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A Survey of Desertification in Al-Hira and its Surroundings Areas in Libya

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Abstract - In Libya, about 90% of the country is classified as desert land within the range of the Sahara and the remaining 10% is threatened by desertification.
The study area of Al-Hira is one of the most important pastoral area in the plain of Al Djfara in the northwest of Libya and it was until recently considered a good pasture zone where there is vegetation that protects the soil against erosion. The study area covers an area of approximately 269,938 hectares.
The goal of this study is to analyze the status of desertification in El Hira study area and the extent of its severity and its impact on the vegetation cover as well as the environmental components of the area.
Information and data related to the study area were collected such as basic maps, topography, soil characteristics and climate data.
Average annual rain is about 200 mm. Organic matter rate is very low, less than 0.5%. Average filed capacity is very low, about 6%.
The analysis of satellite images (Landsat) for the two years 1976 and 2005 indicated the degree of the change that occurred on vegetation, desertification and urbanization.
A clear increase in desertified areas and a decrease in the natural vegetation cover in the area were observed.

Keywords: Libya, Al-Hira region, natural vegetation decrease, apparition of sand dunes

Résumé- En Libye, environ 90% du pays est classé comme désertique et les 10% restants sont menacés par la désertification. La zone d'étude d'Al Hira est l'une des zones pastorales les plus importantes de la plaine d'Al Djfara au nord-ouest de la Libye. Cette région était jusqu'à récemment considérée comme une bonne zone de pâturage où une végétation est présente protégeant le sol contre l'érosion. La zone d'étude couvre une superficie d'environ 269 938 hectares.
Le but de cette étude est d'analyser l'état de la désertification dans la zone d'étude d'al Hira et l'étendue de sa gravité et de son impact sur le couvert végétal ainsi que les composantes environnementales de la zone. Des informations et des données relatives à la zone d'étude ont été collectées telles que des cartes de base, la topographie, les caractéristiques physico-chimiques des sols et les données climatiques.
La pluie annuelle moyenne est d'environ 200 mm. Le taux de matière organique est très faible, inférieur à 0,5%. L'analyse des images satellites (Landsat) pour les deux années 1976 et 2005 a montré le degré de changement intervenu sur la végétation, la désertification et l'urbanisation.
Une nette augmentation des zones désertifiées et une diminution de la couverture végétale naturelle dans la zone ont été observées.

Mots clés: Libye, région d'Al Hira, diminution de la végétation naturelle, apparition des dunes de sable

1. Introduction

Desertification is one of the most important environmental issues that have become of concern to the whole world, (UNEP, 1978). Desertification affects about 150 countries in the world. The problem of desertification has become highly influential.
Due to Libya geographical location, its climatic conditions and low rainfall, this has created a cruel environment and a sensitive land for compressive and irresponsible human use in some areas such as the study area (Ben Mahmoud,1993). Climatic changes and desertification of the study area are evident.
The study area is a semi-dry area with sensitive soil and prevailing climatic conditions made it a pasture area for long periods (Hamza, 2006). The present study aims to identify the dimensions of one of the environmental problems of desertification in El Hira area.

2. Materials and methods

2.1 Study area

The study area of Al-Hira is located in the northwest of Libya (Tab.1), south of the city of El Azizia. The study area covers an area of approximately 269,938 hectares.

Table 1. Basic information of El Aziziya meteorological station

Station	altitude	Geographic location	
		Longitude	Latitude
El Azizia	119 m	31 ° N	13: 01 ° E

2.1.1 Geomorphology of the study area

The study area is located in the Al Djfara plain wish is divided into three parts: the coastal strip that extends from the seashore to a distance ranging from 10-20 km to the south and is covered by the sediments of the fourth era, represented by both the composition of Gargarsh and the composition of the Al Djfara formation. The coastline follows the south of the central part of the plain, which is covered by sediments of the formation of Al Djfara and sand dunes with the emergence of some hills forming El Azizia especially around the city of El Azizia and the width of this part ranges between 60 to 90 km and rise from sea level 100 meters and overlaps to the south with the third part of the Al Djfara plain, which represents the last part of Mount Nafusa and is covered by gravel sediments of varying degrees.

2.1.2 Geology of the study area

The Al Djfara plain covers sediments between the Mesozoic and the fourth era, as well as the presence of volcanic rocks in the form of overlaps, basalts. The study area is covered by the composition of El Azizia. The composition of El-Aziziyah consists mainly of gray dolmitic limestone with some delicate interventions of marl, clay, flint lenses and tubers. The upper part of the composition is observed as thin phosphate overlays above sandstone interventions. The Al Djfara plain can be divided into two geological parts:

The northern part of El-Azizia: It is characterized by the presence of Eocene layers which increase as we head north. The thickness of the quadrilateral layers is about 600 meters along the coast where sand is formed with overlays of clay. Jawaris is located in the western part of the area and it is located directly above the upper sandy Cretaoui rocks in the eastern part.

