EFFECT OF LAND DEGRADATION DEGREE ON THE LAND COVER TYPE USING GIS TECHNOLOGY IN THE WEST OF BAGHDAD /IRAQ

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Abstract

In this study is the phenomenon of desertification risk assessment in the Abu Ghraib area west of Baghdad / Iraq, which has an area of about (384.168 km 2), that the annual mean temperature is more than (22 C °). Rainfall was low, ranging from the (200 mm) per year for Iraq and (2.82) mm per year of the study area * temperature is high and evaporation is also high (mm 7.73) per year *, so the climate in general of the dry type and the system of soil moisture is the kind of Aridic (Torric). To this study was to identify three indicators to monitor for the period from 2001 - 2005 using GIS and these indicators are (soil, groundwater and the nature of land use), using ArcGIS 9.1. The results showed that the risk of desertification was part of the level observed in three out of five and the other areas are also within the level significantly, but to a lesser extent, it is possible to enter the top level if no aids by the authorities responsible for combating desertification and land degradation.

*This data is the annual rate for the period (2001 to 2005).

Key word: land Degredation, land cover, GIS technologies.

تأثير درجة تدهور الأراضي على نوع الغطاء الأرضي باستخدام تكنولوجيا نظام المعلومات الجغرافية في منطقة غربي بغداد.العراق

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الخلاصة

في هذا البحث تم تقييم مخاطر ظاهرة التصحر في منطقة أبي غريب الواقعة غرب محافظة بغداد / العراق، والتي تبلغ مساحتها حوالي (384.168 كم٢) ، أن المعدل السنوي لدرجات الحرارة أكثر من (٢٢ م°). أما مـن ناحية الرطوبة فأنّ الأمطار قليلة إذ تصل إلى (٢٠٠ ملم) سنوياً للعراق و(٢.٨٢) ملم سنوياً لمنطقة الدراسة * ودرجة الحرارة مرتفعة والتبخر مرتفع أيضا (ملم ٧.٧٣) سنوياً* لذا فان المناخ على نحو عام من النوع الجاف وان نظام رطوبة التربة هو من نوع Aridic(Torric). وتحقيقاً لهذه الدراسة تم تحديد ثلاث مؤشرات لمراقبتهـا للفترة من ٢٠٠١ - ٢٠٠٥ باستخدام نظام المعلومات الجغرافية وهذه المؤشرات هي (التربة والميـاه الجوفيـة وطبيعة استخدام الأراضي)، وكان هذه باستخدام برنامج ArcGIS 9.1. أظهرت النتائج إن خطر التصحر كـان ضمن المستوى الملحوظ في ثلاث مناطق من أصل خمسة وأما المناطق الأخرى فهي أيضا ضـمن المسـتوى

ملحوظ ولكن بدرجة اقل ، حيث من المحتمل أن تدخل للمستوى الأعلى إذا ما أسعفت هذه مـن قبـل الجهـات المسئولة لمحاربة ظاهرة التصحر وتدهور الاراضي.

*هذه البيانات هي المعدل السنوي للفترة من (٢٠٠١ إلى ٢٠٠٥).

الكلمات المفتاحية : تدهور الأراضي ، الغطاء الأرضي، تقنيات نظم المعلومات الجغرافية.

Introduction

Desertification refers to land degradation in dry lands. Although over 100 definitions of desertification have been developed emphasizing different processes contributing to desertification, the United Nations convention to combat desertification provides the most current, authoritative definition: 'land degradation in arid, semi-arid and dry sub-humid areas resulting form various factors including climatic variations and human activities' [1]. Dry lands include those land areas of the earth receiving under 600 mm/year of precipitation and for which the ratio of average annual precipitation of potential evapo-transpiration is between 0.05 and 0.65 [2]. Desertification is often produced by a multiplicity of interacting environmental and socio-economic causes. Political instability, poverty, poor irrigation methods, deforestation, and overgrazing can all undermine the productive capability of land. The degradation process can be attended by reduced vegetation cover and soil organic matter, soil compaction, decreased infiltration, increased runoff, and increased wind and water erosion.

