➔DOI : 10.15740/HAS/AJBS/12.2/248-253 ASIAN JOURNAL OF BIO SCIENCE
e ISSN-0976-8343 | ■ Visit us : *www.researchjournal.co.in* Volume **12** | Issue 2 | Oct., 2017 | 248-253

RESEARCH PAPER

Erodibility status of soils under different land uses in Chiephobozou sub-division soils of Kohima, Nagaland

MANOJ DUTTA, RUOPFIINUO MEZHII, RIZONGBA KICHU AND SEWAK RAM

Department of Soil and Water Conservation, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema Campus, MEDZIPHEMA (NAGALAND) INDIA
Email : manojdutta1997@yahoo.com; mercymez30@gmail.com; rizongba09@gmail.com; sewaksasrd@gamil.com

Article Info : Received : 30.07.2017; Revised : 24.08.2017; Accepted : 22.09.2017

Land use effect on soil erodibility parameters were studied in four villages, *viz.*, Tsiesema, Riisoma, Chiephobozou and Botsa in Kohima district, Nagaland, under four land uses, *viz.*, orchard, shifting cultivation, lowland and forest in each village. The mean textural classes of the soils were clay, clay loam and sandy clay loam. Dispersion ratio and erosion index were recorded to be usually higher than the threshold limits. Dispersion ratio of the soils ranged from 8.16 to 30.53 whereas, erosion index varied between 5.28 and 23.91. A significant negative correlation of clay with dispersion ratio and erosion index was observed. The highly significant and positive correlation between erosion index and dispersion ratio indicated the susceptibility of these soils to water erosion. Proper agronomic and mechanical soil and water conservation measures need to be adopted to protect the soils from further degradation.

Key words : Land uses, Dispersion ratio, Erosion index

How to cite this paper : Dutta, Manoj, Mezhii, Ruopfiinuo, Kichu, Rizongba and Ram, Sewak (2017). Erodibility status of soils under different land uses in Chiephobozou sub-division soils of Kohima, Nagaland. *Asian J. Bio. Sci.*, **12** (2) : 248-253.**DOI : 10.15740/HAS/AJBS/ 12.2/248-253.**

INTRODUCTION

One of the main causes of soil loss intensification around the world is associated with land-use changes. The relationship between different land use and soil susceptibility to erosion has attracted the interest of a variety of researchers and have highlighted the impacts of changes on vegetation cover and agricultural practices on soil properties. Land use changes affect many natural resources and ecological processes such as surface runoff and erosion and affects soil resilience with hazardous environmental impacts. Land use changes, especially cultivation of deforested land, may rapidly diminish soil quality and severe degradation in soil quality may lead to a permanent degradation of land productivity. The consequences of such changes in land use are the intensification of natural degradation processes such as soil erosion (Sharma and Arora, 2015). Several works have shown that inappropriate land use aggravates the degradation of soil physico-chemical and biological properties. Changes in land use and management practices often modify most soil morphological, physical, chemical and biological properties to the extent reflected in agricultural productivity. The north-eastern hilly region of India is characterized by heavy soil erosion, loss of soil fertility and deforestation causing acute environmental degradation and severe ecological imbalance. The soil erosion not only causing the loss of production base, but it also results in shallowing of the soil profile, affecting the soil physicochemical properties and disappearance of natural water resources. This situation needs immediate attention for conservation and sound management of soil and water resources which can be achieved by formulating and implementing an effective soil and water conservation programme for which the knowledge on soil erodibility status and its assessment is important. The data pertaining to erodibility of soils under different land use pattern in Chiephobozou sub-division of Kohima, Nagaland was found lacking. Therefore, the present investigation has been conducted to determine the soil erodibility characteristics under various land use patterns in the region.

Research Methodology

Soil samples from 0-15 and 15-30 cm depth were collected from four different land uses, *viz.*, orchard, forest, shifting cultivation and low land from four different locations around Chiephobozou sub-division *viz.*, Tsiesema, Riisoma, Chiephobozou and Botsa. The site has an average elevation of 154 m (altitude) and a total area of 487.67 sq. km which is situated between longitude 94°E-95°E and latitude 25°N-26°N of the equator. These collected soil samples were air dried and processed and analyzed for particle-size distribution following International Pipette method (Piper, 1966) using 0.5 N NaOH as a dispersing agent. The water holding capacity was determined using Keen Rackzowaski boxes as described by Baruah and Barthakur (1997). Suspension percentage (water dispersible silt + clay) was determined by dispersing 25g soil in 1000 ml distilled water without adding any dispersing agent, shaking end over end for 20 times and pipetting out 20 ml of soil suspension from 10 cm depth as suggested by Middleton (1930). The erodibility indices *i.e.* dispersion ratio and erosion index were computed using the procedures described by Middleton (1930) and Sahi *et al*. (1977), respectively as follows:

$$\text{Dispersion ratio} = \frac{\text{\% water dispersed (silt + clay)}}{\text{\% (silt + clay) particle size analysis}}$$

$$\text{Erosion index} = \frac{\text{Dispersion ratio}}{\text{Clay/0.5 water holding capacity}}$$

The statistical analysis of the data was done as per procedure outlined by Gomez and Gomez (1984).

