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Monitoring desertification in the Euphrates region south Iraq using Remote Sensing Techniques

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Monitoring desertification in the Euphrates region south Iraq using Remote Sensing Techniques

Omar B. AL-Jarrah
Applied Geology Department – College of Sciences – Anbar University

oaljarrah@uoanbar.edu.iq

Abstract . Although Euphrates regions are very important agricultural areas, the land fertility declined due to drought episodes of desertification. Sand dunes developed into Euphrates areas and salinity increased, Landsat satellite images for years 1972 , 1984, 1990 , 2002 , 2016 where used to study such changes and match for all records to identify negative phenomena . Separated layers and its spatial area for each year showed expansion of desertification (29%) during the period 1972 – 2002 as a result of wind come from two major sand resources areas on the other hand, period 2002 – 2016 witnessed a low of rate about 7% desertification due to the invasion of the Ahwar (swamps) by water that partly cover sand areas, salinity increased up to 21% on river banks and places of shallow groundwater with high evaporation , Gravel covering is a highly recommended to prevent soil erosion and dune development, about salinity must establish an active drainage channels for all area.

Keywords , Landsat ; desertification indicators ; wind erosion ; dry lands ; Iraq

1. Introduction

Global warming that led to causes the spread of drought and desertification continuous loss of agricultural lands, Middle East region is greatly affected by such phenomenon, especially in Iraq where some places suffer strongly particularly in the area mid of Euphrates river between cities Kut , Naseryah and Dewanyah .

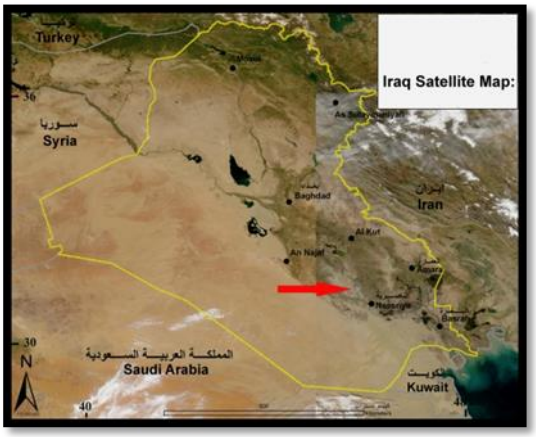

Fig.1. Studied area [1]

Two phenomena desertification and sand dunes affect badly the studied area , a continuous losing of vegetation cover and high erosion rate for healthy part of soil by effect of intensive erosion lead to degradation for agricultural areas , our study area within the third sand dune series in Iraq , Figure(1). about Salinity its noticed as a white salty spots are observed in many places s especially at middle and the south Iraq [2].

The general aim of this study to determine the next areas will threatened by desertification and find the rate and location for losing agriculture areas within past 44 years.

1.1 General characteristics of study area:

Previous negative factors changed the area from Fertile one to un valuable. The topography is generally flat and surround by some high lands Figure (2), Winds blow strongly with average speed (3.6 m/sec) that developed dunes from West and Northwest inwards [3], more over very high annual average Temperature (23.7 C°) and low precipitation (119 mm / year) yield severe drought [4] . Previous studies showed the possibility of sand dunes and dust to move or rise even at low wind speed [5]. Several sand and dust feeding areas are located near our studied area which cause many heavy sandy storms to happen there about (22 - 30 / year) , Figure (3), But the normal sandy storms have much more of that number [3], Figure (4) .

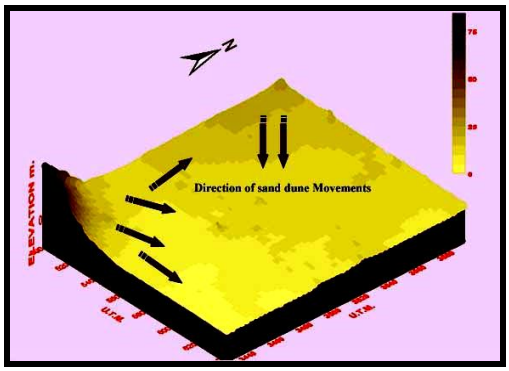

Fig.2.Topographic map of Area (by Author)

