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Spatial Variation of Some Indicators of Soil Degradation in the Desert Lands of Anbar Province through Use of Geospatial Technologies

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Abstract
The desert area extending from the 39° to 40° longitude east and from 31° 30′ to 34° 30′ North is selected with a total area of 79213 km^2 (within the Northern Badia) which represents a large area of land in Anbar province in western Iraq. The aim is to study some indicators of soildegradation, which are wind erosion factors and peeling plants. This coefficient, according to the US division, fell within the intermediate range and its value ranged from 0.07 - 0.71. It had the highest value within the 113CCW soil series, the same series that contained the highest value of the soil crusting coefficient, which had a range of 0.08 - 1. The DE33 and 142SCW series contained the lowest values for the coefficients respectively. The soil quality index showed the results of good, medium, and poor soil, with the best near the river and the desert depressions.
Keywords: Soil, Soil desert, Degradation, Wind erosion, Soil crusting.

Introduction

Land degradation is defined as a temporary or permanent decline in the productive capacity of the land, and it occurs when the natural balance is disturbed due to misuse or overexploitation of land as a result of human activities or as a result of natural factors.
It is a general problem occurring around the world but taking on a serious dimension in drylands and it is one of the environmental problems facing desert areas (FAO, 2004).
Buringh, 1960, indicated that 2.4 million hectares of Iraqi land are exposed to wind erosion, which constitutes 60% of the total area.
Soil degradation has taken various forms, including physical degradation, such as wind erosion, water erosion, or dust storms. And the chemical degradation, which isinvolved primarily salinization of the soil, as well as biological degradation of the soil (Al-Juraysi, 2013).

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De Angelis et al., 1987, explained that several natural and human factors lead to physical degradation. One of the most important of these factors is soil erosion which is attributed to 85% of soil degradation. Wind erosion is at the forefront of soil erosion, especially in dry and semi-arid regions. The conditions for this process are fragile, dry, and finely separated soils, with low vegetation cover and strong winds. Wind erosion is a global problem that affects the ecosystem in particular, and its intensification in recent years is due to climate extremes in these regions.
Jasim, et al., 2018, said western areas of Iraq vary in terms of their susceptibility to wind erosion and soil crusting ability, as dust storms are active in the summer due to high temperatures and low vegetation cover.
Daglia, 2022, confirms that the deterioration of wind erosion is a serious natural disaster worldwide, causing the degradation of a third of the world's land.

Objective of study

To identify areas with high erosion and crusting factors that significantly affect the process of wind erosion.

Materials and Methods

A desert area in western Iraq was identified, between 39° and 44° east longitude and between 31° 30' and 34° 30' north latitudes. It represents a large area of Anbar province (Northern Badia) estimated at 79,213 km^2. A number of analyzes of previous studies were taken within the specific area, which represents 60 Bidoon. **Figure 1**.
The values of some analyzes of the surface horizon were mapped, such as sand, silt, and mud, as well as the extraction of wind erosion factors, clay assembly factor, soil crusting factor, and soil quality guide extraction, along with the mapping of the soil type with the method proposed by the Akidi 1981.

