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Study the Wet Region in Anbar Province by Use Remote Sensing (RS) and Geographic Information System (GIS) Techniques

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Abstract

Recently, in the last years, the world interested with Ecosystem is increased, and that is interrelation with global atmospherically, by the existence followed continuous animate variables, that is immediately influence at ecosystem nature by inspection systems process such as satellite imagery or aerial photographs, that can determination the wetland regions which aid fulfillment balance globe ecosystem. In this study a determination of wetland regions in IRAQ, was done for Anbar province, because many of regions Saturated with water or sponge and aquatic of plant, additionally, existence metrology factors that significant role were depended to be as important factor to define the wetland regions as temperatures, relative humidity, and rainfall. The ArcMap-GIS tools of interpolation tchniques of IDW type were applied to interpolate these metrology data exact interpolation.

Also remote sensing is utilized exploitation Landsat satellite imagery production of 2007 year for March month, and it is processing by vegetables and (water, rainwater) regions determination, and it may processed variable factors measurements for metrology subject at regions by determined affirmative influence wetland activeness by using geographic information system (GIS).

Keywords: remote sensing techniques (RS), geographic information system (GIS), Landsat satellite imagery, interpolation techniques.

دراسة المناطق الرطبة في محافظة الانبار باستخدام تقنيات التحسس النائي ونظم المعلومات الجغرافية

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الخلاصة

في السنوات الاخيرة زاد اهتمام العالم بالنظام البيئي وعلاقته بالغلاف الجوي للكرة الارضية، من خلال متابعته للمتغيرات الحياتية المستمرة والتي لها تاثير مباشر على طبيعة النظام البيئي ومن خلال انظمة المراقبة ومنها صور التوابع الارضية او الصور الجوية ومعالجتها مكن من تحديد المناطق الرطبة والتي تساعد على تحقيق التوازن البيئي للكرة الارضية.في دراستنا هذه تم تحديد مناطق رطبة في العراق في محافظة الانبار وذلك لوجود المسطحات المائية والمناطق المتفرقة المغمورة بالمياه او اسفنجية، بالاضافة الى عوامل الانواء الجوية التي تم اعتمادها كي تلعب دور هام في تعريف المناطق الرطبة منها درجة الحرارة والرطوبة النسبية ونسبة تساقط الامطار ودرجة الندى ورطوبة التربة. وقد تم تطبيق تقنيات الاستيفاء من أدوات ArcMap نظم المعلومات الجغرافية نوع IDW تم تطبيقه على هذه البيانات استيفاء المحدد.وفي دراستنا تم الاستفادة من تقنيات التحسس النائي باستغلال المصورات الفضائية للتابع الارضي لاندسات سنة 2007 للشهر الثالث وتم

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معالجتها بتحديد المساحات الخضرية والمائية للمنطقة، كذلك تم معالجة قياسات العوامل المتغيرة لعناصر الانواء الجوية للمنطقة لتحديد مناطق التاثير الايجابي والمكون المنطقة الرطبة بتطبيق تقنيات نظم المعلومات الجغرافية.

Introduction

Electromagnetic radiation (EMR) which travels at a velocity of 3×10^8 ms^{-1} from the source is usually recorded by remote sensors. EMR is travel directly through the vacuum of space or indirectly by reflection or reradiation to the sensor. As such, EMR represents a High-speed communications. It links between the sensor and remotely located phenomena [1].

The studies of Landuse & Landcover have turn out substantial and effective in new years because of the explosively outgrowth in the inhabitance and frugality. As the growth continues, landscape is changed in dramatic ways [2].

Wetland is the land saturated with water, either permanently or seasonally adjusted, so that takes on distinctive ecosystem characteristics [3. Wetlands play a several of important environmentally functions, fundamentally water filter, control of flood, carbon sink and the beach stability. Wetlands are considered the most biologically diverse regions of all ecosystems, employ as homeland to a vast field of living creatures. [4] Wetlands are mainly classified to four types: Marshes, swamps, bogs and fens. Some Scientists also distinguish as additional wetland kinds a wet meadows and aquatic ecosystems [5].

The UN Millennium Ecosystem Assessment concluded that environmental degradation is more notable at the systems of wetland than any other Earthly ecosystem.[6] Usage of international conservation efforts are being in conjugation with the advancement of prompt assessment tools to educate people about wetland cases. Wetlands may be constructed to use for remediating indigenous and industrial wastewater as well as floodwater runoff. Wetlands have nonesuch characteristics: they are mostly prominent from other water bodies or landforms based on their water level and on the kinds of the live plants within them. Wetlands are specifically recognized as having a water table that stands at or near the land surface for a long quite period each year to support aquatic plants[7].Wetland have also been qualified as ecotone, saving a transition between water bodies and dry land. land would be transformed to a wetland ecosystem when the immersion by water results soils dominated by anaerobic processes which in turn forces the biota specially rooted plants to adapt to flooding.[8] Wetlands can be not wet during the dry season and unnatural (Non rainy) at the wet season, but in the normally states of the environmental, these soils are appear as wetland, have a saturated surface with water or inundated such that they become anaerobic, and those wetland conditions will still through the wet section of the growing seasons [5].

2. Wetland Ecology

Flooding is the most important factor producing wetlands. The duration of the flooding determines whether the resulting wetlands have aquatic, swamp vegetation or marsh. There are other interest factors like fecundity, natural disturbance, competition, herbivory, burial and salinity.When peat is accumulate, fens and bogs arise [9].

2.1 Characteristics of wetland

Wetlands vary due to regional and local differences in topography, vegetation, hydrology, and other factors, including the human involvement. Wetlands may be mainly classified to: tidal and non-tidal regions [9].