Fig. 3 . Big sand storm [1]

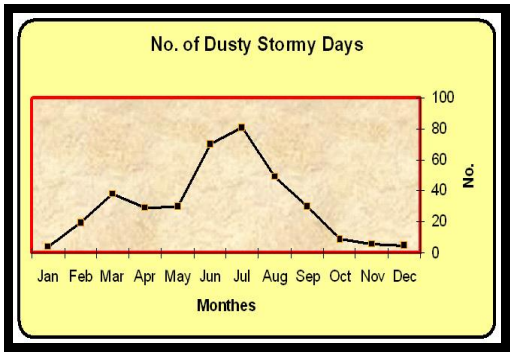

Fig. 4 . Sandy storms days [3]

Losses of agricultural areas is highly affected by salinity increment which is common in middle and southern Iraq, with different types of salts mostly Nacl with some other types like $Cacl_2$, $Mgcl_2$, Kcl, Na_2So4, these salts resulted in the development of high osmotic pressure that inhibit causing stop the feeding of plants roots [6].

Three sources of salts in the area which are : 1- underground water when its rise up to the earth surface pass through some marine original layers (such as Fatha formation contend muddy Anhydrite marine rocks with thick Gypsum rocks and some limestone) with very high salt, contents will dissolve them and carrying up these new salty solutions to the surface, by high temperature water will evaporate and leave the salt crystals on surface. 2- floods (last two floods at 1988 and 1992) when water covered adjacent areas, after which flood water evaporated by effect of temperature leaving salt crystals there , 3 – high speed wind carried salt crystals then spread over earth surface [7].

2. Data and Methods

In order to evaluate the spread of negative environmental specific images were selected through the Landsat satellite records (Table 1)

Table 1 The satellite images used for classification [8]

Type	Path & Raw	Date	Resolution
Landsat – Multi spectral scanner Mss.	168 - 38	1972	80 m.
Landsat – Thematic Mapper Tm	168 - 38	1984	30 m.
Landsat – Thmatic	168 - 38	1990	30 m.

mapper Tm			
Landsat – Enhance Thematic Mapper Etm	168 - 38	2002	30 m.
Landsat – Enhance Thematic Mapper plus Etm+	168 - 38	2016	30 m.

ArcGIS 9.0 program was used to determine expansion of sand dunes and salty areas by using as a function of time, In addition recognizing the expansion of desertification and salty spot processed Landsat Images (with spectral Bands 2, 4,7) of digital classified maps with 4 major classes, Which is dominated in area.

Supervised Classification with maximum likelihood equation software was carried out because its fast time saving and more applicant features. Theory of that software to calculate spectral value of each pixel in the image then matching with standard classes given before as standard features, best coincidence between an image pixel and standard class can be considered as one of that class .

The 4 main classes were (dry lands such as sand dunes - agricultural areas - salty areas - water bodies) checked by field work , since these varieties are the main presence in the area through which the expansion of negative environmental cases (like desertification) can be detected.

Classification methods yielded excellent results with a limitation percentage of (2.6%) where maximum likelihood software could not classify them , relatively small rejection rates (10% - 20%) and low error rates can be further reduced significantly [9] . by standardizing the scales for all new digital maps ,and total matching between them based with ground control points such as Landmarks or facilities Figures (5,6,7,8&9) , showed the main changes at the our studied area .

