluated with respect to their inherent soil properties. It was found that the soils of Sibsagar district are relatively more susceptible to erosion than those of Jorhat district, and the percentage of total geographic area (TGA) under high erodibility ratings were 63 and 68% for Jorhat and Sibsagar districts, respectively. The soil erodibility factor 'K' varies from 0.184 to 0.562 for Jorhat, and 0.205 to 0.404 for Sibsagar district. Presence of high silt fraction render these soils susceptible to erosion under high rainfall. It was found that the soils with higher content of intermediate size fractions (silt + very fine sand) are more erodible than the soils with higher clay (clayey soils) and higher sand content (sandy and sandy loam soils). Entisols were found to be more erodible than Inceptisols. The study indicated that the soils of Jorhat and Sibsagar districts are in general, highly erodible which needs suitable soil conservation measures to reduce soil loss and protect existing productivity.

Additional key words : Soil loss, soil erosion, Brahmaputra valley, recent and old alluvium

Introduction

Water erosion is the severe problem for the agricultural development threatening entire north-eastern region in general and the Brahmaputra valley in particular. Sheet erosion and river bank erosion of the Brahmaputra contribute substantially to the sedimentation problem of the rivers and productivity decline of farm land covering lakhs of hectares. It is also frightening that the mighty river is drifting towards southern bank due to huge sedimentation in the north bank (Sen *et al.* 1996). Sibsagar and Jorhat districts represent a major part of the Brahmuputra valley where a number of crops including tea are grown. The soils of this region were reported to be deep, acidic with poor nutrient reserve (Sen *et al.* 1999). It is known that the conservation of top soil is an important management target for sustainable agriculture, however, little information is avaialble on soil erodibility of these soils. With this in view, an attempt has been made to estimate the status of soil erodibility of Jorhat and Sibsagar districts of Assam using inherent soil properties.

Materials and methods

Study area

The area under study includes Jorhat and Sibsagar districts of Assam which lies between 93°57' to 95°22' E longitudes and 26°20' to 27°15' N latitudes with total geographical area of 5.46 lakh hectares. The area represents a major part of the Brahmaputra valley encompassing numerous landscapes from dissected hills in the south bordering Nagaland to active flood plains of the Brahmaputra in the north. The altitude ranges from 60 to 450 m above mean sea level. The Brahmaputra is the principal river that drains the area. Numerous tributaries originating from Naga hills alongwith a number of streams flowing from the south and south-east merge into the mighty river Brahmaputra in the north.

The climate of the area is humid subtropical. The mean annual precipitation for Sibsagar and Jorhat districts are 2504 mm and 1950 mm, respectively. Rice is the most important crop of the area. Wheat, potato, pulses, mustard, jute and vegetables are also grown in patches. The district of Sibsagar has the highest area under tea in the state.

Soils of the region are developed in the recent and old alluvium. The soils in general are deep to very deep, medium textured, acidic with low CEC and poor mineral reserve. Flood plain soils are stratified indicating cycles of erosional or depositional episodes.

Erodibility estimation

The Universal Soil Loss Equation (USLE) is an erosion prediction model, for estimating the long-time averages of soil losses from a specified land in a specified cropping and management system. The equation predicts only the losses from sheet and rill erosion under specified conditions. It computes the soil loss for a given site, as a product of six major factors, whose most likely values at a particular location can be expressed numerically (Wischmeier and Smith 1978) as :

$$A = RKLSCP$$

Where

A = The computed soil loss per unit area, expressed in the units selected for K and for the period selected for R. In practice, these are usually so selected that they compute A in tonne per ha per year, but other units can be selected

R = The rainfall erosivity factor, is the number of rainfall erosion index units for a particular location

K = The soil erodibility factor, is the soil loss rate per erosion index unit for a specified soil as measured on a unit plot, which is defined as 22.13 m length of uniform 9 per cent slope continuously in clean tilled fallow

L = The slope length factor is the ratio of soil loss from the field slopes length, to that from a 22.13 m length, under identical conditions

S = The slope-steepness factor, is the ratio of soil loss from the field slope gradient to that from a 9 per cent slope under otherwise identical conditions

C = The cover and management factor, is the ratio of soil loss from an area with specified cover and management, to that from an identical area in tilled continuous fallow

P = The support practice factor, is the ratio of soil loss with a support practice like contouring, strip-cropping, or terracing to that with straight-row farming up and down the slope