Research Findings and Analysis

The findings of the present study as well as relevant discussion have been presented under following heads:

Mechanical composition of soil:

The mechanical composition of soil under different land uses are presented in Table1 and 2.

Dispersion ratio:

The dispersion ratio of the surface soils (0-15 cm depth), in different villages under orchard, shifting cultivation, lowland and forest soils varied from 20.44 to 28.64, 19.57 to 27.14, 15.29 to 27.20 and 8.16 to 16.29 with a mean value of 25.44, 23.69, 20.05 and 11.88, respectively. The highest value of dispersion ratio in surface soils was recorded in Botsa village under orchard land use and the lowest was recorded in Riisoma village under forest land use. The highest mean dispersion ratio in surface layer was found in Riisoma soils and the lowest was recorded in Botsa soils. Similarly, the dispersion ratio of the sub-surface soils (15-30 cm depth), in different

Table 1 : Mechanical composition of soil under orchard and shifting cultivation land uses

Village name	Soil depth (cm)	Land uses							
		Orchard			Textural class	Shifting cultivation			Textural class
		Sand (%)	Silt (%)	Clay (%)		Sand (%)	Silt (%)	Clay (%)	
Tsiesema	0-15	49.48	17.17	32.15	scl	40.43	24.14	33.38	cl
	15-30	48.11	19.82	30.19	scl	38.64	24.98	34.44	cl
Riisoma	0-15	42.51	20.81	34.77	scl	46.23	21.05	29.78	scl
	15-30	40.46	22.84	27.41	scl	44.98	19.77	32.64	scl
Chiephobozou	0-15	54.12	19.08	23.82	scl	40.58	24.55	32.05	cl
	15-30	57.92	16.92	22.28	scl	45.16	20.05	32.95	scl
Botsa	0-15	48.73	19.42	28.89	scl	33.76	31.93	32.26	cl
	15-30	49.95	19.89	27.84	scl	45.92	24.44	27.80	scl
	0-15	48.71	19.12	29.91	scl	40.25	25.42	31.87	cl
Mean	15-30	49.11	19.87	26.93	scl	43.68	22.31	31.96	scl

Index : scl = Sandy clay loam cl = Clay loam villages under orchard, shifting cultivation, lowland and forest soils varied from 21.48 to 29.17, 21.57 to 30.53, 18.56 to 27.62 and 10.86 to 13.78 with a mean value of 26.51, 25.69, 22.69 and 13.85, respectively (Table 3). The highest value of dispersion ratio in sub-surface soils was recorded in Riisoma village under shifting cultivation land use and the lowest was also recorded in Riisoma under forest soils. The highest mean dispersion ratio in sub-surface layer was found in Riisoma soils and the lowest was recorded in Tsiesema soils. As per the land use adopted, the highest mean dispersion ratio in both surface and sub-surface layers was found in orchard soils followed by soils in shifting cultivation land use, lowland soils and forest soils. Generally, in all land uses, forest soils were found to have a lower dispersion ratio as compared to those of cultivated lands. Similar results were reported by Kumar and Singh (2007); Karagul (1999) and Khera and Kahlon (2005). This may be due to the high amount of organic matter in the soils and their good permeability (Chaudhary *et al.*,1999). A significant positive correlation was also found between dispersion ratio with sand and a significant negative correlation with silt and clay (Table 5). According to the criterion of Middleton (1930), soils with dispersion ratio value more than 15 are erosive in nature. The study revealed that in almost all the villages, under all land uses, the soils were highly erosive in nature except under forest land use and require conservation measures.

