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Assessment of Environmental Sensitivity Index to Desertification Using GIS: Case Study in West El-Minia Governorate, Egypt

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ABSTRACT

The aim of this work is the identification of the Environmental Sensitivity Index (ESI) to desertification in West El-Minia Governorate of Egypt using GIS, based on the MEDALUS model. Three main indicators in this model were considered, including: soil quality, vegetation quality and climate quality. Topographic maps, geologic maps, Landsat-8 satellite image, DEM, NDVI, land surveying, laboratory analyses and climatic data were used for estimating the ESI to desertification in the studied area. The results obtained in this study reveal that the very sensitive and sensitive areas to desertification were in the eastern and central parts of the studied area, where the soil, vegetation and climatic qualities are low. These vulnerable areas are representing 81.49% of the study area (543575 ha.). The western parts of the study area are characterized by low sensitivity to desertification and represent 14.68% of the total area (97907 ha.). The low sensitivity for desertification in the study area is due to the good soil quality and vegetation quality. Small area in the western part of the study area are medium sensitive to desertification and represent 4.43% of the total area (29579 ha.). Sand dunes and Hills occupied 3.83% of the total area. The factors that effect on the sensitivity to desertification are parent material, soil texture, soil depth, slope, vegetation type, drought resistance and erosion protection. The integration of these factors may lead to plan a successful resistance to degradation and very important for decision making in ESI to desertification in the study area.

Keywords: Environmental Sensitivity Index, Desertification, GIS, El-Minia Governorate.

INTRODUCTION

The main problem in Egypt is over population against food production, for this reason governorate exerts great efforts to recover the gap between over population and food production by desert reclamation for sustainable agriculture development (Abdel-Hamid, 2010 and Sayed, 2013). Nile River is considered the main water source in Egypt, while the second water source is groundwater especially in desert areas (NWRP, 2003). The horizontal agricultural expansion in the Western desert is one of the most important objectives of Egyptian agricultural policy to meet the food security needs of the growing population (Ismail *et al*., 2010). Small areas of Western desert lands are suitable for agricultural production (Bakeer, 2008 and Sayed, 2013). West El-Minia Governorate of Egypt is considered one of the promising areas for future development plans in Egypt and is the most desert area which subjected to reclamation depending mainly on the groundwater extraction though drilled wells (Azzam, 2016 and Yousif *et al*., 2018). Quaternary aquifer is the most target aquifer for extraction in West El-Minia Governorate (Abdel Moneim *et al*., 2016). The most aquifer potentiality has a good water quality in the Western Desert, especially West El-Minia and West Asyut is the fracture limestone of the Samalut Formation (Shabana, 2010; Al Temamy and Abu Risha, 2016).

Soil is one of the highest effective environmental factors and is a main source for providing vital plant nutrients, water reserve, and a medium for plant growing (Ghaemi *et al*., 2014). The growth of the world's population is increasing the pressure on natural resources, particularly on soil systems. Agricultural practices are causing widespread soil degradation (Abd-Elmabod *et al*., 2019). Land degradation considers as a phenomenon that decrease the potential soil capability to produce goods and involve two complex systems: the natural ecosystem and the human social system (WMO, 2005 and Abdel Kawy and Darwish, 2019). Soil degradation is a serious threat to fulfill the expected demand of food and clean water (Jónsson *et al.* 2016). Desertification is defined as the result of different interactions between environmental changes and human activities in arid and semiarid zones (UNEP, 1992; Batterbury and Warren, 2001and Tombolini *et al*., 2016). Approximately 15% of the world's population are affected by desertification (Adger *et al*., 2001). Areas in Mediterranean countries display different sensitivities to desertification, depending on low precipitation, low vegetation cover, gentle slopes, and highly erodible parent materials (Ferrara *et al*., 1999).

The environmental sensitivity index (ESI) is a complex concept, it relevant to the damage risk of the natural environment and can be caused by many different factors which environmental and socio-economic factors are not sustainable for that particular environment (Basso et. al., 2000 and Zou and Yoshino, 2017). The MEDALUS model is used firstly by (Kosmas *et al*., 1999) and used frequently afterward for assessing ESI in many areas in the Mediterranean Sea and other areas (Lahlaoi *et al*., 2017 and Saleh *et al*., 2018). The ESI framework in the Mediterranean