2.2 Hydrology

The hydrology of wetland is related with the spatiality and temporality of dispersion, physio-chemical attributes of surface, flow and ground water in its reservoirs. depend on the hydrology, wetlands may be assorted as riverine (associated with streams), palustrine (isolated) and lacustrine (related with lake and reservoir). Sources of hydro-logical flows into wetlands are surface water, predominantly precipitation, and ground water. Water is flow out of wetland by surface runoff, evapotranspiration, and sub-surface water outflow. Hydrodynamics (water movement through and from wetlands) influences hydro-periods (temporally vicissitudes in the levels of water) by controlling the balance of water and the storage of water within a wetland [10].

2.3 Role of salinity

Salinity has a robust effect on the water chemistry of wetlands, particularly wetlands along the coast. [11] For non-riverine wetland, natural salinity is adjusted by interactions between surface and ground water, which mostly influenced by human activities [12].

3. The using remote sensing and GIS applications

3.1 Ratio images are enhancement resulting from the division of digital number values in a selected spectral band by the corresponding values in another band. A major advantage of the ratio images is that they convey the color characteristics of image features, regard less of variations in scene illumination conditions. Obviously, the utility of a given spectral ratiov is depend on the specific reflectance properties of the feature involved and the application type. The number of ratio combination is a available of the image analyst and also varies depending upon the source of the digital data. The number of possible ratios that may be developed from n bands of is n(n-1). Thus for the bands (except band 6: the thermal band) of Landsat TM or ETM+ data there are 6(6-1), (i.e. 30, possible combinations). The manner in which ratios are computed and displayed will also greatly influence the information content of a ratio image. For example: the ratio between two raw digital numbers for a pixel will normally be quite different from that between two radiance values computed for the same pixel. The reason for this is the detector response curves for the two channels will have different offsets, which are additive effects on data. Some trial and error may be necessary before the analyst can determine which form of ratio works best for a particular application [13].

Ratios can blow up mathematically (become equal to infinity) if the band in the denominator has a DN of zero. At the same time, ratios less than 1 are common and rounding to integer values will compress much of the ratio data into gray level 0 or 1. So that it is important to scale the results of ratio computations somehow and relate them to the display device used. One means of doing that is to employ an algorithm of the form

$$DN^{'} = R\tan^{-1}\left(\frac{DN_x}{DN_Y}\right)\text{..........................}1$$

$DN^{'} =$ Digital number in ratio image.

$R =$ Scaling factor to place ratio data in appropriate integer range.

$\tan^{-1}\left(\frac{DN_x}{DN_Y}\right) =\equiv$ Angle (in radians) whose tangent represent the ratio of the digital numbers in Bands X and Y; when DNY equals 0, this angle is equal to 90 degree.

The above angle whose tangent is equal to the division of one band to the other (ratio of them) can range from 0^o to 90^o, or in radian from 0 to approximately 1.571 rad. Therefore, DN/ can range from 0 to approximately 1.571R. If an 8-bit display is used, R is generally chosen to be 162.3, and DN/ may then rang from 0 to 255 [14].

3. 2 Interpolation Techniques (ITs)

Interpolation method is the process of using values of known data to estimate unknown data values. Many ITs are generally utilized in the atmospheric science. One of these simplest methods is the linear interpolation; it is require familiarity of two points and the constant rate of variation between them. These methods are generally utilized to station datasets with patchy spacing between stations.

Interpolation predicts values for cells (in a raster) from a limited number of sample data points. Interpolation methods can be used to predict unknown values for any geographic point data, such as rainfall, noise levels, elevation, chemical concentrations, and so on.

Spatial interpolation is defined as the procedure to estimate values any one of them has characteristics at tentative sites into a covered area by existent observations.

Estimations of mostly spatial interpolation methods may be represented as weighted averages of sampled data. They all share in the same general estimation formula, as follows:

$$\hat{z}(x_0) = \sum_{i=1}^{n} \lambda_i z(x_i) \qquad \text{.............................. (2)}$$

Where $\hat{z}$: The estimated value of an attribute at the point of interest $x0$, z : The observed value at the sampled point x_i, λ_i: The weight assigned to the sampled point, and n represents the number of sampled points used for the estimation. The attribute is called the primary variable, especially in Geostatistical, [15].

3.2.1 Interpolation Methods

1. *The deterministic:* Deterministic interpolators make predictions from mathematical formulas that form weighted averages of nearby known values.

A. The local: Nearest Neighbor, Fixed Radius, Inverse Distance Weighting (IDW), Splines.

B. The global: Classifications, regressions, trend surfaces,.

2. The geostatistics: In geostatistics interpolators uses weighted averages as well, but also probability models to make predictions Kriging: optimal weighting interpolation, Co-Kriging.

Note: Deterministic interpolation techniques are considered ***exact*** when the resulted surface passing through the data value (the generated surface minimum and maximum values occur only at sample points), and ***inexact*** when they do not pass through measured data values. Interpolation methods have been developed based on the theory that points closer to each other are more similar and highly correlated to each other than those farther away. The IDW method is assumed that the rate of correlations and similarities between neighbor values is proportional to the distance between them. The IDW method is assumed that this correlation can be defined as a reverse distance function of any point from neighboring points. The definition of the neighboring radius and the related power of the reverse distance function are represented as important factors, [16].

3. 2. 1.1 Inverse Distance Weighted Interpolation method

Inverse Distance Weighted (IDW) interpolation method implements a basic law of geography; i.e. closely things to each either are more alike than things that are far apart. To predict values for unmeasured locations, IDW interpolation uses the measured values surrounding the prediction location. Those measured values (closest to the prediction location) have more influence on the predicted value than those are farther away (so that it named ***inverse distance weighted***). Which values are included in the calculation may be determined by specifying and customizing the search neighborhood, which is a region of the map around a selected point, in which the data points are considered for the extrapolation. IDW assumes that for each measured points, there are some local influence that diminishes with distance.

