The Determination Of Desertification Phenomena Using Remote Sensing Techniques

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Abstract:

In this present work, the digital image analysis is used as a developed remote sensing technique to study the effects of desertification phenomena in Karbala South west of Iraq. Two satellite images used in this study with coverage area of 80 km^2. The first was SPOT panchromatic image, 10 m resolution taken in 1999. The second was Landsat (TM) visible image, 30m resolution taken in 1987.

An area of 1 km^2 was selected from each image to be the site of the field experiment. The experiment period was six months from. Nine points were selected within the selected area to be the measuring points. The measurements were done every two months for both the vertical and horizontal accumulated sand in the nine points. These field measurements led to an average of 1.5 cm/day of sand creeping within the measuring period.

Key Words: Remote Sensing, Desertification.

(تحديد ظاهرة التصحر باستخدام تقنيات التحسس النائي)

الخلاصة :

في هذا البحث تم استخدام التحليل الرقمي للبيانات الفضائية وتطوير بعض التقنيات لدراسة وتحديد ظاهرة التصحر في منطقة كربلاء جنوب غرب بغداد . تم استخدام صورتين فضائية لتغطية 80 كم^2 تمثل منطقة الدراسة الصورة الأولى نوع spot للمتر الصناعي الفرنسي بقدرة تميز 15 م والثانية نوع الراسم الداخلي (TM) بقدرة 30م وتم اختيار كم^2 واحد لإجراء القياسات الميدانية لمدة 6 اشهر واختيار 9 نقاط بمعدل قياس كل شهرين لتحديد حركة وتجمع الرمال.
وتبين من تحليل القياسات بان حركة الرمال بمعدل 1.5 سم / يوم خلال فترة القياس .

Introduction:

Desertification is the end-product of a combination of both natural and anthropogenic or man-mage factors of the environment which work together to produce a desert condition in an area. There are other geoclimatic factors such as temperature, evaporation and wind.

Desertification is at the heart of the development problematic of many countries, in fact, of large regions of the world. Destruction of arable land is jeopardizing development while, simultaneously, lack of development is preventing any action against desertification.

Action can only be successful if it is an integral part of a comprehensive development plan and strategy, which takes fully into account the

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communities directly. Affected by drought or desertification. The causes of drought and desertification in west of Iraq have been identified as meteorological, pedological, geological and agriculture, loss in soil fertility, movement of desert environment, population migration, and great losses in human and material resources.

The negative effects of desertification include loss of lands for habitation and agriculture, loss in soil fertility, movement of desert environment, population migration, and great losses in human and material resources. All these constitute serious threats to human and animal life. No one state or country alone cans successfully combat drought and desertification.

The encroachment of sands upon agricultural lands and cultural features did not pose a problem serious enough to be considered in scientific literature until very recently[3].

2. Site Investigation And Measurements:

Large areas in Iraq are threatened with dangerous phenomena that may causes problems in agriculture, human life and activities, and water resources, this problem known as desertification phenomenon. Which are very clear in the westren side of iraq were infected with sand movement towards agricultural lands and cities, which converted those lands to useless areas [6].

One of the threatened areas is Karbala. Karbala lies at middle of Iraq. A piece of land was selected from Karbala to study, which lies between (32° 25' 14" - 32° 30' 25") latitude and (44° 10' 55" - 44° 16' 40") longitude. The area selected covers an area about 80 km^2. This area threatened by desertification from the west side where; The desert lies.

Two satellite images of Karbala were collected; the first image was taken by **SPOT** satellite in 11/6/1999. This image is panchromatic with 10 m resolution. The second image was taken by Landsat (**TM**) satellite in 16/2/1987. This image was taken in the visible band with 30m resolution. The selected area bounded from the east and northern east sides with agricultural lands, which make them chancier to infect by desertification. The selected area could be recognized in Figure (1) in Appendix A, which illustrates; The Iraq map with selection window representing the study area.

