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Monitoring the Land Covers around Al- Razaza Lake - Iraq Based Upon Multi-Temporal Analysis Technique

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ABSTRACT

Remote sensing techniques are very important for the identification of land cover patterns and monitoring changes occurred, thus three different periods were taken for Al-Razaza lake region. The Summer and spring months were chosen by mean of climate changes were observed and their effect on land covers were monitored. According to the applied supervised classification, the study area was divided into four land covers, nearly closed Al – Razaza Lake was deeper in its western portions, thick vegetation cover was found. The eastern and southern portion of the lake was bounded by desertic and semi-desertic land. The water level in the lake was fluctuating with different seasons. During the period 2000 and 2015 the area of the lake was height decreased around 320 Km2. Climate changes led to increasing of drying out water areas and a high increase in the amount of saline areas in 2015.This study shows a significant decrease of water cover In terms of depth and area of the lake due to the large decline in the value of the NDWI index.

KEYWORDS: Land cover; drought; supervised classification; NDWI; Al-Razaza lake.

الخلاصة

أهمية تقانات التحسس النائي في معرفة ومراقبة التغيرات في انماط الاغطية الارضية. ثلاث فترات مختلفة اختيرت لمنطقة بحيرة الرزازة. أخذت اشهر الصيف والربيع لأجل ملاحظة التغيرات المناخية وتأثيرها على الاغطية الأرضية . طبقا لتطبيق التصنيف المراقب فأن المنطقة قد قسمت الى أربعة أنواع من الاغطية الارضية . ان منطقة بحيرة الرزازة الشبه مغلقة كانت أكثر عمقاً في اجزائها الغربية، حيث الغطاء الكثيف من النباتات. اما أجزائها الشرقية والجنوبية فكانت محاطة بأراضي صحراوية وشبه صحراوية . ان مستوى المياه في البحيرة متذبذب حسب الموسم المناخي. في الاعوام مابين ٢٠٠٠-٢٠١٥ فأن مساحة البحيرة قد نقصت بمقدار ٣٢٠ كم ٢. أن الجفاف أزداد مع التغير المناخي. في عام ٢٠١٥ هذا قد ادى الى النقصان في مياه البحيرة وزيادة المساحة الملحية. هذه الدراسة بينت بأن النقصان الكبير في الغطاء المائي فيما يتعلق بعمق ومساحة البحيرة كان قد أستنتج من النقصان الكبير لقيمة المؤشر المعياري للأختلاف المائي NDWI.

INTRODUCTION

The Land cover and its spatial patterns are key ingredients in environmental studies consider large regions and the impacts of human activities. Because humanity is a principal driver of land-cover change over large areas [1], land-cover data provide direct measures of human activity, and both direct and indirect measures of ecological conditions within human-dominated landscapes [2]. Thus, incorporating land-cover information is a way to place humans directly into regional ecological models and assessments. The land use/land cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space. The terms "land use" and "land cover" are often used simultaneously to describe maps provide information about the types of features found on the earth's surface and the human activity is associated with them [3].

Numerous studies have shown the importance proportions of different land-cover types (e.g., forest, agriculture, urban) in explaining the spatial variation of other environmental parameters [4]. Although patterns are sometimes easy to see on a land-cover map, further processing of land-cover data is needed to quantify those patterns. In other cases, further processing is needed to extract pattern information not visually apparent. At many parts of the world, water scarcity occurring frequently mainly due to agricultural activities and population growth.

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The water scarcity is being further compounded by droughts affect both surface water and groundwater resources and can lead to reduced water supply, deteriorated water quality, crop failure, and disturbed riparian habitats. Drought is related to deficiency of precipitation over an extended period of time, usually for a season or more [5]. Remote sensing technologies are a very important tool in monitoring changes in land, water resources and plants … etc. The remote and inaccessible nature of several lands covers such as vegetation, forest, Sahara and sea regions Limits the statistic of ground based and observing methods for vast land areas. Ongoing operations to monitor the land cover and the land-use alter are increasingly dependent on information obtained from remotely sensed data. Thus such information provide data associated with other techniques to understand the Processes occur due to increased water areas and water levels, as well as, desertification on each of the plant and livestock wealth, growing population and economy [6][7]. Therefore, this paper aims to use Remote Sensing technologies (RS) in the follow-up the changes that have occurred over surface area coverage, by comparing satellite images for 1987-2000-2015. Detection of the possibility of using the water cover indicator (NDWI) to identify changes in water content of the area over different periods of time and the extent their affected by changes in Climatic conditions.