IDW is an exact interpolator; It means that the predictions will be exactly equal to the data value if predictions occur at locations where data have already been collected. This method basically depends on estimating the height of unknown points by calculating the distances from this point to the other known points, as it mathematically clarified by the following equations.

$$Z(X,Y) = \frac{\sum_{i=1}^{n}\left[\frac{Z_i}{d_i^P}\right]}{\sum_{i=1}^{n}\left[\frac{1}{d_i^P}\right]} \qquad \text{...(3)}$$

$$Z\ (X,Y) = \sum \lambda_i \times Z_i \quad \underline{Where} \quad \sum \lambda_i = 1 \text{........................(4)}$$

$$d_i = \sqrt{(X_i - X\ )^2 + (Y_i - Y\ )^2} \text{ ....(5)}$$

Where Z(X, Y) represents the predicted value at the ensample location X,Y.

i: is the measured sample points number within the neighborhood defined.

Z_i represents the observed value at location i.
d_i represents the distance between the estimated placement X,Y and the measured location i.
λ_i represent the distance-dependent weight associated with each sample point.
p represents the power parameter that defines the rate of reduction of the weight as distance increases.

4. Wetland study region and data forms

The land of Iraq, is one of the richest and most diverse territories. Especially many of its territories have a wetland features that is because of many of rivers, canals and lakes, as well as in the most years, winter in Iraq have a many rainy days.

The study area is located in Al- Anbar province. It was selected to be a study area to defined it as a wetland area. This region is located at the north of Al-Habbaniyah lack and at the south of the Euphrates River. Its coordinates: The lowar left corner long.43.284717, Lat. 33.352704 and the upper right corner Long.43.600594, Lat. 33.436938. This region geographic location of the land of Iraq is shown in Figure- 1.

The using data is a multispectral image of Landsat -7 satellite of the ETM^+ senser for the year 2007.

The metrological average monthly mean and annual data of rain, relative humidity and air temperature was used in this study.

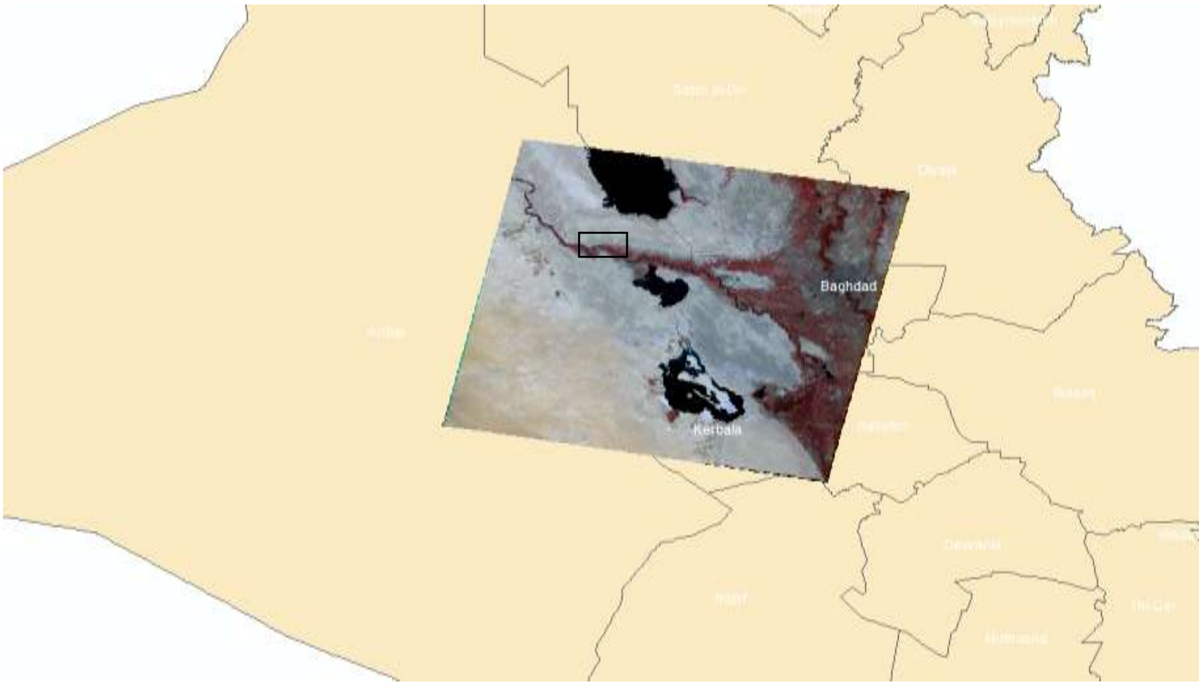


Figure1-The geographic location of the wetland region at the north of Al-Habbaniyah lack and at the south of the Euphrates River.

5. Methodology

In this paper, the Band ratio techniques has been utilized on the multispectral remotely sensed image of Landsat-7 satellite of the ETM^+ senser for the year 2007 of March month of the study area to detect the identity of the land cover of that region.

1. Perform image ratioing technique using the tools of ArcMap GIS (ver 9.2), by ratioing band5/band2 as a first step to classify the multispectral image.
2. Perform normalization technique (using Unique Values Criterion) on the Scene of ratioing to yield different wetland areas, vegetation and soil as clarify in Figure-2.