2.1 field experiments

Nine wood sticks fixed at the nine points, each point has one stick. Each stick dimensions are (2m height above the ground, 15cm x 2cm cross sectional area). When the nine sticks fixed at the nine points, the position of each point was taken as a reference of the other measurements. The measurements were taken at each stick every two months. Three measurements were taken for each point, so the total measuring period take about six months.

The coordinates of the nine points were determined using the GPS (Global Positioning System) device with model (Garmin II +) with accuracy of ± 15m.

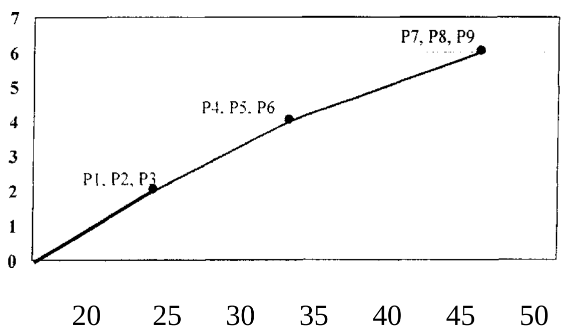
The (GPS) is a radio positioning system which provides suitably equipped user with highly accurate position, velocity and time data.

The purpose of using the GPS device in the field experiment was to insure right distances between the nine points.

The measurements done by measuring the height and length of the accumulated sand progress in the period from 1/4/2001 to 1/10/2001. The height is measured in the (W-E direction) as well as the horizontal sand progress.

The vertical measurements were documented in a Table form to calculate the amount of sand progress and produce the progressive curve for the measuring period. These measurements are shown in Table (1).

After these measurements, the average height value of the accumulated sand progress of each point in three readings (each two months) was calculated, then the average height value of the accumulated sand progress of each three points lies on the same column (i.e. PI, P2, and P3) was calculated. After that, the vertical accumulated sand progress curve of the three columns after calculating the average height value of each column was drawn. Figure (2) shows the vertical accumulated sand progress measured in (mm) with respect to time (month).



The vertical average accumulated sand progress (mm)

Figure 2. The accumulated average sand height progress-time curve.

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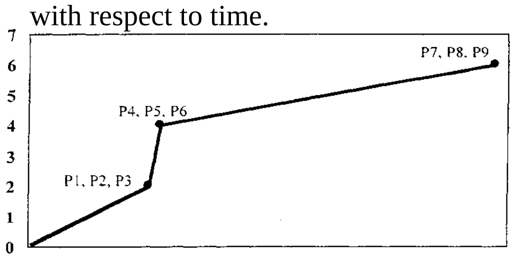
Also, the horizontal average accumulated sand creep behind the *vood* sticks was measured. When the sand moves from one place to mother, it makes sand waves on the ground.

These waves are differing from each other in shape and size depending upon the metreological factors that effected on this phenomenon and the mother rock. The horizontal distances of accumulated sand progress are shown in Table (2). The measurements were taken from the stick position as a reference to the end of the sand wave. All horizontal average accumulated sand progresses were measured in meter unit. Also, the average horizontal accumulated sand progress in each column was measured by calculating the average measurement of the three points lying on the same column. Figure (2) illustrates the horizontal average accumulated sand progress with respect to time.



Time (months)

2.5 2.6 2.7 2.8 2.9

The horizontal average accumulated sand progress (m)

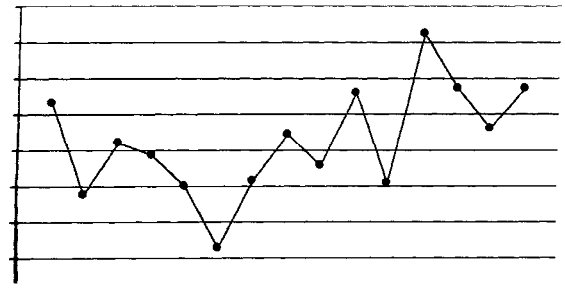
Figure 3. The horizontal accumulated sand progress-time curve.

