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Evaluating Environmental Sensitivity to Desertification in El-Fayoum Depression, Egypt

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THIS STUDY aims to use spatial analyst tool in a Geographic Information System (GIS) to assess the environmental sensitivity for desertification in El- Fayoum Depression, Egypt. The thematic layers of soils, vegetation and climate quality indices are the main required data for estimating the Environmental Sensitivity to desertification. These layers were established in geographic information system depend upon land surveying and laboratory analyses data, Landsat ETM image, Digital Elevation Model (DEM), geological map and climatic data. Spatial analyst tool in Arc-GIS 9.3 software is used for matching the thematic layers and assessing the desertification index, accordingly the map of environmentally sensitive areas of El- Fayoum Depression is produced. The obtained data reveals that the high sensitive areas for desertification in the study area are found in the southern parts of Qarun Lake, it represents 18.31 % of the depression area. The areas of sensitive for desertification exhibit an area of 54.09 % of the total area. The areas of moderate sensitive for desertification exhibit an area of 27.6 % of the total area. The integration of different factors contributing to desertification sensitivity may lead to plan a successful combating. The use of remote sensing data and GIS proved to be useful in visualizing the sensitivity situation of different desertification parameters.

Keywords: Desertification sensitivity, Land degradation, Geomorphology, El- Fayoum .

Desertification is an advanced stage of land degradation where the soil has lost part of its capability to support human communities and ecosystems. Desertification is the consequence of a set of important processes that are active in arid and semi-arid environments, where water is the main limiting factor of land use in ecosystems, and several factors may cause it, such as climate change and human activities (Parvari *et al.,* 2011). Desertification of an area will proceed if certain land components are brought beyond specific threshold, in which further change produces irreversible change (Tucker *et al.,* 1991 and Nicholson *et al.,* 1998). The environmental sensitivity of an area to desertification is a complex concept to rationalize since, depending on the context, it can be caused by many different factors operating in isolation or in association (Rubio, 1995, Thornes, 1995, UNEP, 1992 and Basso *et al.,* 2000). An Environmental Sensitive Area (ESA) can be considered, in general, as a specific and delimited entity in which environmental and socio-economical factors are not balanced or are not sustainable for that particular environment. The environmentally Sensitive Areas (ESA's) to desertification around the Mediterranean region are found in a different sensitivity status to desertification for various reasons, *i.e.* low rainfall and extreme events due to low vegetation cover, low resistance of vegetation to drought, steep slopes and highly erodable parent material (Ferrara *et al.,* 1999). A thorough assessment of desertification would require the analysis of several physical and socio-economical factors. Quantitative information on the causal factors is scarce and the use of models to assess the sensitivity to desertification and drought is the most common approach (EC 2004). Desertification indicators are those, which indicate the potential risk of desertification while there still time and scope for remedial action. Regional indicators should be based on available international source materials, including remotely sensed images, topographic data (maps or DEM's), climate, soil and geologic data. At the scale ranging 1: 25,000 to 1:1,000,000 the impact of socio-economic drivers is expressed mainly through pattern of land use. Each regional indicator or group of associated indicators should be focused on a single desertification process. The various types of ESA's to desertification can be distinguished and mapped by using certain key indicators for assessing the land capability to withstand further degradation, or the land suitability for supporting specific types of land use. The key indicators for defining ESA's to desertification, which can be used at regional or national level, can be divided into four broad categories defining the qualities of soil, climate, vegetation, and land management (Kosmas *et al.,* 1999). The Environmental Sensitivity Index (ESI) to desertification of an area can also be seen as the result of the interactions among elementary factors (information layers) that are differently linked to direct and indirect degradation or desertification phenomena (Basso *et al.,* 1998). Severe, irreversible environmental degradation phenomena could be result from a combination of poor management quality together with various combinations of critical environmental factors (soil, climate and vegetation). In order to make informed decisions it is necessary to be able to characterize and identify the significant factors which produce critical situations. Assessment of desertification would require the analysis of several physical and socio-economical factors. Quantitative information on the causal factors is scarce and the use of models to assess the sensitivity to desertification is the most common approach. Several models have been developed to estimate land degradation rate and evaluate desertification severity.