Study area description

This study was conducted on Al- Razaza Lake, located approx. 15 km northwest of Karbala, and 50 km southeast of Ramadi governorates. It lies between Coordinates 32º 15` and 32º 45` N latitudes, 43º 25` and 44º00` E Longitudes. It has an elevation of 27 m. a, s. l. The length of Al – Razaza Lake 60 km and width 30 km, so comprise areas is 1810 km ^{2}. This lake was formed in the 1970s as a second storage reservoir to control floods of the Euphrates, in this year the water rise more than 21 m [8]. Al- Razzaza Lake is connected to water via an artificial narrow canal links it with Habbaniya Lake running through semi-desert, called Sin-Al-Thibban Canal [9], Figure 1 represents the location of the study area on the map of Iraq. The Climate of lake is characterized by a semi-arid and hot dry summer, cold dry winter with annual mean rainfall (109 – 122mm) mainly during January to April and

annual mean evaporation (3194.3 – 3332.7 mm). This Lake represents an important tourist center and a fishing site in the area [10].
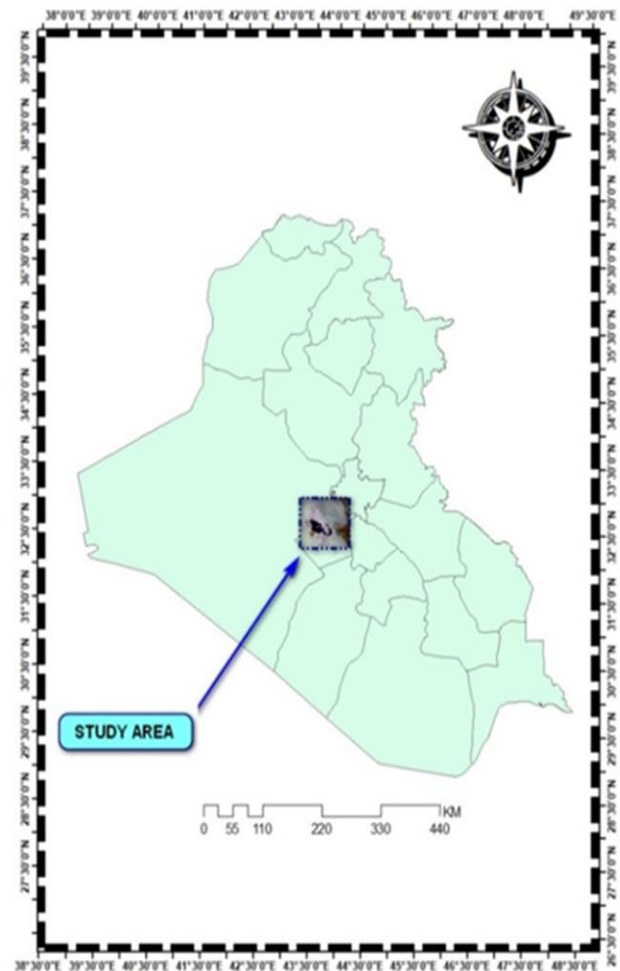

Figure 1. Location of the study area.

Data Source and software

In this study six images were used from Landsat 5 and 7 which carry TM, ETM+ sensors respectively. The images were obtained in 1987, 2000 and 2015 from the US Geological Survey site (USGS) http://earthexplorer.usgs.gov/. They are multi spectral images taken in summer and spring as shown in Table 1. The annual and monthly rates of meteorological parameters (Temperature, Precipitation, relative humidity and evaporation) for a period of twenty-nine years (1987-2015) were provided from the European site ECMUF http://apps.ecmwf.int. The software packages used in this research are (Arc GIS 9.3 – ERDAS 14 and Microsoft Excel 2010).

