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Use of the (MEDALUS) model in assessing the environmental sensitivity of the desertification of the lands of the North Al-Jazira Irrigation Project in Nineveh / Iraq

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Abstract:

In view of the phenomenon of desertification and its environmental risks that began to appear in Iraq, this study was conducted for the area of the North Al-Jazira Irrigation Project, located in the west of Nineveh Governorate, as it is one of the strategic irrigation projects in the country, in which the problem of salinity has emerged in the recent period due to the irrational use of irrigation processes and the nature of the agricultural system in it. These phenomena are among the most important problems facing the agricultural sector in the country, as soil salinization and the lack of vegetation cover help the soil lose its fertility and the disappearance of vegetation cover, which results in low crop productivity and threatens the continuation of deterioration and desertification of land with increased water scarcity and low agricultural productivity in most countries in the regions Dry and semi-arid, which poses a threat to the future of agriculture in the country. This study aims to prepare and prepare a unified map showing the degrees of environmental sensitivity to desertification for this region and to develop possible solutions and treatments by studying a number of factors and indicators that help exacerbate the problem of desertification and land degradation. land use In the study of environmental sensitivity to desertification, and the satellite image of the study site for the year 2021 was obtained through the official website of the United States Geological Survey (USGS) United States Geological Survey Which was the type of sensor (ETM), and then the treatment and analysis of the factors and influences of the phenomenon of desertification and land degradation in the study area were carried out, and then the final map was prepared and prepared, which shows the degrees of desertification, and it was measured into areas of high, moderate and low sensitivity.

I. INTRODUCTION

The problem of desertification and land degradation is one of the most important and most serious problems facing agricultural workers, especially in arid and semi-arid areas, due to the nature of the prevailing climatic conditions, which are represented by high temperatures and evaporation in summer, as well as low rainfall rates. Ideal conditions for the expansion of this phenomenon, as this problem is

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exacerbated by the irrational use of natural resources and thus the occurrence of desertification or land degradation, which means the quantitative and qualitative decrease or decrease in the productive capacity of the land and thus leads to an increase and acceleration in the known major degradation processes , namely: removal of vegetation cover, salinity, waterlogging, water and wind erosion, increased toxicity ... and other processes that lead to reduced productivity. This definition is what was agreed upon at the Earth Summit held in the capital of Brazil (Riodoganero) during the month of June of 1992, according to What was stated in the Bulletin of the United Nations Environment Program (1999) UNEP. The study area was selected within the North Al-Jazira Irrigation Project because it is one of the irrigation projects The strategy in the country, in which the salinity problem began to appear in the recent period due to the irrational use of irrigation and the nature of the farming system in it with the absence of an efficient drainage system, as it was noted that there are different degrees of salinity in the project stages according to the old use and other soil conditions, as well as the availability of some Remote sensing data in the form of aerial photos or satellite data and information in the form of reports and brochures on the project helps and supports the process of using remote sensing techniques in the study of desertification and land degradation by assessing the environmental sensitivity to degradation and desertification.

Many models have been developed with different scales and different theories and indicators for estimating the rate of land degradation and evaluating the severity of desertification, and among these models is what is known as the (Mediterranean Desertification and land use) model, which stands for (MEDALUS), as many studies have confirmed that the (MEDALUS) model is characterized by some benefits. It differs from other models in that its elements that can be obtained from field and environmental survey reports on the one hand, and on the other hand, the indicators can be placed in the form of maps in the form of layers in the ArcGis program as well as other programs such as the ERDAS IMAGINE program as it is characterized by high speed and Accuracy in data processing.

II. OBJECTIVES OF THE STUDY

The research was conducted to achieve the following objectives:

1. The study aims to determine the degrees of environmental sensitivity to desertification of the lands of the North Al-Jazira Irrigation Project using the MEDALUS methodology, remote sensing techniques and geographic information systems (GIS).
2. The possibility of appropriateness of the MEDALUS model in its application - for the first time - in evaluating the lands of the North Al-Jazira Irrigation Project.
3. Assessing the degradation status of the project lands based on the standards described by the world Dregene and approved by the United Nations Environment Program (UNEP) and the Food and Agriculture Organization (FAO) in the work and mapping of desertification in the world.
4. Preparing an environmental sensitivity map for the desertification of the lands of the North Al-Jazira irrigation project.