Stalinization, alkalinization, leaching, and acidification can contribute to soil degradation by reducing vegetation cover and triggering these physical mechanisms. Much of the concern over desertification of dry lands stems from the resulting decline in the biological productivity of the land, ultimately reducing the land capability for crop production, livestock grazing, and thus supporting human populations. Dry land environments extend over one-third the earth's surface, encompassing more than (1) billion residents who must make their livelihoods here [3]**.** Roughly, 70% of these areas have experienced some degree of degradation [4], resulting in a wide range of environmental, cultural, economic and political ramifications both locally and globally. However, good information on the extent and severity of desertification is lacking, and many estimates are largely based on opinion. Desertification is to a significant extent unmeasured or poorly documented, with the result that it does not receive the attention it might in national planning efforts and as a spending priority [5]. Furthermore, sufficient detail on local environmental conditions is lacking, undermining land management efforts at specific sites. Geospatial technologies,
including global positioning systems (GPS), satellite imagery, aerial photography, and geographic information systems (GIS) hold great promise for improving the quality and quantity of information on degradation trends over large areas as well as provide for more effective management of that information. Furthermore, it is believed that dry land degradation can be slowed and reversed if areas undergoing desertification can be identified and properly managed [6].

Furthermore, the GIS data can be transmitted from one use to another using various digital media, including the internet. The resultant growth of digital databases and information exchanges should enhance research of underlying causes and means of addressing desertification. For example, Desert Watch of the European Space Agency manipulates combined in situ data and satellite information with various processing tools, models, and geographic information systems to produce a variety of national and regional risk maps, severity /recovery maps, and pressure indicators that meet the United Nations Convention of Desertification reporting requirements [7]**.** The vast spatial extent of dry lands and our inability to effectively measure land degradation in these areas has traditionally limited our ability to understand, address and prevent desertification. Using recent advances in geospatial technologies, including remote sensing, aerial photography, GPS and GIS, remotely sensed environmental indicators of desertification can be merged with in situ data to monitor and evaluate physical and socioeconomic operators over large areas. Current developments in satellite technology, computer speed and capacity, and resolution of imagery hold exciting prospects for the development of informational products that allow both effective monitoring and protection of the dry lands that support a significant portion of the world's population.

Land cover refers to the observed biophysical cover presented at the land surface. Example land cover classes include agricultural land, forested areas, woodlands, grasslands, bare soil, water bodies, transportation infrastructure, and various-sized settlements. Land cover mapping has been a particularly valuable and cost effective application of remote sensing. It can be performed from all optical satellite data, but high resolution data, particularly from Landsat Thematic Mapper, are particularly cost effective [8]. Land degradation processes involve two interlocking, complex systems: the natural ecosystem and the human social system [9]. Natural forces, through periodic stresses of extreme and persistent climatic events, and human use and abuse of sensitive and vulnerable dry land ecosystems, often act in unison, creating feed back processes. Interactions between the two systems determine the severity of the degradation process. Inclusion of climate, vegetation, and land use into desertification assessment is reviewed by Gad [**10**]. The Universal Soil Loss Equation (USLE) was developed in the mid-1960s for understanding soil erosion for agricultural applications. In 1985, it was updated and renamed the Revised Universal Soil Loss Equation (RUSLE) to incorporate the large amount of information that had accumulated since the original equation was developed and to address land use applications besides agriculture. The RUSLE is derived from the theory of soil erosion and from more than 10 000 plot years of data from natural rainfall plots and numerous rainfall simulations. The factors used to describe erosion and transport in most models are land use, land cover, slope, precipitation amount and intensity, runoff and peak runoff rates, soil cohesion, and surface roughness. The problem for development of models based on these factors is that many of these factors are often difficult to assess, far from constant in space and time, and interact with each other. Drawbacks of the above erosion models are the fixed data requirements, and the fact that models are developed for a certain region, scale, and often specific process. Also the models only provide an average quantitative value of the erosion phenomena. Although such outputs are valuable and helpful for the prioritization of conservation projects, they cannot provide detailed information or map erosion features. Further, models of soil erosion have been shown by some researchers to be in disagreement with current experimental evidence. [11]

Purpose:

The purpose of this paper is to detail the use of geospatial technologies in enhancing monitoring and management efforts for land areas subject to desertification.

Methodology:

The study area located in the middle of Iraq/ Baghdad Governments/ west of Baghdad) which is located between longitude 43˚50 and 33˚25 northward, and latitude 44˚12 and 33˚8 eastwards with an area of 648510.42 Km^2, figure (1). The study area is described by being an agricultural area, which includes irrigation channels and drains besides bare soil, which is influenced by salts (salt affected soils).