The main problem in El- Fayoum Depression is the land degradation resulted from the mismanagement of natural resource (*i.e.,* water, soils), the storing capacity of Qarun Lake and its salinity and inadequate land use planning. Therefore, the current work aims to: 1) build up a geographic soil database for the area that can be used for different development and management models needed for decision makers and 2) map the Environmental Sensitivity Areas (ESA's) to desertification in El-Fayoum Depression depends upon the soils, climate, and vegetation quality indexes using spatial analyst tool in a Geographic Information System (GIS).

Material and methods

Research region

El- Fayoum Depression is a circular old deep depression at the Western Desert of Egypt. It is bounded by 30º 15’ and 31º 06’N longitudes and 29º 10' and 29º 34' E latitudes covering a total area of 1704 km^2, approximately 90 kilometers southwest of Cairo (Fig. 1). It is connected to the Nile River by the Hawara canal, through which Bahr Yousef canal is transporting the Nile water. The physiographic units of El- Fayoum Depression include three main landscapes, *i.e.,* lacustrine plain, fluvio-lacustrine plain and alluvial plain (Ali and Abdel Kawy, 2012). The main landforms in the depression are resent and old lake terraces, depression, plain, and basins (Abo El- Enean, 1985). The study area includes different types of landforms, soils and vegetation cover, therefore, the sensitivity for desertification is differing widely in the depression.

El- Fayoum depression is characterized by a hot and dry summer with scanty winter rainfall and bright sunshine throughout the year. According to the aridity index classes (Hulme and Marche, 1990) the area is located under arid climatic condition. The climatic data of El- Fayoum district show that mean annual rainfalls is 7.2 mm/ year. The mean minimum and maximum annual temperatures are 14.5 and 31.0 °C , respectively. The lowest evaporation rate (1.9 mm/day) is recorded in January while the highest value (7.3 mm/day) is recorded in June (CLAC, 2004). According to Egyptian Meteorological Authority (1996), Climatologically Normal for Egypt (2011) and Keys to Soil taxonomy USDA (2010) the soil temperature regime of the studied area could be defined as thermic and soil moisture regime as torric.

Fig. 1. Location of the study area.

Digital image processing

Digital image processing of Landsat 7.0 ETM+ satellite image acquires in 2010. ENVI Software version 4.7 is used to elaborate preprocessing, and classification of the satellite image according to ITT (2009). The bands were chosen with the ultimate applications of the data more firmly in mind. A selection of most adequate combination of bands (7, 4 and 2) was executed according to Lillesand and Kiefer (1979). The raw ETM^+ image was geometrically corrected. Rectification method (image to map) was followed. Image enhancement is done by digital image histogram manipulation. Gaussian stretch enhancement was used to expand the narrow range of brightness values present in the image. ASTER images were used for producing a Digital Elevation Model (DEM) generated with a 30 m spatial resolution used to generate a slope map of the study area within Arc-GIS 9.3 software (ESRI, 2008).

Physiographic map

Satellite ETM+ image was draped over the Digital Elevation Model (DEM) to get the feel of natural 3D terrain, to get the better understanding of the geomorphologic units and to facilitate extracting of these units (Dobos *et al.,* 2002).The physiographic units were described according to Zink and Valenzuala (1990).

Field studies and laboratory analyses

Field studies and ground truth were carried out to identify the geomorphologic units and to examine the reality of the interpretation. Twenty soil profiles were taken from two sample areas, typically covering about 10% of the investigated area. This sample areas crossed the different mapping unites (Hengl and Rossiter, 2003). A detailed morphological description of 20 soil profiles was elaborated on the basis outlined by FAO (2006) . Representative disturbed 80 soil samples have been collected. The samples were air dried and the less than 2 mm particles were used for chemical analyses. Electrical conductivity (EC) was determined conduct-metrically in saturated soil paste extracted. Exchangeable sodium percentage (ESP) was determined by ammonium acetate (NH_4OAC). Soil bulk density was determined by core method. Total calcium carbonate was determined volumetrically using Collin's Calcimeter method. Particle size distribution of the soil samples was determined according to the international pipette method. The laboratory analyses were carried out using the soil survey laboratory methods manual (USDA, 2004). The soils were classified to the sub great groups level based on the American Soil Taxonomy (USDA, 2010). Then the physiographic and taxonomic units were correlated in order to identify the major soil sets of the studied area (Elberson and Catalan, 1987).