The soil erodibility factor 'K' is defined as the rate of soil loss per erosion index unit from unit plot size (Wischmeier and Smith 1978). In reality, the direct measurement of K from experimental run-off plot is expensive, and time consuming. In view of this, a simple nomograph developed by Wischmeier *et al.* (1971) was employed in the present study. The emperical equation to estimate the K value is given below :

$$100\ K = 2.1 \times 10^{-4}\ (12-OM)\ M^{1.14} + 3.25\ (S-2) + 2.5\ (P-3)$$

Where, OM = Organic matter in per cent

M = (% silt + % very fine sand) (100 − % clay)

S = Soil structural code

P = Profile permeability class

The present study was carried out using soil survey information of Sibsagar and Jorhat Districts (Anonymous 1993, 1995) which includes a total of 33 soil series (21 from Jorhat and 12 from Sibsagar districts).

Table 1. Physical properties and soil erodibility factor for different soils of Jorhat district (Assam)

	Soil series	Soil sub-group	Sand (2-0.1 mm)	Slit (0.05-0.002 mm)	v.f. sand (0.1-0.05 mm)	Clay (<0.002 mm)	OM	Slit v.f. sand	Texture	Structure		Permeability		Soil Erodibility Factor (K)*
			---------- (%) ----------							Class	Code	Class	Code	
1.	Disai-I	Fluventic Dystrochrepts	57.10	22.4	12.5	11.5	0.93	34.9	Sandy loam	fg	2	Mod. rapid	2	0.184
2.	Disai-II	Typic Dystrochrepts	20.8	14.3	46.7	18.2	1.34	61.0	Sandy loam	fg	2	Moderate	3	0.368
3.	Disai-III	Typic Udorthents	46.3	18.6	20.7	14.4	1.14	39.3	Sandy loam	fg	2	Rapid	1	0.189
4.	Murmurya	Typic Udorthents	42.8	21.3	17.7	18.2	1.98	39.0	Sandy loam	sbk	4	Moderate	3	0.273
5.	Sildubi	Dystric Eutrochrepts	32.7	34.9	6.9	25.5	1.99	41.8	Loam	sbk	4	Mod. rapid	2	0.242
6.	Gajpuria	Typic Haplaquepts	3.2	61.0	13.6	22.2	2.13	74.60	Loam	sbk	4	Mod. slow	4	0.495
7.	Matikhola	Aeric Fluvaquents	17.9	47.5	9.7	24.8	1.25	57.3	Silt to clay loam	sbk	4	Mod. slow	4	0.404
8.	Puranimati	AericHaplaquents	23.8	28.7	29.2	18.3	1.09	58.0	Loam	m	4	Moderate	3	0.435
9.	Adhakota	Typic Haplaquents	39.1	24.9	21.5	14.4	0.59	46.5	Sandy loam	sbk	4	Moderate	3	0.369
10.	Sangsoa	Typic Dystrochrepts	1.8	52.0	21.1	25.1	2.17	73.1	Sandy loam	mg	3	Moderate	3	0.410
11.	Teok	Typic Dystrochrepts	56.6	12.8	21.4	9.2	2.37	34.4	Silty clay loam	mg	3	Moderae	3	0.227
12.	Nahattipomia	Typic Fluvaquents	22.1	57.4	10.7	9.8	0.75	68.7	Sandy loam	Sbk	4	Moderate	3	0.562
13.	Bareragaon	Aeric Haplaquepts	3.6	55.8	13.3	27.3	1.32	69.1	Silt loam	sbk	4	Moderate	3	0.486
14.	Dohotia	Typic Haplaquepts	8.0	55.8	9.6	26.6	1.64	65.4	Silty clay loam	sbk	4	Moderate	4	0.432
15.	Napamuagaon	Typic Haplaquepts	50.6	20.4	20.8	8.2	1.07	41.2	Silt loam	sbk	4	Slow	3	0.340
16.	Akahugaon	Typic Haplaquepts	8.0	52.7	14.9	24.4	1.51	67.6	Sandy loam	sbk	4	Slow	5	0.487
17.	Jankhana	Typic Udifluvents	48.8	15.0	23.5	12.7	1.08	38.5	Sandy loam	m	4	Moderate	3	0.305
18.	Marangiagaon	Typic Udipsamments	17.9	40.1	35.1	6.9	3.70	75.2	Sandy loam	sbk	4	Rapid	1	0.305
19.	Pakajara	Mollic Fluvaquents	38.6	14.6	32.2	14.6	3.87	46.8	Sandy loam	m	4	Mod. rapid	2	0.258
20.	Ratanpur Kathalkhoa	Typic Fluvaquents	5.0	56.8	17.4	21.3	2.86	74.2	Silt loam	m	4	Moderate	3	0.443
21.	Lahangaon	Aquic Udifluvents	18.9	35.6	31.6	13.9	3.34	67.2	Loam	sbk	4	Moderate	3	0.419