The MEDALUS [12]. methodology was modified and adopted, and the risk of desertification was evaluated on a regional level by defined the ESA (Environmental Sensitive Area) Index. ESAs method takes into consideration three broad systems of indicators:

GWI: Ground Water Indicators (Water Table, Cl, Ec, Sar)

LUI: Land use indicator

SI: Soil quality indicators (Ec, Sar, Organic Mater, Texture).

Each indicator was weighted in relation to its influences on desertification process. Each of indicators is assigned a score ranging from 100 (best) to 200 (worst). Value zero is assigned to the areas where the measure is not appropriate and /or those which are not classified (e.g. water bodies, urban areas, etc.). The function representing the variation of the indicators (scores) is liner ranging between the extreme values (100 - 200). The tables (1 ,2 and 3) show the classification of each layer.

The integration was done using GIS technology and with help of **ArcGIS 9.1** Software, the various information layers for each index were collected, prepared in a suitable format then overlaid in order to calculate the index as the geometric mean of the parameters related to each single index according to the following equation:

Index _ X = [(Layer _ 1). (Layer _ 2)…. (Layer _ n)] $^{1}/n$

Where n is the number of indicators for each index. And the geometric mean of the three Index gives the ESA index:

ESA = (GWI * LUI * SI) $^{1/3}$

Values of three indexes are subdivided into three classes of equal range:

1- High: 100-133

2- Medium: 134-166

3- Low: 167-200…... [13].

And ESA index was classified by four main classes of land degradation as:

High (ESA from 175 to 200),

Medium (ESA from 150-174),

Low (ESA from 125-149) and

Absent (ESA from 100 to 124).

