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Distribution of Environmentally Sensitive Areas to Desertification at the North Eastern Coast of Libya

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ABSTRACT

The study area located in the north eastern coast of Libya around Darnah in the north of Al-Jabal Al-Akhdar area which extends between Latitudes 32º 36' to 32º 59' N and Longitudes 21º 47' to 22º 42' E, with an area about 2702.01 km^2. Soil quality index obtained data varied from < 1.13 to >1.67. The areas of high soil quality index which is slight by sensitive to desertification (value <1.13) was estimated about 17.64% (476.68 km^2). The moderate soil quality index (value 1.13 - 1.45) represents about 19.30% (521.55 km^2). The low soil quality index (value 1.46-1.66) represents about 43.62% (1178.75 km^2); and very low soil quality index was estimated as 19.43% (525.03 km^2). The landform of the investigated area was identified using Digital Elevation Model satallite images and land surveying data. The obtained data illustrated that the main landscape units are divided into two main landscapes units as plateau and coastal plain that includes several landform units. The layers soil, vegetation and climate indices were driven together to assess the environmentally sensitive areas to desertification, on basis of the calculated desertification sensitivity index (DSI). The obtained results show that about 11.62% (314.11 km^2) of the area is exhibited by a very severe sensitivity to desertification. While a wide area 40.49% (1094.17 km^2) is characterized by a severe sensitivity. The areas of moderate severe to desertification represent about 30.23% (816.80 km^2). On the other hand the areas of slight sensitivity to desertification represent 17.65% (476.94 km^2) of the total study area.

Key words: Assessment, Environment, Sensitivity, Desertification, Soil, MEDALUS, Darnah Libya

Introduction

The northern eastern coast strip of Libya is characterized by a relative abundance of rainfall and soil fertility that make it suitable for the appearance of rich wildlife, thus differing from the rest of the country. El-Jabal El-Akhadar and Marmarica plateau have a unique relatively large biodiversity, particularly in valleys and depressions that act as a haven for many species (El-Barasi and Saaed, 2013). Domrös and Gongbing (1988) stated that most descriptions of climate deal with temperature and precipitation characteristics because these two major climatic elements usually exert more impacts on environmental conditions and human activities than other elements do, such as wind, humidity, and cloud cover. Mean monthly precipitation and temperature data were used to investigate the main characteristics. The precipitation is about 250 mm/yr at Tripoli, Zuara, Misurata, Derna, Benina and Shahat which are along the Mediterranean coast. Winter totals of precipitation decrease moving toward the south due to the decreasing Mediterranean climate effect. About 50-70% of the annual precipitation total falls during winter. Temperatures generally increase southwards. Temperature rises to an uncomfortable 30 °C, (Griffiths and Soliman, 1972). On the mountain Jebal El-Akhdar, annual precipitation rises to 559 mm at Shahat, towards the east, the amount of precipitation decreases and became at Derna 269 mm (Kanter, 1967).

The main landforms of Libya can be identified as follow: In northern Libya, coastal plain includes coastal as well as Sebkhas, lagoons, salty marshes, swamps and coastal sand dunes. Coastal lowlands are separated from each other by pre-desert zone and backed by plateaus with steep, north- facing scarps. In the west, along the coast of Tripoli, more than 300 km coastal oases alternate with sandy areas and lagoons. In the east, there are fewer coastal oases and the Marj Plain extends inland at a maximum of 50 km along the coast, the cliffs of an arid plateau reach to the Mediterranean Sea in northeastern Libya. Behind the Marj Plain the terrain rises abruptly to form Jebal El-Akhdar (Green Mountain); McMorris, (1979).

In some coastal depressions and at the ends of some valleys, there are salt-marshes (sabkha) that have a high value of TDS which ranged between 6,769-14,471 ppm, and have a high value of alkalinity due to the accumulation of alkaline salt. Where the value of pH reached up to 10.6, it was occupied by Halophyte plant species (Omar, 2009).

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According to Brullo and Furnari (1979), the vegetation of this area represents in most of its aspects a pronounced autonomy, although there is less evidence to connect the west and east Mediterranean areas.
There are three main habitats that can be distinguished in the study area: The coastal zone, the piedmont and mountain zone .South El-Jabal El-Akhadar and Marmarica plateau are floristically and ecologically considered to be as a pasture zone.