A geological map with 1/100000 scale was used to integrate the suggested study area with map information. In recent few years, large areas in Karbala have been developed and converted to agricultural areas specially those which are near the river (Euphrates).

Although Karbala lies at the desert boundaries, it was necessary to find out any factors, which have a major effect on desertification phenomena production. In the next section, one of the most effective factors is briefly described, which is the metreological state of Karbala.

2.2 Metreological Data Analysis

One of the most important factors that have a major effect on land condition, human activities, and agriculture is the metreological factor. The metreological factors are temperature (maximum, minimum, and bulb), wind speed and direction, humidity, and amount of rain fall. Figures from (4) to (7) represent the changes in the metreological data during the twelve years . These data is collected as monthly measurements by the General Incorporation of IRAQ Metreology and then the averages of each collected data were calculated for the field work period (1/4/2001 to 1/10/2001).



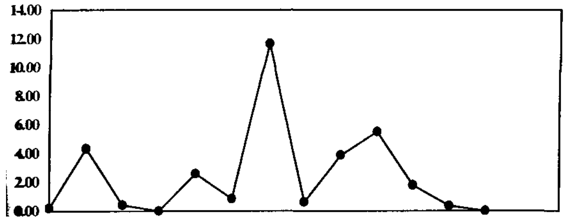
Year 1988 1990 1992 1994 1996 1998 2000 2002

Figure 4. Mean maximum temperature degrees of Karbala.

In Figure (4) which represent the maximum temperature degrees in Karbala for twelve years, the highest temperature between 1998 and1999.

Also we can see that the period from 1995 and 2001 has high relative humidity for the field work period. This high humidity with rather high temperature causes the water to be transported into water drops and settle in rock pours. In some cold nights, the water drops in the rock pours transformed into ice crystal, which make their size to be much bigger than the water size. This operation helped to cause the rock erosion and then sand creep [4].

In Figure (5), we can see that the period between 1998 and 2000 rather has no rain which makes the erosion easier to take place by the wind. Wind speed could be seen in Figure (4-10) which represents the speed of wind in Karbala; also Figure (7) represents the highest wind speed in Karbala for the field work study.



Year 1987 1989 1991 1993 1995 1997 1999 2001

Figure 5. Rain fall averages of Karbala.

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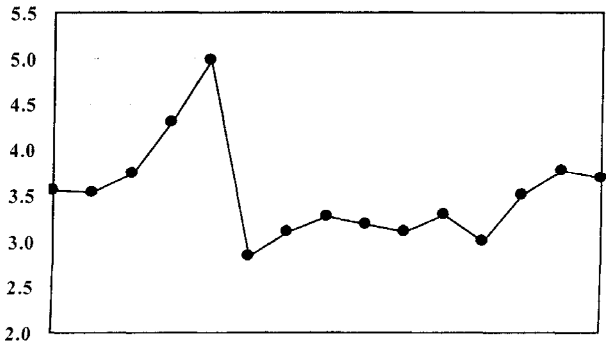
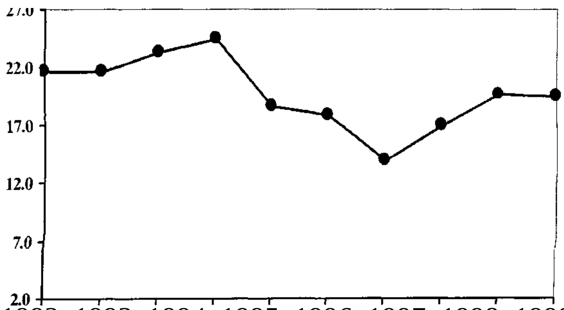


Year 1987 1991 1993 1995 1997 1999 2001

Figure 6. Mean monthly of wind speeds of Karbala.