III. STUDY AREA

Forty sites were selected within the North Gezira irrigation project in order to form a clear picture of the degrees of desertification and land degradation for these areas, which varied in their degrees of

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degradation. And pasture lands, in addition to the presence of areas of land that suffer from the problem of salinity and the formation of the salt crust on its surface, and thus not benefiting from it in the cultivation process. The selected areas included as shown in Table (1) and Figure (1), a map showing the study area:

Table (1) shows the coordinates of the sampling sites for the study areas, the nature of agricultural use and vegetation cover

No.	Region	**E**	**N**	agricultural use
1	dashboard	42° 27' 18.72" E	36° 41' 04.39" N	Wheat, barley and vegetable crops
2	Oweinat	42° 24' 18.98" E	36° 41' 18.37" N	wheat
3	Tell Wardan	42° 21' 35.7" E	36° 43' 16.04" N	wheat
4	Khan Jadal	42° 19' 02.12" E	36° 44' 57.61" N	wheat and barley
5	Rabia	42° 15' 30" E	36° 40' 34.04" N	vegetables
6	honoree	42° 6' 49.72" E	36° 48' 44.12" N	wheat and barley
7	Salhia	42° 03' 15.08" E	36° 45' 31.05" N	wheat and barley
8	Tal Al-Hawa	41° 58' 49.43" E	36° 36' 26.03" N	field crops
9	mummy	42° 02' 52.75" E	36° 37' 38.36" N	wheat and barley
10	sandy	41° 59' 10.09" E	36° 38' 42.05" N	Thistles and thorns and thorns of Sham
11	lover	42° 27' 37.24" E	36° 45' 34.66" N	wheat and barley
12	as a photo	42° 24' 08.67" E	36° 43' 55.49" N	barren
13	musha	42° 19' 30.12" E	36° 43' 22.7" N	wheat and barley
14	Crane Hill	42° 21' 01.97" E	36° 46' 17.76" N	wheat and barley
15	the booth	42° 15' 47.01" E	36° 43' 13.59" N	Wheat, barley, vegetable crops and some eucalyptus trees
16	Tell request	42° 14' 33.97" E	36° 41' 02.88" N	wheat and barley
17	Khirbet Talab	42° 12' 16.37" E	36° 44' 52.06" N	wheat and barley
18	big ruin	42° 14' 25.64" E	36° 38' 20.74" N	Wheat, barley and vegetables
19	Tell Almosha	42° 20' 43.98" E	36° 41' 29.11" N	vegetables
20	Abu Kila	42° 19' 36.18" E	36° 40' 10.9" N	barley
21	salt	42° 27' 09.62" E	36° 38' 48.5" N	vegetables
22	perch	42° 23' 15.94" E	36° 37' 10.31" N	wheat and barley
23	Tel Smir	42° 09' 40.28" E	36° 45' 05.74" N	barley
24	the softest	42° 01' 58.8" E	36° 42' 29.06" N	wheat and barley
25	awissa	42° 03' 32.02" E	36° 39' 45.94" N	Wheat, barley and fodder crops
26	Gluing	42° 07' 37.77" E	36° 40' 07.98" N	wheat and barley
27	triangular	42° 17' 53.78" E	36° 37' 58.09" N	wheat and barley
28	Tel Hasso Al-Ayesh	42° 06' 19.74" E	36° 43' 33.9" N	Wheat, barley and some shrubs
29	Bayader	42° 09' 22.22" E	36° 43' 20.2" N	Wheat, barley and vegetables
30	Tell about	42° 09' 14.44" E	36° 47' 46.45" N	wheat and barley
31	pure thiab	42° 15' 44.37" E	36° 44' 39.79" N	wheat and barley
32	Bazouna	41° 56' 51.58" E	36° 37' 18.16" N	wheat and barley
33	Tell Hassan	42° 04' 01.88" E	36° 42' 10.46" N	wheat and barley
34	spells	42° 06' 24.54" E	36° 37' 52.64" N	wheat and barley
35	Khirbet Saad	42° 01' 30.77" E	36° 35' 11.08" N	wheat and barley
36	Tell Abu Hujaira	42° 12' 38.16" E	36° 46' 01.35" N	Wheat, barley and vegetables
37	cherry	42° 12' 39.22" E	36° 42' 30.5" N	wheat and barley
38	Galbarat	42° 07' 58.23" E	36° 49' 42.03" N	Wheat, barley and fodder crops