The MEDALUS method (Kosmas *et al.,* 1999) identifies regions that are environmentally sensitive areas (ESA's). In this model, different types of ESAs to desertification can be analyzed in terms of various parameters such as landforms, soil, geology, vegetation, climate and human actions.

The main objective of this study is to assess the areas sensitive for desertification processes in area located in the north eastern coast of Libya around Darnah in the north of Al-Jabal Al-Akhdar area by using the desertification method ESAs (Environment Sensitive Areas to Desertification) based on remote sensing and GIS tools.

Materials and Methods

The study area is located in the north eastern coast of Libya around Darnah in the north of Al-Jabal Al-Akhdar area which extends between latitudes 32º 36' to 32º 59' N and longitudes 21º 47' to 22º 42' E, with an area about 2702 km^2. This study is based on the multi concept of remote sensing, thematic maps, climatic and land surveying data. Thus, materials related to these data sources were used as the following details: Landsat ETM+ image acquired during the year 2012 were employed in this study (i.e. ETM+ path 183 / 037) Fig. (1).

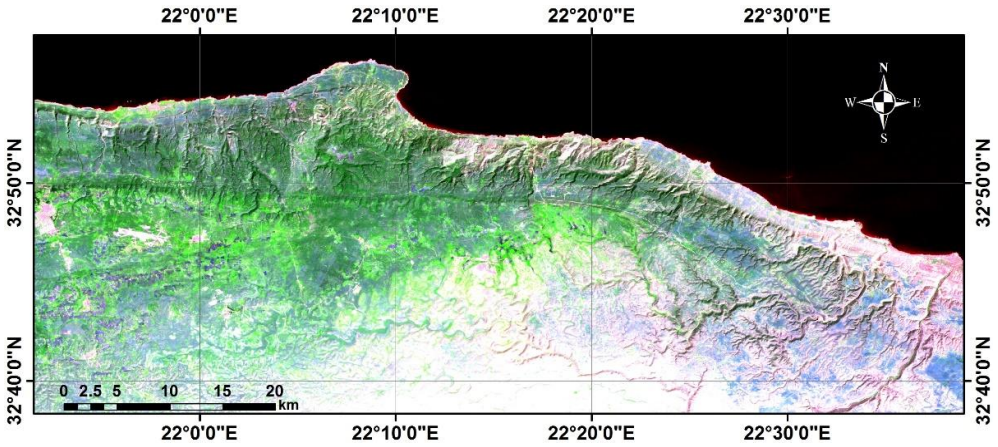

Fig. 1: Landsat ETM+ (path 183 / 037) of the study area.

Digital elevation model (DEM) of the study area was extracted from the Shuttle Radar Topography Mission (SRTM), Fig. (2). DEM could be used in conjunction with controlled imagery sources to provide better visualization of the terrain. The Landsat ETM+ image and SRTM data are processed using ENVI 4.7 software to identify the different landforms and establish the soil database of the studied area using the methodology described by Zink and Valenzuala (1990) and Dobos *et al.* (2002). The thematic maps used in this study include the soils and geology, these maps were collected from different sources and converted to digital form by using Arc-GIS 9.2 software. The geology of the investigated area was extracted from the geology of the Libya after (Thomas, 2008).

In this study, several contrast-stretching processes were applied to the images. The histogram equalization stretching process was used and resulted in the maximum contrast between features. False color composite enhanced images were produced using the combination of bands 7, 4 and 2, that were rendered in red, green and blue respectively. Rectification of studied scenes was performed using sufficient number of GCP's, which are distributed randomly all over the images. The root mean square (RMS) error was found to be 0.74 hence; image to image registration was accomplished.
Different quality indexes were calculated and displayed as GIS ready maps from which class areas were deduced. The Desertification Sensitivity Index (DSI) was calculated in the polygonal attribute tables linked with the geographic coverage according to the following equation:

$$DSI = (SQI * VQI * CQI)^{1/3}$$

The Ranges and classes of DSI are illustrated in Table (1).