Environmental sensitivity to desertification assessment

The DISMED model was used for calculating the environmentally sensitive area (ESA) index to determine the situation and tendency of desertification in the study area (EEA, 2008). The DISMED approach (Desertification Information

System for the Mediterranean) was derived from the MEDALUS methodology for Environmentally Sensitive Areas. Sensitivity to desertification is defined by an index (SDI: Sensitivity to desertification index) obtained from the geometrical average of three indexes of the soil quality, climate and vegetation. The value of each index is divided into a number of classes, the thresholds of which have been determined empirically from extensive field work. Each class is given a weighted index according to the importance of its role in land degradation processes from 1.0 (least) to 2.0 (worst). For example, the annual rainfall has three classes: >650, 650–280 and <280 mm, with weighted indices of 1.0, 1.5 and 2.0, respectively. The soil quality index (SQI) is given by the geometric average of the indexes for parent material, soil texture, soil depth, slope gradient, rock fragment and drainage. Climate quality index (CQI) is based on the indexes of aridity, rainfall and slope aspect. For vegetation quality index (VQI) is given by the geometric average of the indexes for erosion protection, drought resistance, vegetation cover and fire risk. Table 1 represents classes, assigned weighted indices for the various parameters used for assessment of soil and vegetation qualities.

The three quality indices are calculated from the algorithm Eq. (1):

$$\text{Quality\_x ij} = (\text{parameter\_1 ij} \times \text{parameter\_2 ij} \times ... \times \text{parameter\_n ij})^{(1/n)} \quad (1)$$

where i,j = rows and columns of a single elementary land unit of each parameter;
n = number of parameters used .
In turn, the ESA index is calculated as per algorithm (2), thus:

$$\text{ES ij} = (\text{Quality\_1 ij} \times \text{Quality \_2 ij} \times \text{Quality \_3 ij})^{(1/3)} \quad (2)$$

where i,j = rows and columns of a single elementary land unit of each quality;
Quality_nij = values calculated from (3)

The quality indices were calculated and displayed as GIS ready maps from which class areas were deduced. The final overall Desertification Sensitivity Index (DSI) was calculated in the polygonal attribute tables linked with the geographic coverage using the spatial analyst tool in Arc GIS 9.3 software. Based on the estimated value of DSI the classes of desertification sensitivity in the area can be described.

In terms of the data required for estimating the Environmental Sensitivity to desertification, the indices of soils, vegetation and climate were computed. The main input data for calculating theses indices include land surveying and laboratory analyses data, Landsat ETM^+ image 2010, Digital Elevation Model (DEM) of the area, geological map of El- Fayoum Depression area (CONOCO, 1989) and climatic data (Egyptian meteorological Authority, 1996). An image processing system (*i.e.,* ENVI 4.7) and a GIS system (*i.e.* Arc GIS 9.3) were the main tools in indices computations and ESA’s mapping. Weighting factors of each category of the considered parameters were used on basis of Kosmas *et al.* (1999).

TABLE 1. Classes, assigned weighted indices for the various parameters used for assessment of soil and vegetation qualities .

Parameter	Class	Description	Index
Soil texture	1	L, SCL, SL, LS, CL	1
	2	SC, SiL, SiCL	1.2
	3	Si, C, SiC	1.6
	4	S	2
Slope	1	<6	1
	2	6-18	1.2
	3	18-35	1.5
	4	>35	2
Parent material	1	Shale, schist, basic, ultra basic, Conglomerates, unconsolidated	1
	2	Limestone, marble, granite, Rhyolite, Ignibrite, gneiss, siltstone, sandstone	1.7
	3	Marl, Pyroclastics	2
Soil depth	1	Deep (>100 cm)	1
	2	Moderate (100 – 75 cm)	1.2
	3	Shallow (75 – 30 cm)	1.6
	4	Very shallow (<30 cm)	2
Drainage	1	well drained	1
	2	Imperfectly drained	1.2
	3	Poorly drained	2
Rock fragments	1	Very stony (>60%)	1
	2	Stony (20 – 60%)	1.3
	3	Bare to slightly stony (<20 %)	2
Fire risk	1	Bare land, perennial agricultural crops, annual agricultural crops (maize, tobacco, sunflower).	1
	2	Annual agricultural crops (cereals, grasslands), deciduous oak, (mixed), mixed Mediterranean, macchia/evergreen forests.	1.3
	3	Mediterranean macchia.	1.6
	4	Pine forests.	2
Erosion Protection	1	Mixed Mediterranean macchia/evergreen forests	1
	2	Mediterranean macchia, pine forests, Permanent grasslands, evergreen perennial crops.	1.3
	3	Deciduous forests.	1.6
	4	Deciduous perennial agricultural crops (almonds, orchards).	1.8
	5	Annual agricultural crops (cereals), annual grasslands, vines.	2
Drought resistance	1	Mixed Mediterranean macchia/evergreen forests, Mediterranean macchia	1
	2	Conifers, deciduous, olives	
	3	Perennial agricultural trees (vines, almonds, ochrand)	1.2
	4	Perennial grasslands	1.4
	5	Annual agricultural crops, annual grasslands	1.7
			2
vegetation cover	1	Plant cover (>40%)	1
	2	Plant cover (40-10%)	1.2
	3	Plant cover (<10%)	2