The southern part extending from El Azizia to the southern boundary of the plain: the quadrilateral rocks are characterized by their small thickness falling over the upper jars rocks, which consist of an exchange between sandy rocks, intermingled with clay, limestone and dolomite in the southwestern part, and the evaporative jawars of the central west and Triassic, dolomite limestone in the middle part and finally the sandstone of the lower Cretaceous era in the eastern part.

2.1.3 Climate of the study area

The study area is within the scope of the El Azizia Meteorological Station. The available data include climatic information for temperature, relative humidity, rain, atmospheric pressure and surface winds for the period 1946-2006.

-Temperature

The temperature in the study area is influenced by several factors, including the location for latitude and terrain. El Azizia is characterized by high temperatures in summer. The average annual air temperature is 26 ° C.

Table 2. Monthly and maximum average temperature of El Azizia meteorological station (1945-2006). (http://www.wmo.int/pages/mediacentre/news_members/documents/Libya.pdfhttp://www.wunderground.com/blog/weatherhistorian/comment.html?entrynum=2)

Month	1	2	3	4	5	6	7	8	9	10	11	12	Annual average
Average temperature (°C)	15	16	19	22	27	34	35	35	33	2 7	22	16	25.8
The highest temperature measured (°C)	30	33	44	48	49	52	51	5 6	5 1	50	43	30	56 (maximum temperature measured)

-Rainfall

The average annual rainfall is very low, varying between 200 and 250 mm for the study area. In fact, the amount of rain for any month does not indicate the reality associated with precipitation may fall torrential rain in a month and then pass several years without a drop of water and rain is characterized by its local nature, where it does not fall in the whole region.

- Relative humidity:

Relative humidity in the study area can generally be described as medium. The highest average relative humidity recorded by the meteorological station was 80% during the month of Junuary and the lowest average relative humidity was 30% during the month of August.

-Wind

The most important winds with an average speed more than 3 m/s, that dominate the study area are southern winds blowing from the desert, especially in the spring, autumn and early winter. These winds cause a sudden rise in temperature and a rapid decrease in relative humidity in the study area.

All these combined to make the granules of the soil alone and non-contiguous, which makes its weight light and prone to transport by wind, which leads to desertification of the region and we note the presence of sand dunes in the region is only a result.

2.1.4 Field and laboratory measurements

Soil samples were analyzed and physical and chemical properties that have an impact on the ability of the soil to resist desertification.

Soil samples (10 profiles) were collected during August 2007 according to the specific location of the study area. Soil samples were taken and the area was divided into 10 squares and from a depth of 0-30 cm. The samples in the designated bags were numbered and the date of the sample was taken and then taken to the soil analysis laboratory of the artificial great Libyan river authority. Soil samples were taken in the aim to determine soils characteristics as:

- The pH
- Soil salinity (electric conductivity) estimated using an electric-Conductivity device
- Organic matter estimated using the calibration method.
- Calcium carbonate was determined using digestion method.
- Textures determined using an hydrometer.
- Mechanical analysis of soil (volumetric estimation of granules).
- Field capacity and wilting point determined by pressure membrane device.

Due to Libyan political conditions during the last years, it was impossible to consider more recent date and also doing any field experimentations.

2.1.5 Satellite images, maps

Updating the data and information on which the study relied. The methods of collecting, analyzing and presenting them varied according to the following:

-Satellite images:

It is represented by satellite images taken by the American satellite Landsat, through which this phenomenon was tracked and its prevalence was determined by comparing two satellite images representing 1976 and 2005.

-Maps

The topographic paintings on a scale of 1/50000 were obtained from the Survey Department. The geological map (Tripoli plate) on scale 1/250,000, produced in 1974, was used.

2.1.6 Field visits

The study included a series of field visits to identify the specificities of the region and its deterioration, especially wind and water effects as well as the encroachment of sand dunes and the status of vegetation and the extent of exposure to plants and the study of some of these plants and the possibility of their return to the previous reality from the analysis of satellite images have been taken. Photographs show desertification in general and the extent of sand dunes in the region.

3.Results and discussion

3.1 Sand Dunes

Sand dunes are sandy clusters of different shapes and their height ranges from 30 cm to more than 100 meters and is the result of wind and sand transported (Sultan Hamza, 2006). There are many forms of sand dunes on the limits of the road link between El Azizia and Gharyan cities where the height ranges from43 cm to 90 cm and many of these roads were closed by long dunes. It extends with the direction of the wind and these dunes are located on the limits of roads and sand dunes are scattered in the study area where take many forms and ranges from a height of 50 cm to 71 cm and a length between 13 meters and 460 meters approximately.