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region is applied for evaluating land desertification essentially due to its simplicity in model building and its flexibility in the building and use of relevant indicators (Symeonakis *et al*., 2016). The factors for identifying ESI, which can be classified into four categories including each of soil, climate, vegetation, and land management qualities (Kosmas et. al. 1999). The GIS tools are a very important method to determine the environmental sensitivity index (ESI) to desertification detected at both the global and regional scales (Tombolini *et al*., 2016 and García-Ayllón, 2018). Regional desertification indicators should be including remotely sensed images, geologic maps, topographic maps, climatological data, and soil characteristics (Lahlaoi *et al*., 2015 and Gyssels *et al*., 2016). The ESI indicators are indicate the potential risk of desertification. However, desertification phenomena can be accurately evaluated through matching survey data to satellite images (Yang *et al*., 2007 and Zambon *et al*., 2017). Remote sensing data and GIS using to assess ESI to desertification, and GIS has been shown to be a very useful tool in the preparation, visualization, manipulation and analysis of spatially referenced information (Coscarelli *et al*., 2016 and Saleh *et al*., 2018).

This study aims to: 1) assess the Environmental Sensitivity Index (ESI) in the West El-Minia Governorate of Egypt by modifying MEDALUS model; 2) interpolate the data for spatial distributed mapping of SQI, VQI and ESAI for decision making and future environmental monitoring.

Methodology

Site description

The study area is allocated in the western part of the River Nile and Nile valley and at the west of the western limestone plateau (Tableland) of El-Minia Governorate. It lies between longitudes 29°75' & 30°64'E and latitudes 28°00' & 28°58'N. It covers an area of about 667020 ha. (Figure 1). The soil temperature regime of the study area is hyper-thermic, and the soil moisture regime is torric (USDA, 2014). The study area is described as arid climate with hot summer, warm winter, high evaporation and low rainfall intensity. The meteorological station of El Minia Governorate (EMA, 2009) records during 30 years (1984–2014) as follows; the main monthly temperature ranges between 12.9℃ in January and 30.2℃ in Aug. Rainfall is rare throughout this region; the total mean precipitation is 28.0 ml/ year. The mean relative humidity ranges from 33 % in May to 67% in December. The evaporation values range from 4.17 ml/ day in January to 12.2 ml/ day in June. Four geomorphologic units in West El-Minia Governorate including the flood plains (silt plain, sandy plain and gravely plain), the tableland, isolated hills and sand dunes (Shabana, 2010). El-Minya Governorate lies between the Eocene limestone plateau from the west and the Recent Nile deposits from the east (Abdel Aziz, 1994).

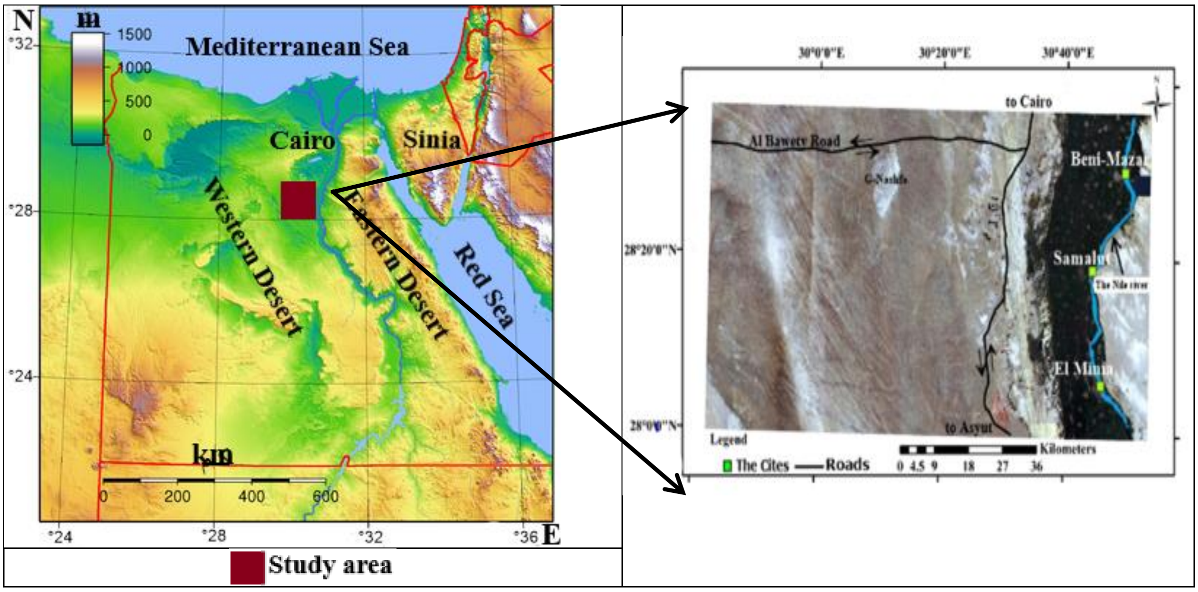

Fig. 1. Geographic location of West El-Minia Governorate.

