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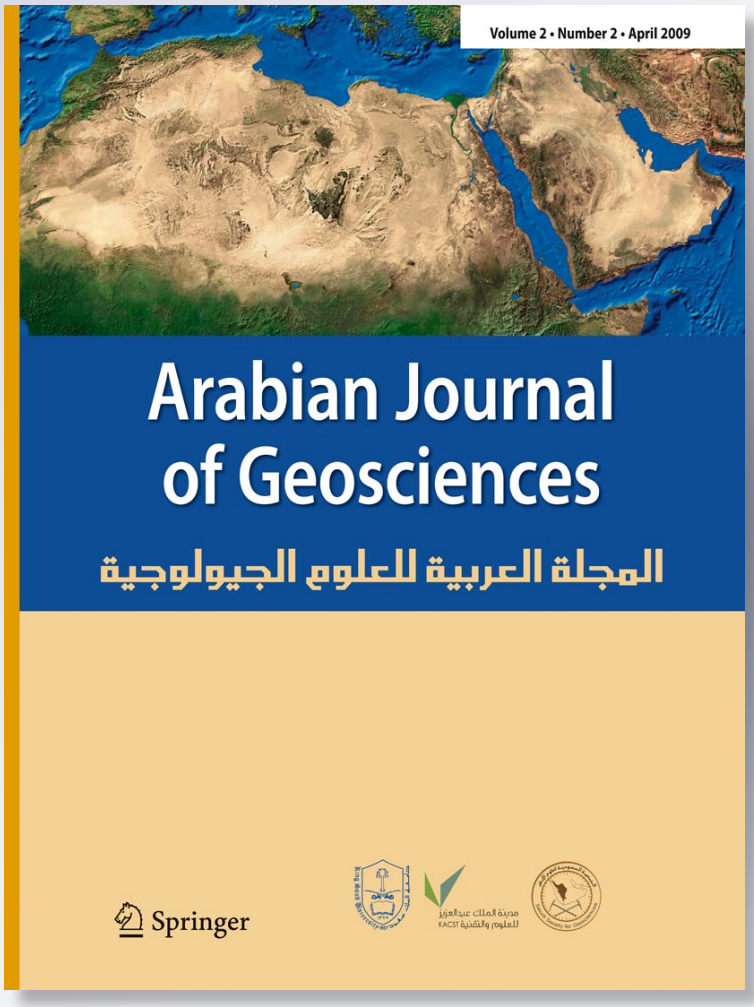
Arabian Journal of Geosciences

ISSN 1866-7511
Volume 5
Number 3

Arab J Geosci (2012) 5:465-469
DOI 10.1007/s12517-010-0257-4



Springer

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ORIGINAL PAPER

Climatic prediction of the terrestrial and coastal areas of Iraq

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Received: 11 August 2010 / Accepted: 29 November 2010 / Published online: 23 December 2010

Abstract Climatic data from four meteorological stations in Iraq (Mosul, Baghdad, Basra, and Rutba) were obtained. The recorded temperature data since 1960 till 2007 and rainfall and evaporation data since 1960 till 2008 and 1970 till 2008, respectively, were used and interpreted. This study showed an increase in temperature of about 5°C/47 years and an increase in evaporation rate with a decrease in the rainfall rate. Carbon dioxide in the atmosphere appears to be a factor controlling climate change. Basra climate, due to its location which is nearest to the Arabian Gulf, is expressed as a coastal climate and has a different behavior from Mosul, Baghdad, and Rutba, which are considered as terrestrial climates.