Results and Discussion

Physiographic of the investigated area

Geomorphologic units could be identified throughout interpreting satellite image which is considered one of the most common, versatile and economical forms of advanced techniques. The geomorphologic units of the study area are represented in Fig. 2.

The geomorphic units were recognized and delineated by analyzing the main landscape that extracted from the satellite image with the aid of the different maps and field survey. The obtained results indicate that the major landscapes in the studied area are alluvial, lacustrine and alluvial –lacustrine plains. The included lanforms are namely recent terraces (relatively low, relatively high and moderately high), lacustrine terraces (relatively low, relatively high and moderately high), Old terraces (relatively low and relatively high), Oldest terraces (relatively low and relatively high) and basins (decantation and overflow) covering area of 887, 150, 128, 138 and 406 km^2 , respectively.

Soils of the investigated area

According to field studies and laboratory analyses the soil texture class of the studied area varies widely between clay to silt clay loam. Soil salinity varies between slight and highly saline, as the EC values range between 1.22 and 37.2 dS/cm. The soil depth, ESP, and CEC of this landscape range from (55 to 135 cm), (9.85 to 30.12%) and (17.52 to 49.73 meq/100g), respectively. The calcium carbonate content ranges between 3.41 and 29.38%. Organic matter content ranges between 0.23 and 1.98% in the successive layers of the representative profile. The main sub great groups in the study area are, Typic Torrifluvents, Vertic Torrifluvent, Typic Natrargids, Typic Haplosalids, Typic Haplocalcids and Typic Haplargids represent 30.88, 19.88, 2.16, 15.09, 21.11 and 10.88 % of the total area, respectively (Fig. 2).

Environmental sensitivity to desertification assessment

Three layers were used to assess desertification sensitivity index (DSI) and mapping the environmentally sensitive areas (ESA,s) in the studied area, *i.e.*, soils, climatic and vegetation quality indexes. These layers were created in a geographic information system (GIS) using the spatial analyst tool. The Landsat ETM+ image of the studied area and digital elevation model were used to establish the main land type layer, this layer was used as a base map in the geographic information system.

Soil quality index (SQI)

Soil is an essential factor in evaluating the environmental sensitivity of an ecosystem, especially in the arid and semi-arid zones. Soil properties related to desertification phenomena affect the water storage and retention capacity and erosion resistance. The soil quality index (SQI) was evaluated depend upon the drainage condition, rock fragments (%), slope gradient (%), soil texture class, soil depth (cm) and the parent material. Table 2 illustrates the general characteristics, classes and scores of the soil quality index.

