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Soil Erodibility Effect on Sediment Producing in Aras Sub Watershed

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Abstract: The direct measurement of erosion is very difficult and expensive. So use of erosion and sediment models is important to determine the amount of soil erosion. To determine the soil erodibility, has taken 300 soil samples from different fields with 0-12 cm depth that are located in the Aras sub watershed in North West of Iran in 2005-2006. The soil samples were analyzed and some factors such as soil texture, organic matter were measured. By use of the factors the other factors such as soil structure class, soil percolation class, total sand, fine sand, clay and silt percentage was measured. The study used the soil structure class and percolation to determine the soil erodibility. This study evaluates the effects of soil erodibility and the factors on sediments amount in the hydrological watersheds that have station to measure the sediment. Soil erodibility was measured by the formula follow this: $100K = 2.1M^{1.4} \times 0^{4} \times z(12 - \% OM)+3.25(S-2)+(P-3)$. Soil erodibility and some factors such as soil organic matter, fine sand percentage and soil structure class can predict the amount of soil erosion. Analysis of variance and the means comparisons with LSD test was done by MSTATC software. Linear correlation coefficients between different traits were done by SPSS software. The variance analysis results of the studied attributes showed that there is significant difference among the erodibility, fine sand and soil structure class. The studied location mean showed that Mashiran, Pole Almasi and Borran station in comparison the other locations, had the most erodibility. Soil erodibility cannot be the factor that has effect on the sediment producing in a station, alone. This factor must be evaluated with other factors such as soil organic matter, soil fine sand percentage, soil structure class, watershed area, topography and plant cover. In the prospective research, we should improve method to measure and calculate soil erodibility, strengthen the research on the mechanism of soil erodibility and conduct research on soil erodibility by both water and wind agents.

Key words: Erosion, K factor, structure class, erosive factors

INTRODUCTION

Aras sub watershed has extended from Ardabil Province center part to North areas of this province and its geographical boundaries is from 46° 45' 00" till 48° 30' 00" Eastern lengths and from 38° 00' 00" till 39° 30'00" Northern width and its scale is 1:250000. In the latest century, soil erosion caused the major problems for human society. So study the erosion, sediment and the factors that have effect on them is important for researchers (Rezaie, 2003).

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A soil with relatively low erodibility factor may show signs of serious erosion, yet a soil could be highly erodible and surfer little erosion (Nyakatawa *et al*., 2001). Soil erosion is a function of many factors as stated in the Universal Soil Loss Equation (USLE). These factors include rainfall factor (R), soil erodibility factor (K), Slope Length (LS), crop factor (C) and control practice factor (P). This is represented in the universal soil loss equation as. Soil erodibility is related to the integrated effect of rainfall, runoff and infiltration on soil loss. Cropping and soil management that accumulate plant residues tend to reduce soil erodibility by increasing soil aggregate stability, shear strength and resistance to splash detachment (Rachman *et al*., 2003). The K factor is defined as the rate of soil loss per erosion index unit for a specified soil as measured on a standard plot (Mohammad *et al*., 2006). Soil erodibility is an important index to evaluate the soil sensitivity to erosion. Soil erodibility can be evaluated by measuring soil physiochemical properties, scouring experiment, simulated rainfall experiment, plot experiment and wind tunnel experiment. Soil erodibility is a complex concept, it is influenced by many factors, such as soil properties and human activities (Yang *et al*., 2005).

Soil erodibility of the USLE can be used for development of potential risk assessment maps of water erosion. However, whilst reasons of instability of K factor remains still not recognized, use of soil erodibility approach in event-base models to predict erosion can be misleading (Rejman *et al*., 2008).

The soil erodibility factor K is a quantitative expression of the inherent susceptibility of a particular soil to erode at different rates when the other factors that affect erosion are standardized. Erodibility varies with soil textures, aggregates, stability, shear strength, soil structures, infiltration capacity, soil depth, buck density, soil organic matter and chemical constituents (Lal, 2003). The organic and chemical constituents of the soil are important because of their influence on stability of aggregates. Soils with less than 2% organic matter can be considered erodible. Most soils contain less than 15% organic content and many of the sands and sandy loams have less than 2%. Morgan (2001) suggested that soil erodibility decreases linearly with increasing organic content over the range of 0 to 10% (Idah *et al*., 2008).