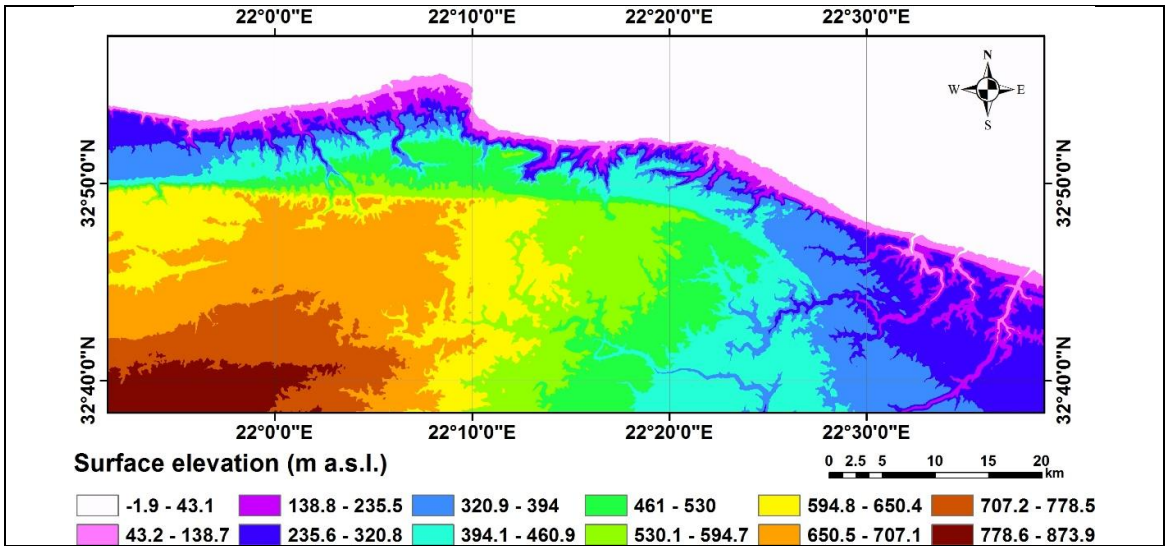

Fig. 2: Surface elevation of the study area as extracted from the Shuttle Radar Topography Mission (SRTM) images.

Table 1: Ranges and classes of desertification sensitivity index (DSI).

Classes	DSI	Description
1	> 1.2	Non affected areas or very low sensitive areas to desertification
2	1.2 < DSI < 1.3	Low sensitive areas to desertification
3	1.3 < DSI <1.4	Medium sensitive areas to desertification
4	1.3 > DSI <1.6	Sensitive areas to desertification

Results and Discussion

The obtained data of using DEM satellite images data illustrated that the study area is divided into plateau and coastal plain that includes several landform units as coastal plain, sabkhas, dry valley, depression and plateau. According to keys to soil taxonomy (USDA, 2010) soils of the study area are classified to *Lithic Torriorthents* (7.80%), *Typic Haplocalcids* (17.65%), *Typic Haplosalids* (0.55%), *Typic Petrogypsids* (17.27%), *Typic Quartzipsamments* (10.93%), *Typic Torriorthents* (15.43%) *and Typic Torripsamments* (18.75%). Soil quality index (SQI) varied from < 1.13 to >1.67 as represented in Table (2) and Figure (3) as follows: The areas of high soil quality index which is slight by sensitive to desertification (value <1.13) was estimated about 17.64% (476.68 km^2). The moderate soil quality index (value 1.13 - 1.45) represents about 19.30% (521.55 km^2). The low soil quality index (value 1.46-1.66) represents about 43.62% (1178.75 km^2); and very low soil quality index was estimated as 19.43% (525.03 km^2) of the total area.

The vegetation quality index was estimated and the obtained data reflect a great variation of vegetation quality index in this area as illustrated in Table (3) and Fig. (4). The data indicate that the areas of slight sensitive areas (value <1.20) represent about 44.20 %, the moderate sensitive areas (value 1.2 – 1.4) dominate an area about 44.18 %. The very high sensitive areas (value >1.60) occupied an area about 11.62% of the total area. The quite quality vegetation cover in the area is due to the good density of vegetation cover in the study area.

