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Soil Erodibility Characteristics under different Land uses in Dhansiripar, Nagaland

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ABSTRACT: Inappropriate land use practices are one of the major causes of land degradation and are a concern for sustainable productivity. Evaluation of soil erodibility characteristics is very much important to adopt proper soil and water conservation practices for a particular location. The present study was conducted to determine the soil erodibility characteristics under different land uses in six different villages of Dhansiripar, Nagaland *viz*., Razhaphe, Dhansiripar, Doyapur, Kiyeto, Amaluma and Melongmen. The land uses were lowland paddy, field crop, orchard and forest. The textural class of the soils were fond as clay loam, loamy, clay and silty clay loam with clay loam being the most dominant. The dispersion ratio (DR) of surface and sub-surface soil varied from 12.63 to 20.50 and 11.30 to 20.70, respectively. The erosion index (EI) varied from 7.30 to 16.27 and 7.00 to 13.10 in surface and sub-surface soil, respectively. EI showed significant positive correlation with DR (r= 0.65*). The soil erodibility was high in the sampled soils of field crop land use, while the least erodibility was recorded in the forest land.

Keywords: Dispersion ratio, erodibility, erosion index, surface soil, sub-surface soil.

INTRODUCTION

Soil erosion is an important economic, social and environmental concern in many countries today. Globally, soil erosion has an impact on agricultural production and natural resources leading to land degradation and a significant threat to agricultural output. Soil erosion causes loss of top soil leading to decline in fertility of the soil in agricultural land. In agricultural land, the combination of intensive farming activities, improper farming practices, rainfall regimes and topography conditions leads to soil erosion problems (Ahmad *et al.,* 2020). Soil erosion is a function of soil physical characteristics, climate, and land-use practice (Hudson, 1995). Soil erosion can directly or indirectly cause soil quality decline, land degradation, loss of soil resources and even result in serious natural disasters. Intensified soil loss is associated with changes in land use. The rate of soil erosion was lower in forest areas, whereas it was higher in the barren land (Bhandari *et al.,* 2021). Pidenro *et al.* (2023) reported that the dispersion ration of soils under various land uses in Kohima district of Nagaland varied between 12.4 and 19.6; whereas, erosion index ranged from ranged from 8.3 to 12.6. A particular land use system may directly or indirectly affect the physicochemical properties of soil. Soil properties are constantly affected by land use especially in cases where the increasing human population results in increased cultivation of land leading to noticeable alterations of the land use patterns. Changes in the soil characteristics lead to change in the rate of soil erodibility. Determination of soil properties and land use capabilities is essential to diminish the loss of soil by soil erosion process. The predicted severity of soil erosion can provide a basis for conservation and planning processes at the decision makers (Thapa, 2020).

Soil erodibility refers to the susceptibility of the soil to erosion agents. Soil erodibility can be determined using various soil erodibility indices based on soil characteristics. Soil erodibility is also an important factor in predicting soil erosion, soil and water conservation planning and ecological risk assessments. However, there has been very little information available on the erodibility status of this area. Therefore, the present study was undertaken to help to formulate appropriate strategies for sustainable use of land resources, precise farming practices and to increase crop productivity.

MATERIALS AND METHODS

A. Study area

The study area was located in Dhansiripar sub-division under Dimapur district of Nagaland. Dhansiripar sub-division lies between 25°75′N latitude and 93°66′E longitude. The climate of the study area is a humid subtropical agro climatic zone with 93% humidity. The average annual rainfall is around 1514 mm. The sub-division is located 18 km towards South from district headquarter Dimapur. The experiment was conducted during 2021-22 in the Department of Soil and Water Conservation, School of Agricultural Sciences and

Rural Development, Nagaland University, Medziphema Campus, Nagaland.

B. Layout of experiment

Soil samples were collected from at a depth of 0-15 and 15-30 cm from four different land use of each village viz lowland rice, field crop, orchard and forest. A total of 48 soil samples were collected and processed for subsequent analysis. The collected soil samples were processed for further laboratory analysis.

C. Analysis of soil samples

The particle-size distribution was determined following International Pipette method (Piper, 1996) using 0.5N Sodium Hydroxide (NaOH) as a dispersing agent. The value of dispersion ratio (DR) was computed by using the relationship given by Middleton (1930). Erosion index (EI) was computed from the relationship described by Sahi *et al.* (1976). The soil erodibility indices were worked out as follows:

$$DR = \frac{\%\ \text{water dispersed (silt + clay)}}{\%\ \text{(silt + clay) Particle - size analysis}}$$

$$EI = \frac{DR}{\text{Clay/0.5 water holding capacity}}$$

The correlation coefficient was worked out in order to find out the interrelationship among various soil characteristics using the procedure outlined by Gomez and Gomez (2004).