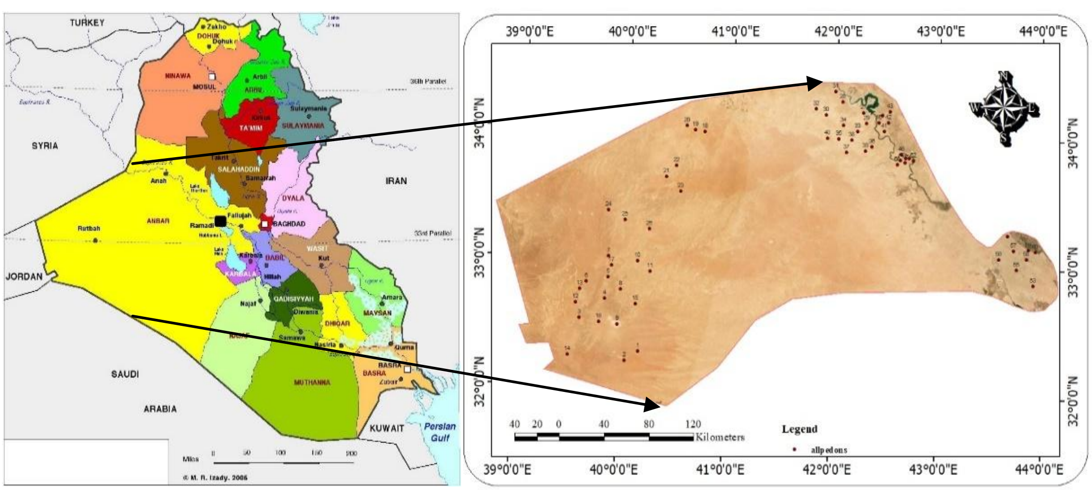

Figure 1: The location of the study area for desert soils in western Iraq.

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Soil Erodibility factor to wind erosion and soil crust factor were calculated For each horizon, according to an equation (Fryrear et al., 2000), to use as basic criteria in classifying and characterizing the region's soil series for desertification cases, and conservation purposes, according to the following formula:

1-
$$EF=1/100[29.09+(0.31x\%sand)+0.17x\%silt) + (0.33x\%sand/clay) - (4.66x\%organic\ matter) - (0.95x\%CaCO3)]$$

Whereas:

EF=Soil Erodibility factor

2-
$$SCF = 1/ [1+0.0049(\%clay)^2]$$

Whereas:

SCF= Soil crust factor.

Soil quality index (SQI) according to the following equation:

3- SQI= (Texture* EC *OM)$^{1/3}$

Results and discussion:

Physical evidence adopted as indicators of the state of soil degradation

Soil Erodibility Factor (SEF)

The term erosion generally expresses the destruction of soil by human, water or wind action. In dry and semi-arid regions, wind erosion comes at the forefront of soil erosion processes.

The values of the Soil Erodibility Factor were calculated by applying theequation ofFryrear, et al., 2000,Table (1), using some physical and fertility analyzes of the soil. The values of the wind erosion factor were distributed in the range 0.07-0.71 and an average of 0.32, which exists within the average level according to the American division. The highest value recorded of the soil series was 113CCW at Bidoon16, while the lowest value was at Bidoon47 within the DE33 soil series. The results were circulated after being divided into 6 categories and the area and percentage of each category were calculated as well as the map was drawn for it. Figure(2).

Table 1: Analysis of soil separation and values of wind erosion and crusting factor and soil quality.

NO.	Sand gm.kg-1	Silt gm.kg-1	Clay gm.kg-1	SEF	SCF	SQI
1	476	212	312	0.27	0.17	1.58
2	738	240	22	0.39	0.98	1.19
3	746	150	104	0.27	0.65	1.14
4	640	340	20	0.38	0.98	1.39
5	788	160	52	0.29	0.88	1.19
6	914	76	10	0.54	1	1.40
7	612	308	80	0.27	0.76	1.75
8	688	272	40	0.32	0.93	1.31