1992 1993 1994 1995 1996 1997 1998 1999 2000 2001

Figure 7. highest wind speed of Karbala.

The wind direction indicates the position of the most threatened lands and determine the optimum fieldwork site. Table (3) illustrates the directions of which the wind comes from 1992 to 2001 in all months.

The letters in Table (3) indicate to the first letter of the four global sides (North-South-West-East).

3- Digital Image Processing

One of the more methods of desertification phenomena is how to connect the field data with satellite image procedure. The same procedure was employed in edge detection filtration process. The six types of edge detection filters were used on both SPOT and TM images. As the previous stage, the histogram of each filtered image was drawn before and after the equalization process to find the differences that happened to each filtered image.

The results of applying the "Laplace 4-point" edge detection filter type (1) and the equalization process on SPOT image are shown inappendex (A). Figure (2) & (3) illustrates the histogram of each filtered image of the above process [7].

The results of applying the "Laplace 4-point" edge detection filter type (2) and the equalization process on SPOT image are shown in Figure (4). Figure (5) illustrates the histogram of each filtered image of the above process.

The results of applying the "Laplace 8-point" edge detection filter type (1) and the equalization process on SPOT image are shown in Figure (6). Figure (7) illustrates the histogram of each filtered image of the above process [2].

The results of applying the "Laplace 8-point" edge detection filter type (2) and the equalization process on SPOT image are shown in Figure (8). Figure (9) illustrates the histogram of each filtered image of the above process.

The results of applying the "Vertical direction" edge detection filter and the equalization process on SPOT image are shown in Figure (10). Figure (11) illustrates the histogram of each filtered image [7].

The results of applying the "Horizontal direction" edge detection filter and the equalization process on SPOT image are shown in Figure (12). Figure (13) illustrates the histogram of each filtered image of the above process.

3. Conclusions:

After finishing the three steps of work (field experiment, metreological data analysis, and digital image processing) of Karbala SPOT and TM images. The following conclusions are obtained:

1. From the fieldwork, the average accumulative sand in horizontal direction is about 1.5 cm per day.
2. The fieldwork result above can not be considered as a constant value in Karbala. The results differ from point to point of measuring depending upon the metreological situation within the measuring period and the position of the experimental site.
3. The worse period of Karbala within the twelve years from 1987 to 1999 is between 1998 to 2000, which cause desertification to take place much more than other periods within the twelve years mentioned.
4. The location of the field experiment effects on the measurements, which causes differences in the final conclusion.
5. The more threatened areas are those which lie in the western north direction from the site of the experiment. This conclusion is obtained from the common wind direction in the metreological data section in chapter four because the common wind direction in Karbala within the twelve years from 1987 to 1999 is northern west.
6. Using the current SPOT panchromatic image

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gives more details about the study area because of the high resolution of SPOT image and the unsuiTable band of Landsat (TM) image.

7. Only the smoothing filters (Type 1 & Type 2) gave an enhancement to SPOT image to determine the shape of sand dunes and other sandy hills.

8. The three types of smoothing filters gave no enhancement to TM image because of the low resolution of TM image.

9. The four types of sharpening filters gave no enhancement to TM image also after histogram equalization process because of the unsuiTable band for desertification study and low resolution of TM image.

10. The first two edge detection filters (Laplace 4-points) gave more enhancements to SPOT image and separated the sand dunes and other features from the image.

11. The Laplace 8-points (Type 1) edge detection filter gave more brightness to SPOT image and also gave a little separation between the sand dunes and other features.