*K is expresed in U.S. customary units of ton/acre per 100 foot ton/acre inch hr
Multiplication by 1.2917 will give K in metric units of tonne/ha per 100 m tonne/ha cm/hr.
Division by 7.59 will give K in SI-units of tonne/ha per MJ/ha mm/hr

Results and discussion

The physical properties and soil erodibility factor for different soils (series wise) of Jorhat and Sibsagar districts are furnished in table 1 and 2, respectively. The soil erodibility factor (K) is the combined effect of particle size distribution, organic matter, structural strength and permeability. The estimated erodibility (K) of different soils showed variation ranging from 0.184 to 0.562 for Jorhat and 0.231 to 0.404 for Sibsagar districts. The most susceptible textural ranges for detachment and transportation were very fine sand and silt. Similarly the soils with 40 to 60 per cent silt were reported to be more erodible (Richter and Negendank 1977).

In the present study, it was observed that as the per cent of slit plus very fine sand increases and attains more than 60, the erodibility reaches higher values ranging from 0.40 to 0.53. It indicates that soils with more content of the intermediate particle size fractions between sand and clay (silt to very fine sand) erode more. In Jorhat district (Table 1) all the silt loam and silt to clay loam soils viz. Gajpuria, Sangsoa, Nahattipomia, Bareragaon, Dohotia, Akahugaon and Ratanpur-Kathalkhoa series covering 78, 177 ha (27.3% of TGA) are relatively more prone to erosion. It is evident from the results that in most of the sandy loam and loam soils with more sand (40-57%), the erodibility is relatively low (0.184 to 0.30). This could be due to inherent resistance of the soil when the flow velocity to cause detachment of the soil must attain a threshold value before erosion commences (Hjulstrom 1935). For grain sizes larger than 0.1 mm diameter, the critical velocity increases with particle size indicating a larger force is required to move larger particles. Therefore, the soils covering Disai-I, Disai-III, Murmurya, Sildubi, Teok and Pakajara series being mostly coarse textured (sandy loam and loam soils) are less erodible. These soils contain 22 to 35 per cent silt and 31 to 42 per cent silt plus very find sand.

It is known that the soils with high organic matter content are less erodible. However, the soils of Marangiagaon, Pakajara, Ratanpur, Kathalkhoa, Lahangaon, Gajpuria, Sangsoa and Teok series of Jorhat with fairly high organic matter content are more erodible than the soils of adjoining areas with comparably less content of organic matter. This anomaly could be due to presence of higher content of silt and very fine sand which overcome the effect of organic matter.

The soils of Sibsagar district (Table 2) showed narrow variation in K values (0.205 to 0.404). Romagaon and Solmari series with high silt plus very fine sand content recorded the highest erodibility. Similarly the soils of Desoipathar, Ikarani and Katanipara series with higher content of intermediate size particles showed higher erodibility. In contrast, the soils of Mathurapur, Chengalibari and Kalugaon series of Sibsagar district are relatively less erodible likely due to higher content of sand and/or clay. With few exceptions, Entisols in general were found to be more erodible than Inceptisols.

Based on the erodibility indices the soils were rated and grouped into different classes in the line of FAO/UNESCO (1974). The soils and their corresponding area under each erodibility classes are given in table 3. The results indicate that majority of the soils qualify for highly erodible class (68.3% of Sibsagar and 63.4% of Jorhat). Characteristically, there is no soil with low erodibility rating. The erodibility study indicates that the soils of Jorhat and Sibsagar have high risk of erosion. It is hardly possible to bring down the erodibility to a safer limit within a reasonable time as it depends upon the inherent soil properties. It is concluded that soil conservation management with wide range of practices are urgently needed to protect these soils and their existing productivity.

Table 3. Erodibility ratings

Soil Erodibility Rating	Jorhat District		Sibsagar	District
	(ha)	(%)	(ha)	(%)
Low (<0.1)	Nil	Nil	Nil	Nil
Moderate (0.1–0.3)	66,135	23.14	82,601	31.73
High (>0.3)	1,81,446	63.45	1,77,689	68.27
Miscellaneous*	38,359	13.41	Nil	Nil
Total	2,85,940	100.00	2,60,290	100.00

*Extremely sandy/mud and water bodies

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