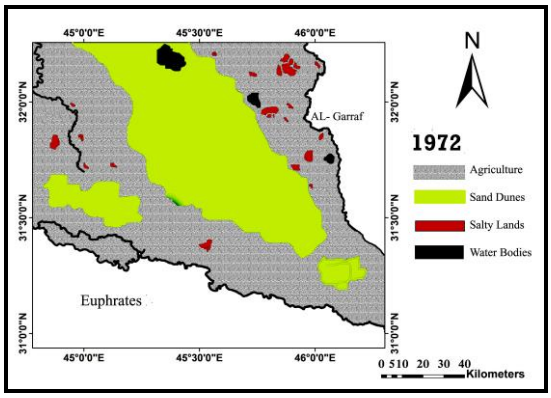

Fig. (5). Classified map for Area at 1972

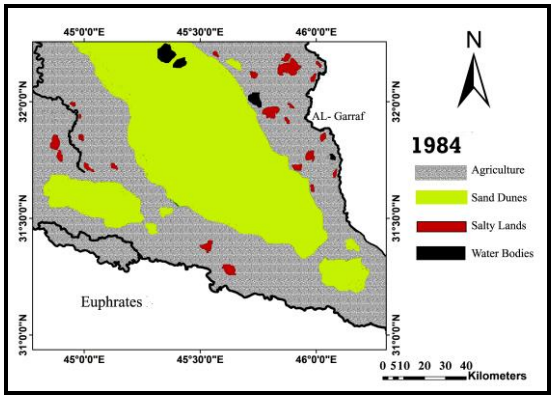

Fig .(6). Classified map for Area at 1984

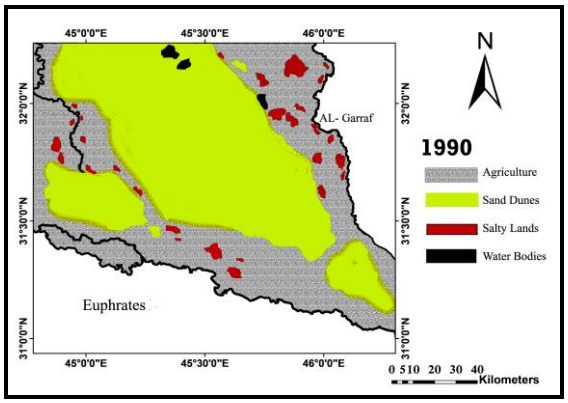

Fig. (7). Classified map for Area at 1990

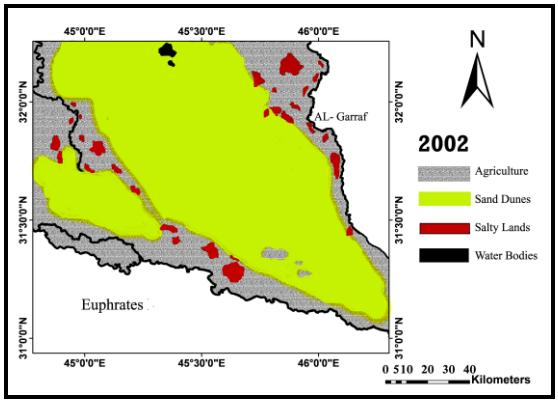

Fig. (8). Classified map for Area at 2002

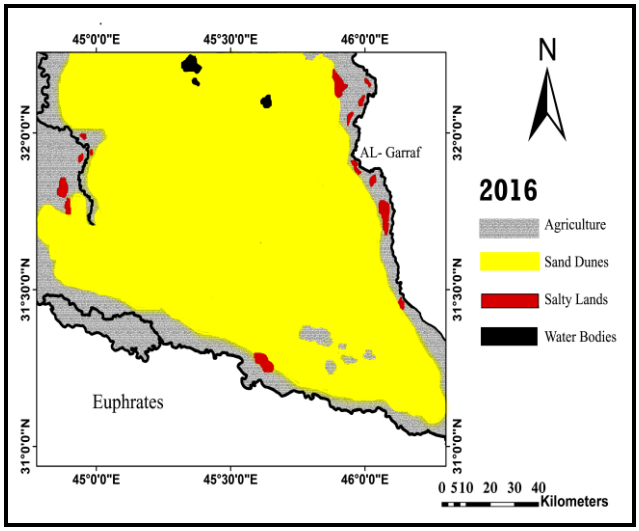

Fig. (9). Classified map for area at 2016

3. Calculations

ArcGIS 9.0 software was used to create a new layers to the classes as a unique layer for a period of (44) years (1972 – 2016), In order to obtaining the best calculations for changes within period, some control points were chosen with following characteristics : 1 - fixed 2 - easy to identify 3 – existing since 1972 (Bridges - Big Building – High Tension Towers.etc.),

Matching was followed to subtract the changes between any two sequence maps, results a new map for that periods Figure (10), obtaining the changes , showed increasing of desertification and sand dune development with(36%) increment, as well as increasing of salty areas about (21%).

