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Assessment Rate of Soil Erosion by GIS (Case Study Varmishgan, Iran)

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ABSTRACT

Soil erosion not only weakened soil, makes discouraging farms and a lot of hurt, but also causes destruction by sedimentation solid of materials in streams. Sources, dames, ports and decreases the amount of their capacity. One of the most central purposes in local studying and land use evaluation the hazard of erosion variation areas and determine its quantity.

For evaluating erosion, there are many methods. In these methods, there are different factors such as rain erosion, value of erosion soil and plant coverage. In this study, we are studying soil erosion in Romeshgan basin between geographical length of 47º - 47º,38' and geographical width of 33 º,13' – 33 º,36' in Kohdasht in the northwest Lorestan province with SLEMSA method and using Arc GIS 9.3. SLEMSA is a model for estimation of soil erosion in southern Africa and developed and validated by Ewell(1978) and Stoking(1981,1988). For evaluating soil with this model, we obtained information maps contain topography, rainfall, slop and plant coverage. Then with composing this layers, basin is separated to 100 units and the value of erosion soil is measured and giving value is as unit of erosive hazard in basin.

The results showed that the main erosion factor at the risk focuses was at first slope and the second factor was soil fatigue capability. The research finding showed erosion rate of average 667 ton per hectare.

KEYWORDS: evaluation, soil erosion, Romeshgan.

INTRODUCTION

Soil is basic to all life forms. It is the primary means of food production, directly supporting the livelihood of most rural people and indirectly everyone; it is an essential component of terrestrial ecosystems, sustaining their primary producers(micro-organisms, herbivores, carnivores) while providing major sinks for heat energy, nutrients, water and gasses. Weathering, the water balance, organic matter accumulation, erosion and sedimentation, and human actions all control soil development and degradation; thus, soils reflect both natural processes and human impacts (Renschler & Harbor, 2002). Soil erosion, as one of the main processes in land degradation, is the single most immediate threat to the world's food security (Stocking, 1994). It can roughly be divided into a two phase process:

1. The detachment of individual particles from soil aggregates
2. The transportation of particles by erosive agents - windor water.

These transported particles are eventually deposited to form either new soils; to fill lakes and reservoirs or get carried to the ocean. In Iran, it is estimated that 20to 30 billion tonnes of sediment are carried to the ocean every year. As a result of the diverse nature of soil erosion the rates of national and continental soil erosion are virtually impossible to measure accurately.

1-1-Background in research

Model SLEMSA first by Elwell (1978) to assess rates of erosion in Zimbabwe were the results of her research showed that this strategy is acceptable for the study of soil conservation in the country ,after Elwell and Stocking (1984 and 1982), this model for assessing erosion in North Africa to apply the results of this model was also acceptable. Igwe et al (1997) have examined the use of models to estimate the potential risk of erosion USLE and SLEMSA in mapping erosion in SouthWestNigeria Josefine Svorin (2003) examines three models of USLE / RUSLE, SLEMSA, and is believed of choosing the model that proved its quality.Mouinou Igue Attanda (2002) assessment Quality of water erosion in lowland humid Benin using the two models, USLE and SLEMSA and has concluded that

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the model SLEMSA due to the similarity of the results with the results of projects carried out, fit better with tropical there. Gandomkar and colleagues (2008), Mosa Abad Tyran catchment, have evaluated erosion with use of SLEMSA models. Igwe et al (1997) examined the use of models to estimate the potential risk of erosion USLE and SLEMSA in mapping erosion in South West Nigeria have paid. The purpose of this study Rvmshgan watershed erosion rates, erosion, and identify categories of factors are.

1-3-Geographical location and general characteristics of the study area:

The study area is in the southwestern Koohdasht city of Lorestan province . These range from 47 degrees to 47 degrees and 38 minutes and 13 minutes longitude and 33 degrees to 33 degrees 36 minutes latitude, and is 1167 square kilometers Fig. 1.