Image processing and physiographic units:

Digital image processing of Landsat-8 Operational Land Imager (OLI) acquired in 2020. The satellite image was collected along path 177 and row 40. The image processing is carried out using the ENVI 5.3 software package and includes data calibration (Lillesand and Kiefer, 2007). The DEM was combined with the Landsat-8 OLI image to recognize different landform types, and it is assisted in detecting a range of properties that can assist in mapping landforms and soil types. The information extracted from a DEM i.e., surface elevation, slope and slope direction. The Landsat-8 OLI image and the DEM were managed in the ENVI 5.3 software package and ArcGIS 10.2 software to obtain the physiographic units and establish a soil database (Dobos *et al*., 2000). This study used the GIS for assessing and mapping of ESI in the investigated area.

Field work and laboratory analysis:

19 soil profiles representing the different physiographic units in the studied area (Figure 2). The soil profiles were morphologically described according to FAO (1990). The soil samples were analyzed to determine their chemical and physical properties according to USDA (2004) and Bandyopadhyay (2007).

The methodology of The MEDALUS model.

The MEDALUS (Mediterranean Desertification and Land Use) model is used to assess the environmental sensitivity index (ESI), and the general methodology has been fully described by (Kosmas *et al*., 1999). The ESAI is a combined index that uses three quality indices: soil quality index (SQI), vegetation quality index (VQI) and climate quality index (CQI). These qualities are calculated from several individual parameters. Based on the MEDALUS model, each parameter according to its quality was given a weighting factor of between 1 (best value) and 2 (worst value), the final ESI are identified by integrating the three-quality layers. The ESI is calculated according to the flow chart as shown in Figure 2. The main input to this model is mosaicked Landsat-8 OLI satellite image, the geologic map of the study area produced by CONOCO (1987), and climatic data derived from (EMA, 2009). The ENVI 5.3 and ArcGIS 10.2 software's packages are used to calculate these indices and create maps of ESI to Desertification. The ESI was calculated on basis of the following equation:

$$ESI= (SQI * VQI * CQI)^{1/3} \ldots\ldots \text{(Eq. 1)}$$

The final overall ESI is obtained as a geometrical mean of the quality indices and classification was done according to the Medalus project Mediterranean desertification and land use- Manual (European Commission, 1999).

Soil Quality Index (SQI).

The soil is considered as the important factor in arid and semi-arid zones in evaluating the ESI of a terrestrial ecosystem because its effect on biomass production. The soil quality indicators which used in mapping ESI related to water availability and erosion resistance (El-Baroudy, 2013). A number of four soil parameters were considered at the current investigation (i.e. parent material, soil texture, soil depth and slope gradient). Weighting factors were assigned for these parameters, on basis of European Commission (1999). The SQI was classified considering the criteria shown in Table (1) and estimated from the weighted index assigned to each of the four parameters using the following equation:

$$SQI= (SI_p \times SI_t \times SI_d \times SI_s)^{1/4} \ldots\ldots \text{(Eq. 2)}$$

Where:

SI_p of parent material, SI_t of soil texture, SI_d of soil depth, SI_s of slope gradient).

Vegetation quality index (VQI)

Vegetation quality index plays a significant role in alleviating the desertification effects. According to Basso *et al* (2000), vegetation quality index is evaluated in terms of three factors: (1) vegetation cover (the percentage of the soil area covered by plants); (2) drought resistance and (3) erosion protection to the soils; all of the factors that affect the VQI depend on the type of vegetation cover. The fraction of soil cover is obtained from normalized difference vegetation index (NDVI) values derived from a Landsat-8 OLI satellite image. Weighting factors were assigned for these parameters, on basis of European Commission (1999). The VQI was classified considering the criteria as shown in Table (1) and estimated from the weighted index assigned to each of the three parameters using the following equation:

$$VQI= (VI_c * VI_r * VI_p)^{1/3} \ldots\ldots\ldots \text{(Eq. 3)}$$

Where:

VI_c of vegetation cover, VI_r of drought resistance and VI_p of erosion protection.

Climate quality index (CQI).