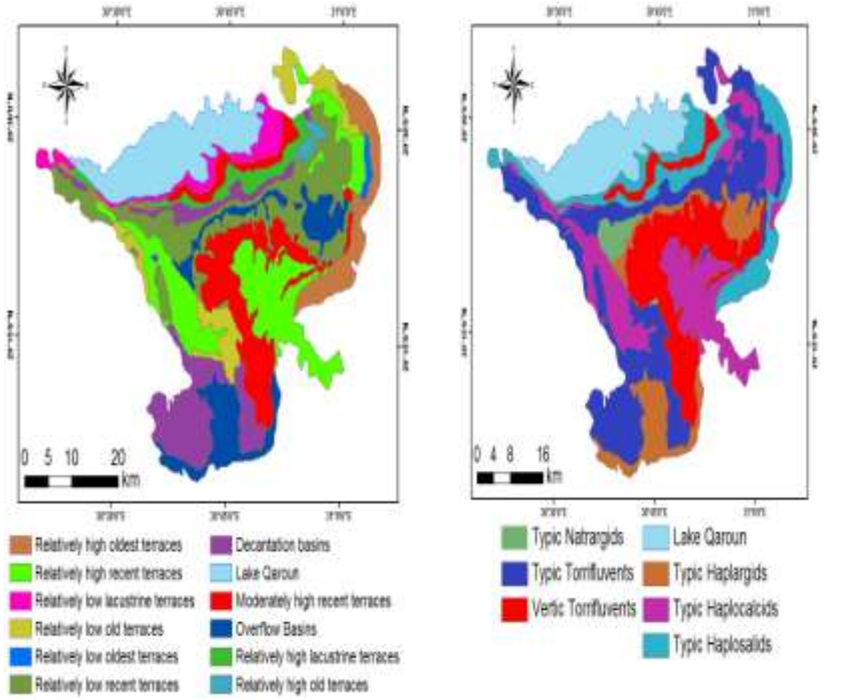

Fig. 2. Physiographic and soil maps of the study area.

TABLE 2. Classes and scores of the soil parameters .

Mapping units	Soil depth cm		Parent material		Soil texture		Slope %		Drainage		Rock fragments %	
	C	Sc	C	Sc	C	Sc	C	Sc	C	Sc	C	Sc
DB	>100	1	L/S	1.7	C	1.6	1.2	1	W	1	<20	2
MHRT	75-30	1.6	S/U	1	C	1.6	1.5	1	I	1.2	<20	2
OB	75-30	1.6	L/S	1.7	C	1.6	1.7	1	P	2	<20	2
RHLT	100-75	1.2	L/S	1.7	SiCL	1.2	1.1	1	I	1.2	<20	2
RHOT	>100	1	L/S	1.7	C	1.6	1.8	1	W	1	<20	2
RHOsT	>100	1	L/S	1.7	C	1.6	1.6	1	W	1	<20	2
RHRT	>100	1	L/S	1.7	SiC	1.6	2.1	1	W	1	<20	2
RLLT	100-75	1.2	S/U	1	SiC	1.6	1.4	1	I	1.2	<20	2
RLOT	>100	1	S/U	1	SiL	1.2	1.5	1	W	1	<20	2
RLOsT	100-75	1.2	L/S	1.7	SiCL	1.2	1.5	1	I	1.2	<20	2
RLRT	>100	1	S/U	1	SCL	1	1.4	1	W	1	<20	2

Where:DB= decantation basins, MHRT= moderately high recent terraces, OB= overflow basin, RHLT = relatively high lacustrine terraces, RHOT = relatively high old terraces, RHOsT= relatively high oldest terraces, RHRT= relatively high recent terraces, RLLT= relatively low lacustrine terraces, RLOT= relatively low old terraces, RLOsT= relatively low oldest terraces, RLRT= = relatively low recent terraces, C= Class, Sc= score, S/U= shale and unconsolidated materials, L/S= limestone and sandstone, C=clay, SiCL= silt clay loam, SiC= silt clay, SiL=Silt loam, SCL= sand clay loam W= well drained, I= imperfectly, P= poor drained.

The SQI (Soil Quality Index) is estimated from the weighted index assigned to each of the six parameters using Eq. (4):

SQI = (texture× parent material ×rock fragment ×depth × slope × drainage) $^{1/6}$ (4)

Figure 3 represents the description and areas of soil quality index of the study area. The results indicate that the areas of high soil quality index (value <1.13) represent 16.37 % of the total area (*i.e.*, 279 Km^2), the areas of moderate quality index (value = 1.13 – 1.45) represents 40.18 % of the total area (*i.e*, 685 Km^2) and the areas of low soil quality index (value >1.45) represents 43.45 % of the total area (*i.e.*, 740Km^2). The low soil quality dominates the areas which characterized by sandy texture, shallow depth and poor drainage soils.