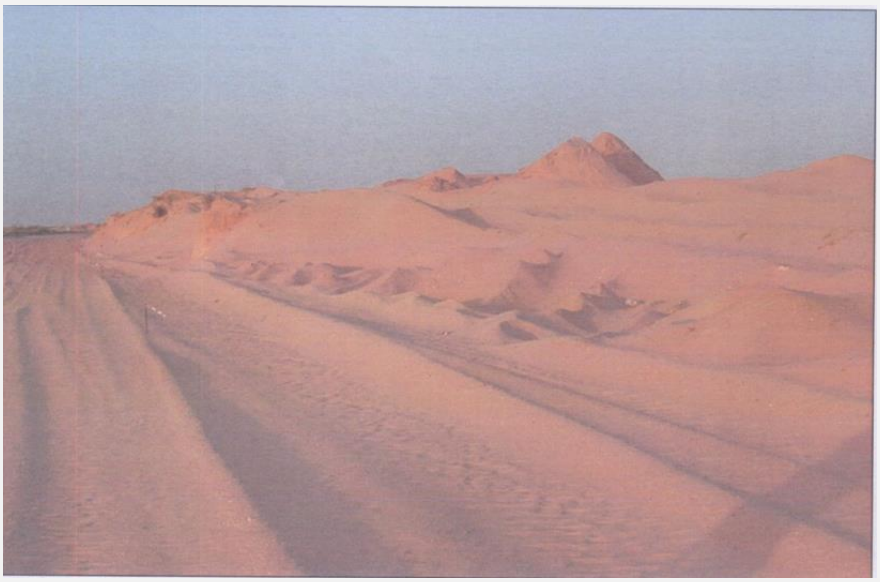

Figure 1. Distribution of sand dunes in El Hira study area

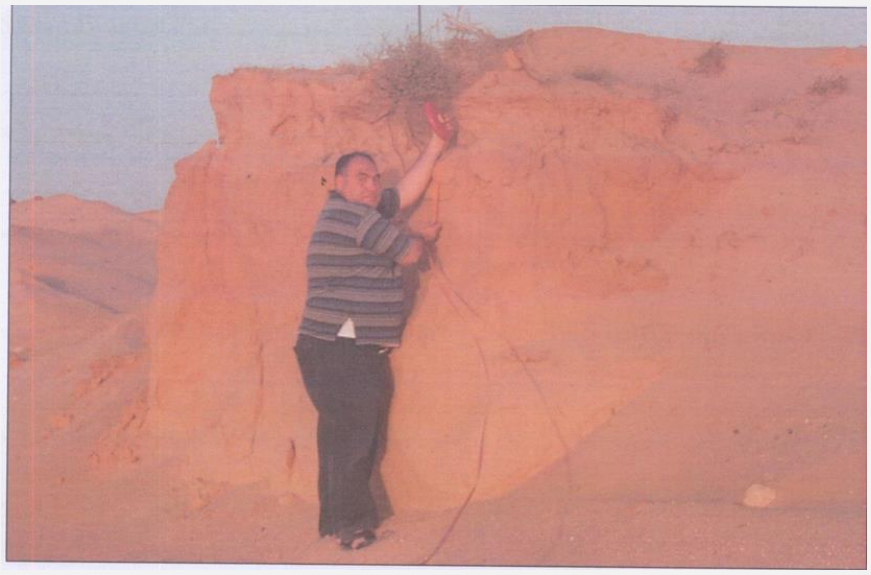

Figure 2. Measurements of sand dune heights in El Hira study area

Through field visits, the following types of land cover can be observed in the study area. The vegetation covering the study area is not dense. Desert plants were encountered in most areas such as castor crops (Ricinus-Communis), ring crops (Typhaelephanfing), retama retama, bitter melon (Citrullus - Colocyntis) and prickly pear (Opuntia - Flcus - Indica).

In the study area, there are forest trees along the road linking El Azizia and Gharyan cities, where the national program of vegetation from cultivation along the road in order to protect these roads from the encroachment of sand dunes on the road of these newly cultivated trees are in the process of growth and types of these trees: Conifers (Pinus-Halepensis) and Oak (Quercus-Calliprinos).

3.2 Physical and chemical analysis

Physical and chemical properties are given in table 3. The percentage of Calcium Carbonate in the soil of the study area varies between 0,5% and 14,5%. The area is vulnerable to wind erosion and water erosion. The lack of organic matter is very clear. Total dissolved salts shows acceptable values varying between 0.69 and 1,53 dS/m . Field capacity and wilting point in all samples are very low, which means that there is little capacity of soil moisture retention and gives an indication that the soil is sandy or predominantly sand induced by wind erosion (Tab. 3). In the Irrigated areas, localized irrigation is recommended.