The objective of this study is evaluating the soil erodibility effects on sediment producing in Aras sub watershed and to receive this aim, at first we need to measure the soil erodibilty of Ardabil (in Iran). Certainly we cannot account the pure amount of soil erodibilty so we must study some factors such as organic matter, fine sand percent and soil structure class effect on soil erodibility and at the end evaluate the relationship between the sediment amount and soil erodibility in Aras sub watershed of Ardabil watershed.

MATERIALS AND METHODS

To determine the soil erodibility, has taken 300 soil samples from Ardabil, Nir, Namin, Sareien, Pars abad and Bilesavar fields with 0-12 cm depth that are located in the Aras sub watershed in north west of Iran in 2005-2006. The soil samples location was determined by GIS (global position system). The numbers of samples depended to the field area and compression. The soil samples were analyzed and some factors such as soil texture, organic matter were measured. By use of the factors the other factors such as soil structure class, soil percolation class, total sand, fine sand, clay and silt percentage was measured. Soil texture was clay loam, silty loam, clay loam and silty loam in Ardabil, Pars Abad, Nir and Bilesavar, respectively. Regarding to the soil texture and percolation, soil percolation class was determined according to the wischmeier and smith tables that this class was 4, 4, 4 and 3 in

Table 1: Soil structure class

Soil structure class	Soil structure size (mm)
I	<1
II	1-2
III	2-5
IV	5-10
V	>10

I: Very fine granule, II: Fine granule, III: Medium granule, IV: Coarse granule, V: Compaction

Table 2: Soil percolation class

Soil percolation class	Amount (cm h^{-1})
I	<12.50
II	6.25-12.5
III	2-6.25
IV	0.5-2
V	0.125-0.5
VI	>0.125

I: Very excess-excess, II: Excess-medium, III: Medium, IV: Medium-less,V: Less, VI: Very less

Ardabil, Pars Abad, Nir and Bilesavar regions, respectively. In this study was used of the soil structure class and percolation to determine the soil erodibility and fine sand percentage that these classes were shown as number and cod (Table 1, 2). Soil organic matter was measured by soil analysis.

Soil erodibility was measured by the formula follow this:

$$100K = 2.1M^{1.4} \times 0^{-4} \times (12 - \% OM) + 3.25(S-2) + (P-3)$$

Where:

K : Erodibility
M : (Clay percentage-100)×(Silt percentage+Fine sand percentage)
OM : Organic matter percentage
S : Soil structure class
P : Soil percolation class
S1 : Total sand percentage
Fine sand percentage = $0.3374/s_1^{1.02}$

Analysis of variance and the means comparisons with LSD test was done by MSTATC software. Linear correlation coefficients between different traits were done by SPSS software. Cluster analysis was done for the location by use Ward method.

RESULTS AND DISCUSSION

The variance analysis results of the studied attributes showed that there is significant difference among the erodibility, fine sand and soil structure class (Table 3).

The studied location mean showed that Mashiran, Pole almasi and Borran station in compare of the other locations had the most erodibility. These locations had the coarse granula soil structure. As organic matter, Borran and Kozetopraghi stations included the most amounts (Table 4).

There was positive significant correlation between sediment and erodibility, but there is not significant difference between erodibility and organic matter and among the sediment, fine sand and organic matter. Borran station had the high amount of sediment and Seahpoosh station had the lowest amount of sediment among the other station (Table 5).

Table 3: Attributes variance analysis in studied stations

		MS			
SOV	df	Erodibility	Fine sand	Organic matter	Soil structure class
R	19	0.009	0.001	0.002	0.073
T	8	0.010+	0.001**	0.002	0.918**
E	152	0.006	0.0001	0.001	0.044
C.V%	-	16.57	17.88	3.35	5.36