The climatic quality index (CQI) layers of the area refer that the area is characterized by low (>1.80) climatic quality index due to the low amount of rainfall compared with the evapotranspiration. The value (score) of climatic quality index (CQI) encourages the desertification process in such area. The layers of soil, vegetation and climate indices were driven together to assess the environmentally sensitive areas to desertification, on basis of the calculated desertification sensitivity index (DSI). The obtained data indicate that about 11.62% (314.11 km^2) of the area is exhibited by a very severe sensitivity to desertification. While a wide area 40.49% (1094.17 km^2) is characterized by a severe sensitivity. The areas of moderate severe to desertification represent about 30.23% (816.80 km^2). On the other hand the areas of slight sensitivity to desertification represent 17.65% (476.94 km^2) of the total area (Table 4 and Fig. 5).

Table 2: Soil Quality index (SQI) in the study area.

SQI	Rate	Area (sq km)	Area %
slight	< 1.13	476.68	17.64
moderate	1.14 -1.45	521.55	19.30
Severe	1.46-1.66	1178.75	43.62
Very sever	> 1.67	525.03	19.43
Total		2702.01	100.00

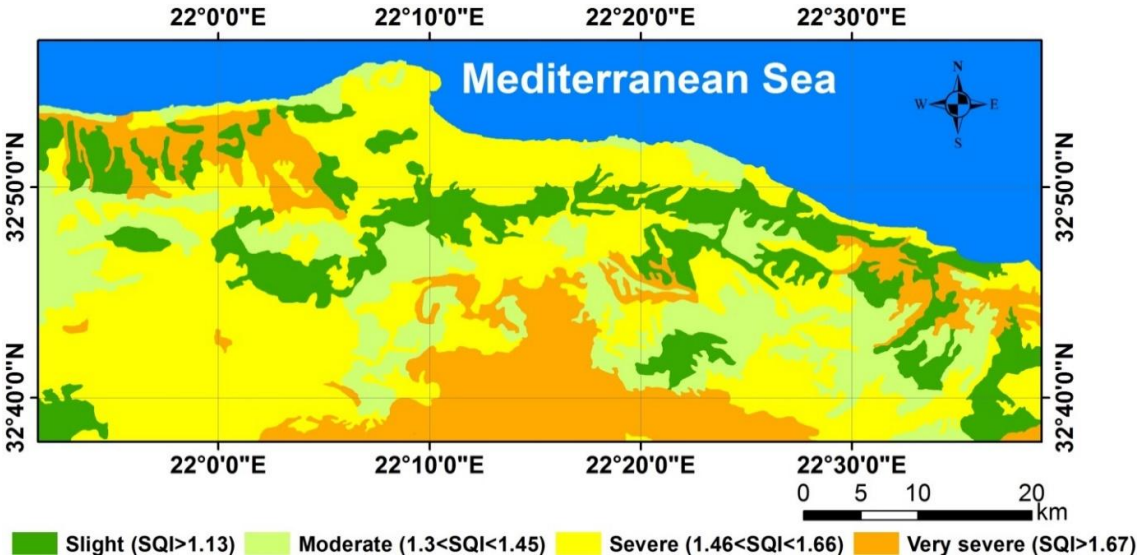

Fig. 3: Class and scores, of soil quality index in study are

Table 3: Areas of vegetation quality index classes and scores in the study area**.**

Vegetation Index class	Vegetation Index score	Area (sq km)	Area (%)
Slight	(VQI>1.2)	1194.34	44.20
Moderate	(1.2<VQI<1.4)	1193.66	44.18
Very high	(VQI>1.6)	314.01	11.62
Total		2702.01	100.00