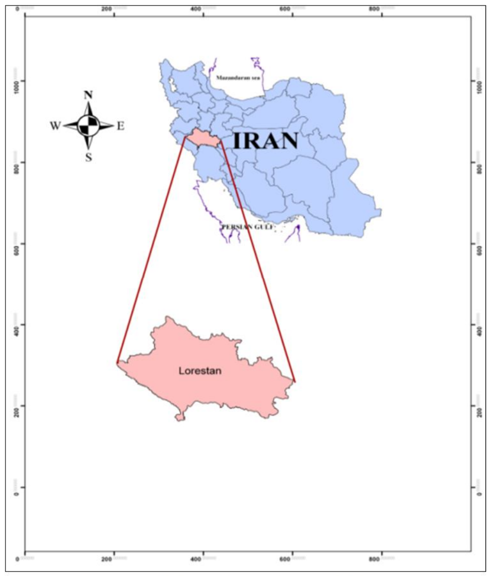

Fig. 1 Geographical location of the study area

2-MATERIALS AND METHODS

Note that the set of elements, factors and phenomena associated with the natural environment within the basin are causing erosion in the study using the system has been subject to erosion.

For the first boundary of the basin and range, then specify the amount of erosion factors in determining the quantity to be paid by them. Through statistical techniques to examine the factors interact in the model is SLEMSA. Collecting information and the primary consideration of factors models, determine coefficients related to any one of the factors, and the combination of layers of the numeral, among other things that in this study was done.

It also can determine the mean weight, coefficient of determination for each homogeneous erosion, particularly erosion in the area studied, analyzed and Comparing the results of the model SLEMSA noted. Finally, the basin has been classified according to the rate of erosion, and erosion class map to be drawn.

3-Calculation of erosion soil using SLEMSA in the basin

SLEMSA was developed largely from data from the Zimbabwe highveld. According to the model's creator Elwell (1996), the SLEMSA framework is a systematic approach for developing models for estimating sheet erosion from arable lands in southern Africa. The model is based upon a body of experimental data supplemented by data extrapolation in which process relationships are assumed (Stocking, 1980). It is also designed to incorporate the practical advantages of empirical methods with the greater flexibility of introducing variables that have not been individually monitored (Stocking, 1980). Elwell (1978) acknowledged that this compromise would lead to a loss of accuracy but argued that for a developing country, such as Zimbabwe (and indeed South Africa!) immediate answers of the right order of magnitude were needed urgently in order to plan for conservation.

The SLEMSA model is still in its infancy stage, and it is hypothesized that when fully developed, it will have required less than one sixth the capital and one third the labor of that needed to develop the USLE to an equivalent degree of proficiency (Elwell,1981).It’s definitive appeal lies in its relative ease of use and limited data requirements.

According to Stocking (1980) SLEMSA has various other advantages for developing countries, in that:

- it combines reasonable accuracy without the need for excessively elaborate and expensive field experiments
- flexibility is maintained by the use of rational and easily-measurable parameters such as rainfall interception
- refinement and up-dating of information can be incorporated as and when new data become available

The SLEMSA model divides the soil erosion environment into four physical systems: crop, climate, soil and topography. Major control variables are then selected for each system on the basis that they should be easily measurable and the dominant factor within each system (Stocking, 1980). These control variables are subsequently combined into three sub-models; the bare soil sub model, topographical sub model, and the crop sub model. The main model is then simply the three sub models multiplied together. The SLEMSA equation is as follows:

$$Z = K * C * X$$

where
Z = the mean annual soil loss from the land (in tons.ha^{-1}.yr^{-1})
K = Erodibility Factor (in tons.ha^{-1}.yr^{-1})
X = Topographic Factor
C = Crop factor
The following sections describe these factors in more detail(Gregory,2004).

3-1-Erodibility Factor :

The erodibility factor (*K*) is the annual soil loss (tons.ha-1.yr-1) from a standard conventionally tilled field plot 30m by 10m on a 4,5% slope for a soil of known erodibility, *F*, under a weed free fallow (Stocking, 1980). The erodibility factor is determined from the rainfall energy and soil erodibility control variables.

- To calculate the amount (K) is necessary to calculate the amount of precipitation. Precipitation in this basin are as follows:

Table 1: Parameters of the basin precipitation.

precipitation characteristics in the	maximum precipitation(mm)	minimum precipitation(mm)	Average precipitation(mm)	kinetic energy of rainfall(E)
Romeshgan Basin	750	327	550	10207

- In terms of lithology, the area is very diverse. The mountainous terrace deposits and alluvial fans new and old, limestone, sandstone, conglomerate, marl, shale and schist in the basin are the most important geological materials (Table 2).