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9	808	180	12	0.49	0.99	1.06
10	848	80	72	0.34	0.8	1.44
11	800	146	54	0.29	0.87	1.14
12	668	320	12	0.45	0.99	1.53
13	603	360	37	0.30	0.94	1.19
14	860	140	10	0.56	1	1.27
15	568	392	40	0.30	0.93	1.19
16	804	190	6	0.71	1	1.27
17	608	360	32	0.30	0.95	1.44
18	482	16	502	0.30	0.08	1.37
19	963	2	35	0.41	0.94	1.34
20	663	16	320	0.31	0.17	1.19
21	683	111	205	0.32	0.33	1.27
22	658	8	334	0.31	0.15	1.19
23	820	10	170	0.33	0.41	1.19
24	677	12	311	0.31	0.17	1.22
25	626	10	364	0.31	0.13	1.22
26	730	9	261	0.32	0.23	1.31
27	384	405	211	0.16	0.31	1.26
28	474	336	190	0.20	0.36	1.53
29	392	458	150	0.22	0.48	1.44
30	480	351	169	0.31	0.42	1.44
31	566	362	72	0.35	0.8	1.26
32	262	538	200	0.28	0.34	1.44
33	750	100	150	0.33	0.52	1.37
34	760	95	145	0.26	0.53	1.19
35	695	140	165	0.30	0.44	1.19
36	803	92	105	0.43	0.71	1.44
37	390	430	180	0.35	0.49	1.44
38	710	130	160	0.35	0.44	1.44
39	670	135	195	0.36	0.41	1.37
40	407	358	235	0.23	0.99	1.37
41	525	236	239	0.27	0.3	1.37
42	591	210	201	0.29	0.36	1.37
43	510	128	362	0.29	0.28	1.19
44	439	325	236	0.29	0.41	1.19
45	482	296	222	0.27	0.26	1.45
46	454	326	220	0.18	0.29	1.26

47	**538**	**237**	**225**	**0.07**	**0.29**	**1.26**
48	**729**	**137**	**134**	**0.21**	**0.53**	**1.26**
49	**676**	**193**	**131**	**0.30**	**0.54**	**1.26**
50	**420**	**380**	**200**	**0.17**	**0.34**	**1.44**
51	**354**	**422**	**224**	**0.29**	**0.29**	**1.26**
52	**760**	**114**	**126**	**0.32**	**0.56**	**1.26**
53	**470**	**137**	**393**	**0.30**	**0.12**	**1.19**
54	**632**	**121**	**247**	**0.35**	**0.25**	**1.26**
55	**531**	**162**	**307**	**0.34**	**0.18**	**1.19**
56	**406**	**256**	**338**	**0.26**	**0.15**	**1.19**
57	**438**	**223**	**340**	**0.30**	**0.15**	**1.26**
58	**396**	**489**	**115**	**0.34**	**0.61**	**1.26**
59	**324**	**376**	**300**	**0.36**	**0.19**	**1.26**
60	**428**	**358**	**214**	**0.31**	**0.31**	**1.19**

Table 2: Area values of wind erosion, crusting, and soil quality factor

	%	Area km^2		%	area km^2		%	Area km^2
SEF	0.05	36.39	SCF	4.31	3410.18	SQI	52.05	41227.50
	19.37	15343.33		19.87	15742.99		46.36	36723.18
	67.06	53121.20		36.76	29116.55		1.59	1262.32
	11.01	8719.52		10.07	7976.12			
	2.38	1888.98		16.39	12983.25			
	0.13	103.59		12.6	9983.91			

The highest and lowest area of the category was 103.56 and 36.39 km^2, and in percentages of 0.13 and 0.05 respectively. Table (2). Low organic matter, lack of natural vegetation, the dominance of the sand season, and poor soil construction are factors that contribute greatly to the negative impact of wind erosion in dry and semi-arid areas. Ibrahim and others, 2017, confirmed that wind erosion is a problem affecting the ecosystem and one of the most important reasons for its intensification in recent years in arid and semi-arid regions is climate extremism. Some studies have indicated that winds traveling at 6.62 m.s^{-1} can raise the minute soil $\leq$ 1 mm. (General Authority for Meteorology, 2012).