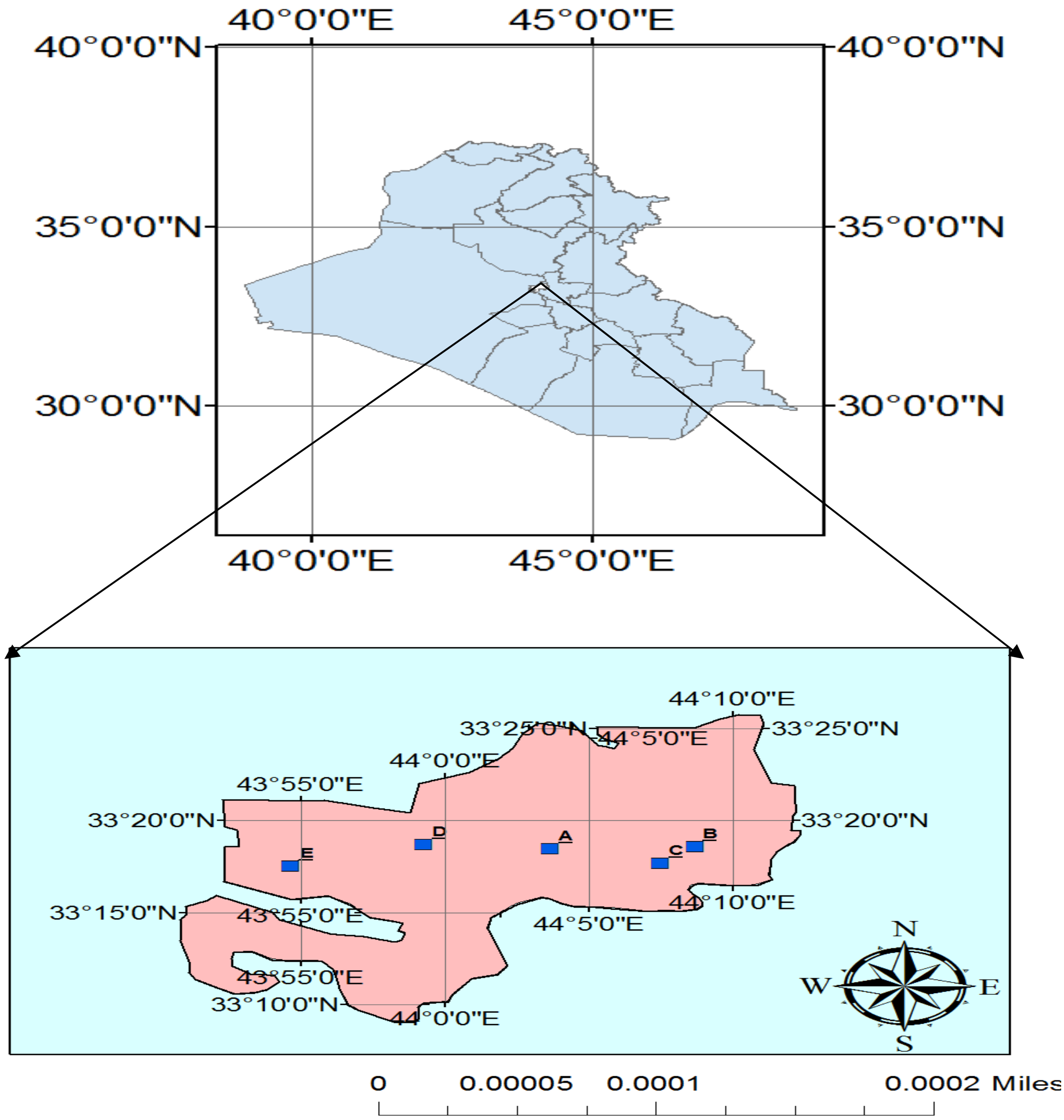

Figure 1: The map of study area.

Table 1: Groundwater layers, classification and relative scores [13].

Layer	Classes	Scores
Color (CL) (mg/lit)	< 250	100
	250-500	125
	500-1500	150
	1500-3000	175
	> 3000	200
Electrical conductivity (EC) (μmho/cm)	< 250	100
	250-750	125
	750-2250	150
	2250-5000	175
	>5000	200
Water table (cm)	>315	100
	285-315	150
	<285	200
SAR	,10	100
	10-18	133
	18-26	166
	>26	200

Table 2: Land use and relative Scores [13].

Land use classes	Score
Agricultural lands	100
Range lands	133
Range lands (poor and degrade)	166
Barrennless	200

Table 3: Soil layers and relative Scores [13].

Layer	Classes	Scores
Soil EC (mmho/cm)	<4	100
	4-8	120
	8-16	140
	16-32	160
	32-64	180
	>64	200
Soil SAR	<8	100
	8-13	125
	13-30	150
	30-70	175
	>70	200
Soil Texture	Course	100
	Medium	125
	Medium – Fine	150
	Fine	175
	Very fine	200
Soil Organic Matter	>3	100
	2-3	125
	1-2	150
	0.5-1	175
	<0.5	200

After doing reconnaissance several to visits the study area to identify the nature of the variations ground on the topography, flora and natural phenomena, the surface of the soil and the types of land uses prevailing in the study area, Sampling points were selected randomly for the purpose of working on this research, Collected samples of soil at depth (0-30 cm) and taken to the laboratory. The work of the extract of the soil, which was held by analysis, required by the way the world Walkely and Black mentioned.

In [14] & [15] Compared to results obtained with the values (standards) developed by the [9], these values were introduced in the equation above in order to extrapolate their knowledge and by desertification. The Tables (4, 5 and 6) show the values of the criteria derived from the results of analysis of samples of soil and water.

Table 4: Groundwater layers, classification and relative scores.

Local of study area	X longitude	Y latitude	scores			
			Ec	SAR	Cl	Water depth
A	44˚ 023833	33˚ 29444	150	100	100	200
B	44˚ 16611	33˚ 31777	150	100	100	200
C	43˚ 95472	33˚ 31333	175	100	125	200
D	44˚ 0980	33˚ 31583	175	100	100	200
E	44˚ 12944	33˚ 30666	175	100	100	200

Table 5: Soil layers and relative Scores.

Local of study area	X longitude	Y latitude	score			
			Ec	SAR	O.M	Soil structure
A	44˚ 023833	33˚ 29444	100	100	150	150
B	44˚ 16611	33˚ 31777	100	100	150	150
C	43˚ 95472	33˚ 31333	120	100	150	150
D	44˚ 0980	33˚ 31583	100	100	150	175
E	44˚ 12944	33˚ 30666	100	100	150	150

Table 6: Land use and relative Scores.