Table 2: Specifications of geology in the basin.

The most important	Rocks	geological formations
rocks and geological formations in the basin	The mountainous terrace deposits and alluvial fans new and old, limestone, sandstone, conglomerate, marl, shale and schist	Asmari, Taleh zang, SHahbazan, Kashkan, Amiran, Bakhtiari, Gachsaran, Aghajari and Bangestan groups

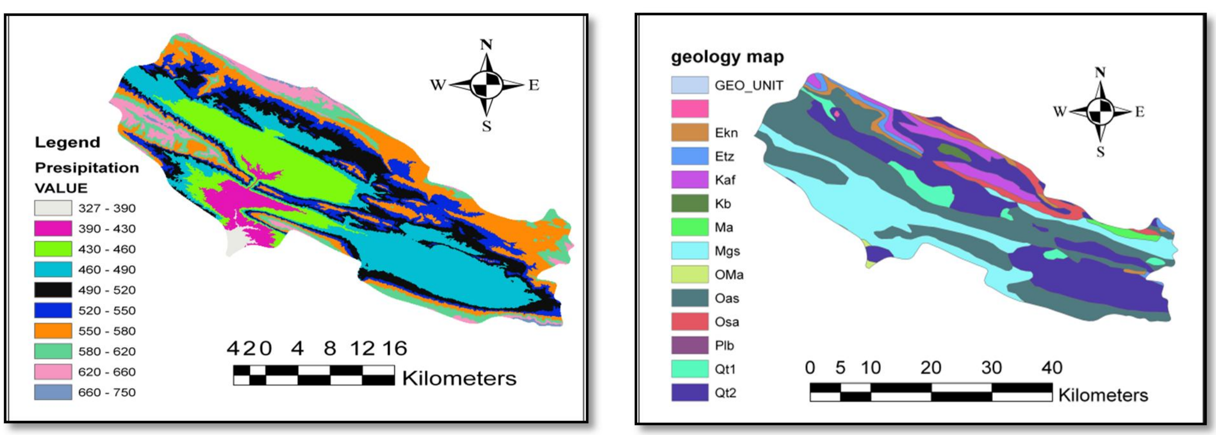

Fig. 2 Geologic map and precipitation map of the basin.

3-2-Crop factor:

The crop factor (*C*) is the ratio of soil loss from a cropped plot to that lost from bare fallow land (Stocking, 1980). It is derived from the energy interception factor, *i*, which is determined by the crop type, yield and emergence date for crops, natural grasslands, dense pastures and mulches (Mughogho, 1998).

- As can be seen in the land use map (Figure 3), respectively, rained agriculture, forestry and pasture are the greatest. Land use characteristics are shown in Table 3.

Table 3; Land use characteristics in the Romeshgan basin.

Type of land use	Ranking (aria)
Dry farming	1
Forest	2
Irrigated farming	5
Out crops	6
Range	3
Scattered Dry farming	4

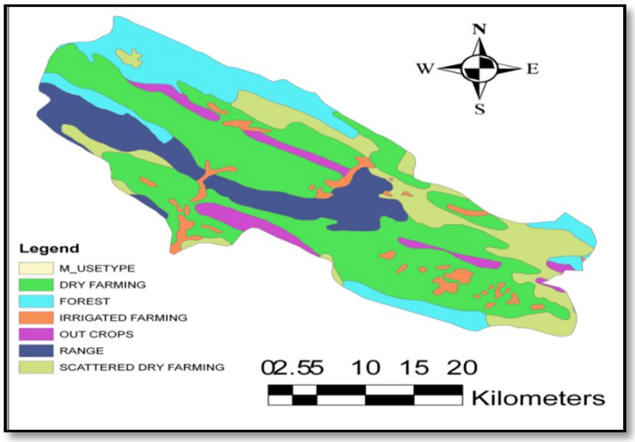

Fig. 3 Map of catchment land use

3-3-Topographic Factor :

The topographic factor (*X*) is the ratio of soil loss from a field slope of length, *L*, in meters and slope percent, *S*, to that lost from a standard plot (Stocking, 1980).