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 32 soils, only 1 was found to be stable, 5 fairly stable, 15 somewhat unstable, 10 unstable and 1 very unstable. The dispersion ratio of the forest surface soil in Riisoma was

Table 2 : Mechanical composition of soil under lowland and forest land uses

Village name	Soil depth (cm)	Land uses: Lowland Sand (%)	Lowland Silt (%)	Lowland Clay (%)	Textural class	Forest Sand (%)	Forest Silt (%)	Forest Clay (%)	Textural class
Tsiesema	0-15	32.30	27.17	53.15	c	16.93	32.27	48.79	c
	15-30	31.65	29.70	35.75	cl	18.49	33.29	45.77	c
Riisoma	0-15	35.64	28.33	34.86	cl	19.72	38.81	43.78	c
	15-30	36.93	24.29	35.88	cl	19.48	34.61	44.29	c
Chiephobozou	0-15	33.39	27.81	36.27	cl	23.85	33.64	39.85	c
	15-30	34.68	29.61	31.82	cl	21.71	34.75	40.90	c
Botsa	0-15	29.76	28.93	38.92	cl	20.43	37.36	40.12	c
	15-30	37.46	25.98	33.77	cl	20.80	35.95	41.73	c
	0-15	32.77	28.06	40.80	c	20.23	35.52	43.14	c
Mean	15-30	35.18	27.40	34.31	cl	20.12	34.65	43.17	c

Index : c = Clay cl = Clay loam

Table 3 : Dispersion ratio of soil under different land uses

Village name	Soil depth (cm)	Land uses: Orchard	Shifting cultivation	Lowland	Forest	Mean
Tsiesema	0-15	20.44	25.44	19.19	11.76	19.21
	15-30	21.48	26.65	22.92	12.40	20.86
Riisoma	0-15	28.37	27.14	18.50	8.16	20.54
	15-30	29.60	30.53	21.67	10.86	23.17
Chiephobozou	0-15	24.31	22.58	15.29	16.29	19.62
	15-30	25.78	24.02	18.56	18.36	21.68
Botsa	0-15	28.64	19.57	27.20	11.29	16.93
	15-30	29.17	21.57	27.62	13.78	23.04
	0-15	25.44	23.69	20.05	11.88	
Mean	15-30	26.51	25.69	22.69	13.85	

the only one found to be stable. The dispersion ratio of both the surface and sub-surface soils under forest land use in all the villages was found to be fairly stable except the surface the sub-surface soils in Chiephobozou which was recorded to be somewhat unstable. In the lowlands, the dispersion ratio of both the surface and sub-surface soils in all the villages was found to be somewhat unstable except the surface the sub-surface soils in Botsa which was found to be unstable. Under shifting cultivation land use, the surface soil in Riisoma was found to be unstable while the sub-surface soil was found to be very unstable. The surface and sub-surface soils in Chiephobozuo and Botsa were found to be somewhat unstable whereas, the soils in Tsiesema were found to be unstable. Under orchard land use, both the surface and sub-surface soils in Riisoma and Botsa were found to be unstable whereas, the soils in Tsiesema were found to be somewhat unstable. The surface soil under orchard land use in Chiephobozou was found to be somewhat unstable whereas its sub-surface soil was found to be unstable. Kahlon (2006) also found lower values of erosion ratio and dispersion ratio for the soil of forest and grasslands than those of arable and bare lands. In all the soil profile, dispersion ratio was lower in surface soils than in sub-surface soils. Similar observation was also reported by Mehta *et al.* (2005); Singh *et al.* (2006) and Sharma and Kumar (2010). The dispersion ratio and erosion index of forest soil was lower as compared to bare soil (Khera and Kahlon, 2005). Kumar and Singh (2007) also reported lower dispersion ratio in forest land use as compared to orchard and cultivated land use.

Erosion index:

The erosion index of the surface soils in different villages under orchard, shifting cultivation, lowland and forest varied from 14.85 to 22.67, 13.30 to 18.91, 11.29 to 22.47 and 5.28 to 9.28 with a mean value of 18.46, 16.78, 16.14 and 6.86, respectively. The highest value of

Table 4 : Erosion index of soil under different land uses

Village name	Soil depth (cm)	Land uses				
		Orchard	Shifting cultivation	Lowland	Forest	Mean
Tsiesema	0-15	14.85	18.91	14.95	6.21	13.21
	15-30	18.98	20.56	15.47	11.27	16.57
Riisoma	0-15	19.63	18.71	15.86	5.28	14.22
	15-30	21.75	19.26	16.30	6.58	15.97
Chiephobozou	0-15	16.68	16.20	11.29	9.28	13.11
	15-30	22.53	18.64	13.40	12.95	16.88
Botsa	0-15	22.67	13.30	22.47	6.68	16.28
	15-30	23.74	17.30	23.91	8.48	18.36
Mean	0-15	18.46	16.78	16.14	6.86	
	15-30	21.75	18.94	17.27	9.82	