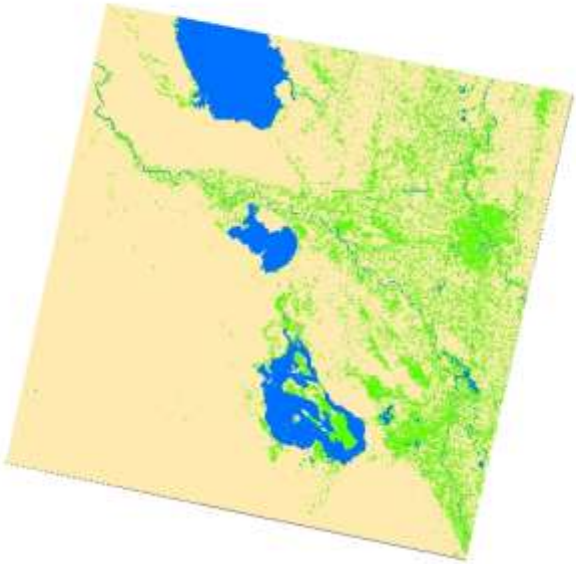
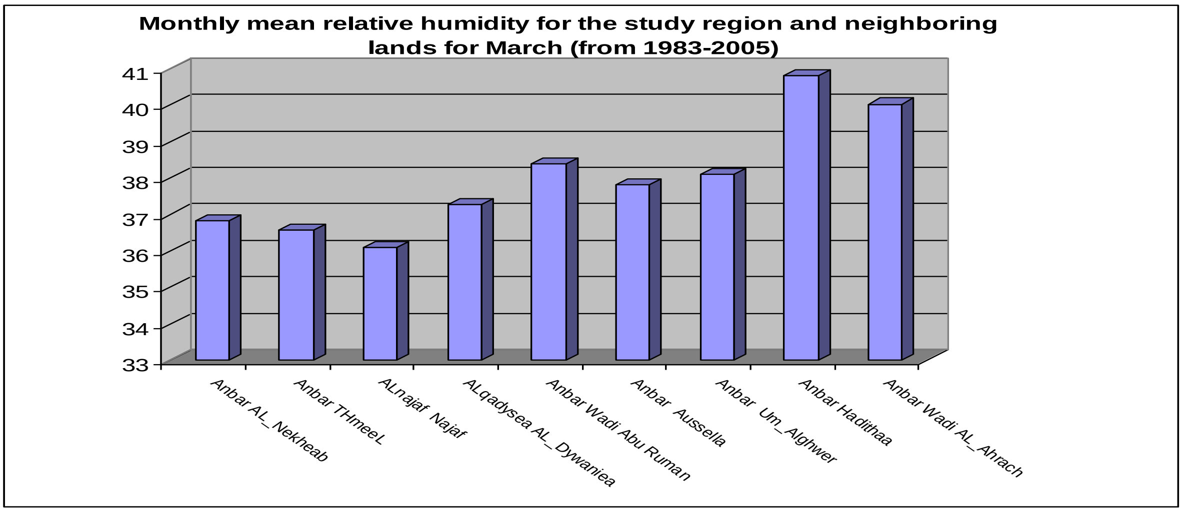


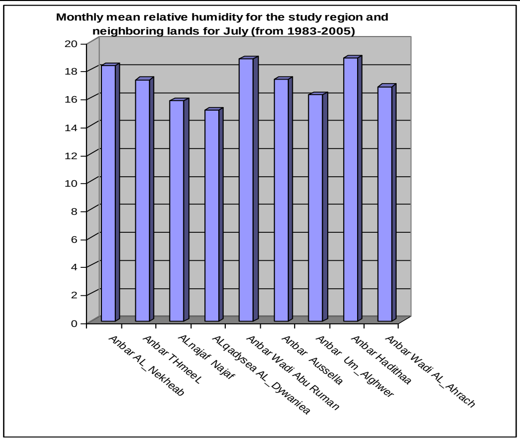
Figure 2- The resulted raster from the normalization technique application on the ratioing raster of the scene.

The metrological average monthly mean and average annual data (from 1983- 2005) of rainfall, relative humidity and air temperature were used in this study. To emphasize that the study area is the land of moist where relative humidity is high in the area compared to the relative humidity of neighboring lands, as well as the area have a high share of annual rains, as well as the air temperature degrees are less than these ranges for the neighboring territories, as were listed in the three tables below, and three diagrams for each of Tables- (1,2), where for each of the two tables, the first diagrams include the metrological data for March month, the second diagrams for July month and the third diagrams are for annual. The third table are represent the rainfall and have the last one diagram.

Table 1- illustration, relative humidity for the study region and neighboring lands.

No	Station Name	Lat.	Long.	X_axis	Y_axis	March	July	Annual
1	Anbar AL_Nekheab	32	42	217752	3546250	36.83002	18.2901	33.040001
2	Anbar THmeeL	32	43	313014	3542642	36.58002	17.2901	32.330002
3	ALnajaf Najaf	32	44	406831	3541198	36.09998	15.78	31.219999
4	ALqadysea AL_Dywaniea	32	45	500649	3541198	37.25998	15.12	31.379999
5	Anbar Wadi Abu Ruman	33	42	217752	3546250	38.38999	18.781	34.68
6	Anbar Aussella	33	43	313014	3542642	37.82	17.309	33.360001
7	Anbar Um_Alghwer	33	44	406831	3541198	38.09	16.201	32.560001
8	Anbar Hadithaa	34	42	217752	3546250	40.81001	18.85	36.23
9	Anbar Wadi AL_Ahrach	34	43	313014	3542642	40.02999	16.799	34.23