Keywords Climate · Temperature · Rainfall · CO_2 · Iraq

Introduction

In the last 200 years, through increased utilization of the world's resources, humans have begun to influence the global climate system, primarily by increasing the Earth's natural greenhouse effect (Buchdahl 1999). Between 1850 and 1990, the global mean temperature at the surface of the Earth warmed by approximately 0.5°C (about 1°F; Lean and Rind 1996). During the same period, the amount of carbon dioxide measured in the Earth's atmosphere increased by about 25%, as a consequence of our ever-increasing use of fossil fuels. This raises the possibility that the two trends are directly connected, and the climate system responds to human activities (Lean and Rind 1996)

Many major and minor types of gases compose the atmosphere, but carbon dioxide (CO_2), the most important of the minor gases in the atmosphere, is involved in a complex global cycle. It is released from the interior of the Earth via volcanic eruptions, respiration, soil processes, combustion of carbon compounds, and oceanic evaporation. Conversely, it is dissolved in the oceans and consumed during plant photosynthesis. Currently, there are 359 parts per million by volume (ppmv) of CO_2 in the atmosphere (Schimel et al. 1995), a concentration which is continuing to rise due to anthropogenic (man-made) emissions from the burning of fossil fuels and forests.

The climate of Iraq is characterized by hot–dry summers and cold–rainy winters. Roughly 90% of the annual rainfall occurs between November and April, most of it in the winter months from December through March. The remaining 6 months (from May to October), particularly the hottest ones, are June, July, and August where the rain has not fallen. The average temperature in Iraq ranges from higher than 48°C (120°F) in July and August to below freezing in January. Of course, there is considerable difference in temperature between day and night. The day is hot, whereas the night is colder. Generally, the climate of Mesopotamia is semi-arid with a maximum temperature of up to 53°C in July–August and a minimum temperature of −7°C in January (Jassim and Goff 2006). The annual precipitation is 150 mm/year (monthly, occurring from November to March); it falls to less than 1,000 mm/year toward the desert in the SW, causing semi-desert to desert

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climatic conditions. The prevailing wind is generally NW and is dry for about 300 days of the year, turning to SE and humid for about 60 days (Jassim and Goff 2006).

In this study, the CO_2 level that had been gotten from the Carbon Dioxide Information Analyses Center (CDIAC) was used in comparison with the temperatures of four meteorological stations in Iraq since 1960 till 2007 for evaluating the local climatic warming and for predicting future warming.

The study area

Four representative meteorological stations were chosen in order to analyze the general climatic elements. Topography plays an essential role in climate. Generally, there are four topographic features in Iraq; they are mountain in the north, desert in the west, flood plain in the center which extends to the south, and flood plain containing marshes in the south, which expresses a coastal environment that lies near the delta of the Arabian Gulf. Accordingly, data were collected from four meteorological stations; they are Mosul in the north, which represents the folded belt and foothills, Rutba in the west, which represents the desert, Baghdad in the center, which represents the Mesopotamia plain, and Basra in the south, which represents the coastal area (Fig. 1).

Distribution of average temperature in Iraq since 1960 to 2007

Since 1960 to 2007, the highest average temperature has been recorded in Basra throughout the year except in October when a higher temperature was recorded in Rutba (Fig. 2). In the summer season (June, July, and August) and September, the temperature in Baghdad and Basra tends to be concordant, approximately for the years 1960 to 1970, 1969 to 1973, 1960 to 1975, and 1960 to 1965, respectively, whereas this concordance changed; as it appears, Basra was warmer than Baghdad for the remnant years (Fig. 2). Generally, a tendency for dissimilarity of temperatures among the four stations was found. However, there are high contrasts between Rutba and Basra throughout the year during the period extending since 1960 to 2007, except for two months, October and November (Fig. 2). Rutba appears to have the highest temperature on October since 1971 to 2007 (Fig. 2). The similarity of the Rutba and Mosul temperatures since 1960