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39	the slaves	42° 00' 30.41" E	36° 39' 01.78" N	barren lands
40	rmo	41° 56' 10.99" E	36° 38' 14.36" N	wheat and barley

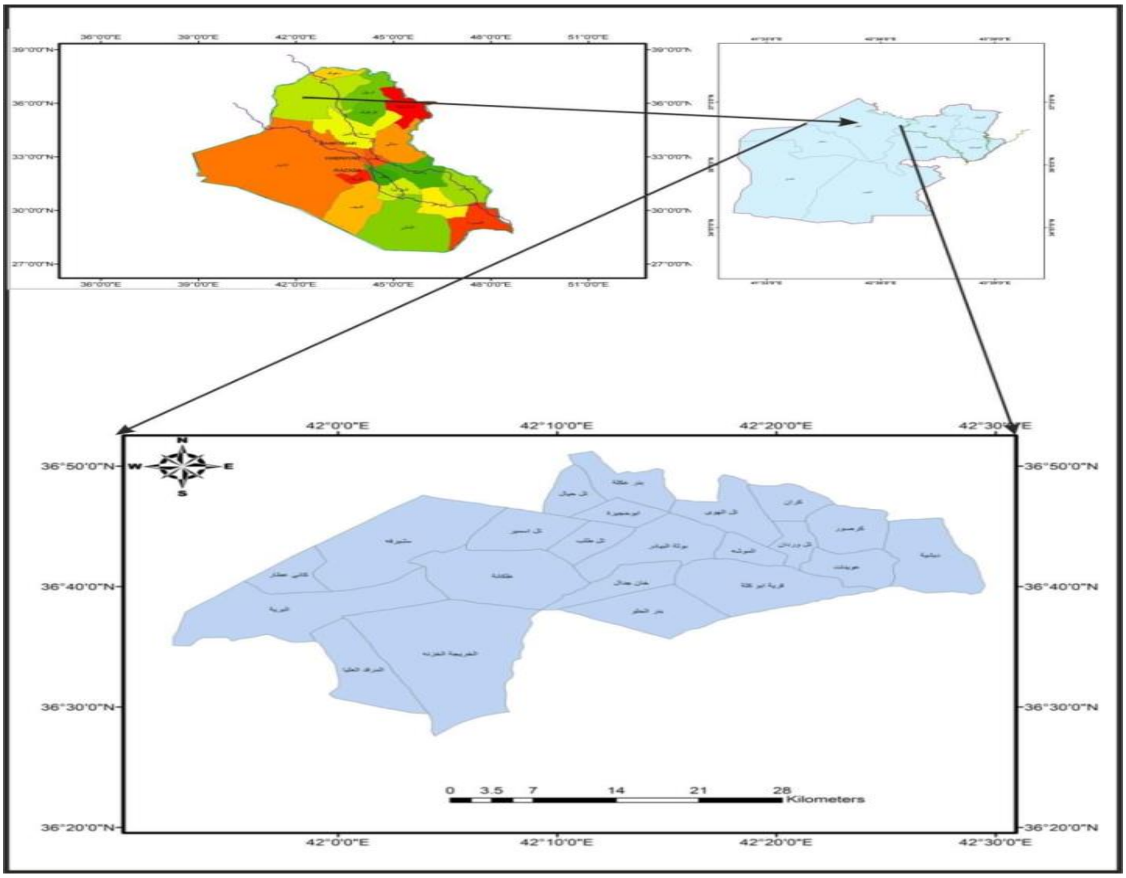

Figure 10. Map showing the study area

IV. MATERIALS AND WORKING METHODS

Environmental sensitivity to desertification

The environmental sensitivity of the desertification of the lands of the North Gezira irrigation project was studied based on previous reports of available soil surveys on the study sites and then compared with the data and information recorded from field tours and the results of physical and chemical laboratory analyzes obtained during the study stages for the year 2020 by the researcher, and in order to obtain the value The final guide to the Environmental Sensitivity to Desertification Guide has adopted a number of guides, represented by the SQI Soil Quality Index, the Vegetation Quality Index, and the Climate Quality Index.