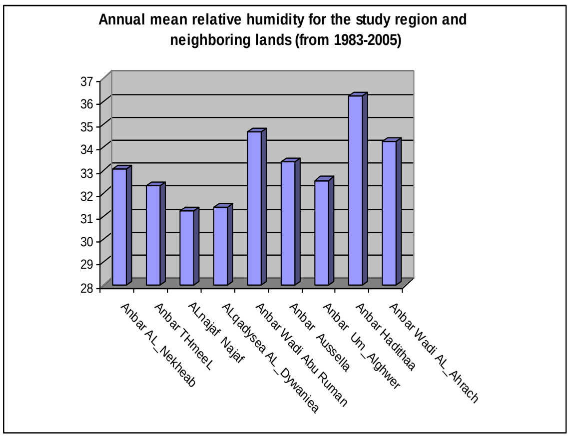
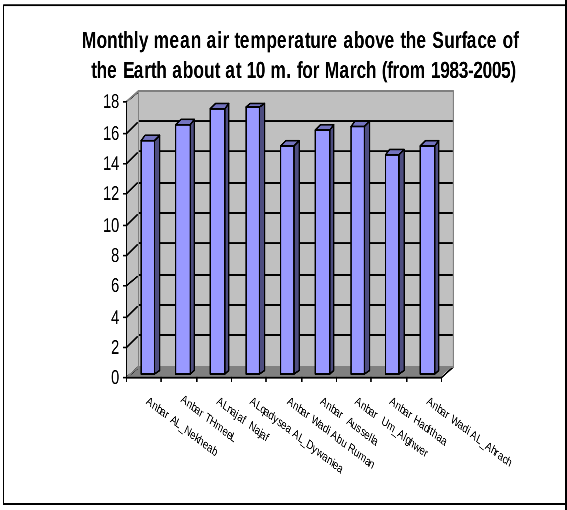
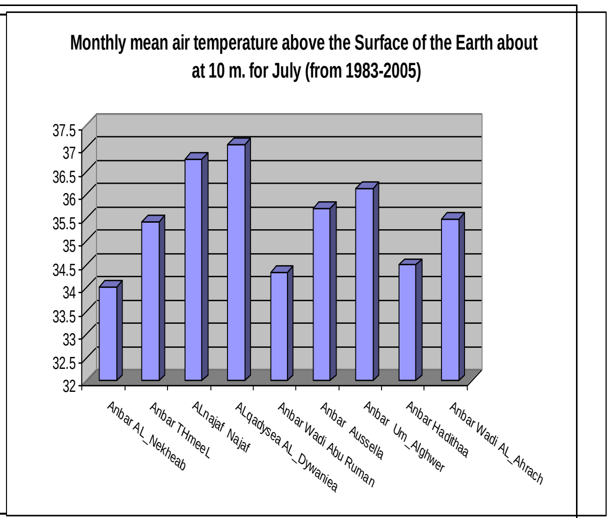


Table 2- illustration, air Temperature at 10 meter above the earth surface.

NO	Station Name	Latitude	Longitude	X_axis	Y_axis	March	July	Annual
1	Anbar AL_Nekheab	32	42	217752	3546250	15.27	34.01	22.12
2	Anbar THmeeL	32	43	313014	3542642	16.31	35.42	23.30
3	ALnajaf Najaf	32	44	406831	3541198	17.33	36.78	24.44
4	ALqadysea AL_Dywaniea	32	45	500649	3541198	17.41	37.09	24.64
5	Anbar Wadi Abu Ruman	33	42	217752	3546250	14.92	34.33	21.93
6	Anbar Aussella	33	43	313014	3542642	15.94	35.70	23.15
7	Anbar Um_Alghwer	33	44	406831	3541198	16.22	36.15	23.56
8	Anbar Hadithaa	34	42	217752	3546250	14.37	34.49	21.64
9	Anbar Wadi AL_Ahrach	34	43	313014	3542642	14.97	35.49	22.51