Table 3. Percentage of Calcium Carbonate, Percentage of organic matter, total dissolved soils, field capacity, wilting point and soil texture of the study area of El Hira.

Sample number	Percentage of calcium carbonate	Percentage of organic matter	Total dissolved salts (dS/m)	Field capacity (%)	Wilting point (%)	pH	Soil texture
1	5.4	0.563%	1.36	5.23	4.3	7.3	Sandy silty
2	1.0	0.504%	1.19	4.52	2.99	7.5	Sandy
3	4.5	0.344%	0.94	2.8	1.8	7.5	Sandy
4	10	0.63%	1.44	9.81	6.77	7.4	Sandy silty
5	0.5	0.256%	0.69	3.3	1.9	7.4	Sandy
6	14.5	0.773%	1.53	11.2	8.19	7.4	Clay Sandy silty
7	5	0.445%	0.91	6.88	3.6	7.5	Sandy silty
8	6.5	0.294%	0.82	4.19	3.1	7.6	Sandy silty
9	10.4	0.319%	0.92	7.2	5.93	7.6	Sandy silty
10	5.8	0.470%	1.16	5.8	2.93	7.4	Sandy silty

3.3 Determination of Granules volumes

The volumetric estimation of the sand grains is an indicator of the actual occurrence of desertification (Tab. 4).

Table 4. Volumetric estimation of sand grains in El Hira study area (%)

Sample number	Too rough	Rough	Medium	Soft	Very soft
1	0.04	0.67	1.43	16.58	14.44
2	0.08	2.83	18.60	19.3	2.77
3	0.07	0.03	10.6	14.04	19.16
4	0.06	0.04	0.25	12.75	12.6
5	0.53	0.40	4.90	18.98	11.86
6	0.02	0.21	0.67	4.88	16.42
7	0.08	0.63	6.29	22.7	1.41
8	0.01	0.06	0.15	14.59	14.39
9	0.01	0.08	0.38	21.38	3.35
10	0.04	0.73	1.02	18.02	6.96

From these results, the samples consist of very fine and soft sand grains exposing the area to wind and water erosion.

3.4 Satellite imagery analysis

These satellite images were analyzed using ERDAS and ArcGIS. By analyzing and comparing these two images, the degree of the change in vegetation and the increase of the urban area and the spread of irrigated areas were identified.

- Trees density
- Traffic plants
- Natural plants and herbs
- Soil and rocky land
- Movement of sand dunes
- Land use

The change in the land cover of the study area and the surrounding areas was analyzed. The US Landsat satellite imagery was used with a resolution of 79 meters for the Landsat MSS satellite images for 1976 and Landsat TM with a resolution of 30 meters for 2005.

The changes over time were derived between 1992 and 2002.

-Case of whole area which includes the Al Djafara Plain (study area and surrounding area)

Digital optical analysis of satellite images for the entire area covered by the Landsat satellite image showed an increase in the areas covered by irrigated crops for the entire area. Irrigated area increased from 23,309 ha to 26,420 ha. For natural crops and herbs, the area increased from 58,613 ha to 68,422 ha due to irrigation. The extension of the irrigated areas will allow reducing the pressure on natural resources by the creation of fodder units, sources of survival for the local populations. But this type of irrigated area can be assimilated to oases and must be considered with social, environmental and economic problems, (Xiaobin, 2018). Experience in the management of these oases already existed in arid regions and should serve as a basis for ensuring the sustainability of these new irrigated areas (Aragüés, and al., 2011).

-Case of the area adjacent to El Azizia-Gharyan road

The results of the study area show that there is a significant reduction in the cultivated areas. These areas have changed and turned into non-cultivated areas and pastures. The study showed that there is a noticeable increase in the desertified area as shown in figure 5, (Hamrouni and Daghari, 2010).

Conclusion

The Al Hira study area is a semi-dry area with sensitive soil and prevailing climatic conditions.

In the first phase of the study, information and data related to the study area were collected such as basic maps, topography, soil characteristics and climate data. Temperatures of more than 50 °C were recorded.

The percentage of organic matter is very low (about 0.4%). Field capacity and wilting point are very low, respectively less than 7 and 4%. Soil total dissolved salt is less than 1dS/m.

It was noted that there is a significant reduction in the cultivated zones in the study area. A decrease in the natural vegetation cover in the area such as Al-Athl and Sidr is observed.

Through detailed analysis of satellite images of the region, it was noted that there is a clear increase in desertified areas.

The operation of the transfer of water from the south of Libya to the plain of El Djafarta allowed the creation of the irrigated areas which provided a certain agricultural and fodder production, likely to reduce the pressure on the natural resources of the region but irrigation scheduling and management is necessary. Even if the soil total dissolved salt is low, with the practice of irrigation, it is certain that problems of salinity and hydromorphy will be posed in the future.

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