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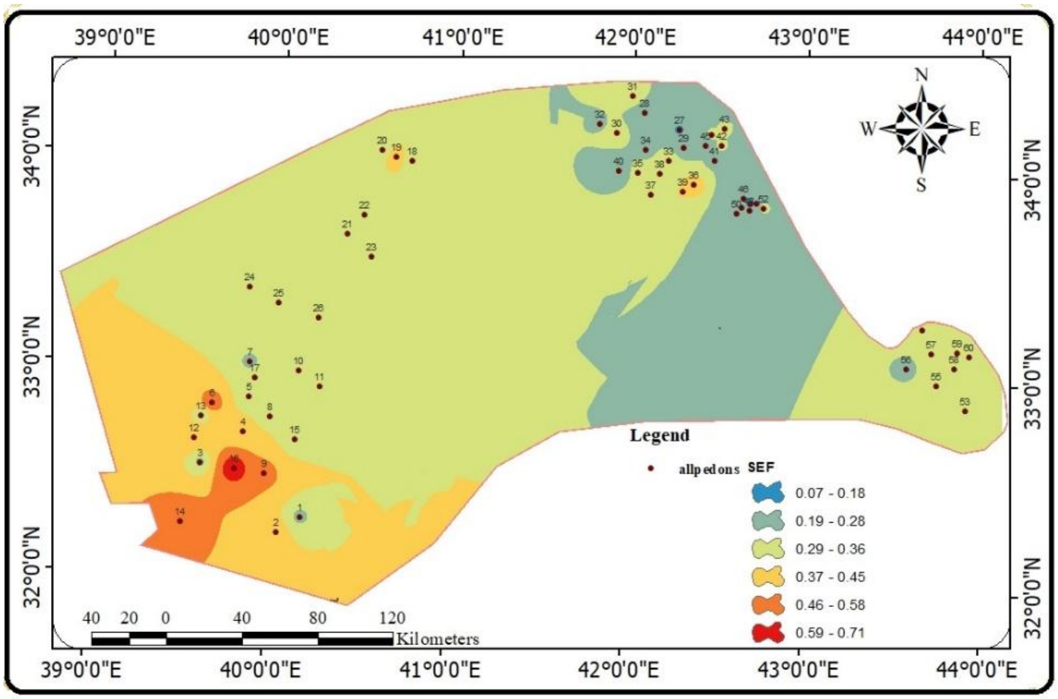

Figure (2) Geographical distribution map of the wind erosion factor in the study area 0-25 cm.

Soil Crust Factor (SCF):

The results are shown in Table (1) showed a variation in the values of the Soil Crust Factor, as it was distributed in a range of 0.08-1 and an average of 0.52. This variation may be attributed to the lack of vegetation cover, which causes a decrease in the values of organic matter and a difference in soil texture, as well as the impact of humans and animals. The values were distributed into 6categories and the results were generalized using the inverted IDW method, and the regions of the classes were extracted in Figure (3). The area of the highest and lowest categories were 9983.91 and 3410.18 km^2 with rates of 12.6 and 4.31, respectively, table (2).). Soil series 113CCW recorded the highest value for Bidoon16, while Bidoon18 recorded the lowest value which is within soil series 142SCW. It is noted that the highest value of the wind erosion factor spatially coincided with the highest value of soil crusting, which requires addressing the weakness in soil structure which causes presence of northwest windsand occurred of soil transfers. As can be seen from figure 3, the first and the basis for dust storms start from the area west and south-west of Rutbah towards the east and south-east regions, where the second erosion line is located .

Accordingly, this issue must be addressed by planting drought-tolerant shrubs, along with planting green belts that contribute to reducing wind speed and dust storms.