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Table 1: Information about the Landsat images used in the study.

Rank	Satellite types	Sensor	Date	Resolution (km)
1	LANDSAT-5	TM	5/3/1987	30
2	LANDSAT-5	TM	13/8/1987	30
3	LANDSAT-5	TM	9/3/2000	30
4	LANDSAT-5	TM	21/8/2000	30
5	LANDSAT-7	ETM+	17/3/2015	30
6	LANDSAT-7	ETM+	11/8/2015	30

METHODOLOGY

Data Preprocessing

All the images used in this study have been converted into a formula img by ERDAS software in order to start the processing. Therefore, the geometric correction process was carried out and became images with geographic coordinates. Then, the process of merging the bands was applied to produce a new color image (RGB). In this domain band 3, 4, 5 were merged, Figure 2 represent methodology Flow chart. The program Arc GIS and Focal Analysis (provided by ERDAS) was used to correct and erase the black lines and fill the gaps in the ETM+ sensor images for Landsat 7. Figure 3 shows the final form of the images after processing.
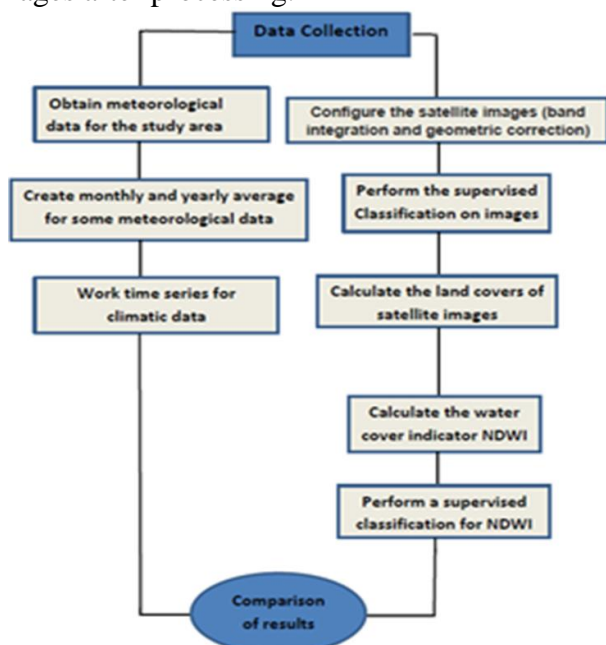

Figure 2. Methodology Flow chart.

Interpretation and Image Classification

At first stage multi temporal color composite images have been examined. The Visual interpretation was applied, and a land cover classification was obtained in two levels as shown in Table 2. Secondly, the supervised classification technique was applied to satellite imagery using

Arc GIS software. Four main categories of land covers were recognized at first level representing land covers of the al-Razaza Lake region. The maximum likelihood statistical procedure was applied, the areas shown in table (3), and five sub categories were identified at the second level of Al- Razaza lake region, figure (4).
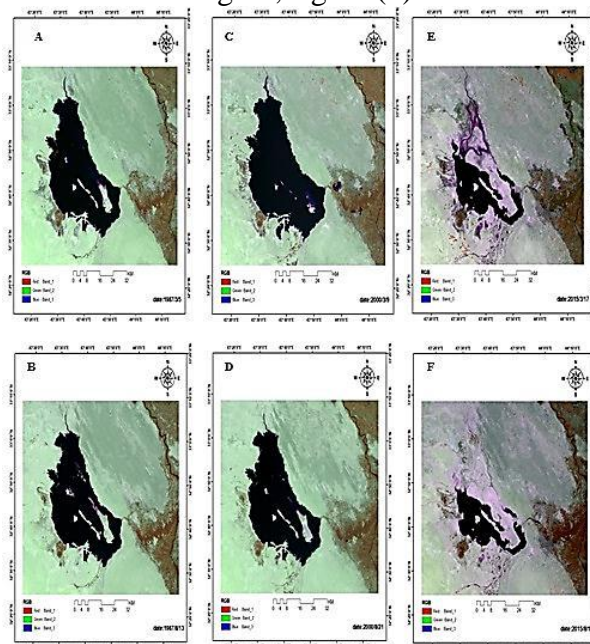
Figure 3. The preprocessed satellite images of the study area.