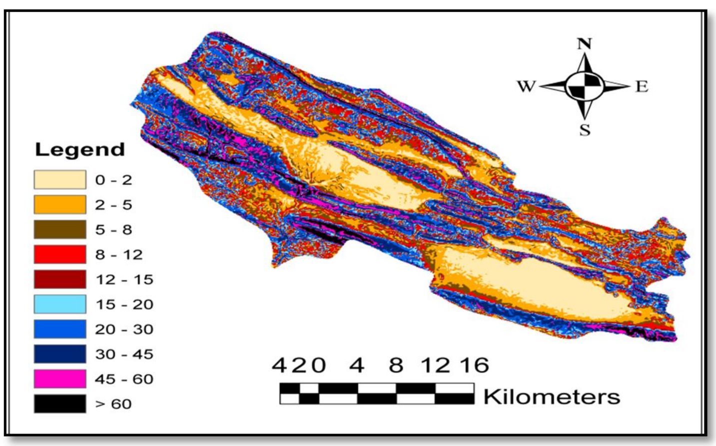

Fig. 4 Map of catchment slope

Finally, using the equation $\mathbf{Z = C.X.K}$ erosion risk is calculated. This method can actually show us the numbers that we want to evaluate the risk of attrition in each region and between regions. Furthermore, local variables, the possibility of applying the framework provides a specific methodology to assess the relative risks of attrition in a broad attempt to evaluate or predict the risk of soil erosion Vrzym and advanced techniques beyond the way we are able to model Other factors in the erosion can be combined with each other, and we use the very good progress towards the simple things that have already been made .

4-DISCUSSION AND RESULT

4-1-Mapping and analysis of the risks of erosion in the watershed

For mapping zonation erosion zone, in a table in the first column of X (longitude), and the second column of the Y (latitude), and the third column, the value of Z (the erosion) will be (Table 4).

Table 4: The amount of erosion in each of the squares of the tour (study area), (ton per hec per year).

Number of grid squares	X	y	Z	Number of grid squares	x	y	z
1	47.1	33.8	2.605918	49	47.31667	33.38333	0.63694
2	47.11667	33.8	4.266736	50	47.35	33.38333	34.47543
3	47.05	33.55	0.537272	51	47.4	33.38333	3.375722
4	47.1	33.56667	3.809316	52	47.45	33.38333	11.71773
5	47.13333	33.56667	4.144725	53	47.48333	33.38333	5.26314
6	47.16667	33.56667	2.582824	54	47.13333	33.35	4.711166
7	47.01667	33.51667	1.655016	55	47.18333	33.35	1.929647
8	47.05	33.53333	0.119788	56	47.21667	33.35	25.7563
9	47.1	33.53333	2.044473	57	47.26667	33.35	2.358668
10	47.13333	33.53333	42.71184	58	47.31667	33.35	1.494243
11	47.18333	33.53333	0.763007	59	47.35	33.35	0.591874
12	47.21667	33.53333	14.0523	60	47.4	33.35	0.748509
13	47.26667	33.53333	9.859803	61	47.45	33.35	0.555167
14	47.4	33.7	13.98436	62	47.48333	33.35	0.406885
15	46.9	33.5	3.088939	63	47.53333	33.35	0.782507
16	47.05	33.5	4.029843	64	47.56667	33.31667	1.555979
17	47.1	33.5	0.248307	65	47.8	33.31667	0.669702
18	47.13333	33.5	1.270282	66	47.8	33.31667	4.633564
19	47.18333	33.5	11.35433	67	47.8	33.31667	5.463578
20	47.21667	33.5	0.70004	68	47.26667	33.31667	43.01
21	47.26667	33.5	12.36075	69	47.31667	33.31667	1.191255
22	47.31667	33.5	8.709716	70	47.35	33.31667	0.106291
23	47.33333	33.5	17.94638	71	47.4	33.31667	4.141948
24	47.03333	33.46667	5.923982	72	47.45	33.31667	5.094564
25	47.05	33.46667	3.703065	73	47.48333	33.31667	0.989901
26	47.1	33.46667	6.229026	74	47.53333	33.31667	3.547128
27	47.13333	33.46667	0.565865	75	47.56667	33.31667	3.305178
28	47.18333	33.46667	0.130127	76	47.61667	33.31667	3.176026
29	47.21667	33.46667	3.747819	77	47.18333	33.3	0.067872
30	47.26667	33.46667	29.60083	78	47.35	33.28333	0.625509
31	47.31667	33.46667	0.640452	79	47.4	33.28333	0.326357
32	47.35	33.46667	27.81064	80	47.45	33.28333	1.421432
33	47.4	33.46667	1.948601	81	47.48333	33.28333	3.035839
34	47.03333	33.43333	22.98213	82	47.53333	33.28333	8.3446
35	47.1	33.41667	2.973591	83	47.56667	33.28333	15.23108
36	47.13333	33.41667	9.191181	84	47.61667	33.3	29.62964
37	47.18333	33.41667	2.043818	85	47.36667	33.26667	11.74411
38	47.21667	33.41667	0.033192	86	47.4	33.25	2.084824
39	47.26667	33.41667	3.593717	87	47.4	33.25	1.497506
40	47.31667	33.41667	15.82926	88	47.45	33.25	0.958034
41	47.35	33.41667	3.311086	89	47.48333	33.25	1.796041
42	47.4	33.41667	0.717636	90	47.53333	33.25	17.88592
43	47.43333	33.41667	1.18734	91	47.56667	33.25	32.44014
44	47.1	33.4	2.8541	92	47.6	33.23333	1.587004
45	47.13333	33.38333	1.27139	93	47.48333	33.15	1.013071
46	47.18333	33.38333	2.777703	94	47.53333	33.15	4.331113
47	47.21667	33.38333	1.993242	95	47.56667	33.15	15.80167
48	47.26667	33.38333	0.289223	96	47.61667	33.15	15.38984

