Effects of landuse types at different slopes on soil erodibility factor (A case study from Amol area, north of Iran)

Farzin Shabani[A], Manouchehr Gorji[B], Ahmad Heidari[B] and Atefeh Esmeili[C]

[A] M.Sc Student Email F.shabani1984@gmail.com
[B]Faculty of Soil Science, University of Tehran, Iran, Email mgorji@ut.ac.ir, ahaidari@ut.ac.ir
[C]M.Sc Student Email ESMAEILI1985@yahoo.com

Abstract
The soil erodibility factor (K) represents the combined effects of susceptibility of soil to detachment and transportability of the sediment, and the amount and rate of runoff given a particular rainfall erosivity. This study investigated the Effects of land use and slope on soil erodibility factor in four adjacent land use in northern Iran. Land uses were forest, pasture, irrigated farming, and dry farming that were located in three sites with different slopes of 3-8, 8-18, and 18-40 percent. Three replicated soil samples were collected from each land use at each site. Some chemical and physical properties of soil samples were determined. K values were estimated by using the nomograph method (k equation). Data analysis showed that there are significant differences between different slopes and land uses. K value increased with slope for most land uses due to changing erodibility components such as SOM, texture, structure, and permeability. Pasture land with slope of 8-18% had minimum value of erodibility (0.023). The maximum K value was for irrigated farming with 8-18% slope (0.078). In addition, forest has the second highest value; however dry farming has much more erosivity than forest.

Key Words
Erodibility factor, Soil erosion, Soil erodibility nomograph, USLE, Iran.

Introduction
Soil erosion is one of the most important factors involved in destroying many fertile agricultural soils around the world. Hence , predicting the erosion factor can be of great help in solving the problem. USLE is among the equations which may enable us to estimate soil erosion. Definition of K factor is:

$$K = \frac{A}{R} = \frac{A}{E \times I30} = \frac{M/L^2}{(FL/L^2)(L/T)} = \frac{MTL^2}{L\ LFL^2} = [(Mg/ha)\ (ha\ .h/MJ.mm)]$$

The concept of soil erodibility was introduced as the K factor, which was defined as the average rate of soil loss per unit of rainfall erosion index from a cultivated continuous fallow plot, on a 9% slope 22.1m long. Thus, the K factor for a specific soil can only be determined from long-term observations of rainfall erosivity and soil loss from a unit plot. To allow estimation of soil erodibility from measurable soil properties, the soil erodibility nomograph was published in the early 1970s (Wischmeier *et al.* 1971). Factors which affect soil erodibility are generally categorized into two groups. One relates to the physical characteristics of soil which are easier dealt with compared to the second one which is related to farming management or conservative actions.

There are different direct and indirect methods to evaluate soil permeability. To evaluate through direct methods, using some especial tools, the permeability is evaluated directly, while to evaluate permeability through indirect methods, some parameters are measured and mathematical relations are used. Lufran experiment, falling head, constant head, Porche method, using particle size distribution and double ring are some methods of estimating permeability. Landuse change from non-agricultural to agricultural has led to decrease of soil organic matter which cause adverse effects on the soil structure. Riezebos and Lorts (1998) have found a correlation between soil quality and land use. When a forest changes to cultivated farming, soil organic matter decreases significantly. Soil legislation is of great importance around the globe to limit the amount of soil loss. As the country of Iran is located in a mountainous land, there is a high level of erosion. The aim of the present study is to determine effects of landuse types on different slopes on the soil erodibility factor.

Material and methods

The studied area is located on latitudes between 36.25and 36.50 and longitudes 52.25 and 52.50 in Amol area northern Iran. Sampling positions were determined according to the map resulting from intersecting between landuse and slope maps in Arc-GIS environment. Four different landuses including forest, range, irrigated farming and dry farming and three slope categories in each landuse including A- 3-8% B- 8-18% C-18-40% were selected. Using the aforementioned data the exact sampling positions were determined (Figure 1). The four land uses were chosen with the nearest possible distances from each other in order to prevent changing parent material (Figure 2).

