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Monitoring the change in annual drought conditions in Iraq for the period (1981-2022), using statistical methods and modern technologies

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Abstract:
Climate change is a natural phenomenon that occurs every several thousand years, but with the increase in human activities, climate change has accelerated. Since climate is the average of successive weather conditions in a place over a long period, it may be a month, a season, a year, or several years. Therefore, we find that climatology is concerned with showing the average or median weather conditions prevailing in a region rather than showing daily changes in weather conditions in the region. Therefore, climate change had a significant impact on drought conditions in the location of the study area during the period (1081-2022). The reason for this is that Iraq is characterized by its equatoriality and flat surface in the central and southern regions, which makes it enjoy fast wind movement that raises dust storms that reduce the level of humidity. Stations in southern and central Iraq recorded the highest frequency, represented by the dominance of (south-easterly) winds in the summer season, while stations in the northern region recorded the lowest frequency of this type of wind in the (winter) season. The reason is due to the high temperatures, the variation in humidity, and the frequency of winds in the summer and spring seasons, where air highs prevail and the frequency of air lows decreases, and since climate change causes the retention of rain in the winter with the phenomenon of global warming or the intensity of rain in the spring, summer and fall seasons due to... The phenomenon of convection, which becomes more active due to the heating of the Earth, as well as an increase in the pressure gradient as a result of the deepening of the depression. Seasonal thermal, while the reason for the decrease in wind speed in the fall and winter is due to the lack of thermal activity, the decline of the seasonal low, and the increase in the influence of the Siberian High. Since the drought trend and rising global temperatures have negatively affected drought conditions in Iraq, causing scarcity of rainfall throughout Iraq. Due to the decrease in the frequency of air depressions in the winter, as well as the dominance of air highs, which causes a decline in rain and a lack of humidity or its variation from one region to another, and using statistical methods and the SPSS program, it became clear that Iraq is going through varying periods of drought, which affected the climate conditions over a period of 41 years and during three cycles. Micro-climate cycle and macro-climate cycle.

Keywords: climate change, climatic elements.

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Introduction

Iraq's climate combines a Mediterranean climate with a hot desert climate. There are several factors that affect climate drought conditions in the study area, including the geographical nature, location, air masses, atmospheric pressure systems, and jet streams, in addition to human influences causing climate change. Iraq's climate is characterized by seasonal rainfall, and the rainy season extends from mid-October to mid-May. The period
between June and October is devoid of rain, and thus the amount of annual rainfall is greater in the northern mountainous regions than in the plain regions (central and southern.(
Winter is the rainiest month of the year due to the increased frequency of depressions. As for the spring season, it is less rainy, and the autumn season is also less rainy due to the short duration of rainy days in this season, because the Mediterranean depressions lose their influence on Iraq, and the region becomes under the influence of the depression. Tropical continental air, which is characterized by dryness. With the increasing impact of climate change, catastrophic and unusual fluctuations have appeared over previous years.
In rainfall, whether it increases or decreases, which will have a negative impact on the region. When the amount of rain exceeds the normal rate, it leads to devastating floods, as happened in some years when heavy rains fell on Iraq. The Tigris and Euphrates rivers flooded, destroying villages and homes and destroying agricultural crops.
When the amount of rain is less than the normal rate, this leads to the depletion of surface and groundwater resources, and drought occurs when the region continuously suffers from less than normal rainfall.

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Drought has an impact on the ecosystem, agriculture and the region, and the phenomenon of drought is considered a risk. Natural resources that threaten human life and ecosystems in different regions of the world, including Iraq

1.1 The study Problem

The different climatic regions of Iraq are affected by the phenomenon of drought, which is represented by a decrease in the amount of rainfall falling below its average, high temperatures, and lack of rain, which began to affect human activities significantly. Although large parts of the study area fall within a permanently dry climate, all regions of Iraq, including Stations with heavy rain also suffer from this phenomenon. There are also other climatic factors that play a fundamental role in the fluctuation of the amount of rainfall from year to year and from month to month. Among them are spatial factors and moving factors located within the upper atmosphere.

