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Wind erosion rate estimation in Tasuki-Rigchah region using IRIFR Model (Southeastern Sistan)

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ABSTRACT

Wind erosion occurs all over the arid, semiarid, sub humid and even humid regions of the world and it sparks extensive damage. There are different methods for wind erosion estimation worldwide. One of the main and applicable methods for wind erosion estimation in Iran is IRIFR method (Iranian method). Wind erosion rate is calculated using 9 factors in this method. This research was done in Tasouki-Shileh region in Sistan plain. A series of work units were needed to performed this task. Work units according to Ahmadi method were determined and were separated. In total, 2units, 3 types and 17 faces of Geomorphology were identified in Tasuki-Shileh region. These faces are located in pediment and playa geomorphology units. Then, the scores of 9 factors affecting wind erosion in studied region and total geomorphology faces were determined. For this purpose, all geomorphology faces scores in relation to all factors affecting on wind erosion were calculated. Total obtained scores in each faces and all studied region that was presented by table format using model, lead to calculating wind erosion intensity or classes in region and all geomorphological faces. The results showed that 2.62%, 17.48%, 49.74% and 30.16% of region area have low erosion, medium erosion, high and very high erosion respectively.

Keywords: wind erosion, IRIFR model, Tasuki-Rigchah, Geography information system.

INTRODUCTION

Wind erosion is main factor of erosion in arid and semiarid region and observed unfavorable landscape of it, are desert sand seas and sand dunes forms [1 and 3]. Wind erosion happened in all arid regions of the world and even in sub humid to humid region and caused to extensive damage. The results of studies showed that damage caused by wind erosion is severe in dry years [5]. Wind erosion is including detachment of soil particles, transport and deposit of soil by wind. Wind erosion is severe if wind velocity is high and be not an obstacle along its path that mentioned condition is visible clearly in Tasuki-Shileh region. This process is capable to transport large amount of material in barren or scattered vegetative cover regions and especially in vast desert region without humps and dumps. Overall, quantity assessment of wind erosion is better than quantity assessment of it [7]. About different models of wind erosion, it is noteworthy that the most complete relation for estimation wind erosion rate is a formula that it is similar to USLE model (model for water erosion) [9]. This equal is suggested by Woodruff and Sidui (1965). In this method many parameters was used including: soil adorability, wind energy (determination by climate data), surface roughness, rout length that particles move freely on the ground, amount of surface vegetation cover biomass.

MATERIALS AND METHODS

Site description

Rigchah and Taosuki crisis centers are located in southeastern Sistan plain with an area of about 131660 ha. Study area is located in 30˚0′51″to 30˚ 37′36″E and 60˚54′42″ to 61˚12′47″ N. Mean precipitation is 59.6 mm and mean annual temperature is 22˚c. In the recent 20 years has been diagnosed about 11 years of drought.

The proposed model of wind erosion estimating for Iran

This method prepared by Ahmadi and Ekhtesasi (1995) in accordance with existed ecology condition and facilities in Iran and its use suggested for central and south of Iran. Considering that Most of the related research conducted by the Research Institute of Forests and Rangelands, this method is called as IRIFR.E.A. In this method, based on geomorphological study and providing different levels map, created work unit. In IRIFR.E.A similar to PSIAC method, the effect of 9 important of factors in wind erosion and deposition rate is evaluated and rated. Depend on intensity and weakness of each factor and its effect on sediment yield, Points will be given to those [4]. Total obtained numbers for the different factors, would be represents the intensity of wind erosion. In table 1, 9factors affecting on wind erosion intensity and deposit resulting from it together with range of its scores presented.

Table 1: effective factors on soil erosion and product deposit with related scores in IRIFR model

row	effective factors on soil erosion and product deposit with IRIFR method	Range of scores
1	Lithology	0-10
2	Land form and dumps and humps	0-10
3	Wind velocity and condition	0-20
4	Soil and its surface cover	-5-15
5	vegetation cover density	-5-15
6	Effects of soil surface erosion	0-20
7	Soil moisture	0-10
8	Type and distribution of wind deposits	0-10
9	Management and land use	-5-15

Obtained erosion intensity from 9influences of factors on wind erosion, classified in 5 classes.

Table 2: soil erosion classes in IRIFR model

scores	Erosion intensity and classes
0-25	I
25-50	II
50-75	III
75-100	IV
100>	V

Work-unit identification

To do the study, work-units had to be determined and this was carried out following Ahmadi method. Totally, in Tasouki-Shile region 2 units, 3 types and 17 geomorphological faces (hereupon called geo-faces) were identified. These geo-faces are located in playa and piedmont units. In this study base maps of geology, vegetation, land-use, land-forms and terrains, pedology and land capability and other data like moisture, wind and map of current surface erosion with geomorphology map (as the base map of wind erosion assessments) were superimposed and in each geo-faces nine parameters were evaluated and scored and finally total erosion severity of the area was at hand. The way they were assigned scores could be put simply like this that each parameter’s score in work-units (having equal potential) was determined and with the aid of weighted average, each parameter’s score in the whole area was calculated. The methodology used in calculating scores in each work-unit or geo-faces and the whole area is as following: using field studies and observations, land-use map and other available information scoring was done and the following numbers were averaged weightily.