SQI Soil Quality Index

The index of soil quality and its sensitivity to desertification was calculated based on a number of quantitative characteristics of the soils of the study sites and as in Table (2), where a description, standard and weight were given for each of the traits. And to reach the highest accuracy in evaluating the soil, as the adoption of a limited number of traits will change the degree of soil evaluation from low to medium and good and vice versa, and these traits were adopted based on the sources Vranesevic (2017), Lamqadem

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(2018), Ashraf (2020) and Kosmas (2006) and as in Table (2) which indicates the characteristics used in calculating soil quality.

Soil Quality Index (SQI) = (X1 x X2 …… Xn)1/8…………..7
Soil Quality Index = soil workability index
X1 , X2 …… Xn)) = the attributes involved in calculating the equation

Table (2) shows the physical, chemical and morphological properties of soil to calculate the soil quality index SQI

Guide	item	the description	Standard	Guide
soil texture	1	Good	sandy mix, sandy mix, sandy mix, sandy mix	1
	2	Moderate	sandy clay, clay clay, clay clay	1.2
	3	poor	silty clay, silty clay, silty clay	1.6
	4	so poor	sandy	2
% organic matter	1	very high	3>	1
	2	High	2-3	1.2
	3	medium	1-2	1.5
	4	low	0.5-1	1.7
	5	very low	0.5>	2
The degree of electrical conductivity (Kosmas,2014)	1	very low	2-0	1
	2	light	4-2.1	1.2
	3	moderate	8-4.1	1.5
	4	severe	16-8.1	1.8
	5	very severe	16<	2
Tilt Slope	1	Flat to very slightly inclined	6%>	1
	2	little inclined	18-6	1.2
	3	sloping	35-18	1.5
	4	steep	35%<	2
Calcium carbonate content	1	Very few	3%>	1
	2	few	10-3	1.2
	3	medium	10-25	1.5
	4	High	50-25	1.8
	5	very high	50%<	2
Gypsum content (Al-Zoubi, 2013)	1	poor	2>	1
	2	medium	10-2	1.5
	3	rich	10-25	1.8
	4	very rich	25<	2
stone case	1	Very stone	60%<	1
	2	Stone	60-20	1.5
	3	exposed to few	20>	2
soil surface condition	1	Wetland soils		1
	2	Land with moderate vegetation		1.17
	3	devoid of vegetation		1.34
	4	mountain lands		1.51
	5	saline lands		1.68

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	6	hill lands		1.85
	7	lowland		2
exchange condition	1	A quick	No spotting within the first 100 cm	1
	2	good	Spot depth starts from 90 cm	1.2
	3	Very weak	waterlogged lands	2
parent material	1	schist, suprabasal, conglomerate		1
	2	Limestone, sandy soil, alluvial soil		1.7
	3	clay soil		2

Calculation of the vegetation quality index:

According to the vegetation cover quality guide based on the role of vegetation in protecting the soil surface from erosion and its two types of wind and water and the drought factor.

Climate Quality Index - CQI

After finding the amount of annual precipitation and calculating the aridity index based on the Bagnouls - Gaussen method, and the rainfall, we go to Table (3) to determine the quality of the climate after applying the following equations:

Calculation of the guide huh

BGI = ………. 15

Ti: average monthly temperature (°C), pi: average monthly rainfall (mm), k: climate quality index constant = (rain index x aridity index) 1/2

Table (3): shows the indicators used in calculating the climate quality index

Indications	item	the description	Standard	weighted guide
rain amount	1	moist	650<	1
	2	Dry - semi wet	280-650	1.5
	3	dry	280>	2
BGI Aridity Guide	1	Very humid	50>	1
	2	Humid	75-50	1.1
	3	Humid - Dry	100-75	1.2
	4	Semi dry	125-100	1.4
	5	Dry	150-125	1.8
	6	Very dry	150<	2

ESA index

After finding indicators of soil, vegetation cover and climate, the environmental sensitivity index to desertification is calculated as in the following equation and table (4).