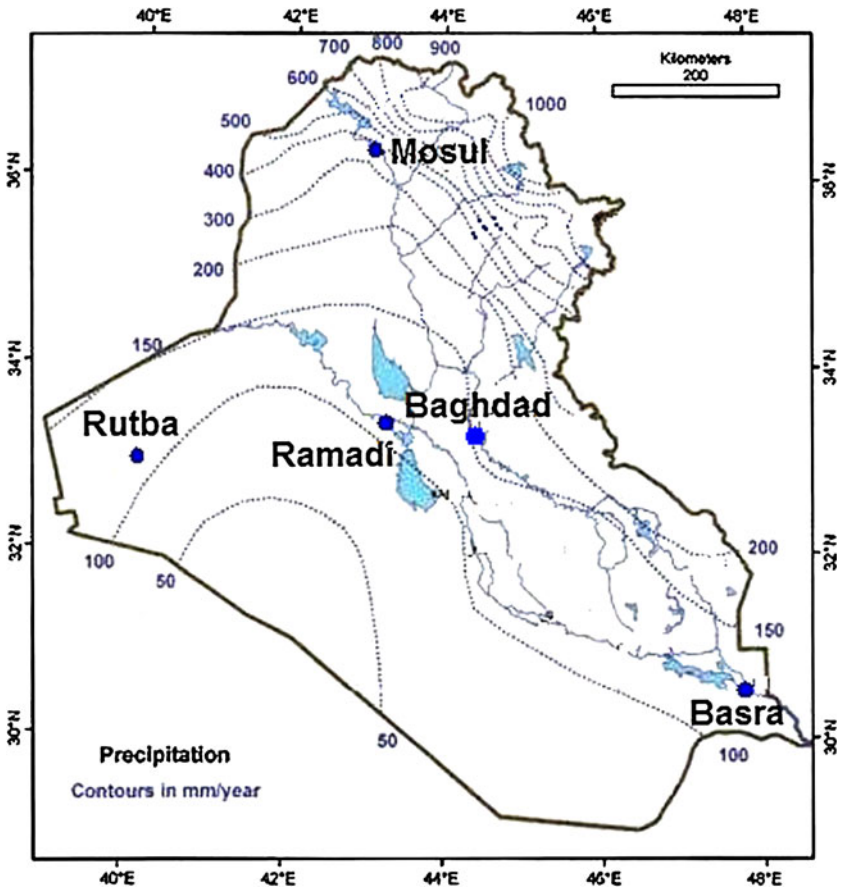

Fig. 1 Precipitation map (after Alsam et al. 1990 in Jassim and Goff 2006) displaying the meteorological stations as *solid circles*