RESULTS AND DISCUSSION

A. Mechanical Composition of Soil

The textural class of the investigated soils were found to be clay loam, clay, loamy and silty clay loam with clay loam being the most dominant. The sand, silt and clay content in the surface soils ranged from 14.10 to 43.80%, 25.00 to 45.00% and 25.00 to 45.00%, respectively. While the sand, silt and clay content in the sub surface soils varied from 15.75 to 44.50%, 25.00 to 45.00% and 25.00 to 45.00%, respectively.

B. Dispersion Ratio

The dispersion ratio in the soils varied from 11.33 to 20.70. The highest dispersion ratio (20.70) was recorded in the sub surface soil under field crop of Doyapur Village. The lowest dispersion ratio (11.33) was recorded in the sub surface soil under forest of Dhansiripar village. Soils under different land uses were found to be vulnerable to erosion taking into account the value of 15 as the threshold limit of DR. Field crop land use showed the most erosive nature. According to the criterion of Middleton (1930), soils having dispersion ratio more than 15 are erodible in nature. The soils under field crop, lowland paddy and orchard were found to be erosive using the above criteria. Dispersion ratio of <5, 6-10, 11-15, 16-25, 26-30 and >30 were categorized as very stable, stable, fairly stable, somewhat unstable, unstable and very unstable. Out of 48 samples, 30 samples were found to be fairly stable and 18 somewhat unstable. Ajibola *et al.* (2018) also found least erodibility indices in forest land uses as compared to others. High correlation between dispersion ratio and erosion index indicate susceptibility of soil to water erosion. Dispersion ratio had significant positive correlation with EI (r= 0.65*) and negative correlation with WHC (r = -0.45) and clay (r= -0.48). Similar findings were also reported by Dutta *et al.* (2016); Jeloudar *et al.* (2018); Pidenro *et al.* (2023).

C. Erosion Index

The erosion index (EI) in the soils varied from 7.00 to 16.27. The highest erosion index (16.27) was observed under field crop of Doyapur village and the lowest (7.00) was recorded under forest of Doyapur village. Considering 2.8 as threshold value of EI, the soils were found to be highly erodible. Forest land use was found to be least erodible. The land use in Kiyeto village was the most erodible while the least erodible was observed in Amaluma village. Forest land use was found to be the least erodible among all the land uses which may be due to higher water retention and infiltration rate. The results are in conformity with Dutta *et al.* (2018). Erosion index of 0-5, 6-10, 11-15, 16-20 and >20 were categorized as very low, low, medium, high and very high. Out of 48 soil samples, 30 were found to be low, 17 medium and 1 high. Significant positive correlation was observed between erosion index and DR (r= 0.65*). Erosion index showed significant negative correlated with silt (r= -0.63*) and negative correlation with clay (r= -0.59). Similar findings were reported by Agnihotri *et al.* (2007); Kumar *et al.* (2017); Dutta *et al.* (2017).

Table 1: Mechanical composition of soils under different land use systems.

Land use & location	Sand (%)		Silt (%)		Clay (%)	
Soil depth (cm)	0-15	15-30	0-15	15-30	0-15	15-30
Lowland Paddy						
Razhaphe	29.45	27.50	35.00	30.00	35.00	40.00
Dhansirpar	28.50	24.45	40.00	40.00	30.00	30.00
Doyapur	33.95	31.50	35.00	35.00	30.00	30.00
Kiyeto	17.50	19.30	40.00	35.00	35.00	35.00
Amaluma	27.30	25.40	30.00	35.00	40.00	35.00
Melongmen	43.80	42.80	30.00	30.00	25.00	25.00
Mean	30.08	28.49	35.00	34.17	32.50	32.50
Field Crop						
Razhaphe	25.40	24.75	35.00	35.00	35.00	40.00
Dhansirpar	43.15	44.50	30.00	30.00	25.00	25.00
Doyapur	39.15	36.20	25.00	25.00	30.00	35.00
Kiyeto	26.15	27.30	35.00	35.00	30.00	30.00
Amaluma	22.80	21.75	40.00	35.00	35.00	40.00
Melongmen	26.50	27.20	35.00	35.00	30.00	30.00