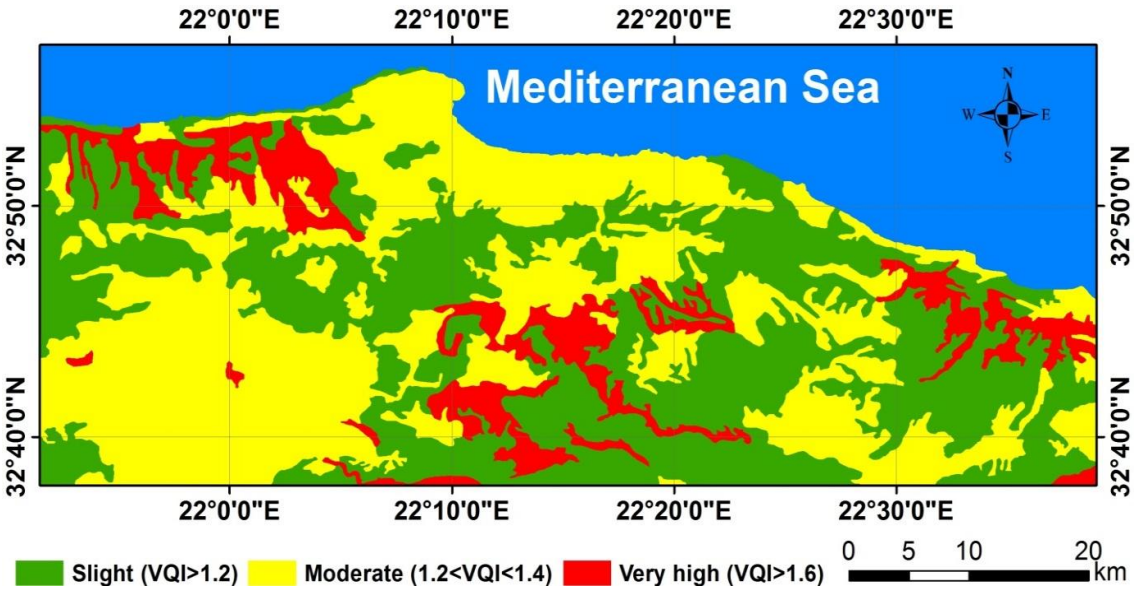

Fig. 4: Class and scores, of vegetation quality index in study area.

Table 4: Environmentally sensitive areas to desertification in study area.

Status	DSI score	Area (km2)	Area (Feddans)	Area (%)
Slight severe	> 1.2	476.94	114464.90	17.65
Moderate severe	1.2 < DSI <1.3	816.80	196030.91	30.23
Severe	1.3 < DSI < 1.4	1094.17	262601.47	40.49
Very severe	1.4 > DSI <1.6	314.11	75385.73	11.62
Total		2702.01	648483.00	100.00

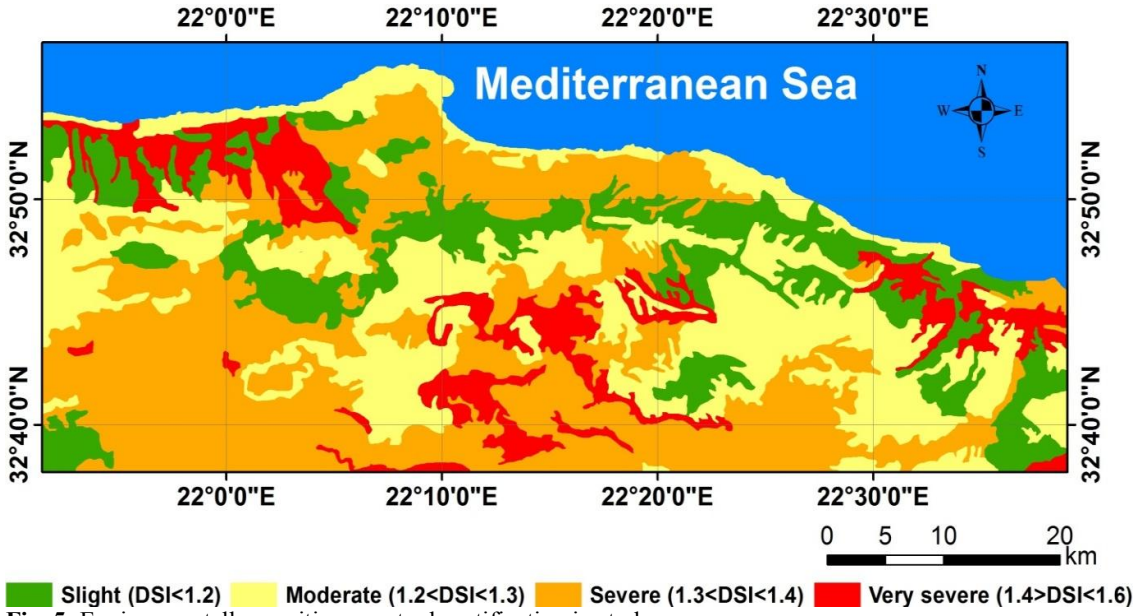

Fig. 5: Environmentally sensitive area to desertification in study area

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