+, **: Significant at 10 and 1% level of probability, respectively

Table 4: Attributes mean comparison in studied stations

Location	Erodibility	Fine sand	Organic matter	Soil structure class	Sediment (ton day^{-1})
Borran	0.458ab	0.010a	1.064a	3.35b	9425.740
Masheran	0.502a	0.013a	1.038b	3.85a	7732.000
Dostbaghloo	0.424b	0.011a	1.049ab	3.95a	2436.210
Samean	0.441b	0.011a	1.058ab	4.00a	568.280
Poolealmas	0.462ab	0.011a	1.047ab	4.00a	311.255
Arzel	0.442b	0.011a	1.043ab	4.00a	72.170
Kozetopraghi	0.445b	0.011a	1.065a	4.00a	17.980
Neir	0.436b	0.009a	1.056ab	4.00a	14.480
Seahpoosh	0.444b	0.009a	1.053ab	4.00a	7.034

Mean with the same letters in each column does not have significant difference at the 5% level of probability to according to value of LSD

Table 5: Correlation between attributes for studied stations

Correlation coefficient	Erodibility	Fine sand	Organic matter	Soil structure class	Sediment
Erodibility	-				
Fine sand	-0.046	-			
Organic matter	0.442	-0.32	-		
Soil structure class	-0.030	-0.54	-0.32	-	
Sediment	0.614*	-0.24	-0.46	-0.87**	-

**Significant at 5 and 1% level of probability, respectively

The factors such as soil textures, aggregates, stability, shear strength, soil structures, infiltration capacity, soil depth, buck density, soil organic matter and chemical constituents change the soil erodibility amount (Agassi and Bradford, 1999). Stability of aggregates is under effect of the organic and chemical constituents of the soil. Erodibility is important phenomenon in the soil with less than 2% organic matter (Idah *et al.*, 2008). Most soils contain less than 15% organic content and many of the sands and sandy loams have less than 2%. Morgan (2001) resulted that increasing organic content has effect on decreasing soil erodibility that this amount is over the range of 0 to 10%.

Results of cluster analysis showed that erodibility grouped in three clusters. The first cluster included 7 (Kozetopraghi), 9 (Seahpoosh), 4 (Samean), 6 (Arzel), 8 (Neir) and 3 (Dostbaghloo), the second cluster 1 (Borran) and 5 (Poolealmas) and the third cluster 2 (Masheran) (Fig. 1).

The organic matter grouped in three clusters. The first cluster included 6 (Arzel), 7 (Kozetopraghi), 4 (Samean), 9 (Seahpoosh), 8 (Neir) and 3 (Dostbaghloo), the second cluster 2 (Mashiran) and the third cluster 1 (Borran) and 5 (Poolealmas) (Fig. 2).

The sediment grouped in four clusters. The first cluster included 4 (Samean), 8 (Neir), 9 (Seahpoosh), 7 (Kozetopraghi), 3 (Dostbaghloo) and 6 (Arzel), the second cluster 5 (Poole Almas), the third cluster 2 (Mashiran) and the fourth 1 (Borran) (Fig. 3).

The highest erodibility related to the second and third cluster. Idah *et al.* (2008) was performed an experiment to solve the problem of soil erosion, in the South-Eastern part of Nigeria and determined some indices of soil erosion in Owerri West Local Government Area. They resulted that Ohi with index of 0.044 has the highest erodibility index while Ava with 0.030 has the least one. The practical implication of these findings is in the area of design of