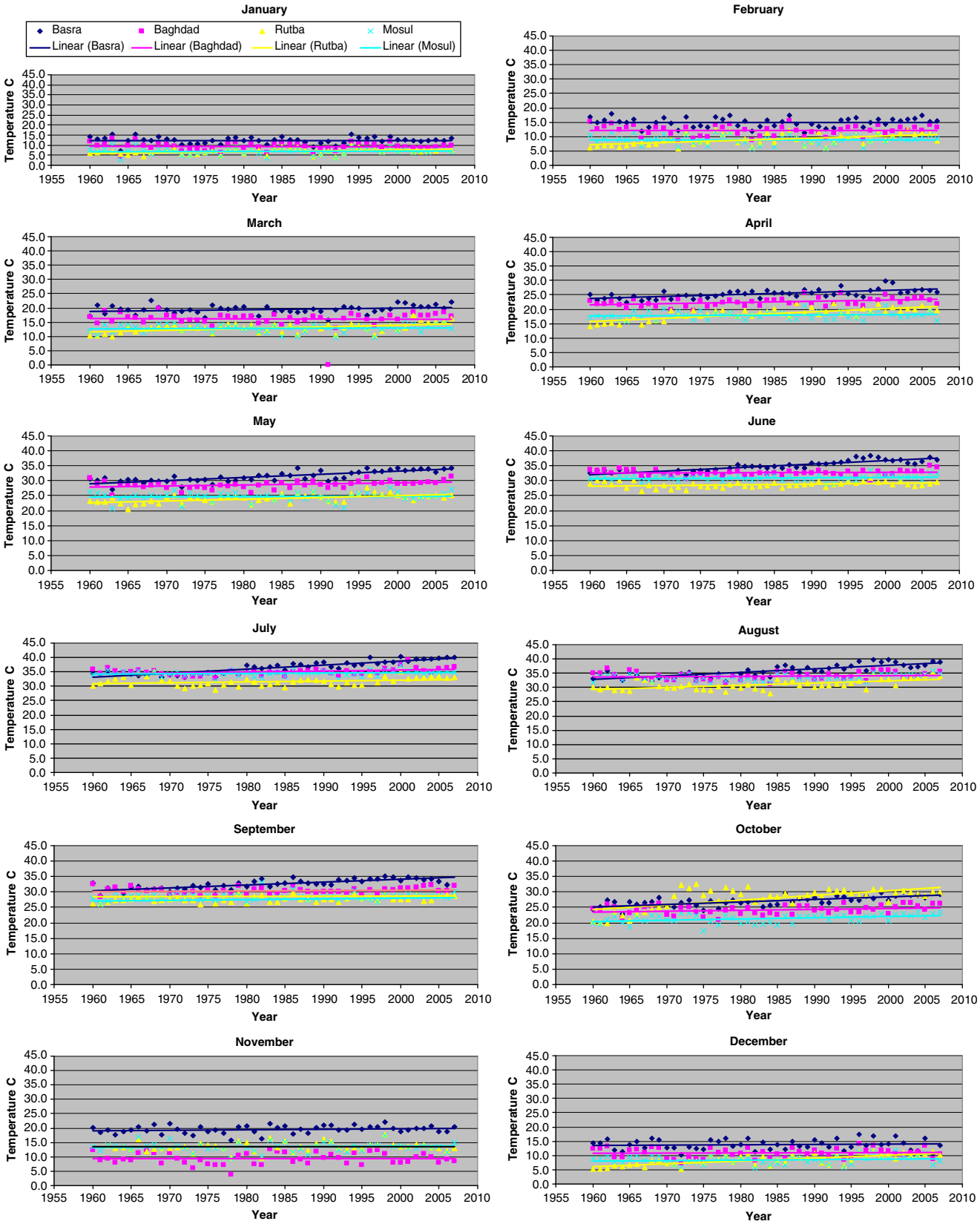

Fig. 2 Average monthly temperatures of Basra, Baghdad, Mosul, and Rutba since 1960 till 2007

to 2007 was detected throughout the years except for October where the temperature of Rutba was higher than that of Mosul by about 8°C (Fig. 2).

Annual rainfall and evaporation

The higher average rainfall in Iraq since 1960 till 2008 was recorded in Mosul, whereas the lower average rainfall was in Rutba (Fig. 3). The relationship between rainfall and time seems negative in Mosul, Baghdad, and Rutba, whereas it appeared approximately constant in Basra (Fig. 3). Evaporation in Mosul and Baghdad is similar and displays a negative relationship (Fig. 4). In Rutba, the climate has highly fluctuated evaporation, with a sudden decrease in the evaporation rate duration from 1990 to 1995 (Fig. 4). In Basra, the rate of evaporation is highly increased with time during 1970 till 2008.

Level and source of carbon dioxide in Iraq

According to the data that had been gotten from CDIAC, carbon dioxide is emitted from many sources, such as fossil fuel burning (solid, liquid, and gas), flaring, and the cement industry. Since 1957 to 2007, the largest quantity of carbon dioxide was emitted from the burning of liquid fuel, whereas the lowest quantity of released CO_2 was from burning gas and cement plants (Fig. 5). Flaring was the origin of a large quantity of CO_2 during the period that extended from 1964 to 1993, which decreased sharply and reached a low level since 1992 to 2007 (Fig. 5). The war in March 2003 is responsible for at least 141 million metric tons of carbon dioxide equivalent ($MMTCO_2e$). Between March 2003 and October 2007, the US military in Iraq purchased more than 4 billion gallons of fuel from the Defense Energy Support Center (DESC). The agency is