Climate quality index is estimated in terms of factors that impact the water availability to plants, specifically rainfall, and the aridity index. The climatic quality index was neglected as the arid desert climate. Table (1) reveals the climatic quality index according to (OSS, 2004). The Climate quality index is calculated through rainfall and aridity index as the following equation:

$$CQI = (CI_r * CI_a)^{1/2} \ldots\ldots\ldots\ldots \text{(Eq.4)}$$

Where:

CI_r is average annual rainfall, and CI_a is aridity index.

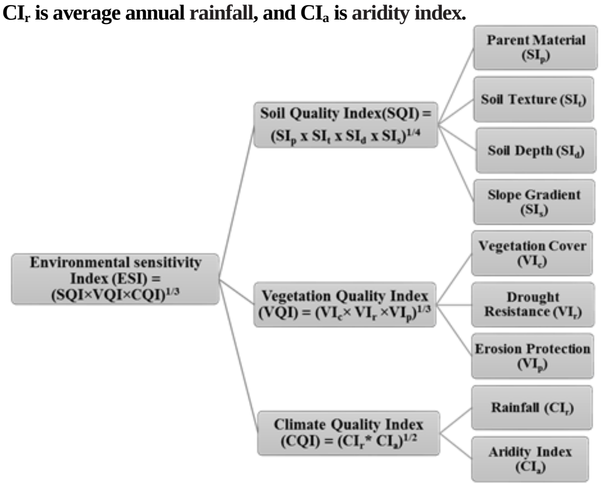

Fig. 2. Flow chart of Environmentally Sensitive Index (ESI).

Table 1. Classes, descriptions and ranges of SQI, VQI, CQI and ESI.

Class	Soil quality index (SQI)		Vegetation quality index (VQI))		Climate quality index (CQI		Environmental sensitivity Index (ESI)	
	Description	Range	Description	Range	Description	Value	Description	Range
1	High quality	<1.2	Good	<1.20	Hyper-Arid (Very low)	2.00	Very low sensitive to desertification	<1.20
2	Moderate quality	1.2-1.4	Average	1.20-1.40	Arid (Low)	1.75	Low sensitive to desertification	1.20-1.30
3	Low quality	1.4-1.6	Weak	1.40-1.60	Semi-Arid (Moderate)	1.50	Medium sensitive to desertification	1.30-1.40
4	Very low quality	>1.6	Very weak	>1.60	Dry Sub-Humid (High)	1.25	Sensitive to desertification	1.40-1.60
5	____	____	____	____	Humid (Very high)	1.00	Very sensitive to desertification	>1.60

RESULTS AND DISCUSSIONS

Assessment of Environmental Sensitivity Index (ESI).

The Medalus (Mediterranean Desertification and Land Use) model is used to assess the environmental sensitivity index (ESI) and determine the state of desertification in the west El-Minia Governorate of Egypt. The general methodology is used firstly by (Kosmas *et al*., 1999) and used for estimating ESI in Mediterranean Sea region due to its simplicity in model building and its flexibility in the choose of indicators. Therefore, this system allows the easy adding or removing of indicators. The ESI to desertification is a complex index that uses three quality indices calculated from several individual parameters. The quality indices are as follows:1) the soil quality index (SQI), 2) the vegetation quality index (VQI) and 3) climate quality index (CQI). The value of each parameter is separated into several classes, the thresholds of which have been determined empirically from extensive field work throughout the MEDALUS model (European Commission, 1999).

Soil Quality Index (SQI)

Under arid and semi-arid conditions, the soil quality index fundamentally indicates the environmental sensitivity index to desertification. The soil quality index (SQI) in the MEDALUS model is calculated based on four parameters and given in soil survey data, include the soil parent material, the soil texture (the relative amounts of sand, silt and clay particles), the depth of soil profile and surface slope gradient. The weighted indices and classes for each of the four parameters are used to assess soil quality. Description of the types, scores and areas of the soil quality parameters in west El-Minia area as shown in Table (2). Parent material was deduced from the geological map (CONOCO, 1987). The results show the coherent parent materials are limited in the studied area, represents about 31.12 % of the total area (207590 ha.), this class is the good sensitivity index. The soft to friable materials covers 65.05 % of the total area (433892 ha.). This type of parent material is the poor sensitivity index class and more sensitive to the desertification processes. Soil texture was deduced from the Landsat-8 satellite mosaic and assessed on basis of the geomorphology and practical size distribution analysis. The soil is classified into two classes according to its texture very light to average and coarse. The class very light to average is least susceptible to desertification and represents 14.68 % and it covers an area of 97907 ha. The rest of the studied area is classified as coarse soil texture, which is the most sensitive coarse textured soils and dominates in the study area, covering 81.49 % of the total area (543575 ha.). The soil depth, which is defined as the vertical distance within a soil profile from the soil surface to the water table or hardpans. Soil depth was also evaluated on basis of both geologic map (CONOCO, 1987) and soil map of Egypt (ASRT, 1982). As illustrated in) the soils in the study area are characterized either by a moderately deep to very deep soil depth (Table, 2). The moderately deep soil covers 81.49 % (513996 ha.). The very deep soil covers an area of 97907 ha., representing 14.68 % of the total area. The slope gradient was classified on basis of topographic maps and digital elevation model (DEM). The soil surface slope gradient is divided into two classes; the gently slope soil with surface slope of less than 6 % which is the lower susceptible to desertification process. It represents 53.13% of the studied area (354374 ha.). While 43.24 % of the area (287108 ha.) is not very gently class where surface slope between 6 and 18 % which is moderately susceptible to desertification.