Table 2. Land covers classification of al- Razaza lake region.

Level 1	Level 2
1.Agricultural land	1.1High density agricultural land
	1.2 Low density agricultural land
2.desertifed land	2.1 Gypsifereous areas
	2.2 Sandy areas
	2.3 Saline's areas
3.moist land areas	-
4.water bodies(lake and canals)	-

So, after the application of supervised classification has revealed many differences water bodies' areas have decreased from 1286.19 Km^2 in 2000 to 320.41 Km^2 in 2015. This is due to the drying out effect in the region which is related to the increasing temperature and the decreasing in precipitation increasing of temperature and decreasing precipitation have negative effect on agricultural land area and their densities too. Desertified land area had recorded high values among other land covers especially in recent years

due to high temperature and high evaporation. gypsiferous areas are lower in March for all study years but in the summer are higher. The effect of dry climate in Iraq has generates soil has a high percentage of gypsum, which is located in the Western Desert, and its presence causes high salinity of the soils, this is the reason of an increase and the highest value of 3813.26 Km^2 in the 2015 year in gypsiferous areas. The other category experienced increase in its total areas, are the moist land areas, recorded the highest value of 1727.32 Km^2 in March 2015.
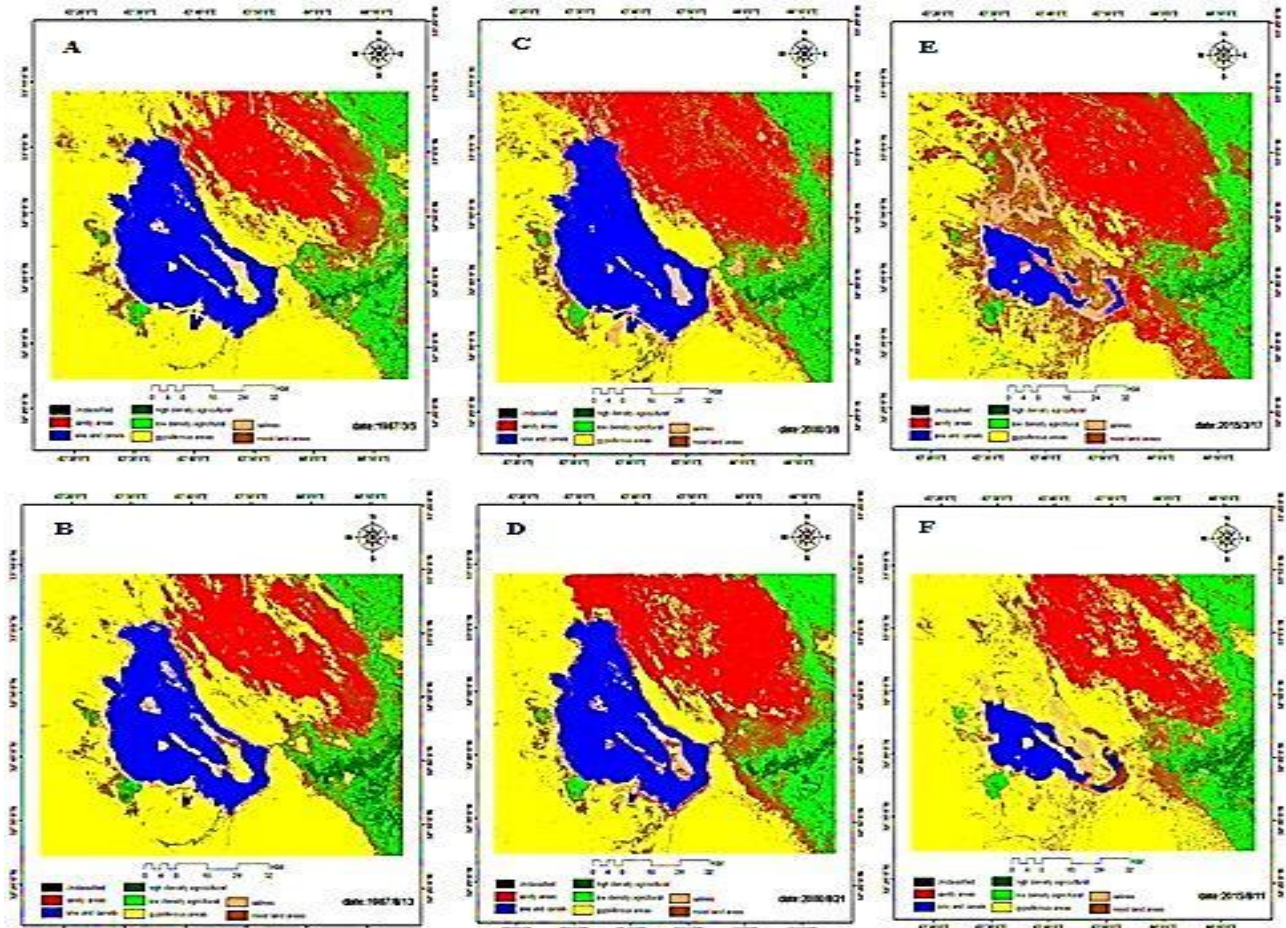