12. The Laplace 8-points (Type 2) edge detection gave no enhancements to SPOT image.

13. The two directional edge detection filters gave a three dimensional shape to SPOT image.

14. The four edge detection filters gave no enhancements to TM image even after equalization process.

4. Reference

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Appendix A

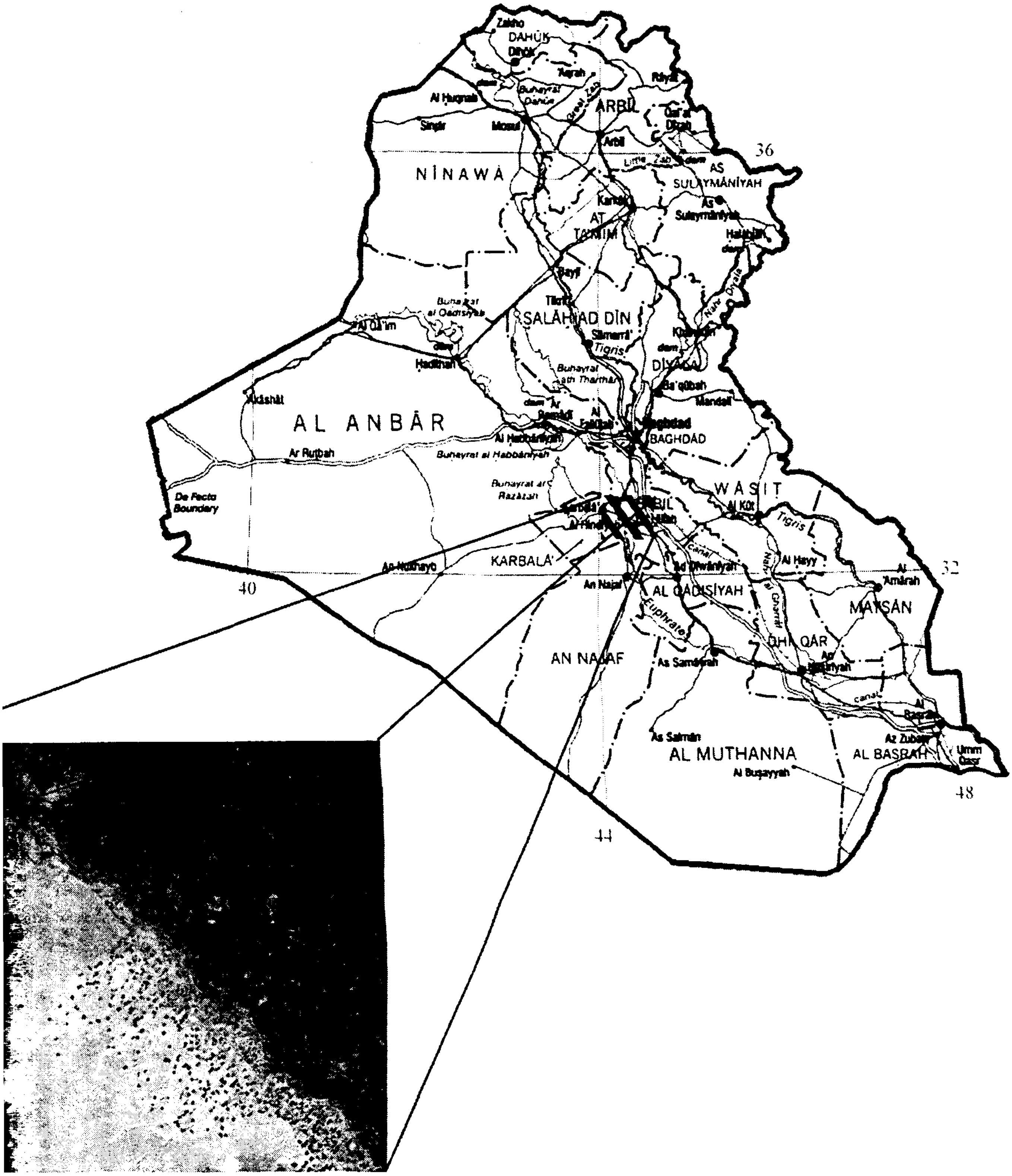

Figure 1. The Iraq map with selection window represents the selected study area.

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