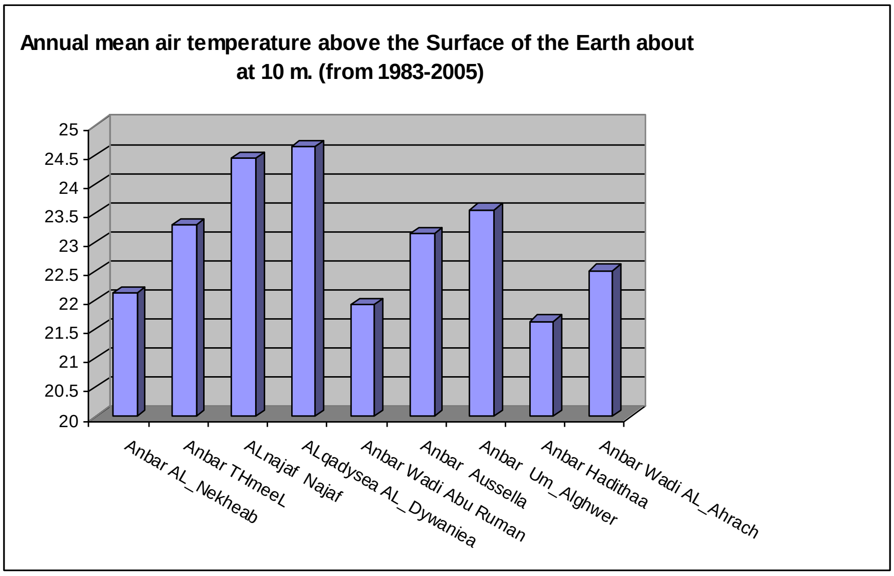
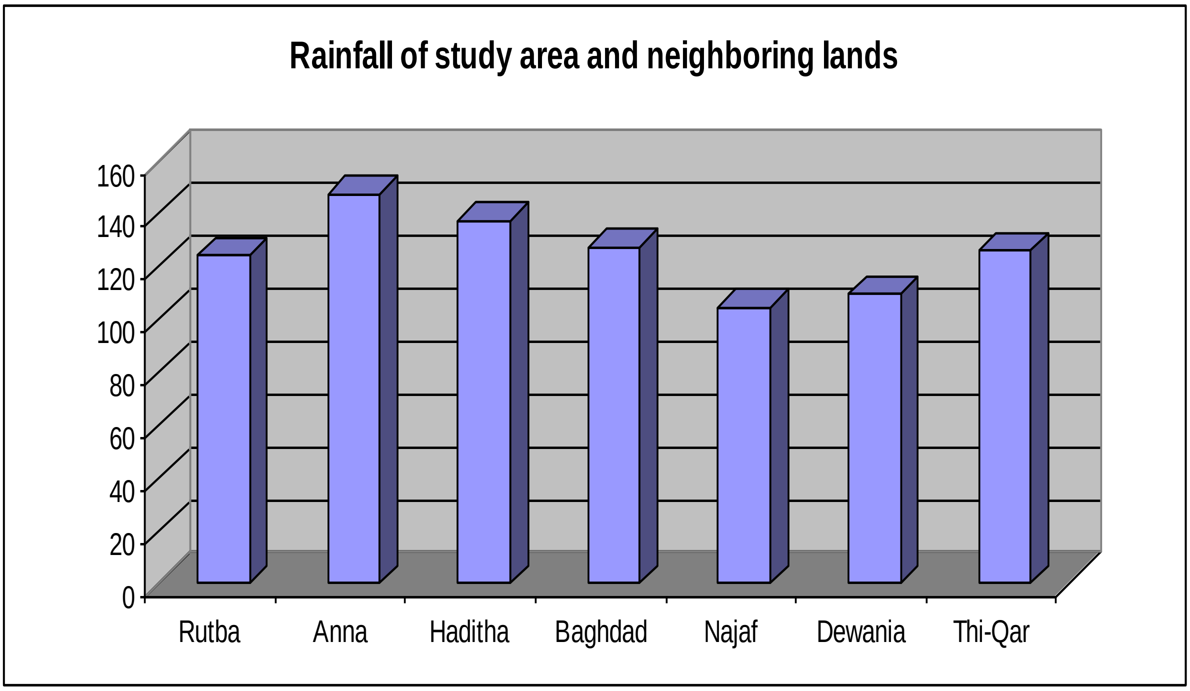


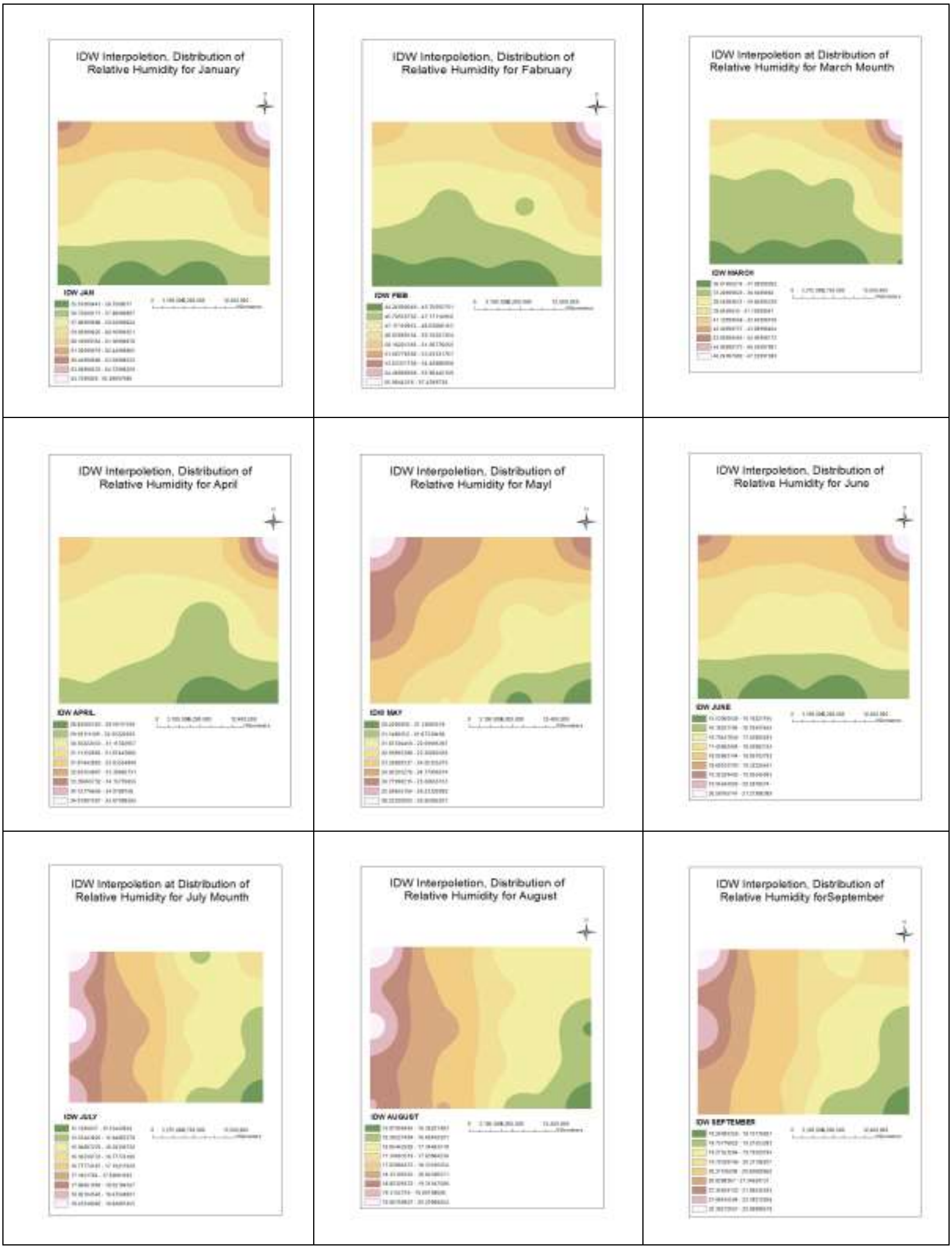
Table 3- illustration, rainfall of study area and neighboring lands.