RESULTS AND DISCUSSION

Petrology

Reviewing literatures and according to the formations of the region and using base tables of petrology, petrology was scored at 6.88. As could be seen the score is 6.88 out of ten which is high already and implies the important role of geology to control wind erosion. The reason why petrology score is high in the region stems from the existence of sedimentary depositions, thus according to the table the score would be high. Accordingly, the region is susceptible to wind erosion from petrology point of view.

Landforms and terrain
As was noted earlier, in order to calculate erosion factor in the area, slope map was used and with regard to the calculations, landform and terrain score assigned to the area is 7.35. From the fact that whole area is devoted to covered piedmonts and playa and all these faces encompass slope of merely 2 percent, the assigned number escalate significantly. Most of the area is flat and even and facilitate wind erosion up to a great extent. The project site is assigned a score 7.35 out of 10 which gives indication of the great potential of these faces for wind erosion [11].

Wind velocity and status in geo-faces
According to chosen indicators for wind velocity and status in the IRIFR model, duration, velocity and continuity for local sand blasts and gale-force winds in all of the geo faces in the region is the same and the highest value is attached to them in such a way that score of 15.11 is approximated for these factors for wind erosion [12].

Soil and surface cover
As was said, to determine soil score and its surface cover, soil sampled from tasouki-Shile region were analyzed in the laboratories and coupled with field survey and the related table (designed in the model), the score was at hand. Given the calculations, soil and surface cover score in the region equals 9.17.

Vegetation
According to calculations, score of vegetation density in the region was determined giving indication of severe status of the area from the vegetation perspective. Based on the assigned scores for every geo-face and averaging weightily, the score for this factor was determined. As could be seen, from the total possible 20 scores for the area, this factor has gained 10. This, points out the lack of appropriate vegetation cover to stand wind pressure. So one of the most important factors acting in wind erosivity is deficit in or shortage of vegetation cover in the area. If attempt is been made to recover vegetation cover, the wind erosion will plummet substantially. As was mentioned earlier, this increase in vegetation cover could modify other implications of other factors and al together could lessen the pressure of wind erosion in the area [6].

Soil surface erosion forms
After scoring these factors for different geo-faces, weighted average score for surface erosion forms for the whole area was calculated. On this basis and with respect to other calculations, score of soil surface erosion forms was determined for the whole area which averages at 12.35.

Soil moisture
Once the calculations were done, soil moisture score for the region equaled 6.05. As is implied, this scores while gets high value, but still severity is less than other ones. So the conclusion could be made is that escalating soil surface moisture is likely to decrease wind erosion in the area largely and is able to minimize its effects.

Type and distribution of wind sedimentary accumulations in geo-faces
The score assigned for this factor is 5.82 implying wide distribution of wind deposits in the area. To put it another way, existence of these wind deposits and further presence of sensitive faces suggest shrilling effect of wind.

Land use
Based upon the calculations, the score assigned to land-use and land management equals 10.94 in Tasouki-Shileh region. The score is high on the grounds that there is a mismatch between land capabilities and status quo of land-use and management even for arable and none-arable lands. The wind erosion lessens as long as land-use and management is suited to the region [8].

Calculating wind erosion
Once all scores for the nine factors and all geo-faces were all set, wind erosion was determined for the region and geo-faces. To do this, all scores for the region and geo-faces were calculated and imported into the table defined into the model in order to approximate the erosion severity and wind erosion class in the whole area.

Table 3: illustrates the scores of the factors included in soil erosion in the IRIFR model along with wind erosion class for each geo-faces and the whole area.

The score of major element of wind erosion in IRIFR model (in non-agricultural area)											Facieses code
classes	Total score of Facieses	Land use -5 - 12	Type and distribution of wind sedimentary accumulations in geo-faces 0 - 10	Soil moisture 0 – 10	Soil surface erosion forms0 - 10	Vegetation -5 - 12	Soil and surface cover **5—15**	Wind velocity and status in geo-faces 0 - 20	Landforms and terrain 0 - 10	Petrology 0 - 10	
IV	78	10	4	7	11	13	5	15	6	7	1.3.2
IV	81	12	4	4	15	8	7	16	7	8	2.3.2
III	50	10	4	4	3	3	2	15	8	5	3.3.2
III	74	12	4	5	10	6	6	17	8	6	4.3.2
V	110	13	10	8	18	12	14	18	9	8	5.3.2
V	121	14	10	8	15	15	15	20	10	9	6.3.2
V	106	14	9	7	18	14	11	18	8	7	7.3.2
IV	86	11	8	7	15	**5**	11	16	7	6	8.3.2
IV	77	11	6	7	17	10	13	15	7	6	1.1.3
V	102	13	7	8	13	13	13	17	**9**	9	2.1.3
IV	97	10	8	8	17	11	11	17	7	8	3.1.3
III	74	9	4	6	10	13	7	10	8	7	4.1.3
II	43	7	2	4	2	4	5	7	7	5	5.1.3
III	64	7	4	4	5	11	7	10	9	7	6.1.3
IV	87	11	2	7	15	11	11	15	9	6	7.1.3
III	57	8	6	3	5	6	5	13	6	5	8.1.3
V	108	14	7	6	16	15	13	18	10	9	1.2.3
IV	88.23	10.94	5.82	6.05	12.35	10	9.17	15.11	7.35	6.88	total