Figure 4. Image classification of land cover of TM and ETM+ Images.

Table 3. Areas of land cover categories in (Km^2).

Date of Image	Areas of High density in agriculture	Areas of Low density in agriculture	Gypsifereous areas	Sandy areas	Saline's areas	Moist land areas	Lake and Canals
5/3/1987	154.68	630.75	3348.72	1159.35	285.14	902.85	1186
13/8/1987	299.83	546.16	3563.47	1145.08	257.84	804.38	1050.73
9/3/2000	156.89	735.73	2676.73	1748.44	279.47	784.04	1286.19
21/8/2000	686.96	147.53	2964.59	1363.47	196.28	1167.83	1140.82
17/3/2015	171.16	776.69	2403.51	1839.15	429.26	1727.32	320.41
11/8/2015	210.32	734.35	3813.26	1264.79	459.98	848.48	336.29

Normalized Difference Water index (NDWI)

The NDWI is the water cover index, is used to oversee the situation of water cover in the area. Water index was computed by the average of summing the NIR and Short Wave IR bands, [11] expressed as follows [12]:

$$NDWI = \frac{R\_green - R\_nir}{R\_green + R\_nir} \qquad (1)$$

This index is designed to maximize reflectance of water by using green Wavelengths and minimize the low reflectance of NIR by water features [12]. In this index, the spectral reflectivity of the water is high in green wavelength range (0.52-0.60) μm and very low in the wavelength range below (0.76-0.90μm), and the high reflectivity of the plant and soil in the wavelength range below Red, (NDWI)

values are positive in water areas and therefore visible water regions (NDWI) Luminous and positive values. The values of variables in the water cover index (NDWI) are between (+ 1 to -1). Negative values are an indicator of the absence of water covers in the area, while positive values are indicators of the presence of water cover [13]. Using this model for the purpose of calculating the changes in water cover of Al-Razaza Lake images, the results are shown in Figure 5. Figure 6 Illustrates water bodies in Km^2 for Al-Razaza lake dated (1987-2000-2015) and the highest to the lowest value for the NDWI index is in the Table (4).

**Table 4.** Highest and lowest value of water cover index (NDWI) for images of Al-Razaza Lake.

Images	highest value of NDWI	lowest of value NDWI
5/3/1987	0.489	-0.764
13/8/1987	0.677	-0.662
9/3/2000	0.908	-0.916
21/8/2000	0.404	-0.576
17/3/2015	0.595	-0.861
11/8/2015	0.494	-0.846

Supervised classification was applied upon water cover indicator and the results were shown in Figure 7. It shows only the areas containing water, such as, the channels and Al-Razaza Lake. The areas of water cover of the images decrease from the year 1987, 2000, and a significant decrease in the year 2015, but images were taken in the spring show high increase of water cover in the year 2000 and decrease in the year 1987 and high decrease in 2015 image.