1.2 Objectives of the study

1. Explaining the role of natural and human factors affecting drought conditions in Iraq.
2. Analyzing the surface and upper weather conditions of the dry seasons while analyzing the conditions that lead to drought.
3. Determine the drought years between 1981-2022.
4. Detecting the climatic phenomena responsible for the occurrence of climatic drought at higher levels, including the dynamic factors affecting the climate of Iraq Upper pressure patterns (jet stream, gully and gully east, bulge and bulge east.(Surface and fixed factors affecting the climate of Iraq (astronomical position, geographical location, and terrain.(Use statistical methods to determine the extent of climate influence on the frequency of droughts

1.3. Study hypothesis

Natural or human climatic phenomena play a fundamental role in the occurrence of climate drought. We assume that upper and surface phenomena have a role in exacerbating the severity of climate drought in Iraq.

1.4 Study methodology

Analysis of climatic elements using drought evidence for the purpose of identifying dry years from wet years in Iraq. Includes drought cases and evidence for the **Thorn Thwaite** equation.

1.5.Temporal and spatial boundaries

Iraq is located between latitudes 5 - 29° - 27 - 37° north and longitudes 39 - 38° - 36 - 48° east. The latitude circles occupy an extension whose length from north to south is about 925 km, while the length of the horizontal extension in relation to lines of longitude, between east and west, is about 950 km. Which means a convergence of horizontal and vertical extension, and this location made Iraq's climate transitional between the desert climate and the Mediterranean climate, which is a continental climate characterized by drought, high temperatures in the summer, and low temperatures with little rain in the winter (1). Iraq's terrain varies from rugged, high mountains extending along its northern and eastern borders to flat land located in the central and southern part of Iraq, and the terrain plays an important role in determining climate variation within Iraq Ali Shalash, Ali, H, "The Climate of Iraq" Amman, Jordan, 1966, P10. [(1)]. The time limits are between 1981-2022.

1.6 the importance of studying

Climate drought is one of the important topics because of its clear impact on the economy and life. Its importance lies in presenting a clear picture of drought in Iraq and knowing ways to reduce this phenomenon. With a lack of rain, economic life is affected and it has a serious negative impact on human, animal and plant life, as it causes Decrease in ground and surface water levels, dryness of soil, and destruction of agricultural crops.

1.7 Study Justifications

Iraq is exposed to many risks, including climate drought, the effects of which are clearly visible on food security.

The lack of studies in this field in Iraq.

1.8 Causes of drought in Iraq

1-The decrease in the depth of the upper groove is important in shaping drought years. As the depth decreases, the slope of the western edge of the groove decreases, and the thrust of the upper westerlies from the east decreases, and the location of the subtropical jet stream has an effect in increasing drought (Bani Doumi, Muhammad, 1997) [(2)]

2 -Whenever a dent accompanies a Siberian Ridge or a European Ridge, it is shallow because the dent works to pump hot air over the cold surface and has little effect, and whenever a dent accompanies a subtropical high, it is deep because the dent works to pump hot air over the hot surface, so it is strong (Al-Rubaie, Shahla (2001) [(3)]

4- The decrease in the depth of the groove has an impact on the decrease in rain rates, as the depth of the groove

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and the direction of the location of the jet stream are an indication of the activity of the main air movements and atmospheric disturbances during their dominance over Iraq (Abdel-Baqi, Faten, 2001) (4)

5-The recurrence of the polar jet stream has a clear effect on the amount of precipitation because it activates cyclonic movement and increases the number of frontal depressions in the rainy months of the dry years, which means its frequency decreases and is reflected in the lack of rain. (Al-Sabhani, Khamis, 2002) (5)

6-He confirmed that the rains of the alluvial plain fluctuate from one season to another, and the rains of the alluvial plain are linked to the Mediterranean depressions and the frontal depressions. Therefore, Iraq records a fluctuation in the amount of rainfall falling from one season to another during the rainy season (Al-Quraishi, Zia, 2008) (6)

7-Altitude is an important factor in increasing precipitation, and the geographical location of Iraq does not encourage the fall of large amounts of rain. Iraq's rain increases towards the north, and its source is the Mediterranean, Sudanese and combined air depressions, and the Mediterranean air depressions have the greatest contribution to rainfall (Al-Samarrai, Ahmed 2008) (7)