Land use classes	Score	Local of study area				
		A	B	C	D	E
Agricultural lands	**100**	**100**	**0**	**0**	**100**	**100**
Range lands	**133**	**0**	**133**	**133**	**0**	**0**
Range lands (poor and degrade)	**166**	**0**	**0**	**0**	**0**	**0**
Barren	**200**	**0**	**0**	**0**	**0**	**0**

Results and Discussion:

The results have been showed in figures (2 , 4 and 5) show the ESA map.

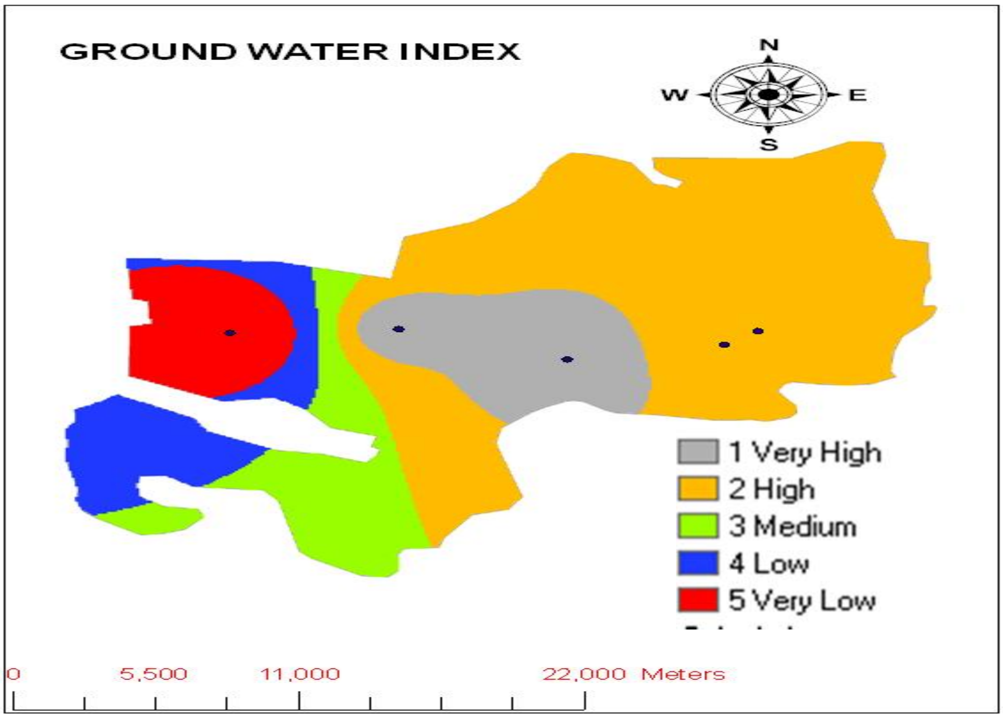

Figure 2: Map of Ground water Index.