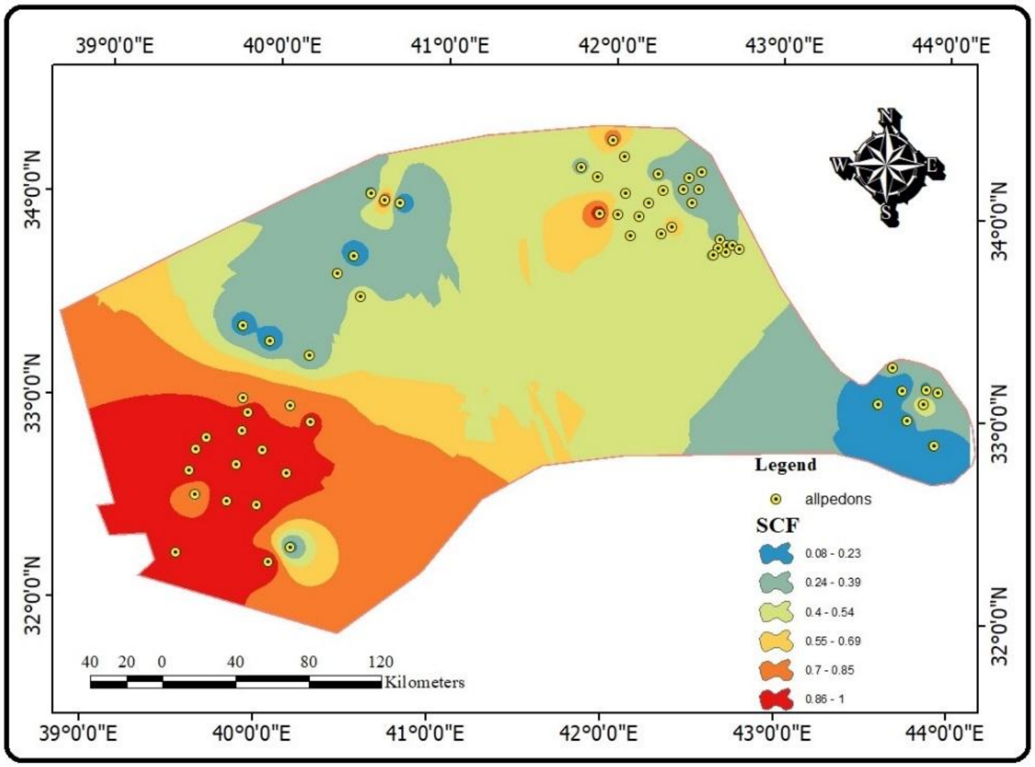

Figure (3) Geographical distribution map Soil crusting factor in the study area 0-25 cm

Soil Quality Index (SQI)

This evidence was extracted for the desert area by relying on some chemical and physical indicators of the surface layer of the selected Bidoon. Each indicator was given a weighted index according to Table (3), as it was given a weighted value for each category. The values ranged from (1) the least important to (2) the most important, as the value of the index is inversely proportional to the quality of the soil. According to the following equation:

$$SQI= (Texture * EC * OM)^{1/3}$$

The values of the soil quality index were distributed in a range of 1.06-1.75 and according to the division shown in Table (1), the desert area was divided into three categories according to the divisions of the soil quality index shown in Table (3). The results were generalized and mapped to the three categories, so the best types of soil quality were near the river, which are located in the Ka'ara depression and other depressions, as well as the desert streams, which are considered as promising areas for agricultural exploitation in Figure(4).