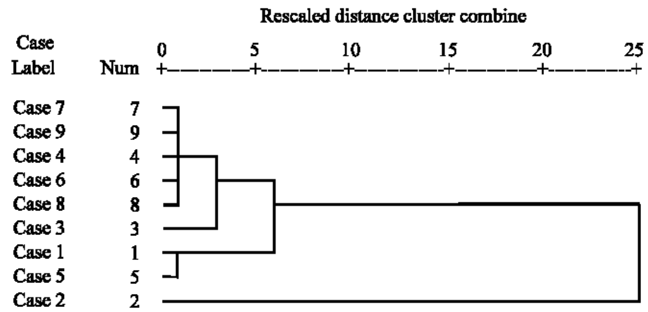

Fig. 1: Dendrogram of erodibility by using ward method

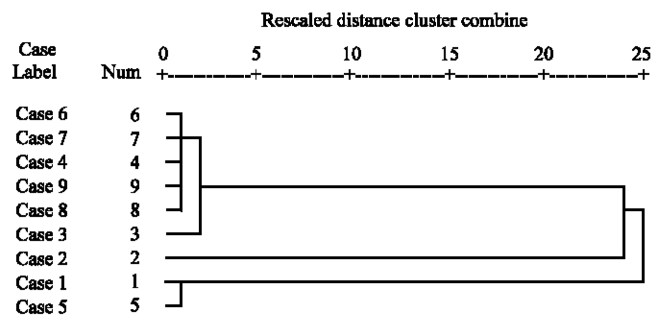

Fig. 2: Dendrogram of organic matter by using ward method

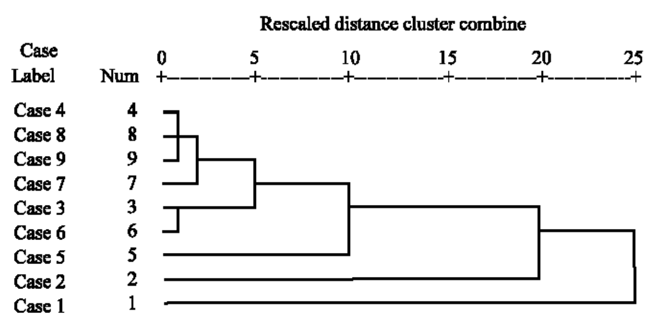

Fig. 3: Dendrogram of sediment by using ward method

control structures that will be able to stand the test of time. Some factors such as water cause the erosion increasing (Wischmeier and Smith, 1978). Relf (2001) resulted that when there is too much water on the soil surface, it fills surface depressions and begins to flow. With enough speed, this surface runoff carries away the loosed soil.

CONCLUSION

Soil erodibility does not affect on the sediment producing, alone. This factor must be evaluated with other factors such as soil organic matter, soil fine sand percentage, soil structure class, watershed area, topography and plant cover. Because these factors have effect on the soil erodibilty. Several obstacles restrict the research of soil erodibility. Firstly, the research on soil erodibility is mainly focused on farmland; Secondly, soil erodibility in different areas cannot be compared sufficiently; and thirdly, the research on soil erodibility in water-wind erosion is very scarce. So, we should improve method to measure and calculate soil erodibility, strengthen the research on the mechanism of soil erodibility and conduct research on soil erodibility by both water and wind agents.

REFERENCES

Agassi, M. and J.M. Bradford, 1999. Methodologies for interrill soil erosion studies. Soil Tillage Res., 49: 277-287.

Idah, P.A., H.I. Mustapha, J.J. Musa and J. Dike, 2008. Determination of erodibility indices of soils in Owerri west local government area of Imo state Nigeria. Agric. Univ. J. Technol., 12: 130-133.

Lal, R., 2003. Soil erosion and the global carbon budget. Environ. Int., 29: 437-450.

Mohammad, H., H. Tariq, H. Kariem and A.K. Othman, 2006. Predicting soil erodibility in northern Iraq using natural runoff plot data. Soil Tillage Res., 94: 220-228.

Morgan, R.P.C., 2001. A simple approach to soil loss prediction a revised Morgan-Morgan-Finney model. Catena, 44: 305-322.

Nyakatawa, E.Z., K.C. Reddy and J.L. Lemunyon, 2001. Predicting soil erosion in conservation tillage cotton production systems using the revised universal soil loss equation (RUSLE). Soil Tillage Res., 57: 213-224.

Rachman, A., S.H. Anderson, C.J. Gantzer and A.L. Thompson, 2003. Influence of long-term cropping systems on soil physical properties related to soil erodibility. Soil Sci. Soc. Am. J., 67: 637-644.

Rejman, J., R. Brodowski and I. Iglik, 2008. Annual variations of soil erodibility of silt loam developed from loess based on 10-years runoff plot studies. Land Reclamation., 39: 77-83.

Relf, D., 2001. Reducing Erosion and Runoff Virginia Cooperative Extension, Pub., USA., pp: 426-722.

Rezaie, H.R., 2003. Soil Erosion by Water and Conservation. Tehran University, Tehran, pp: 8-10.

Wischmeier, W.H. and D.D. Smith, 1978. Predicting Rainfall Erosion Losses a Guide to Conservation Planning. 3rd Edn., USDA Agriculture Handbook, US Government Printing Office, Washington DC. USA., pp: 1-58.

Yang, S., L. Lianyou, Y. Ping and C. Tong, 2005. A review of soil erodibility in water and wind erosion research. J. Geographical Sci., 15: 167-176.