ESA index = (SQI * CQI * VQI) 1/3 ……………..16

ESA index = Environmental sensitivity to desertification

SQI = Soil Quality Index

CQI = Climate Quality Index

VQI = Vegetation Quality Index

Table (4): shows the environmental sensitivity index to desertification in arid and semi-arid areas

No.	type of product	under category	guide weight
1	(N) Non effect		1.17>
2	(P) Potential		1.17-1.22

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3	(F) Frigel	F1	1.22-1.26
		F2	1.26-1.32
		F3	1.32-1.37
4	(C) Critical	C1	1.37-1.41
		C2	1.41-1.53
		C3	>1.53

Soil Quality Index

The soil quality index is one of the indicators included in the equation of the MEDALUS model, which describes the overlapping effect of many physical and chemical properties, including the texture, the content of the organic matter of the soil and the concentration of salts in it, as well as the material of the origin of which the soil is formed, the degree of inclination and its drainage condition, and through the results of the study, a quality guide was identified. The soil of the study areas, which ranged between moderate quality and low quality, and there was no high quality, and the reason for this is due to many overlapping factors that form the outcome of the soil quality index, as most of the study areas suffer from a decrease in the content of organic matter and a high concentration of salts and content of calcium carbonate and the condition of Drainage and all these physical, chemical and morphological characteristics have played a role in influencing these lands over the years, and the value of the evidence ranged in sites (2, 3, 4, 8, 9, 12, 27, 28, 29, 30, 31, 32, 33, 37, 40) which are represented by the sites (Uwainat, Tell Wardan, Khan Jadal, Tel Al-Hawa, Al-Mumi, Karsur, Triangle, Tel Hasso Al-Ayesh, Al-Bayader, Tel Hailah, Khalis Diab, Bazouna, Tel Hassan, Khirbet Saad, Al-Jiri, Al-Rumo) It was d At night, the soil quality in these sites is moderate from (1.36) in the Triangle site to (1.45) in the site of Tel Hasso Al-Ayesh. The soil susceptibility index is described as moderate in a range ranging from (1.13-1.45) and these values were in agreement with the results of physical and chemical analyzes in these sites. As for the remaining 24 sites, the value of the soil quality index was low, as the value of the index was more than (1.45), and the highest values were (1.566, 1.580, 1.582, 1.591) for the sites represented by (Alkanah, Al-Asheq, Khirbat Kubbar, Sandy) on the respectively, and Figure (36, 37) shows the soil quality index for the study areas.

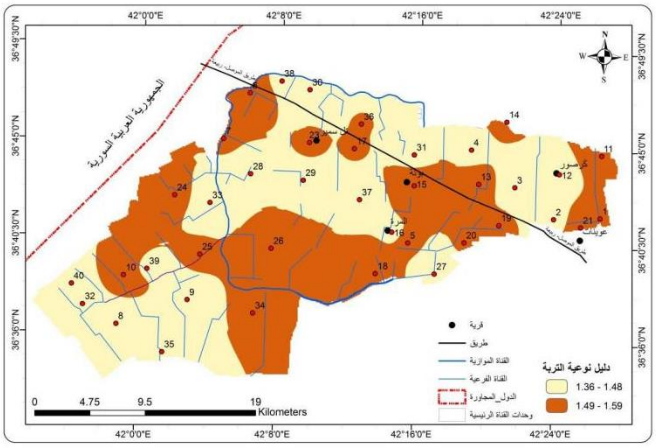

Figure 36. Shows the soil quality index (SQI) map of the study sites

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Vegetation quality guide VQI

One of the most important indicators relied upon in the process of evaluating and studying the phenomenon of desertification is the percentage or density of vegetation cover in the study area, because it reflects the effect of a group of factors related to chemical and physical soil fertility, and sometimes it may indicate the quality of management used in these lands from plowing and irrigation methods. And fertilization in accordance with the needs of the land. Therefore, the vegetation cover quality index can be considered as an indicator of the processes of soil formation and development, due to the high content of organic matter and humus caused by vegetation cover and the level of fertile elements, as well as improving the physical properties of the soil, and from this it is clear that vegetation is one of the ways by which Treating land degradation and desertification, especially in arid and semi-arid areas, as plants help protect the earth's surface from wind erosion factors and high temperatures, which causes a reduction in the oxidation processes of organic matter.

In this study, the vegetation cover quality index (VQI) was found based on the calculation of the soil protection index from erosion, which was obtained through soil susceptibility to water erosion, as well as soil susceptibility to air erosion as well as soil erosion factor, and then the vegetation coverage ratio VgC% and drought index were found. Thus, it was possible to calculate the values of evidence for the quality of vegetation evidence.