Table 3 score of the nine factors included in soil erosion in the IRIFR model along with wind erosion class for each geo-faces and the whole area

In the map no. 1 different wind erosion classes for Tasouki-Rigchah are brought.

To determine wind erosivity in Tasouki-Rigchah and reach a map of land susceptibility to wind erosion, scores for different geo-faces and the area were coupled with the available information. As a matter of fact geo-faces form the basis of all estimations and calculations in current research. The results are brought in table three.

Table 3 determination of wind erosion and estimating land sediment delivery in proportion to wind erosion using experimental knowledge

Sediment production in (ton/km^2)	Total score	Erosion status	Erosion class
< 250	<25	Negligible	I
250-500	25-50	Little	II
500-1500	50-75	Moderate	III
1500-6000	75-100	High	IV
>6000	>100	Very high	V

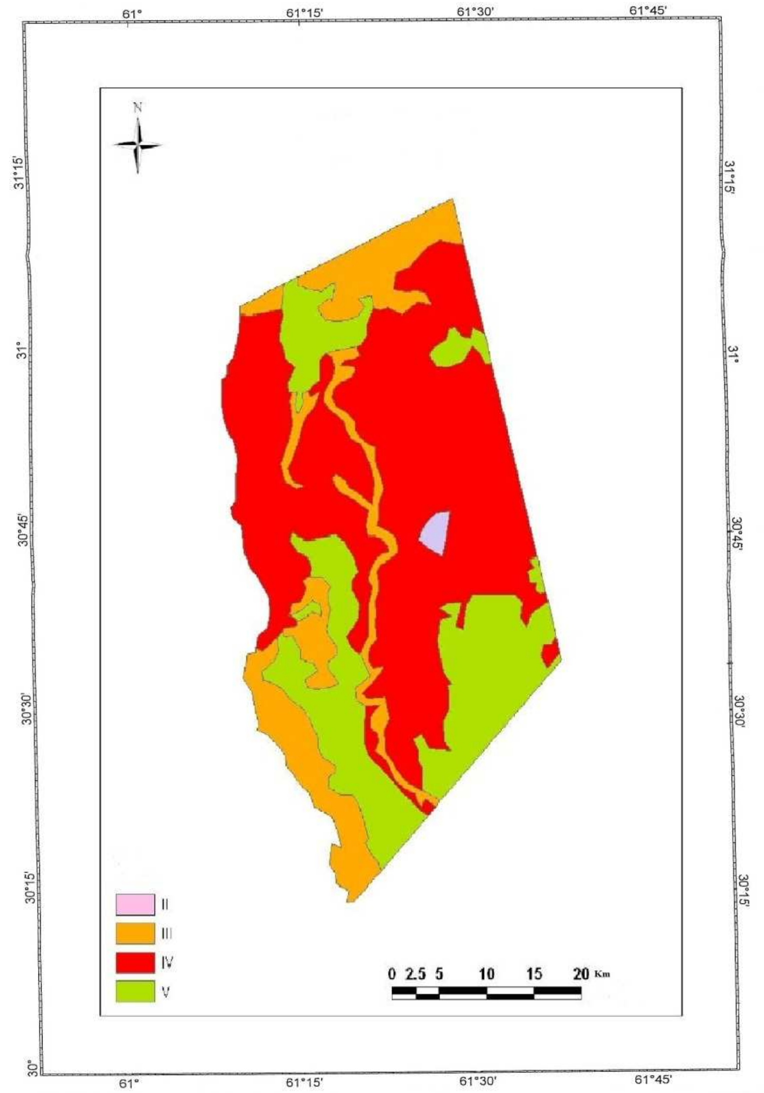

Fig. 1 land susceptibility to erosion for Tasouki-Rigchah

CONCLUSION

Considering the mentioned cases, effectiveness factors in increasing wind erosion are presented in table 1. One of the most important factors affecting on wind erosion in Tasuki-Rigchah region is wind factor. Wind factor has a considerable importance and has received 15.11 scores from existed 20 scores and this issue indicates there are terrible and erosive storms with long time and intensity (especially 120 days winds) in studied region and these winds have a very high role in erodability. These winds are one of the most effective factors on wind erosion in studied region absolutely. One of the methods to control of the wind erosion is creating and establishing windbreak in studied region. The following factor in wind erosion is combination of geological deposits that makes the area be prone to wind erosion and if other factors controlled, this factor can be reduced.

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