8-The rains in Iraq were determined by the same appearance and disappearance of the jet stream, the frontal depression, and the combined one. Also, the rains in Iraq increase from October towards winter, and decrease at the end of the spring to disappear in the summer, and the amount of rain accompanying the groove pattern of the jet stream increases compared to the dent pattern. Because of this, the grooves work to create and activate air depressions, while the dents work to activate Surface high pressure (Al-Zangana, Laith 2008) (8)

9-The repetition of the cold and dryness of the Siberian Highlands is reflected in the lack of rainfall. Because when it controls Iraq's atmosphere, it hinders the progress of the systems that help rain fall, such as the Mediterranean Depression, the Sudanese Depression, and the Integrated Depression, due to its extreme cold and the static air movement therein. However, if the Mediterranean and Sudanese depressions dominate with a high frequency, they lead to precipitation in large quantities (Al-Khazraji, Sarah 2011) (9)

10-The actual values are determined according to the values on the basis of the actual value of the falling rain, which is affected by several influences, and it is not possible to benefit from all the rain that falls, so he relied on Thornthwaite's equations to determine the actual value of the rain in Iraq. The study showed several results, including dividing Iraq into regions according to the adequacy of the actual value of rainfall and the criterion of thermal adequacy (Al-Shalash, Ali, 1976, p. 42) (10)

2-Geographic concept of drought:

There are those who consider that the retention of rain and the decrease in precipitation below the average, that is, considering the amounts of rainfall falling as evidence of years of drought * Drought. It means a decrease in rainfall amounts below the general average for a long or short period. Which leads to a lack of running water in rivers and a decrease in the level of groundwater in the ground (Al-Bayati, Sabri and Al-Douri, Ahlam, Drought in Iraq, 2002, p. 299) (11)

As defined by the United Nations Environment Conference, the Earth Conference in Redoganero in Brazil, drought is a naturally occurring phenomenon that occurs when there is a decrease in recorded rainfall levels that are less than normal (John. 1982. P 304) (12) and in the latest studies of the World Meteorological Organization. I touched on defining the concept of drought, which is the decrease in the amount of rain over a wide area over a period of time. Usually one or more seasons, and most climatic factors are often involved in this, such as high temperatures, high winds, and low relative humidity. (World Metrological Organization. Climate. 1998. P6) (13)

3-The nature of climatic conditions in Iraq

The nature of the climatic conditions in Iraq is represented by winter rainfall and its interruption in the summer over all the lands of Iraq. Drought in Iraq is represented in seasons in which annual rainfall amounts are noticeably lower than usual rates. And the demi-region, of which Nineveh Governorate is a part, and some parts of Diyala Governorate, especially the region with limited rainfall, as well as the semi-guaranteed and even guaranteed region, as in the recent dry seasons. However, the region with limited rainfall and semi-guaranteed remains more vulnerable in all years to drought, as it is exposed to drought for an entire season. The amount of annual rainfall in it is less than the average and may exceed for more than one dry season part of the season. Either it is at the beginning of the season and affects the germination stage, or in the middle of the season and affects the regularity of growth, or at the end of the season, and more precisely the duration of effective growth at the time of flowering and fruit

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formation. (Fakhri, Qasim, Farming in Northern Iraq, 1979, p24.) (14)

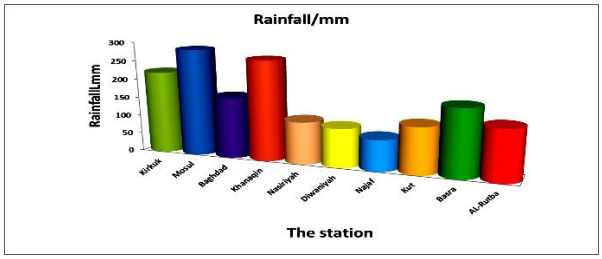
4-Lack of rain and its relationship to drought in Iraq

It has become clear that the recent years of drought - 1998-2020 were characterized by the decline of rainwater from the basins of the Tigris and Euphrates rivers and their tributaries in Iraq and in the upper river countries of Turkey and Syria, which led to a severe scarcity of revenues from the Tigris and Euphrates River, as well as the Diyala River, to levels never witnessed before. The most important manifestations of drought during the occurrence of the drought phenomenon are the recurrence of dust storms, in addition to the emergence of desertification manifestations as a result of the lack of cultivated areas due to water scarcity, as it was found that production decreased to low levels, especially in the desiccated region, but drought begins to appear and affect during the recurrence and succession of years of drought(https://reliefweb.int/report/iraq/iraq-droughtk2022)