The results indicated a clear discrepancy in the values of the vegetation cover index, and the quality of the vegetation cover ranged between the second and third classes and for all study sites. , 9, 12, 27, 29, 30, 31, 32, 33, 35, 37, 40) represented by (Uwainat, Tell Wardan, Khan Jadal, Tel al-Hawa, Mawmi, Karsur, Triangle, Bayader, Tal Hailah, Khalis Thiab , Bazouna, Tel Hassan, Khirbet Saad, Al-Jiri, Al Ramo), which took the moderate variety. The rest of the (25) sites were of the third category, which is referred to as the low-quality description, as the values of the vegetation cover quality index ranged between 1.46 - 1.98 These results were in agreement with the soil quality index, and figures (48, 49) show the evidence and weight of the quality of vegetation cover in the study sites.

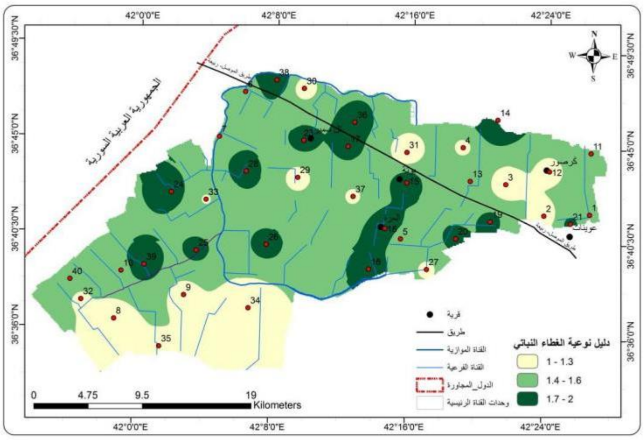

Figure 48. Vegetation quality index map in the study areas

Environmental Sensitivity Guide to Desertification

The results of the study indicated that there is a discrepancy in the values of the environmental sensitivity index to desertification, which was obtained through the equation of the Medulas model, which includes the soil quality index SQI, the climate quality index CQI and the vegetation quality index VQI, as

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the results indicated that all study areas between the two types F and C and under the category F2, F3, C1, C2, and C3, respectively, as the sites (3, 8, 31, 34) represented by (Tel Wardan, Tal Al-Hawa, Khalis Thiyab, Al-Aza'em) were of the F category and under the F2 category. While the locations were (2, 4, 9, 12, 27, 29, 30, 32, 33, 37) represented by (Uwainat, Khan Jadal, Mumie, Karsour, Triangle, Bayader, Tal Hayal, Bazouna, Tal Hassan, Al-Jiri).) in class F and under class F3.

As for the sites that took class C and below class C1, they were in site 35, represented by (Khirbet Saad), while most of the study areas were located in class C and under class C2, which numbered twenty-three sites represented by sites (1, 5, 6, 7, 10, 11). , 13, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 36, 38, 39, 40), which included the sites (Dabashieh, Rabi'a, Mushairifa, Salhiya, Ramliah, Al-Asheq). , Al-Musha, Tal Taleb, Khirbet Talb, Khirbat Kubbar, Tal Al-Musha, Abu Kila, Al-Maleh, Khurmar, Tal Samir, Al-Abtakh, Owaisa, Alkanah, Tal Hasso Al-Ayesh, Tal Abu Hujaira, Gilbarat, Al-Obaid, Al-Ramu) while the sites were under the category of C3 is only two sites, 14 and 15, represented by (Tel Karan and Al-Bothah), and the two figures (50, 51) show the evidence and weight of the environmental sensitivity to desertification of the lands in the study area.

Therefore, the environmental sensitivity of desertification in this region is high, and this may be due to the dry and semi-arid climatic environmental conditions, which play a clear role in causing this negative impact on the soil and on the plant, and then influence on the factors of soil development, and not only this, but also includes the negative impact on soil characteristics. Physical and chemical (such as salinity, gypsum and oxidation of organic matter and their absence in the soil), as well as the role of climate factors in causing erosion processes, whether wind or water, and the consequent removal and transfer of the surface layer of the soil, which is rich in nutrients suitable for plant growth and soil fertility, and all of this constitutes a danger And a clear threat to the deterioration of the vegetation cover and the negative impact on the density of the vegetation cover, which will cause the sand movement and its accumulation to become active, and thus it will become a very fragile and sensitive environment for the various desertification processes.