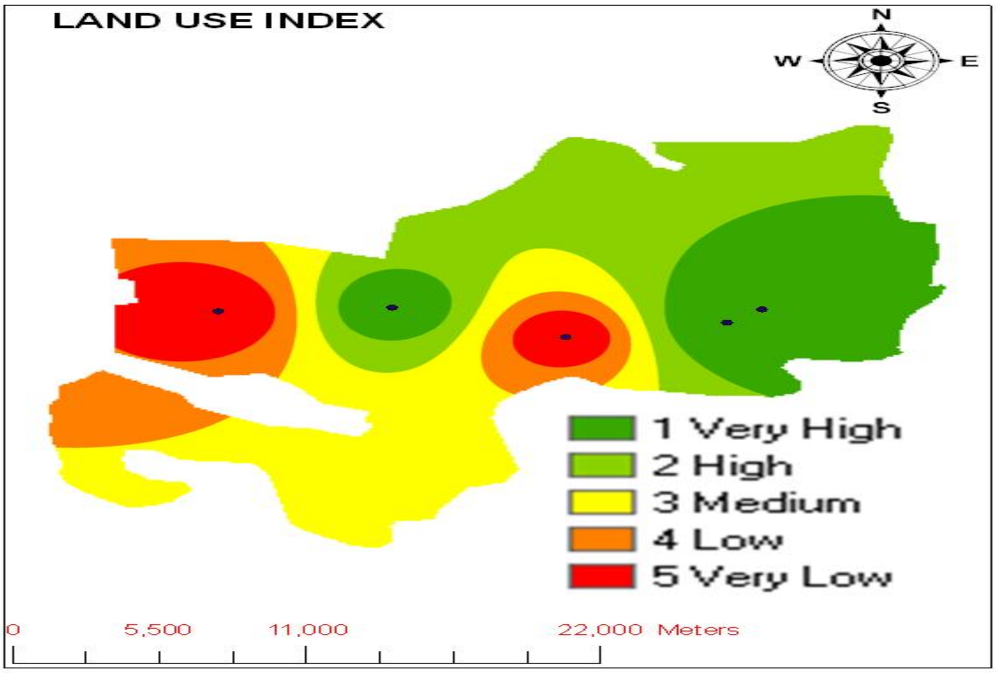

Figure 3: Map of Land Use Index.

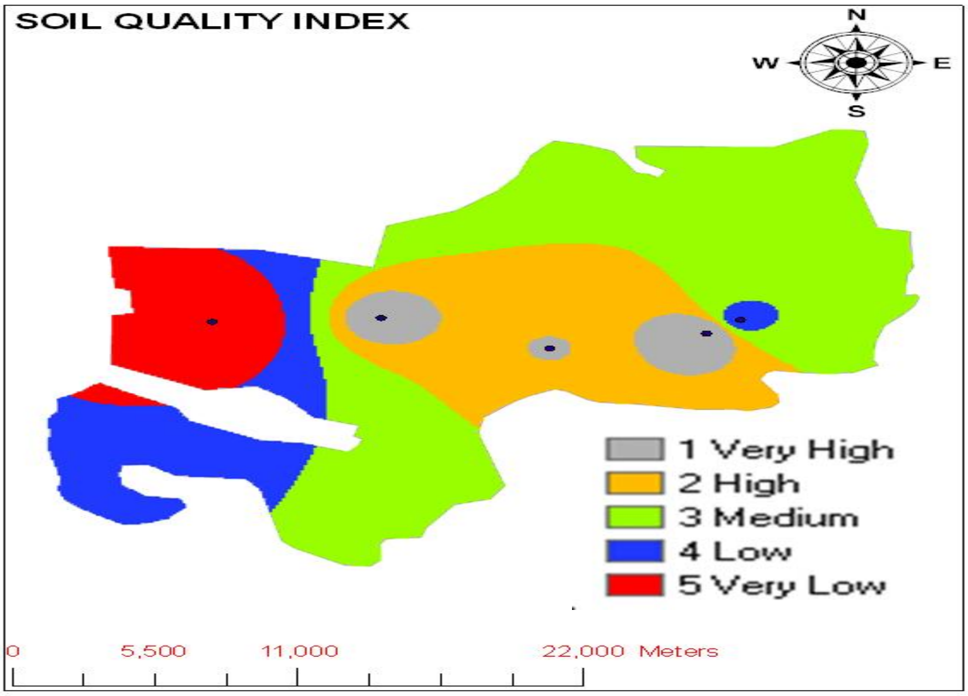

Figure 4 Map of Soil Quality Index.