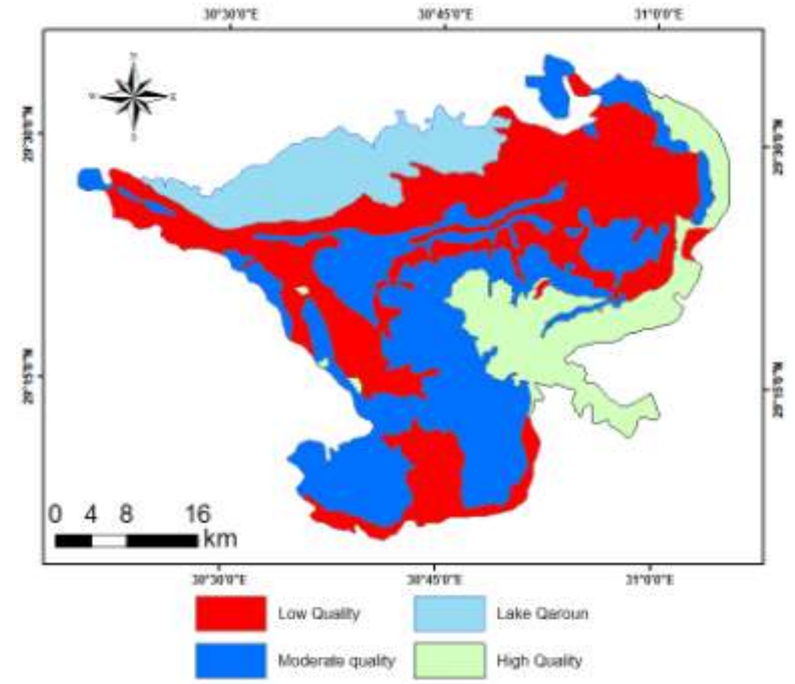

Fig. 3 . Soil quality index (SQI) layer of the study area.

Vegetation quality index (VQI)

Vegetation plays an important role in mitigating the effects of desertification and degradation phenomena. The plant cover (%), erosion protection, drought resistance and fire risk parameters were used for assessing the vegetation quality index (VQI). Fire risk, erosion protection and drought resistance all depend on the type of vegetation cover. The vegetation quality index is estimated from the weighted index assigned to each of the four parameters using Eq. (5):

VQI = (fire risk× erosion protection × drought resistance × vegetation cover) ¼ (5)

Figure 4 represents the layers of vegetation quality index of the area, the data indicate that the areas of high vegetation quality (Value <1.20) represents 35.38 % of the total area (*i.e.,* 603 Km^2), the moderate vegetation quality index (Value 1.2 – 1.4) dominates the south of the lake represents 64.62 % of the total area (*i.e.,* 1101 Km^2). The moderate vegetation index is due to the low density of plant cover.

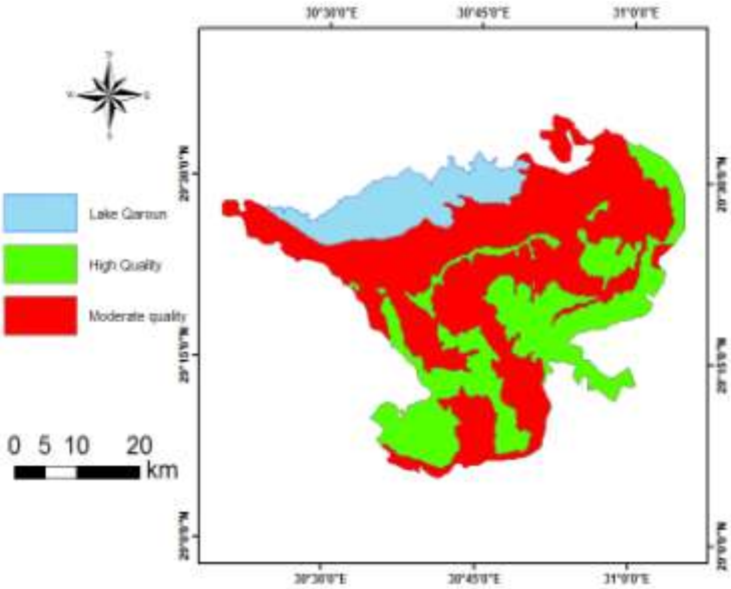

Fig. 4. Vegetation quality index (VQI) layer of the study area.

Climate quality index (CQI)

Climate quality index (CQI) is assessed depend upon the amount of rainfall, aridity and slope aspect parameters. The amount of rainfall and aridity are the same in the study area, but the microclimate is differ from place to another depend on the surface slope and slope aspect. The digital elevation model (DEM) of the study area was established and used for extracting the slope aspect. The climate quality index is calculated from the weighted index assigned to each of the parameters from Eq. (6):

$$CQI = (\text{rainfall} \times \text{aridity x slope aspect})^{1/3} \quad (6)$$

The layer climatic quality index of the area is represented in Fig. 5, it is clear that the area is dominated by moderate (1.50 – 1.80) and low (>1.80) climatic index. The data indicate that the areas of moderate climate quality represents 49.65 % of the total area (*i.e.,* 846 Km^2), the low climate quality index represents 50.35 % of the total area (*i.e.,* 858 Km^2). The changes in the index values are related to the local condition, *i.e.,* surface slope and slope aspect.