Table 2. Distribution of Parent material, Soil texture, Soil depth and slope types, areas and assigned scores in west El-Minia area.

Class	Description	Score	Area (ha.)	Area %
	Parent material type			
Good	Coherent: Limestone, dolomite, non-friable sandstone, hard limestone layer.	1.0	207590	31.12
Moderate	Moderately coherent: Marine limestone, friable sandstone	1.5	0.0	0.0
Poor	Soft to friable: Calcareous clay, clay, sandy formation, alluvium and colluvium	2.0	433892	65.05
	Soil texture type			
Very light to average	Loamy sand, Sandy loam, Balanced	1.0	97907	14.68
Fine to average	Loamy clay, Clayey sand, Sandy clay	1.66	0.0	0.0
Fine	Clayey, Clay loam	2.0	0.0	0.0
Coarse	Sandy to very Sandy	2.0	543575	81.49
	Soil depth type			
Very deep	> 100 cm	1.0	97907	14.68
Moderately deep	100-50 cm	1.33	513996	81.49
Not deep	50-25 cm	1.66	0.00	0.00
Very thin	<25 cm	2.0	0.00	0.00
	Slope type			
Gentle	<6 %	1.0	354374	53.13
Not very gentle	6-18 %	1.33	287108	43.01
Abrupt	19-35 %	1.66	0.0	0.0
Very abrupt	>35 %	2.0	0.0	0.0
	Sand dunes and Hills		25538	3.83
	Total area		667020	100

Classification of the soil quality index (SQI).

Classification of the soil quality index (SQI) within the study area, on basis of Medalus project methodology (European Commission, 1999) as shown in Table (3) and Figure (3) represent the classes, scores and areas. The areas with high SQI values (value = <1.2) represent 14.68% of the total study area which may have least sensitivity to desertification and located in the western part of the study area. Moderate SQI values (value = 1.2-1.4) represent 16.44 % of the total study area, these areas are characterized by poor parent material and sandy texture. Most of the investigated soils range between the low and very low-quality desertification, these classes are in the eastern and central parts of the investigated area. Low SQI values (value = 1.4-1.6) represent 34.02% of the total study area. The areas with very low SQI values (value = >1.6) represent 31.03% of the total study area. The very low and low soil quality dominate in the areas which classified by poor parent material, coarse texture, shallow depth and not very gentle slope. Sand dunes and Hills occupied 3.83% of the total study area.

Table 3. Classification of the soil quality index (SQI).

Class	Score	Area (ha.)	Area (%)
High quality	<1.2	97907	14.68
Moderate quality	1.2-1.4	109683	16.44
Low quality	1.4-1.6	226888	34.02
Very low quality	>1.6	207004	31.03
Sand dunes and Hills		25538.00	3.83
Total area		667020.00	100.00

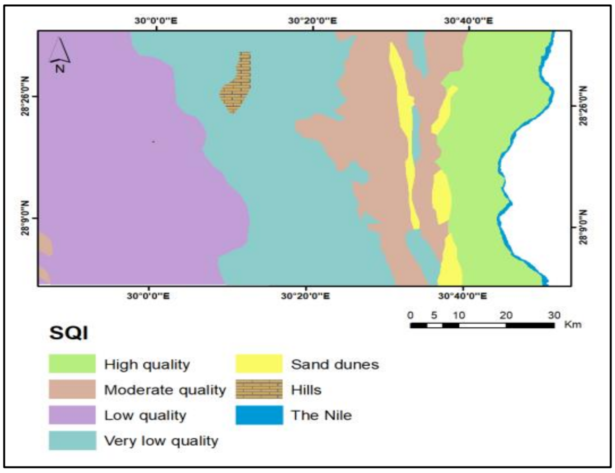

Fig. 3. Soil Quality Index of the study area.