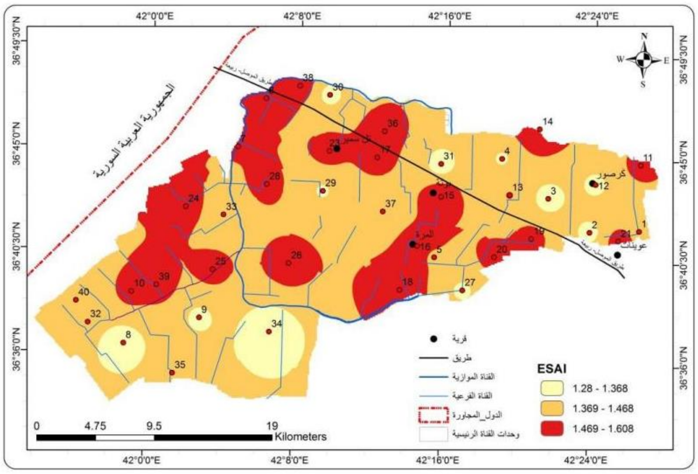

Figure 50. A map showing the evidence of environmental sensitivity to desertification in the study area according to the MEDALUS model

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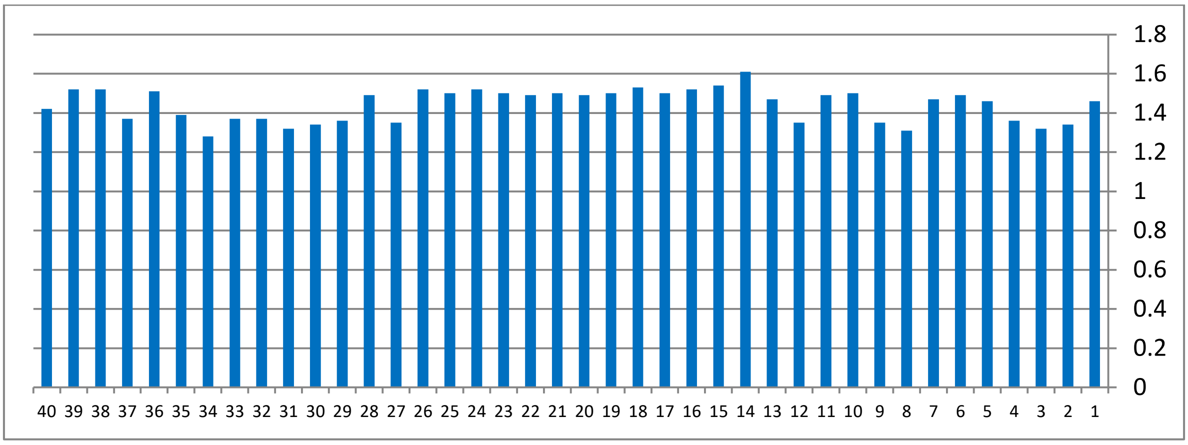

Figure 51. Evidence and weight of environmental sensitivity to desertification in the study area according to the MEDALUS model

V. CONCLUSIONS

1. The results of the study, according to the criteria set by the scientist Dregne, (1983), found that there is a discrepancy and aggravation in the case of soil deterioration and the density of vegetation cover among the study sites, as well as the spread of the phenomenon of sand dunes. The degrees of deterioration ranged from light and moderate to severe and very severe.
2. The results of the study indicated that the Soil Quality Index (SQI) varied between moderate quality and low quality, and there was no high quality, as the value of the soil quality index reached from (1.36 - 1.45) for Triangle and Tel Hasso Al-Ayesh sites, respectively.
3. It was noted through the results that there is a discrepancy in the value of the Vegetation Quality Index (VQI) and the values were between moderate and low quality, as the values of this guide ranged between (1.46 - 1.98).
4. The results of the study indicated that there is a discrepancy in the values of the environmental sensitivity index to desertification for the lands of the North Al-Jazira Irrigation Project, as the sites ranged between classes F and C and below classes F2, F3, and C2, C3, respectively.
5. It was found through the study that there is agreement between the results of the (MEDALUS) model and the results obtained through the evaluation of Dregne. It also came in agreement with the results of the chemical analyzes, which indicated a low content of organic matter and a high calcium carbonate salts and other related characteristics.
6. The study found the possibility of benefiting from the use of the (MEDALUS) model in detecting the state of desertification and determining its degrees in the study area, through which a map of environmental sensitivity to desertification in the study area was prepared.

VI. RESOURCES

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