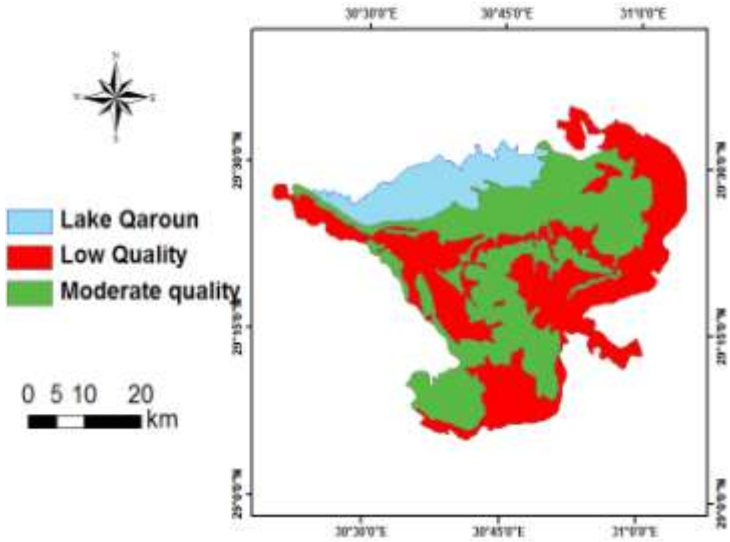

Fig. 5. Climatic quality index (CQI) layer of the study area.

Environmentally sensitive areas (ESA,s)

The final step comprises the matching of the physio-environmental qualities (soil quality, climate quality and vegetation quality) for the definition of the various types of ESAs to desertification. The three derived indices are multiplied for the assessment of desertification in order to obtain the ESAI (ESAs Index) using Eq. (7):

$$ESAI = (SQI \times CQI \times VQI)^{1/3} \quad (7)$$

The classes, scores, description and areas of the environmentally sensitive areas to desertification in the study areas are presented in Table 3. Fig. 6 shows the distribution of environmentally sensitive areas (ESA's), it is clear that the high sensitive areas for desertification in the study area are found in the southern parts of Qaroun Lake, where the soil quality and climatic quality are low; these areas represent 18.31 % of the depression area (*i.e.,* 312 Km^2). The areas of sensitive for desertification exhibit an area of 54.09 % of the total area (*i.e.,* 922 km^2). The region belongs to sensitive area for desertification already highly degraded through past misuse, presenting a threat to the environment of the surrounding areas or with evident desertification processes. The areas of moderate sensitive for desertification exhibit an area of 27.6 % of the total area (*i.e.,* 470 km^2). This type of areas in which any change in the delicate balance between natural and human activity is likely to bring about desertification.

The sensitivity of the various types of ESAs to desertification decreases in the following order:

Very sensitive area > sensitive area > medium sensitive area .

TABLE 3 . Description of the classes of desertification sensitivity index (DSI) .

Classes	DSI	Description	Area %
1	< 1.2	Areas in which critical factors are very low or not present, with a good balance between environmental and socio-economical factors	-
2	1.2 < DSI < 1.3	Areas threatened by desertification under significant climate change, if a particular combination of land use is implemented or where offsite impacts will produce severe problems.	-
3	1.3 < DSI <1.4	Areas in which any change in the delicate balance between natural and human activity is likely to bring about desertification.	27.6
4	1.4 > DSI <1.6	Areas already highly degraded through past misuse, presenting a threat to the environment of the surrounding areas or with evident desertification processes.	54.09
5	> 1.6	Very sensitive areas to desertification	18.31