The amount of erosion in each of the squares on the tour (table 4) states that the erosion of the study area map is drawn. Figure 6 shows that the four focal areas of erosion can be seen in the mountainous regions of North, East and

South regions are located. Centers in the area of erosion, slope factor has the most, except the central focus of the map factor in the emergence of the ability to wear it has had more impact(Figure 5).

For The determining main factor in the erosion (of the factors considered in the model SLEMSA) in any part of the basin, the scattering factors in the erosion map was created (Figure 7) and the impact of each of them has been found in the region.

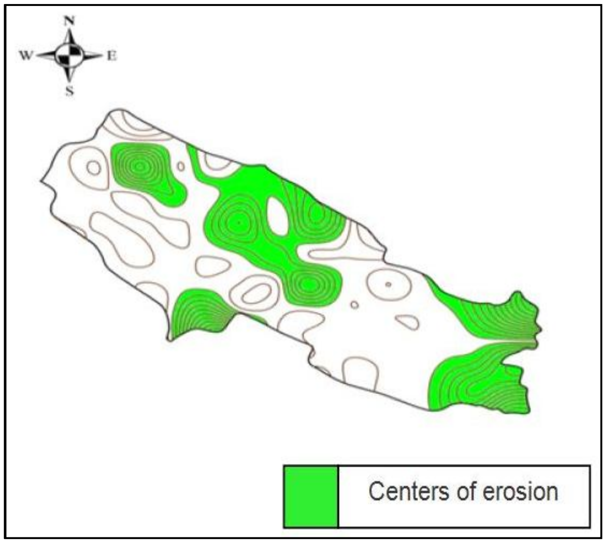

Figure 5: Centers of erosion in the study area

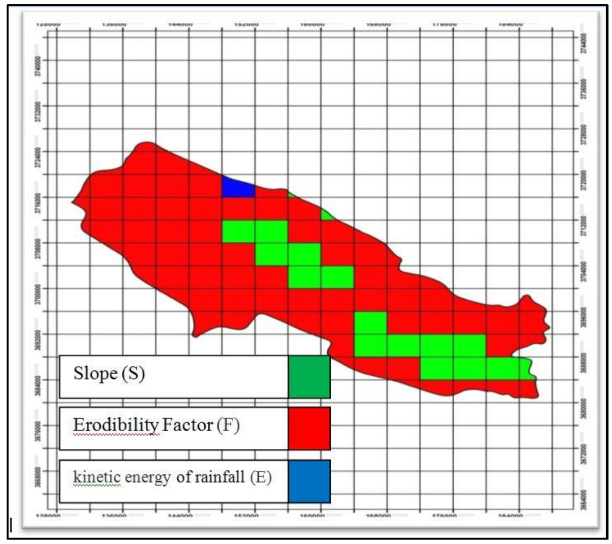

Figure 6: Distribution of causative factors in the SLEMSA model

For The determining main factor in the erosion (of the factors considered in the model SLEMSA) in any part of the basin, the scattering factors in the erosion map was created (Figure 7) and the impact of each of them has been found in the region.