4. Results

Applying the previous matching sequences and the subtraction process, several environmental changes were recognized in area .Places of desertification phenomenon (spots 1, 2 and 3) are directly related to the main wind direction, in region Figure(2), near the cities (Afaq - Al-Badr - Nofeer) located on borders of the sand resource feeding area, The presence of tall trees act as windbreaks and dampers for sandy winds will do down and accumulate sand in adjacent area. [10]

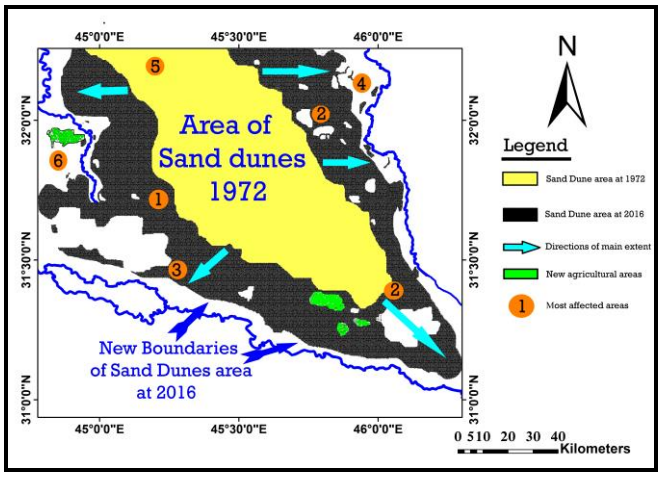

Fig. (10). Total changes for period 1972 - 20166 2016

Similarly region (2) close to the Al Gharraf stream is characterized by agricultural areas and tall trees, In contrary region (3), is an open flat area surrounded by high lands supports sand dunes development from the west and accumulate there [11],Another negative impact Figure (11) affected the highway (No.1) in Iraq that crosses region 3 where some sand dunes accumulate and threaten the heavy traffic[12] .

Fig. (11) One of the High- way parts threatened by sand dunes

Salinity intensely affects region (4) along banks of Gharaf stream , the shallow level of groundwater sometimes rises up as salty solutions. The salinity of the groundwater in the shores of the Euphrates and Al Gharf stream ranges between 1000 and 3000 mg / liter, which is dominated by Calcium-Magnesium -Bicarbonate Ca-Mg-HCO3. The salinity increases as a result of seeping from the surface waters that overwhelms the shallow depressions and as a result of high evaporation rate and less precipitation. These solutions evaporate leaving the salt crystals on ground surface, Flood seasons also increase salinity as that happened at flood of 1988 when water passed over the banks and immersed all adjacent areas then evaporated later leaving salt's crystals [13]. Region (5) show almost the same mechanism because of Hor Aldalmej (small swamp with salty water) which gets water from groundwater as a main resource also from some rains , so because of high temperatures and continued dry seasons the Hor gradually became smaller and large amounts of salts were left on the surface . Region (6) which is elevated (14m a.s.l.) but lower than surrounding areas by about 20 m. Therefor water flow from higher areas resulted in small swamps which destroyed the agricultural areas due to higher summer temperature(arid) and winter's dry conditions.

5. Discussion

Losing agricultural areas by desertification and salinity became one of most important problems caused by global warming and human activities [14],. There are many treatments used to stop that all around the world but no one could be 100% successful ,Regarding desertification there are many world's treatments :

1 - Mechanical and biological Treatments: stopping or changing the direction of sand dunes development far away from agricultural areas, internationally several types of windbreaks have been proposed according to the nature of the region and the facilities available. Long trees - dense plants - artificial walls built (trees branches , boards from wood or steel , soils & rocks veil) are effective means [15]. In addition, dig longitudinal trenches in the direction of sandy wind paths and in opposite directions to the agricultural areas threatened by sand encroachment, act as traps for sand transported by winds.

Spot No. 1 and 2 are the proposed location for wind break walls Figure (12) facing the direction of wind blowing . These artificial means can be made from different materials (branches or steel boards), or by forestations (re-planting trees) , especially at shelter belts, two or three parallel belts of fast rate growing trees effectively achieve good results.