The Impact of climate change on atmospheric elements in the region

From figure 8, the monthly air temperature averages increases can be observed over study area, and the highest rate of temperature was in July (37.6°c). The minimum temperature reductions rate was in January (8.9°c). Air humidity is one of the main climatic parameters in the formation of condensation and precipitation. Therefore, the increase of monthly average relative humidity was in December and January. Relative humidity decreases in June and July. However, the

amount of rain is few and fluctuating where the annual total of precipitation is (146.4 mm). The precipitation starts in October and increases to its highest value in February and decreases to zero during summer. But the total annual evaporation was 2,671 mm, and highest value in July (432.1 mm). The compassion between 1970 and 2015 in evaporate rate was 229 mm and 2.671 mm, respectively. The consequences of a higher rate of evaporation led to increased drought rate for a wide area of the lake.
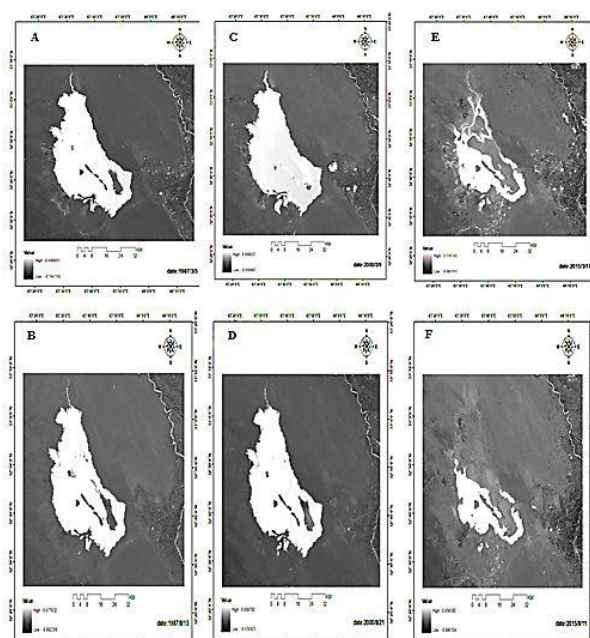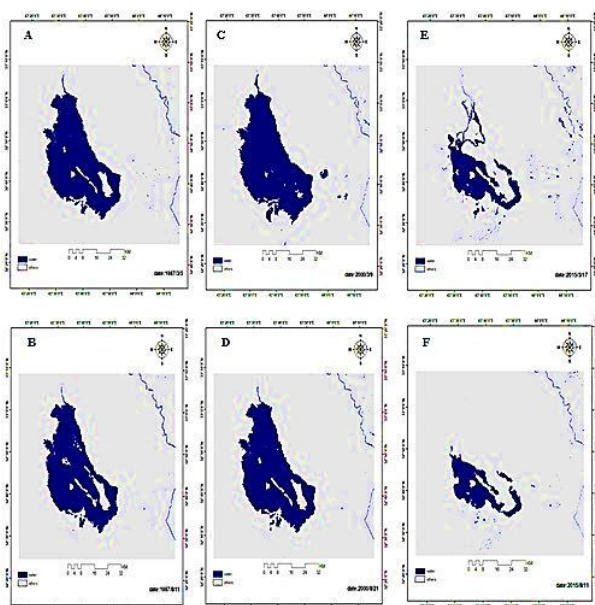

Figure 5. Normalized Difference Water index (NDWI) of Al-Razaza lake images.
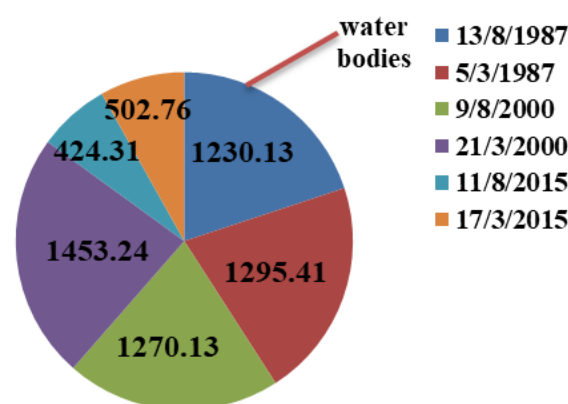
Figure 6. Illustrates water bodies' in Km^2 for Al-Razaza lake dated (1987-2000-2015).