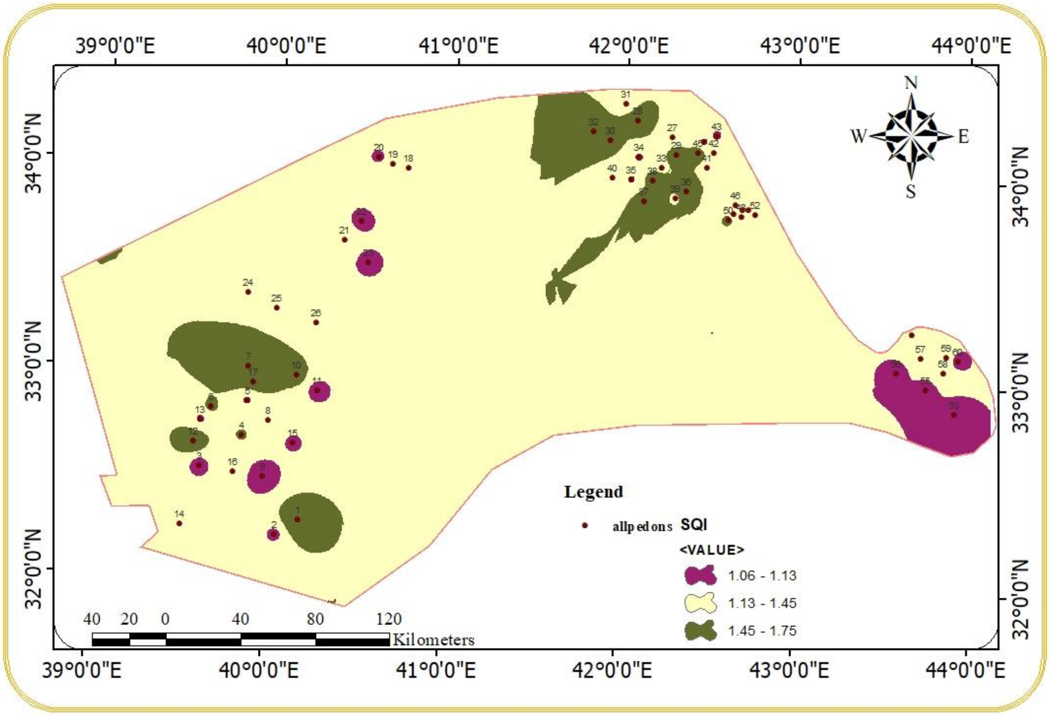

Figure (4) Map of the geographical distribution of soil quality in the study area. 0-25 cm.

Table (3) classes and the weighted index of the indicators used in estimating the soil quality index

Weighted Index	Range	description	class	Indexes	Indicator
1	L ,SCL ,SL ,LS , SiC	good	1	Texture	Soil Quality IndexSQI
1.2	SC, SiLSiCL	moderate	2		
1.6	Si ,C ,SiC	weak	3		
2	S	Very weak	4		
1	<%3	Very good	1	OM(%)	
1.2	2-3	good	2		
1.5	1-2	moderate	3		
1.7	0.5 -1	weak	4		
2	>0.5	Very weak	5		
1	>4	weak	1	Soil salinity	

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1.5	8 -4	moderate	2	ds m^{-1}	
1.8	16 -8	good	3		
2	<16	Very good	4		

Conclusions:

- Desert soils are subjected to a process of removal by wind as a result of weak soil structure and lack of vegetation cover.
- Overgrazing with unstudied land leads to soil disintegration

Recommendations:

- ✓ Work should be done to increase the density of vegetation by growing heat-tolerant plants.
- ✓ Use of conservation agriculture to reduce the risk of soil removal.

References

1. **Al- Agidi, W.K., 1981**. Proposed Soil classification at the series level for Iraqi Soils. II. Zonal Soils. Soil Sci. Dept. Univ. of Baghdad.
2. **Al-Juraysi, S. murshid. 2013**. Classification and evaluation of land degradation within IemenAl-Euphrates and Saqllawiy projected and their relationships with physiographic location using Geo-Information technology. PhD thesis, non-published, college of Agriculture, -University of Anbar.
3. **Buringh, P. 1960.** Soil and soil conditions of Iraq. Ministry of agriculture, Iraq.
4. **Dagliya, M., Satyam, N., Sharma, M., &Garg, A. 2022.** Experimental study on mitigating wind erosion of calcareous desert sand using spray method for microbially induced calcium carbonate precipitation. Journal of Rock Mechanics and Geotechnical Engineering.
5. **De angelis, M., N. I. Barkov& V. N. Petrov. 1987.** Aerosol concentration over the last climatic cycle (160 kyr) from an Antarctic ice core. Nature 325, 318-321.
6. **FAO. 2004**. "Rehabilitation of degraded lands in Sub-Saharan (3) Africa: Lessons from case studies". Paper presented at the Workshop on Strengthening Regional Action-Implementation of the IPF/IFF Proposals for Action in Africa, held at Accra, Ghana, from 16 to 18 February.
7. **Fryrear, D.W, J. D. Bilboro, A. Saleh, H. M. Schomberg, J. E Stout and T.M.Zobeck. 2000** (RWEG; improved wind erosion technology; J. Soil and Water Conservation. Vol – 55:183 – 189.
8. **Jasim, F. Muhammed, Saifulddin A. Salim&Husam N. Mukhlif. 2018.**Study of RATAGA basin valley (western of Iraq) Crusting and Erodibility by wind andwater. Pak. J. Biotechnol. Vol 15 (3) 843-848.