Table 5 : Correlation co-efficients among various soil properties

Soil depth	Parameters	Sand	Silt	Clay	DR	EI
Surface soil (0-15) cm	Sand	1.00				
	Silt	-0.94**	1.00			
	Clay	-0.79**	0.62*	1.00		
	DR	0.75**	-0.78**	-0.57*	1.00	
	EI	0.74**	-0.76**	-0.56*	0.98**	1.00
Sub-surface soil	Sand	1.00				
(15-30) cm	Silt	-0.96**	1.00			
	Clay	-0.94**	0.86**	1.00		
	DR	0.77**	-0.80**	-0.76**	1.00	
	EI	0.84**	-0.85**	-0.81**	0.93**	1.00

Note: * and ** indicate significance of values at P=0.05 and 0.01, respectively DR= Dispersion ratio EI= Erosion index erosion index in surface soils was recorded in Botsa village under orchard and the lowest was recorded in Riisoma village under forest land use. The highest mean value of erosion index in surface soils was recorded in Botsa and the lowest was recorded in Chiephobozou. Similarly, the erosion index of the sub-surface soils in different villages under orchard, shifting cultivation, lowland and forest land use varied from 18.98 to 23.74, 17.30 to 20.56, 13.40 to 23.91 and 6.58 to 12.95 with a mean value 21.75, 18.94, 17.27 and 9.82, respectively (Table 4). The highest value of erosion index in sub-surface soils was recorded in Botsa village under lowland and the lowest was recorded in Riisoma under forest land use. The highest mean erosion index in sub-surface layer was found in Botsa soils and the lowest was recorded in Riisoma soils. As per the land use adopted, the highest mean erosion index in both surface and sub-surface layers was found in orchard soils followed by soils in shifting cultivation land use, lowland soils and forest soils.

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 32 soils, 6 were found to be low, 7 medium, 12 high and 7 very high. The forest soils in all the villages had low erosion index except the sub-surface soils of Tsiesema and Chiephobozou which were found to be medium. In the lowlands, the erosion index of both surface and sub-surface soils were found to be medium, high and very high in the soils of Chiephobozou, Riisoma and Botsa, respectively. In shifting cultivation land use, the soils in Riisoma and Chiephobozou were found to have high erosion index in both the surface and sub-surface soils. The surface soil in Tsiesema was found to have high erosion index whereas, its sub-surface soil was found to have very high erosion index. Under orchard land use, all the surface and sub-surface soils in these villages were found to have an erosion index ranging from high to very high except the surface soil in Tsiesema which was found to have a medium erosion index. In all the soil profile, erosion index was lower in surface soils than in sub-surface soils. These results are in the line with the findings of Singh and Kundu (2008); Kumar and Singh (2007) and Sharma and Kumar (2010). Yilmaz *et al.* (2007) found that at cultivated and forested sites, the erosion index and dispersion ratio increased with increasing soil depth.

The correlation data showed that erosion index has a significant positive correlation with dispersion ratio, sand and a significant negative correlation with silt and clay (Table 5). This is in confirmatory with the results observed by Kumar *et al*. (2005). These results suggest that soils having high sand and silt with low clay and organic matter contents were the most erodible in nature (Agnihotri *et al.*,2007).

Relationship among dispersion ratio, erosion index and mechanical composition:

The correlation co-efficient values revealed that dispersion ratio and erosion index had negative correlation with silt and clay (Table 5). The positive correlation of dispersion ratio and erosion index with sand revealed that the presence of higher amount of sand increased the erodibility of soil as it increased the dispersion ratio and erosion index. Erosion index also increased with increasing dispersion ratio indicating greater susceptibility of these soils to water erosion. The highly significant correlation between erosion index and dispersion ratio was also reported by Debral *et al.* (2001); Kumar and Singh (2007); Agnihotri *et al*. (2007) and Singh *et al*. (2012). The significant negative correlation of dispersion ratio and erosion index with clay suggested that soil erodibility decreased with increase in clay content. Rasheed (2016), Sharma and Kumar (2010) and Singh and Kundu (2008) also reported similar results. Low erosion ratio in forest soil compared to other land uses was also reported by Debral *et al.* (2001). Similar results were reported by (Li *et al.*, 2007). However, considering 2.8 as threshold value of erosion index and 15 as the threshold limit of dispersion ratio, most of the soils can be classified under erodible class. The study showed that most of the soils were highly erodible and needed quick intervention to prevent further degradation.