Vegetation quality index (VQI).

Vegetation type plays a significant role in evaluating the degradation effects. The fraction of soil cover is obtained from normalized difference vegetation index (NDVI) values (Figure, 4) derived from a Landsat-8 OLI satellite image. The vegetation quality index (VQI) in the MEDALUS model is calculated based on (European Commission, 1999), include the vegetation cover type, drought resistance and erosion protection. The weighted indices and classes for each of the three parameters are used to assess the vegetation quality index (VQI).

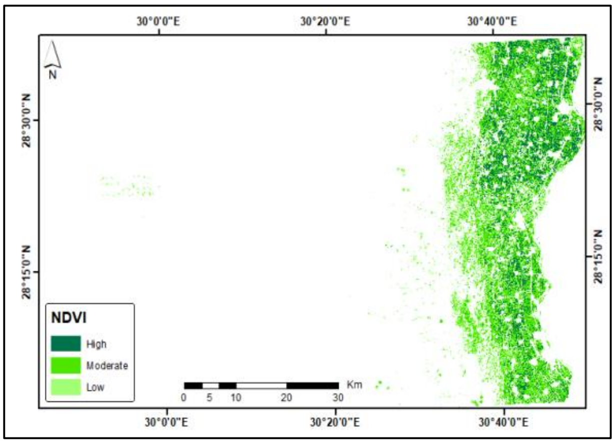

Fig. 4. Map of Normalized Difference Vegetation Index (NDVI) values.

Description of the types, scores and areas of the vegetation cover type, drought resistance and erosion protection in west El-Minia Governorate of Egypt as shown in Table (4). The percentage of vegetation cover is a necessary input in this model to assess the vegetation quality index. As illustrated in (Table, 4) 433892 ha. (65.05%) of the vegetation cover is very weak (vegetation cover <10%) and sensitive to desertification. The vegetation cover > 40% is representing a small area of 127486 ha. (19.11%). The rest of the study area has vegetation cover between 10 and 30%, 12.01% (80104 ha.). The investigated area in reflection to drought resistance classified into four categories as shown in Table (4). Evergreen trees, bedrocks and bare soils; this category represents an about 19.11% of the total area (127486 ha.), this category shows very high drought resistance. Shrubs; this category represents about 12.01% of the total area (80104 ha.) with moderate drought resistance. Annual crops and very low vegetated land; this category represents a significant area about 65.05 % of the study area (433892 ha.); this category is the lowest category of drought resistance. Erosion resistance shows how much land, and its vegetation cover is resistant to erosion. The study area in reflection to the erosion protection shows three categories of erosion resistance (Table 4). Evergreen trees and bedrocks; this category is the highest category of erosion resistance and represents 19.11% of the total area (127486 ha.) and shows very high erosion resistance. Shrubs; this category occupies just 12.01% of the total area (80104 ha.) and shows high erosion resistance. Bare soils; this category represents a significant area of about 65.05% of the total area (433892 ha.). This category shows low erosion resistance.

Table 4. Distribution of vegetation cover type, drought resistance and erosion protection classes and assigned scores in west El-Minia area.

Class	Description	Score	Area (ha.)	Area %
	Vegetation cover type			
Very high	Vegetation cover >40%	1.0	127486	19.11
High	Vegetation cover (40-30%)	1.33	0.00	0.00
Moderate	Vegetation cover (30-10%)	1.66	80104	12.01
Low	Vegetation cover <10%	2.0	433892	65.05
	Vegetation resistance to drought type			
Very high	Evergreen trees; Bedrocks; Bare soils	1.0	127486	19.11
High	Orchards; Deciduous trees	1.33	0.00	0.00
Moderate	Shrubs	1.66	80104	12.01
Low	Annual crops; Very low vegetated	2.0	433892	65.05
	Erosion protection type			
Very high	Evergreen trees; Bedrocks	1.0	127486	19.11
High	Shrubs	1.33	80104	12.01
Moderate	Annual crops	1.66	0.00	0.00
Low	Bare soils	2.0	433892	65.05
Sand dunes and Hills			25538	3.83
Total area			667020	100

Classification of the vegetation quality index (VQI).