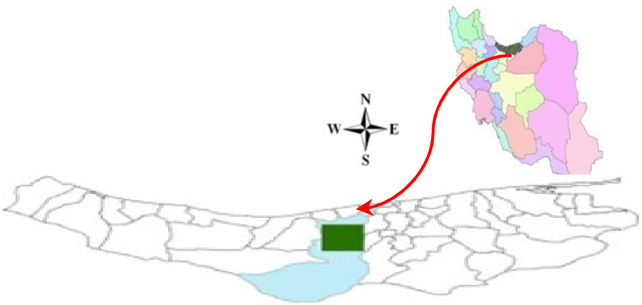

Figure 1. The studied area located in Amol county northern Iran, with the scale of 1:25000.

Figure 2. The four land uses were chosen with the nearest possible distances from each other in order to prevent differences in parent material.

Using GPS the selected positions were found and disturbed samples were collected with three replications for physicochemical analyses and undestroyed samples were collected in 5 replications for determination of bulk density and Ks (Wischmeier *et al.* 1971). Permeability was measured in two replications at different landuse and slope classes using double rings. Organic matter was determined using Walkli and Black (1954) method. Particle size distribution was determined by hydrometer. Erodibility was estimated using nomograph method and the results were analyzed using SAS statistical software. Soil structure codes and profile permeability classes were obtained from National Soils Handbook No. 430 (USDA 1983) and shown in Table 1. There was no dry farming with slope 18-40% in the study area.

Table 1. Average laboratory analyses of soil samples.

Land use	% OM	% Clay	% Silt	% sand	VFS	structure code	Permability code
Pasture 3-8%	1.76	44.44	24.96	30.60	28.52	3	1
Pasture 8-18%	1.69	38.49	50.88	10.63	1.12	3	2
Pasture 18-40%	1.72	14.68	54.71	30.61	22.99	3	3
Forest 3-8%	6.26	22.09	52.51	25.41	15.77	4	4
Forest 8-18%	6.55	20.21	55.21	24.58	20.56	4	4
Forest 18-40%	6.09	19.89	10.87	69.25	59.58	4	4
Irrigated farming 3-8%	2.21	20.88	52.62	26.50	18.68	4	3
Irrigated farming 8-18%	2.64	14.60	52.43	32.97	31.94	4	5
Irrigated farming 18-40%	0.80	3.60	30.76	65.63	17.97	4	4
Dry farming 3-8%	2.87	21.53	52.47	25.99	16.70	3	1
Dry farming 8-18%	1.84	17.42	48.86	33.72	21.55	4	2

Table 2. Analysis of variance for erodibility for different land uses.

Source	DF	Mean Square
Model	3	0.00123695**
Error	29	0.00498827
Corrected Total	32	0.00869912

Table 3. Analysis of variance for erodibility for different land uses and slope.

Source	DF	Mean Square
Model	10	0.00085161 **
Error	22	0.00000832
Corrected Total	32	0.00869912