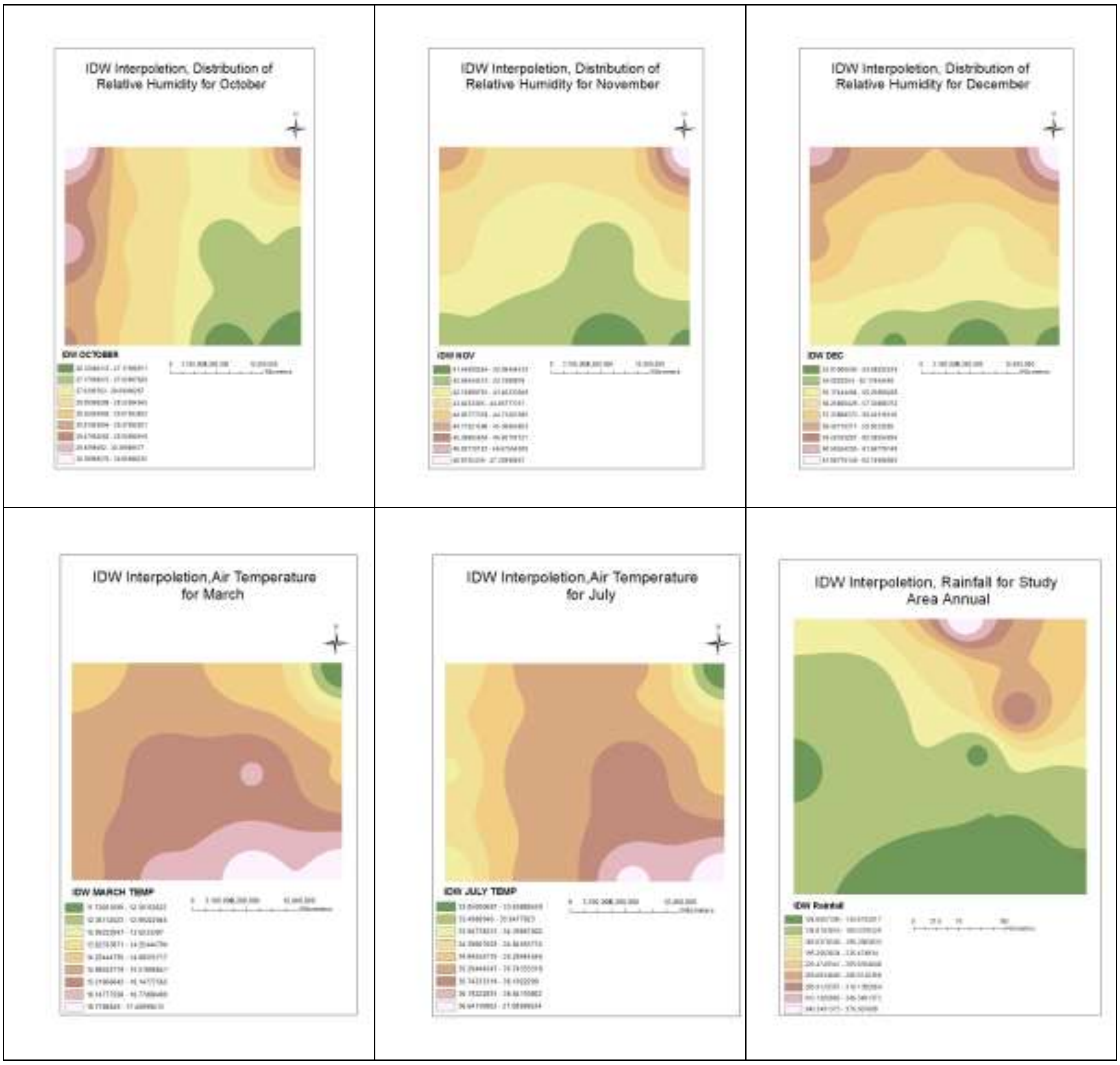
NO	Station Name	Latitude	Longitude	Rainfall	Deviation
1	Rutba	41.186	33.075	124	-0.00167
2	Anna	42.5422	33.8281	147.6	0.000667
3	Haditha	42.336	34.198	137.6	0.000467
4	Baghdad	44.405	33.279	127.4	-0.00133
5	Najaf	43.7911	31.165	104.6	-0.01733
6	Dewania	45.0281	31.8571	109.4	0.000333
7	Thi-Qar	46.245	31.297	126.3	0.000667



The metrological average monthly mean and averagr annual data (from 1983- 2005) of rain, relative humidity and air temperature were then interplated IDW exact interpolation by applicated the following steps:

1. The data were digitized by transformed it to Excel program field.
2. The digitize data were then saved and then opened in the ArcGIS.
3. The tools of interpolation of IDW type were applied to interpolate the data exact interpolation, as shown in the figures (seven figures) below.