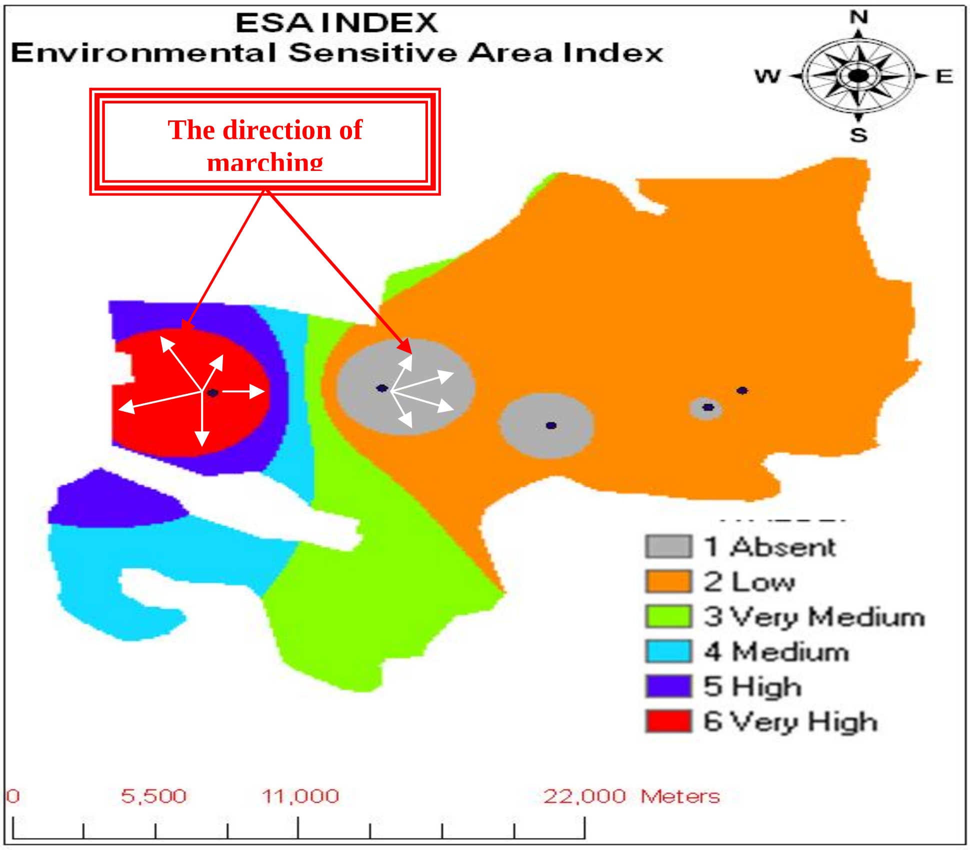

Figure 5:Map of Environmental Sensitive Area Index.

The results of the map guide environmental sensitivity of land and in general the absence of any risk for desertification in the study area, as compared to the standard values set by the Mediterranean Desertification and Land Use: European, 1999 with the values resulting from equations guide environmental sensitivity of land, soil and water. However, according to the nature of land use for agriculture and water availability has been found some differences in these values. Where the given regions (A, D and E) values comparable (114.7 and 117.7 and 116.2), respectively, after comparing the values specific standard found to be within the absent level (not affected) the phenomenon of desertification, at the same time, we find that the areas (B and C) with values (120.9 and 122.7), respectively, also fall within the absent level, but tend to move to the next level (lowest level), is an indication of the transformation of those areas to areas affected by desertification. So shall the department responsible for agricultural affairs and control of desertification to mobilize its full potential to advance the state of this region through the cultivation of the Green Belt and provide systems of water channels to support farmers in agricultural operations. As well as to guiding farmers to use organic material (Animal waste) for the purpose of improving the soil physical characteristics (Stability of soil aggregates). It also describes the map index (ESA) to the regions (A, B, C, and D) are all located within the low range (Low) to the index (ESA), and within this range also, the areas (A, C and D) located within the range observed (Absent), but more may tend to merge with low-scale (ranging towards the worst case), this important indicator shows the status of these areas and will accrue to it if not saved by agencies responsible for protecting the environment. The regions (E) are located within the range of danger. In general, the relationship between the index (ESA) and the percentage size of the area is as follows:

1-percentage of land that fall within the range is remarkable (6.22%) and includes the areas (A, C and D).

2-percentage of land that fall within the range is low (58.71%) and include the region (B).

3-percentage of land that fall within the middle range is very (13.9%) and (8.8%) and (5.9%), respectively, are confined to the region (D and E).

4-percentage of land that fall within the range of very high intensity (ESA) is (6.35%) and includes the region (E).

Conclusions:

Systems which allow us to identify and understand the factors that combine and accelerate land degradation need to be developed in order to adequately manage the land and its resources. The system, outlined here, can be used to isolate current degradation phenomena. To do this, cross-analysis techniques can be applied to the data held in information layers. The information in these layers comes from a variety of sources - some based on pre-existing themes, some based on combinations of these themes, and some created ex-novo from other analyses. It must be emphasized that the main reason for this Environmental Sensitivity Evaluation Model is to define a reference framework to be used in analyzing various situations under the following operational constraints: the system must be reasonably simple to establish, robust in operation, and widely applicable; the selection of the information layers is made, not only on the basis of their actual information content (i.e. their relationship with the phenomena under study), but also as a function of our ability to obtain and update the data with ease and economy; the system must be adaptable and accommodate the development and refinement of the existing information content and the addition of new information.

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