Significant at 5% and 1%, respectively **: and*

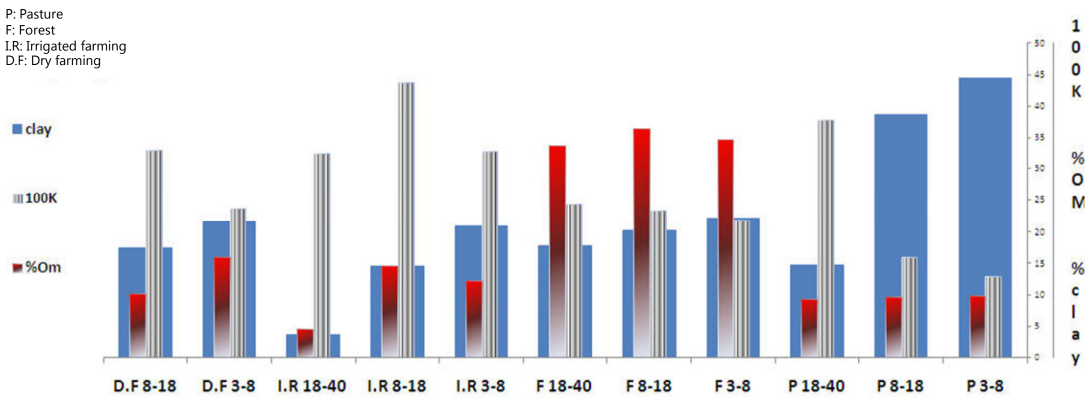

Figure 3. K values for four adjacent land-use types and different slope classes

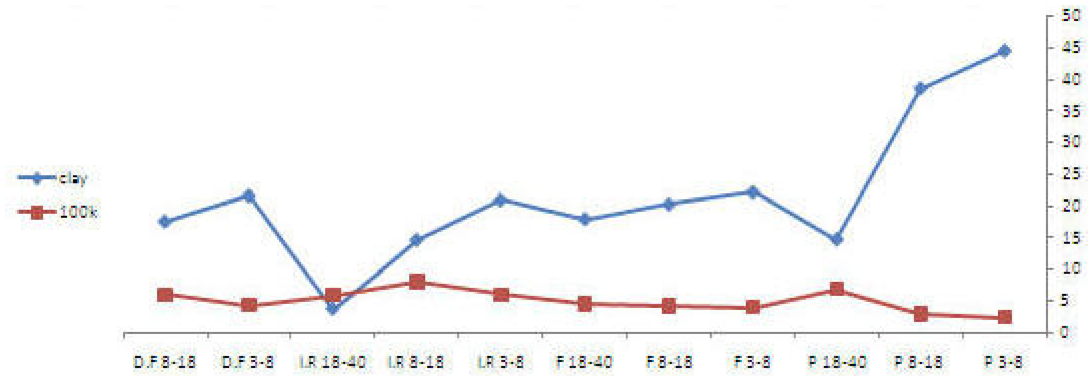

Figure 4. The spatial relationships of clay content and measured K factor

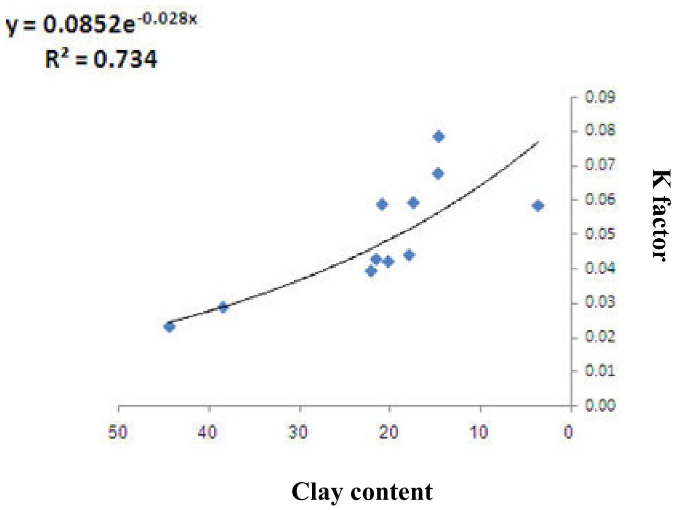

Figure 5. The relationship between clay content and the measured K factor

Dissection

We have proposed a relationship between clay content and the *K* factor using the data from the four sites if there is no significance difference in percent organic mater (Figure 5). With decreasing clay percent, the erodibility factor will be increased (Figure 4), In samples which were collected from site used for irrigated farming and pasture with 18-40 percent slope the effect of other factors led to an improbable erodibility factor. Relationships between percent slope and percent clay indicate that percent of clay decreases when slope increase.

Conclusion

In Iran priorities are given to pastures, forests, dry framing, and irrigated farming respectively. The first and the most important issue for all land uses, is try maximise pastures and forests to limit erosion. The preferred land type for each category of land use is the one with low slope.

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