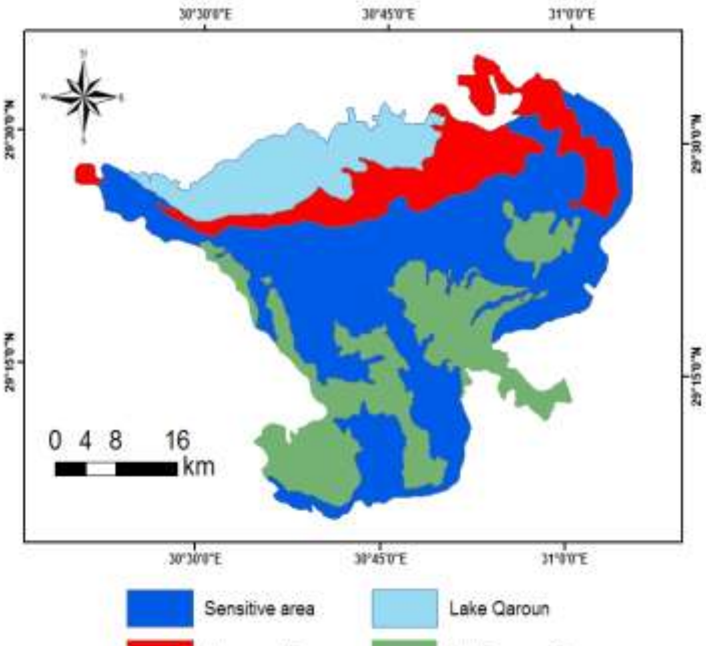

Fig. 6. Environmentally sensitive areas (ESA, s) of the study area.

Conclusion and Recommendation

It can be concluded that the assessment of desertification sensitivity is rather important to plane sustainable development in highly potential desert areas as wadis, plains and depression. Achieved information is essential to improve the employment of natural resources. The merely quantitative aspect of desertification sensitivity demonstrates a clearer image of the risk state, thus, reliable priority actions can be planned. Remote sensing, in addition to thematic maps, may supply valuable information concerning the soil and vegetation quality at the general scale. However, for more detailed scales, conventional field observation would be essential.

The Geographic Information System (GIS) is a valuable tool to store, retrieve and manipulate the huge amount of data needed to compute and map different quality indices to desertification. The quantitative aspect of desertification sensitivity demonstrates a clearer image of the risk state, thus, reliable priority actions can be planned. Actions measures are essential for the sustainable agricultural projects located in El- Fayoum especially in the southern parts of Qaroun Lake which are susceptible to moderate or very high desertification sensitivity.

It can be recommended that mathematical modeling should be developed for the operational monitoring of different elements contributing in desertification sensitivity. Multi scale mapping of ESA's are needed to point out the risk magnitude and causes of degradation in problematic areas.

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تقييم حساسية البيئة للتصحر فى منخفض الفيوم – مصر

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تهدف هذه الدراسة إلى استخدام التحليلات المكانية في نظام المعلومات الجغرافية (GIS) لتقييم حساسية البيئة للتصحر في منخفض الفيوم ، مصر. ولتحقيق هذا الهدف تم تقدير دليل التربة ، الغطاء النباتي و المناخ فى صورة طبقات معلوماتية (Thematic layers). تم إستخراج هذه الطبقات من خلال الخرائط الطبوغرافية والجيولوجية المتاحة ، وصورة وبيانات القمر الصناعي بجانب بيانات الحصر الحقلي. وقد إستخدمت التحليلات المكانية كأحد أدوات نظم المعلومات الجغرافية من خلال برنامج Arc-GIS 9.3 لانتاج الخرائط المعلوماتية المختلفة (خرائط التربة ، الغطاء النباتى ، المناخ) وبإستخدام تقنيات التحليل المكانى تم ربط هذه الخرائط لتقييم مؤشر التصحر ومنها الحصول على خريطة لمنخفض الفيوم توضح فيها المناطق الحساسة بيئيا للتصحر. وقد اشارت النتائج المتحصل عليها أن الأجزاء الجنوبية لبحيرة قارون (الاجزاء الشمالية لمنطقة الدراسة) تمثل مناطق عالية الحساسية جدا للتصحر بنسبة 310.+
18, % . واتصفت الاجزاء الجنوبية من المنخفض بحساسية عالية إلى متوسطة للتصحر بنسبة 54,09 و 27,6% من جملة المساحة الكلية على التوالى . وأوضحت النتائج أن دراسة العوامل المختلفة التى تؤثر على حساسية التربة للتصحر بصورة متكاملة يساهم فى وضع خطة مناسبة لمكافحة هذا التصحر. وأتضح أن أستخدام تقنيات الإستشعار عن بعد ونظم معلومات جغرافية ذات فائدة عظيمة ودقيقة فى تصور الوضع الحالى لحساسية التربة للتصحر .