Classification of the vegetation quality index (VQI) within the study area, on basis of Medalus project methodology (European Commission, 1999) as shown in Table (5) and Figure (5) represent the classes, scores and areas. The weighted VQI values are separated into the following classes: good, weak and very weak (<1.2, 1.4-1.6 and >1.6, respectively). The VQI classes present within the study area correspond to 19.11, 12.01 and 65.05% of the total area, respectively. The very weak of VQI is due to the lack of plant cover. Geographic locations of the studied area influence the vegetation quality, where the existence of fertile alluvial soils in the western part of the studied area are characterized by good VQI. The central parts of the studied area are mostly situated at 146 m elevated plateau; thus, ground water is rather deep resulting in weak and very weak vegetation types quality index.

Table 5. Classification of the vegetation quality index (VQI).

Class	Score	Area (ha.)	Area (%)
Good	<1.2	127486	19.11
Average	1.2-1.4	0.00	0.00
Weak	1.4-1.6	80104	12.01
Very Weak	>1.6	433892	65.05
Sand dunes and Hills		25538	3.83
Total area		667020.00	100.00

Climatic Quality Index (CQI)

CQI is assessed depend upon the amount of rainfall, aridity index and slope aspect parameters. The DEM of the studied area was used for extracting the slope and aspect (Figure, 6). The climatic quality index layer of the west El-Minia Governorate is classified by a low (1.75) CQI as shown in Table 1.

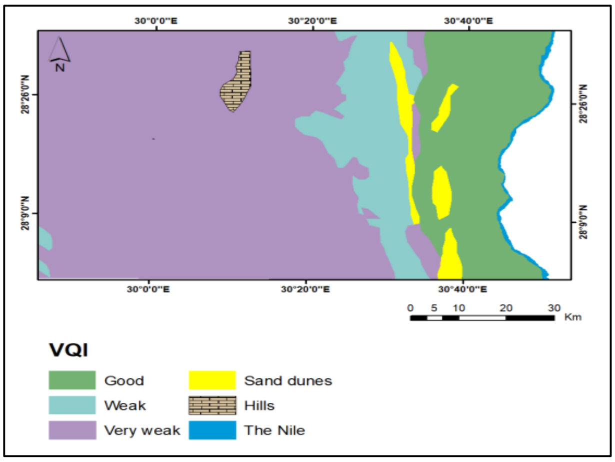

Fig. 5. Vegetation Quality Index of the study area.

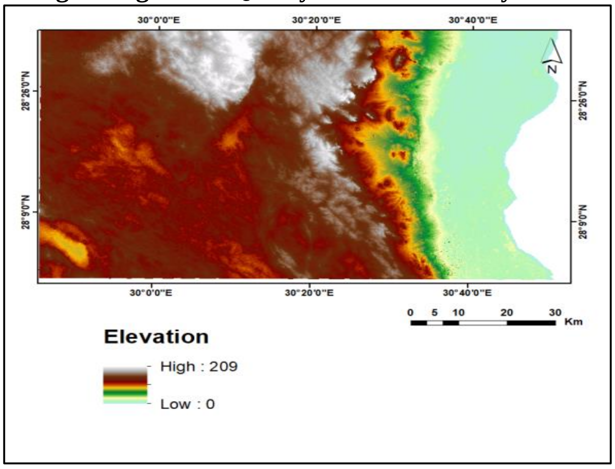

Fig. 6. DEM of the study area.

Classification of ESAI in the west El-Minia Governorate of Egypt.

The environmental sensitivity index (ESI) to desertification was calculated for the geographic coverage of the studied area using the abovementioned layers (soil, vegetation and climate indices), on basis of Medalus project methodology (European Commission, 1999). As revealed from Table 6, about 65.05 % of the area is the very sensitive for desertification and found in the western part of the investigated area, where the soil, vegetation and climatic qualities are low. The areas which are sensitive to desertification representing an area 80104 ha. (12.01%). The medium sensitive areas are found where the vegetation cover is moderate and representing an area of 129579 ha. (4.43%). The areas of low sensitive to desertification are found in eastern part of the studied area, representing an area of 97907 ha. (14.68%). The low sensitivity for desertification is due to the good soil quality and vegetation cover. Figure (7) demonstrate the geographical extension of each Environmental Sensitive index (ESI).

Table 6. Environmentally Sensitive Area Index to desertification in the west El-Minia Governorate.