Mean	30.53	30.28	33.33	32.50	30.83	33.33
Orchard						
Razhaphe	27.20	29.00	40.00	35.00	30.00	35.00
Dhansirpar	22.70	21.20	30.00	30.00	45.00	45.00
Doyapur	21.25	24.30	30.00	40.00	45.00	30.00
Kiyeto	33.15	31.50	35.00	35.00	30.00	30.00
Amaluma	19.70	18.00	40.00	35.00	35.00	40.00
Melongmen	30.90	29.20	30.00	30.00	35.00	35.00
Mean	25.82	25.53	34.17	34.17	36.67	35.83
Forest						
Razhaphe	24.45	22.50	30.00	35.00	40.00	35.00
Dhansirpar	19.00	20.20	45.00	45.00	40.00	40.00
Doyapur	25.75	23.70	35.00	35.00	40.00	40.00
Kiyeto	20.20	21.00	30.00	35.00	45.00	40.00
Amaluma	14.10	15.75	45.00	40.00	40.00	45.00
Melongmen	33.35	35.20	35.00	35.00	30.00	30.00
Mean	22.81	23.06	36.67	37.50	39.17	38.33

Table 2: Erodibility indices of soils under different land use systems.

Land use & location	Dispersion ratio		Erosion index	
Soil depth (cm)	0-15	15-30	0-15	15-30
Lowland Paddy				
Razhaphe	15.50	17.33	10.69	10.44
Dhansirpar	13.19	12.94	11.99	11.16
Doyapur	14.79	15.07	11.74	11.42
Kiyeto	13.07	14.86	11.67	12.18
Amaluma	17.50	14.93	10.80	10.09
Melongmen	17.00	16.83	13.28	12.38
Mean	15.18	15.33	11.70	11.28
Field Crop				
Razhaphe	15.00	14.64	10.27	9.76
Dhansirpar	17.08	16.83	11.54	11.07
Doyapur	20.50	20.70	16.27	13.10
Kiyeto	14.86	14.57	12.49	11.29
Amaluma	12.63	14.71	9.64	9.02
Melongmen	14.57	14.64	10.41	9.32
Mean	15.77	16.02	11.77	10.59
Orchard				
Razhaphe	12.63	14.57	8.96	8.62
Dhansirpar	16.75	17.08	13.29	12.75
Doyapur	17.17	12.94	9.59	7.39
Kiyeto	14.64	14.57	14.50	12.24
Amaluma	12.81	14.64	9.22	9.15
Melongmen	16.92	17.00	10.25	10.06
Mean	15.15	15.13	10.97	10.04
Forest				
Razhaphe	17.00	14.64	10.76	10.38
Dhansirpar	11.39	11.33	7.30	7.08
Doyapur	14.50	14.57	8.63	7.00
Kiyeto	17.25	14.86	10.33	9.41
Amaluma	11.39	12.75	7.54	7.33
Melongmen	14.36	14.50	9.57	9.67
Mean	14.32	13.78	9.02	8.48

Table 3: Correlation coefficient among various soil properties of top soil (0-15 cm).

	Sand	Silt	Clay	DR	EI
Sand	1				
Silt	-0.79**	1			
Clay	-0.83**	0.52	1		
DR	0.78**	-0.98**	-0.48	1	
EI	0.57	-0.63*	-0.59	0.65*	1

** Significant at 1% level of probability (r>0.765) ;* Significant at 5% level of probability (r>0.632)

Table 4: Correlation coefficient among various soil properties of sub soil (15-30 cm).

	Sand	Silt	Clay	DR	EI
Sand	1				
Silt	-0.78**	1			
Clay	-0.95**	0.73*	1		
DR	0.81*	-0.97**	-0.74*	1	
EI	0.61	-0.57	-0.71*	0.57	1

** Significant at 1% level of probability (r>0.765); * Significant at 5% level of probability (r>0.632)

CONCLUSIONS

The study was aimed at assessing the relationship among various land uses and erodibility characteristics of the soil. The study indicated that the soils were highly erodible in nature irrespective of depths. The soils under the agriculture land use systems more particularly field crop land use system was found to be more susceptible to erosion. While forest was least vulnerable to erosion which may be attributable to their canopy cover protecting the soil from the direct impact of raindrops. Therefore, deforestation should be immediately stopped and preventive measures against erosion should be taken in order to ameliorate the rate of soil degradation and prevent further soil loss in cultivated lands.

FUTURE SCOPE

Soil and water conservation practices suitable for various locations with respect to land uses may be evaluated for formulating strategies to protect the soils against degradation.

Conflict of Interest. None.

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