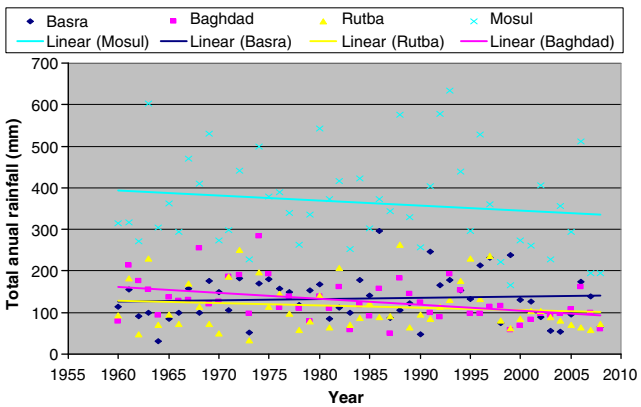

Fig. 3 Annual rainfall average of Mosul, Baghdad, Basra, and Rutba since 1960 till 2008

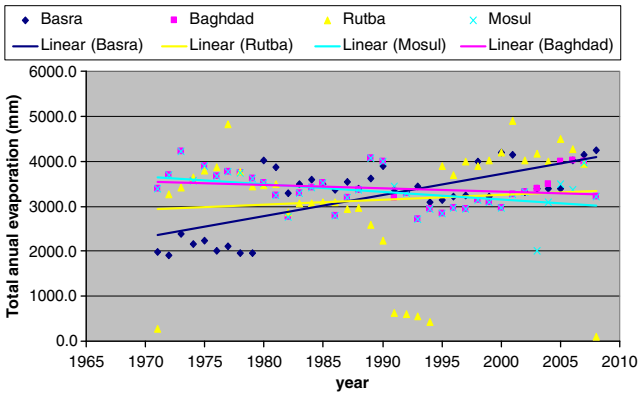

Fig. 4 Evaporation average of Mosul, Baghdad, Basra, and Rutba since 1970 till 2008

responsible for procuring and supplying petroleum products to the Department of Defense. Burning these fuels has directly produced nearly 39 million metric tons of CO_2 (Reisch and Kretzmann 2008). There is a strong correlation between carbon dioxide content in the atmosphere and temperature (Petit and Jousel 1999). Generally, a considerable increase in CO_2 level since 1950 to 2007 had been obviously detected.

Discussion and conclusions

The geosphere, consisting of the soils, the sediments, and rocks of the Earth's land masses, the continental and oceanic crust, and, ultimately, the interior of the Earth itself, represents the fifth of the final components of the global climate system. Each part of the geosphere plays a role in the regulation and variation of global climate, to a greater or lesser extent, over varying time scales (Buchdahl 1999; Bridgman and Oliver 2006). Most of the desertification takes place far away from desert margins. It is a

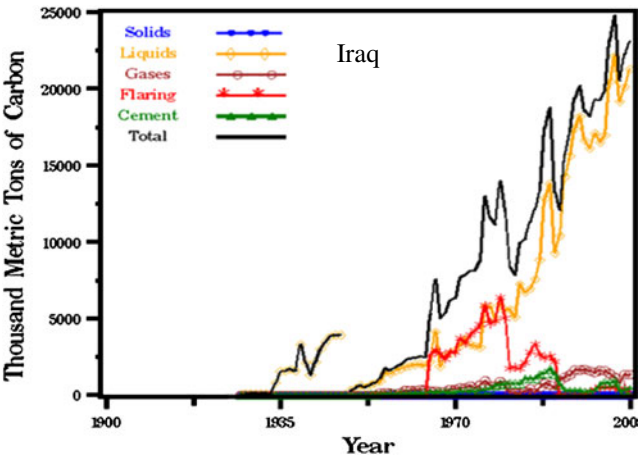

Fig. 5 Concentration of carbon dioxide gas in Iraq (from Carbon Dioxide Information Analysis Center, http://cdiac.ornl.gov)

continuous process that results from the impact of various factors, like climatic variations and human activities. The increasing temperature and high evaporation with a sharp decrease of rainfall quantity led to the expansion of desertification that eventually caused the reduction of vegetative cover and species diversity, loss of soil structure, decrease in soil fertility, alteration of the hydrological cycle, and reduced crop yields and livestock production (Buchdahl 1999). Below 25 km of atmosphere, the average content of carbon dioxide is 0.035%; also, there are 359 ppmv of CO_2 in the atmosphere (Schimel et al. 1995). In Iraq, the concentration of CO_2 had positively increased since 1953 till 2005, which was essentially emitted from the burning of liquid fuel, flaring, burning of gas fuel, and the cement industry (Fig. 5).