Analysis (Figure 7) shows that about 77 percent of land area most affected by the slope of (S) eroded and this causes a major role in the loss of soil basin, and the ability of soil erosion (F) with 12% and rain kinetic energy (E) with 1 percent in the next classes are. However, all factors considered in the model involved in the erosion area and the only influential factor in each section (square) of the basin is. And the absence of land management factor (C) and the minor rain kinetic energy (E) in the absence of effective means of distribution maps in the catchment is erodible.

Determine the amount of soil lost and priority areas from erosion risk (Figure 7 and 8).

The study on the erosion risk map (Figure 7) The study area is divided into five classes of preference erosion risk (Figure 8). The five classes include class attrition rate is very low, low, medium, high and very high.

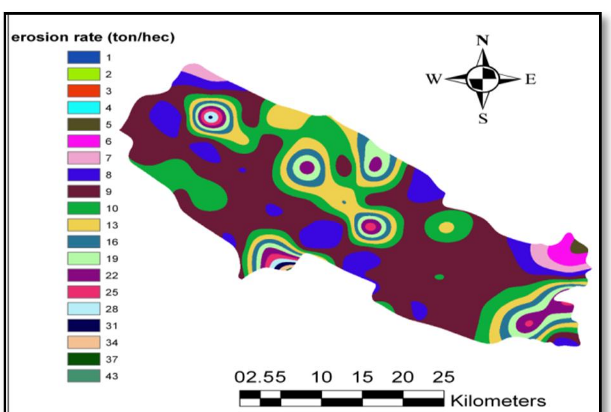

Figure 7: erosion rate map (tons per hectare per year)

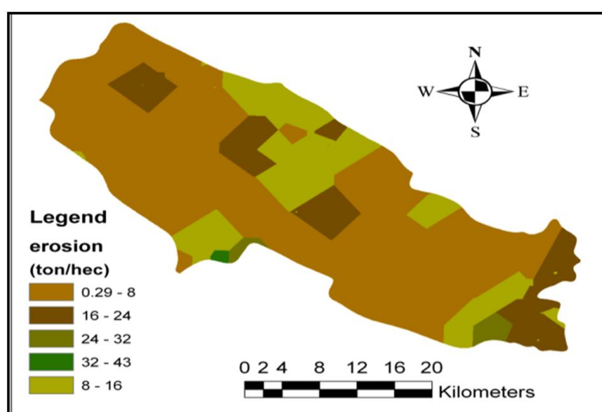

Figure 8: classify Map levels of attrition

4-2-Assessment Specified classes of erosion in the basin :

Erosion classes and their characteristics are shown in Table 5. As is shown in Table 5, the most effective factors the erosion of the basin are Slope (S) and Erodibility Factor (F).

Table 5: Erosion classes and their characteristics

Erosion class	(ton/hec)Erosion rate	Area (percent)	Slope (percent)	precipitation (mm)	Affecting factors
very low	0/29 - 8	67/35	8	480	S – F – E
Low	8 – 16	17/73	17	540	F – S – E
medium	16 – 24	10/42	22	610	S – F
High	24 – 32	1/86	28	600	S – F
too much	32 – 43	0/64	42	605	S – F - E

Conclusion

The major goal of this study was to produce a soil erosion hazard map of study area for agricultural and management planning. The absolute values of 5 erosion hazard classes obtained from this model are low and to moderate. The overall predictive ability of SLEMSA model is good and with some modification may be employed for mapping erosion hazard in the study area. Such modification includes the assessment of individual soil erodibility and not rating or scoring based on taxonomy. The use of complex mathematical equation to derive soil loss values makes the model difficult to apply.

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