2 – Chemical Treatment : heavy chemical material such as crude oil can be used to cement the upper part of sand and prevent soil erosion[16]. However this treatment has some environmental impacts because such chemical materials resulted in recovery.

The most suitable treatment is to cover the source areas with gravels (No. 1- 2) , Figure (12) this procedure will be fixing the upper soils and preventing wind erosion. have many advantages :

1 - Clean environmental effect .

2 – Cost- effective and with close gravel quarries .

3 – Quick soil recovery .

4 – Maintenance free over the time scale.

Salinity is treated by constructing a complex net of drainages in area of high levels of groundwater near the rivers banks and at low topographic areas. These drainages will let saline groundwater to leak and gradually accumulate [17]. This treatment recommended a complete Theodolite surveying works in order to detect the main slope of area.

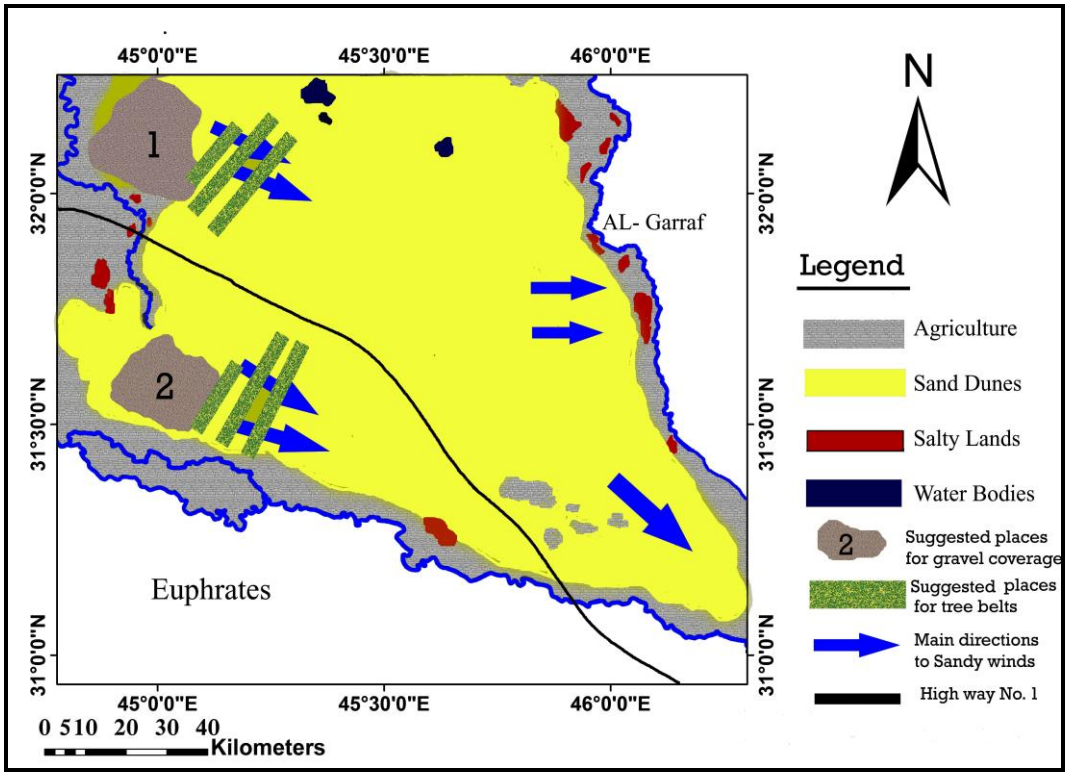

Fig. (12) Proposed treatments to be applied in the study area

6. Conclusion

Regression of agricultural areas and decreasing of grazing plants due to negative environmental impacts resulted in a great economic loss and changed the demographic situation. Farmers immigration, closing of highway or other main roads by moving sand dunes , are great problems.

The Proposed treatments maybe not totally useful or be(100%) successful because they are site specific .However , It can identify dangerous effects, fix the moving of sands dunes and dust blowing by gravel cover that prevent upper soil from erosion or dump wind velocity by

replanting fast grow trees and constructing some artificial walls . Salinity establish active derange channels system to get out salty water to safety areas, such treatments must be done fast to stop agricultural loosing and results can be notice within some years .

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