Figure 2 displays the increase of temperature during the period extending between 1960 and 2007. This refers to the CO_2 role in climatic warming. During chemical weathering, carbon dioxide is extracted from the atmosphere to react with the decomposing rock minerals to form bicarbonates. These bicarbonates are soluble and can be transported via rivers and other fluvial channels. Then, they precipitate on ocean floors as sediment. In essence, carbon dioxide, sequestered from the atmosphere, is thereby decreasing the Earth's natural greenhouse effect and causing further cooling (Ruddiman and Kutzbach 1991). The scarcity of rainfall reduced the chemical weathering which eventually caused further heating. The influence of the Arabian Gulf on the climate of Iraq is very limited but appears to be clear on Basra climate. Near the gulf, the relative humidity is higher than in any other part of the country.

This study differentiated many conclusions; these are:

1. Basra has a warmer climate than Baghdad, Mosul, and Rutba since 1960 till 2007 throughout the months except October, in which Rutba appeared to be colder. The behavior of the Basra climate differs from the others in which it is characterized by considerable increases in temperature and evaporation rate with constant rainfall. The rainfall in Basra looks constant 38 years ago, while the evaporation increased with a rate of 1,600 mm/38 years.
2. Mosul and Rutba have similar climates throughout the months since 1960 to 2007, and they appear to be colder except on October in which Mosul is still colder, but Rutba becomes warmer.
3. Rainfall in Mosul is heavier than that of all the other stations and similar to that of Baghdad. Rainfall in Mosul and Baghdad decreased by about 70 mm/48 years with a slight decrease in evaporation.
4. Rainfall in Rutba decreased in association with an increase in evaporation.
5. The war in 2003 is responsible for climatic warming and desertification because it directly participated in an increase in CO_2 in the Iraqi atmosphere and deforestation.
6. All conclusions above refer to the expansion and rapid growth of desertification.

References

Alsam SI, Saad ZJ, Hanna F (1990) Water balance of Iraq: stage 2, geological and hydrological conditions. Manuscript report. Ministry of Irrigation, Iraq

Bridgman HA, Oliver JE (2006) The global climate system. Cambridge University press, New York

Buchdahl J (1999) Global Climatic Change, student guide. A review of contemporary and prehistoric global climatic change. Manchester Metropolitan University. p 99 http://cdiac.org.gov

Lean J, Rind D 1996 The Sun and climate. Consequences Vol. 2, No. 1, Winter

Petit JR, Jousel J et al (1999) Climate and atmospheric history of the past 420, 000 years from the Vostok ice core, Antarctica. Nature 399:420–436

Reisch N, Kretzmann S (2008) A climate of war. The war in Iraq and global warming, Report by Oil Change International

Ruddiman WF, Kutzbach JE (1991) Plateau uplift and climatic change. Sci Am 264(3):42–50

Jassim SZ, Goff JC (eds)(2006) Geology of Iraq, 1st edn. Dolin, Praque and Moravian Museum, Brno, Czech Republic

Schimel D, Enting IG, Heimann M, Wigley TML, Raynaud D, Alves D, Siegenthaler U (1995) CO_2 and the carbon cycle. In: Houghton JT, Meira Filho LG, Bruce J, Lee H, Callander BA, Haites E, Harris N, Maskell K (eds) Climate change 1994: radiative forcing of climate change, and an evaluation of the IPCC IS92 emission scenarios, intergovernmental panel on climate change (IPCC). Cambridge University Press, Cambridge, pp 35–71