Environmentally Sensitive Index (ESI) Class	Score	Area (ha.)	Area (%)
Very low sensitive to desertification	<1.20	0.00	0.00
Low sensitive to desertification	1.2-1.3	97907	14.68
Medium sensitive to desertification	1.3-1.4	29579	4.43
Sensitive to desertification	1.4-1.6	80104	12.01
Very sensitive to desertification	>1.6	433892	65.05
Sand dunes and Hills		25538	3.83
Total area		667020.00	100.00

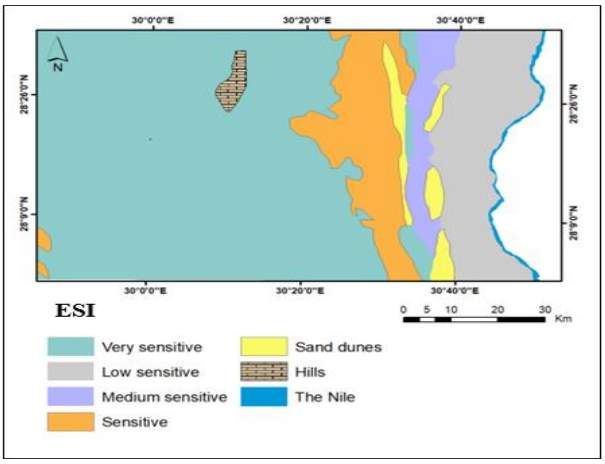

Fig. 7. ESI in west El-Minia Governorate.

CONCLUSION

The important problem facing arid and semi-arid zones is the desertification, as west El-Minia Governorate of Egypt. Using the MEDALUS model for assessment the Environmental Sensitivity Index (ESI) to desertification, this model will help decision makers produce optimal strategies against desertification in sensitive areas. The integration of assessment of soil quality, vegetation quality and climate quality are very important in planning and decision making in ESI to desertification. The results of the ESI to desertification was classified to low sensitive, medium sensitive, sensitive and very sensitive areas which represented 14.68, 4.43, 12.01 and 65.05 % respectively. The usage of remote sensing data and GIS are useful in evaluating the sensitive areas to desertification and appropriate tools to realize the agriculture development in a large scale.

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تقييم دليل الحساسية البيئية للتصحر باستخدام نظم المعلومات الجغرافية: حالة الدراسة غرب محافظة المنيا، مصر

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الهدف من هذا العمل هو تحديد دليل الحساسية البيئية للتصحر في غرب محافظة المنيا-مصر باستخدام نظم المعلومات الجغرافية على أساس نموذج رياضي MEDALUS . هذا النموذج يتضمن ثلاثة مؤشرات وهي: جودة التربة وجودة الغطاء النباتي وجودة المناخ. الخرائط الطبوغرافية والخرائط الجيولوجية والمرئية الفضائية الخاصة بالقمر الأمريكي لاندسات 8 و نموذج الارتفاع الرقمي DEM ودليل الخضرة NDVI وحصر الأراضي والتحليلات المعملية وبيانات المناخ تعتبر كلها البيانات الأساسية لحساب دليل الحساسية البيئية للتصحر في منطقة الدراسة. النتائج المتحصل عليها تكشف ان المساحات الحساسة والحساسة جدا للتصحر تقع في الجزء الشرقي وفى منتصف منطقة الدراسة حيث ان جودة التربة وجودة الغطاء النباتي وجودة المناخ منخفضة وهذه المساحات المتأثرة بالتصحر تشغل نسبة قدرها ٨١,٤٩% من منطقة الدراسة (٥٤٣٥٧٥ هكتار). الجزء الغربي من منطقة الدراسة مصنف على انه قليل الحساسية للتصحر وهذا راجع لجودة التربة والغطاء النباتي في تلك المساحة التي تمثل ١٤,٦٨% من منطقة الدراسة (٩٧٩٠٧ هكتار). والنتائج توضح ان مساحة صغيرة من منطقة الدراسة يكون متوسط الحساسية للتصحر ويمثل ٣,٤٣% من المساحة الكلية (٢٩٥٧٩ هكتار) ويقع في الجزء الغربي لمنطقة الدراسة. الكثبان الرملية والجبال تحتل مساحة قدرها ٣,٨٣% من منطقة الدراسة. العوامل المؤثرة على الحساسية البيئية للتصحر في منطقة الدراسة هي مادة الأصل وقوام التربة وعمق التربة والميل ونوع الغطاء النباتي والمقاومة للجفاف والتعرية. التكامل بين بين هذه العوامل يؤدى الى وضع خطة ناجحة لمقاومة التدهور ويكون هذا التكامل مهم جدا في اتحاذ القرار بشأن دليل الحساسية البيئية للتصحر في منطقة الدراسة.