IDW Interpolation, Distribution of Relative Humidity for January
IDW JAN
IDW Interpolation, Distribution of Relative Humidity for Fabruary
IDW FEB
IDW Interpolation at Distribution of Relative Humidity for March Mounth
IDW MARCH
IDW Interpolation, Distribution of Relative Humidity for April
IDW APRIL
IDW Interpoleation, Distribution of Relative Humidity for Mayl
IDW MAY
IDW Interpolation, Distribution of Relative Humidity for June
IDW JUNE
IDW Interpolation at Distribution of Relative Humidity for July Mounth
IDW JULY
IDW Interpoleation, Distribution of Relative Humidity for August
IDW AUGUST
IDW Interpolation, Distribution of Relative Humidity forSeptember
IDW SEPTEMBER



6. Results & discussions

As a primary results of the applying of the IDW interpolation upon the transformed layer of metrological data over the land of Al-Anbar province to detect the wetland among its' lands is the study region have a characteristics effect of a wetland on the climate of the region. In addition to the region geographical location is bounded by Euphrates river in the north and south of Lake Habbaniyah. As shown from the applicated metrological data of the relative humidity, air temperature and rainfall share. We find:

1. The relative humidity is high comparing with the neighbor regions.
2. The air temperature over 10 meter is low comparing with the surrounding regions.
3. The rainfall of this region is high comprising with the neighbors.

Finally from these results we can say that this region may be defined as a wetland region so it an important land and it may has attention for these rezones.

7. Conclusion

The conclusion from the subject of the study is that: The nature of most of the Iraqi lands, especially in the central and southern regions, when studied carefully, many regions can be considered as wetlands or can be provided the appropriate conditions to be transferred to wetlands, that may be possible because of the sedimentary and mud nature of the Iraqi land because of the existence of rivers, lakes and marshes which is reflected positively on the improvement of climatic conditions by reduce the heat and dust and create environments suitable for many natural plants and organisms threatened with extinction and can also be used as natural reserves.

In addition of the characteristic of the geographical location for any region, the final effect of the land on the climate is mostly represent the signature of that land and give a real idea about its' nature. The metrological data of the relative humidity, air temperatures and rainfall are forming an effective measured data to estimate the land nature. The metrological measured data of average monthly mean of relative humidity, air temperatures for Iraqi country at a period (1983-2005) is used in this study. All the data were interpolated by using the IDW interpolation technique to estimate and comparison the interested region climate relative with surrounding neighbor lands. This land is a wetland then it may take spatial interest to keep its properties and deepen them, to ensure the survival of wetlands. This purpose can be achieved by Avoid dry seasons or days that could lead to changes in the nature of the soil though it must be at least a water drainage directed at them.

References

1. John R. Jensoun, **1986** . *Introductory Digital Image Processing*. Prentice-Hall A.Division of Simon and Schiter, Inc P. 1
2. Kathleen Tucker**, 1997**. *Change Detection in the Area of Benton and Draffenville*. Murraystate/geo/gsc 641
3. State of Florida. *Retrieved.* **2011.** *Department of Environmental Protection State of Florida Glossary*.
4. State of Florida. *Retrieved* **2011**. *Ramsar Convention Ecosystem Services Benefit Factsheets*.
5. Keddy, Paul A. **2010**. *Wetland ecology: principles and conservation.* (2nd Ed.), New York: Cambridge University Press. *p. 497. ISBN 978-0521519403.*
6. Davidson, Nick; D'Cruz, Rebecca; Finlayson, C. Max (2005). *Ecosystems and human well-being: wetlands and water synthesis*: a report of the Millennium Ecosystem Assessment. (PDF). Washington, DC: World Resources Institute. p. 6. ISBN 1-56973-597-2. Retrieved 5 August 2015] Mapping2.orr.noaa.gov. 2012-05-23 *"Glossary".*
7. Mitsch, William J.. James G. , Gosselink (2007-08-24). *Wetlands (4th ed.).* New York: John Wiley & Sons. *ISBN 978-0-471-69967-5.]*
8. Richardson, JL., Arndt, JL. and Montgomery, JA. **2001**. *Hydrology of wetland and related soils*. in JL Richardson & MJ Vepraskas (eds), Wetland Soils, Lewis Publishers, Boca Raton, Florida.
9. Richardson, JL., Arndt, JL. and Montgomery, JA. **2001**. *Hydrology of wetland and related soils*. in JL Richardson & MJ Vepraskas (eds), Wetland Soils, Lewis Publishers, Boca Raton, Florida.
10. Silliman, B.R., Grosholz, E.D. and Bertness (eds.) M.D. **2009**. *Human Impacts on Salt Marshes*. A Global Perspective. University of California Press, Berkeley, CA.
11. Smith, MJ., Schreiber, ESG., Kohout, M., Ough, K., Lennie, R., Turnbull, D., Jin, C. and Clancy, T. **2007**. *Wetlands as landscape units: spatial patterns in salinity and water chemistry*, Wetlands, Ecology & Management, **15**(2): 95–103.
12. James W. Quinn**, 2001.** *Band Combination*. (http://web.www.pdx.edu/emch/ipl/bandcombination.html).
13. Thomas, M., Lillesand, Ralph W., Kiefer, Jonathan W. Chipman **2007** .*Remote Sensing and Image Interpretation*. Sixth Edition, John Wiley & Sons, Inc. printed in the United States of America, p.1, p.252, p.524.
14. Ezekiel Kalipeni, Leo Zulu. **2008.** *Using GIS to Model and Forecast HIV/AIDS Rates in Africa*, Journal of The Professional Geographer. **60**(1), pp: 33-53.
15. Surfer (tm) help for windows version 6.xx Golden software incorporated, help for Surfer package, 1995.
16. Israa J. M. **2010**. High resolution digital elevation model (DEM) for University of Baghdad campus. Ph.D. Thesis, Department of physics, College of Science, University of Baghdad.