Figure 7. Images of the supervised classification of (NDWI).

DISCUSSION AND CONCLUSIONS

The increasing rates of climate change, in recent years in the study area, have a significant impact on the varieties of ground cover. Al- Razaza area suffers from a lack of rainfall and the results showed abnormalities in high temperature thus increasing the rate of evaporation and a decrease in the relative humidity values, the remote sensing technique enabled the temporal analysis to show the expansion of some land cover and the area calculation of each type. The Change has occurred in the land cover patterns for the period between 1987 and 2015. The area of the Desertified Land cover expanded at the expense of the Water Bodies area, It is one of the most important environmental problems causing desertification because the region is characterized by a dry climate and also affected by the problem of global warming, which increased the evaporation rates to 400 mm. due to the water shortage in the lake, the groundwater recharge has decreased and affects the chemical composition of water and soil and the spread of pollutants that negatively affect water, mainly due to the lack of proper management by the local government of this lake. The salt concentration rate in the lake increased as a result of evaporation rate increased, and the lack of water release into the lake. In order to compensate the decreasing of water level in the lake, it should be recharged with water from the adjacent Al- Habbaniya Lake. In this way biodiversity in Al-Razaza Lake could be restored.
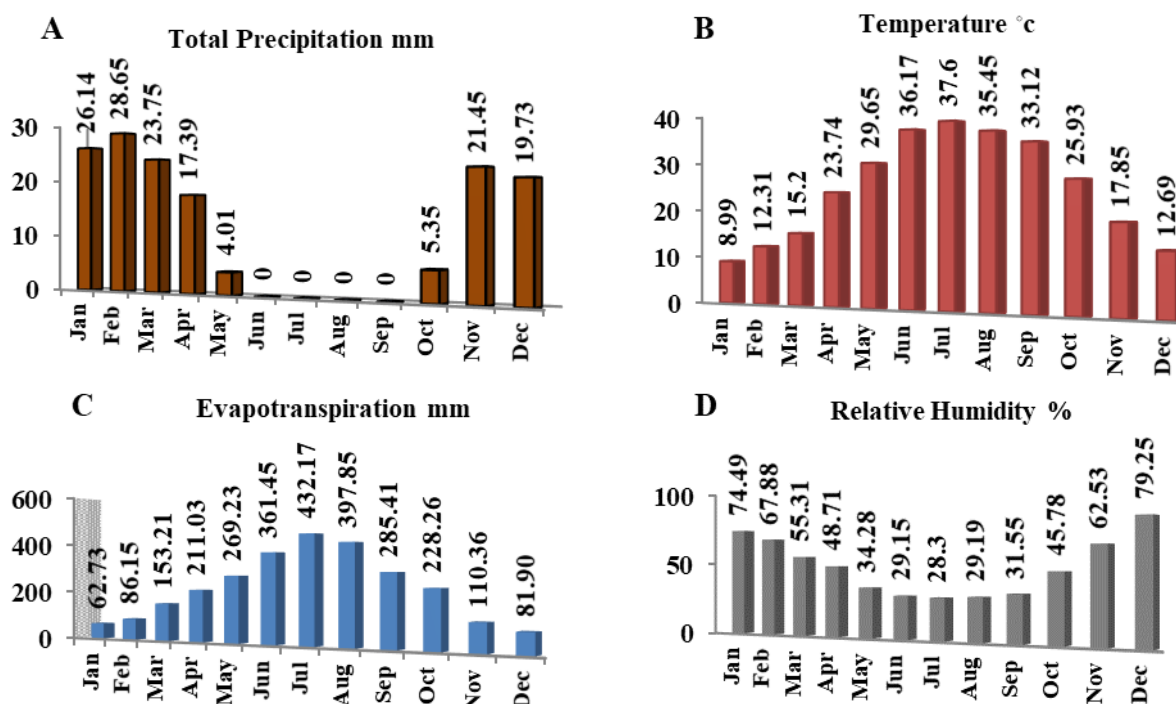
Figure 8. The changes in climate parameters with average mean monthly for years (1987-2015).

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