LITERATURE CITED

Agnihotri, R. C., Yadav, R. C. and Jha, P. (2007). Erodibility characterstics of Entisol soils of riparian zone of the Yamuna river in Agra: Impacts of land form and land uses. *Indian J. Soil Cons*., **35**(3) : 226-229.

Baruah, T. C. and Barthakur, H. P. (1997). *A text book of soil analysis.* 1st Ed., Vikash Publishing Pvt. Ltd., NEW DELHI, INDIA.

Chaudhary, R.S., Gadekar, H. and Patnaik, U. S. (1999). Erodibility under different land uses in soil of eastern ghat highland zone. *Indian J. Soil Cons.*, **27** (2): 118-121.

Debral, P. P., Murry, R. L. and Lollen, P. (2001). Erodibility status under different land uses in Dikrong river of Arunachal Pradesh. *Indian J. Soil Cons.*, **29**(3): 280 – 282.

Gomez, K. A. and Gomez, A. A. (1984). *Statistical procedures for agricultural research*. John Wiley & Sons, INC., UK, 20.

Kahlon, M. S. (2006). Investigation on soil erodibility under different land use patterns of certain soils of sub-montane Punjab, India. *Indian Forester*, **132** (11): 1391-1397.

Karagul, R. (1999). Investigations on soil erodibility and some properties of the soils under different land use types in Sogutludere creek watershed near Trabzon. *Turkish J. Agric. & Forest.*, **23** (1): 53-68.

Khera, K.L. and Kahlon, M.S. (2005). Impact of land use pattern on soil erosion in sub-montane Punjab. *Indian J. Soil Cons*., **33** (3): 204-206.

Kumar, K., Gangwar, M. and Singh, D. (2005). Impact of land use capability classes and present land use on erosional behaviour of Rendhar watershed in Bundelkhand region of Uttar Pradesh. *Farm Sci. J.*, **14** (2): 7-11.

Kumar, S. and Singh, R. (2007). Erodibility studies under different land uses in north west Himalayas. *J. Agric. Physics.*, **7**: 31-37.

Li, X., Hai, C.X. and Liu, G.T. (2007). Spring soil erodibility for different land use patterns in the north piedmont of the Yinshan Mountains. *Arid Land Geography,* **30** (6) : 926-932.

Mehta, A. K., Khera, K. L. and Bhushan, B. (2005). Effect of soil physical properties and land uses on soil Erodibility. *Indian J. Soil Cons.*,**33** (2): 180-182.

Middleton, H. E. (1930). Properties of soils which influence soil erosion. *USDA Technical Bull.*, **178**: 1-16.

Piper, C. S. (1966). *Soil and plant analysis.* Hans Publishers, Mumbai (M.S.) INDIA.

Rasheed, S. M. (2016). The effect of clay content and land use on dispersion ratio at different locations in Sulaimani Governorate—Kurdistan Region—Iraq. *Open J.Soil Sci*., **6** (1) : 1.

Sahi, B. P., Singh, S. N., Sinha, A. C. and Acharya, B. (1977). Erosion index of soil erodibility. *J. Indian Soc. Soil Sci.*, **25** : 7-10.

Sharma, J. C. and Kumar, V. (2010). Erodibility status of soils under different land uses in Shiwalik Hills of Himachal Pradesh. *J. Indian Soc. Soil Sci.*, **58** (4) : 467-469.

Sharma, V. I. K. A. S. and Arora, S. (2015). Land degradation processes and factors affecting crop production in foothills of Jammu Shivaliks. *J. Soil Water Cons*., **14** (4) : 294-299.

Singh, R. and Kundu, D. K. (2008). Erodibility of major soil sub-groups of eastern region of India. *Indian J. Soil Cons*., **36**(3) : 172-178.

Singh, R.P., Yadav, P. N., Tripathi, A. K., Uttam, S. K. and Katiyar, S. C. (2012). Relationship of soil properties with erodiblity indices in different land use systems in Central alluvial tract of Uttar Pradesh. *Curr. Adv. Agric. Sci.*, **4**(2) : 116 - 120.

Singh, R., Singh, K.D. and Parandiya, A.K. (2006). Characterization and erodibility of soils under different land uses for their management and sustained production. *Indian J. Soil Cons.*, **34**(3): 226 - 228.

Yilmaz, M., Usta, A., Altun, L. and Tilki, F. (2007). Effects of land-use regime on soil erodibility indices and soil properties in Erfelek Dam Creek Watershed. *Bulletin of Fresenius Environmental Unye, Turkey,* **16** (12b): 1636-1642.