Table (1): Total rainfall rates, mm, for the period 1981-2022

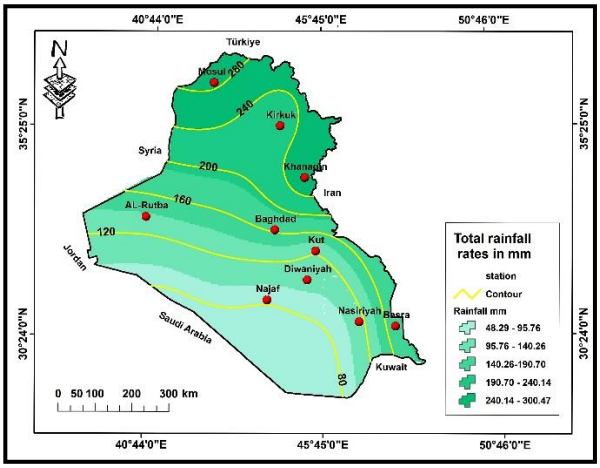
AL-Rutba	Basra	Kut	Najaf	Diwaniyah	Nasiriyah	Khanaqin	Baghdad	Mosul	Kirkuk	The station
136.453	178.985	124.63	83.355	103.724	113.13	267.5195	164.035	285.76	221.06	Rainfall /mm
3.3	4.4	3.0	2.0	2.5	2.8	6.5	4.0	7.0	5.4	Rain intensity/mm/hour

Figure(1)



Source: Satellite data for monitoring floods and water harvesting in Wasit Governorate, Ministry of Science and Technology, Department of Space and Communications, Disaster Information Center, unpublished data, 2016, p. 154

Map(1) of equal rain lines for the period (1981-2022)



Source: From the researcher's work, relying on Appendix No. 2 of the Ministry of Water Resources, General Authority for Survey, administrative map of Iraq on a scale of 1000000:1 dated 2023 using the Are Gis 10.2 program. Ministry of Transport and Communications, General Authority for Meteorology and Seismic Monitoring in Iraq (unpublished data) Density Rainfall (amount of rainfall/time period), Malik Nasser Abboud, daily record rainfall in Iraq, 2018, Journal of the College of Education/Wasit University, issue eighteen, p. 154

5-Frequency of weather depressions and their impact on drought in Iraq

It is possible to clarify aspects of the relationship between the recurrence of pressure systems and their impact on drought in Iraq for the years (1995-2022), which are characterized by a slight deviation from the averages of the years (1981-2022) not exceeding 25-39) as the maximum frequency of pressure systems, as it reaches the number of atmospheric highs that affect the drought. The movement of surface winds in Iraq is (139.5) high during the year, dominating its atmosphere for a period of up to (128.4) days, while the number of air depressions reaches (177.5) low, dominating the atmosphere of Iraq for a period of time up to (238.5 days constituted an impact rate of (70.96%). As for the most frequent depressions, it is the Mediterranean depression with (41.7) depressions during the year (Iraqi Ministry of Transport, General Authority for Meteorology and Seismic Monitoring, 1981-2022 (16)

6- The frequency and intensity of precipitation are associated with the frequency of pressure systems and the prevailing wind movement for years (1981-2022)

Firstly, the rain

Iraq is located within the arid and semi-arid region because it is characterized by varying amounts of rain from year to year. There are years characterized by higher amounts of rain than their general rates, so it is considered a humid year, and other years where rainfall amounts decrease clearly, so it is considered a dry year. The rainfall system in Iraq is similar to the rainfall system

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in the climate. The Mediterranean Sea, but the rain on the greater part of its land is so little that it is closer to the desert climate or the desert steppe regions (Husted, Corden. The Natural Foundations of the Geography of Iraq, 1948, p. 9 (17). When a frontal depression coming from the Mediterranean Sea towards... In Iraq, warm, moisture-laden southeasterly winds coming from the Arabian Gulf are blowing at the front of Iraq. They rise to the top and their temperature drops. Water vapor condenses, causing rain to fall. The mountains of Iraq help increase rainfall because they force the humid winds to rise, so their temperature decreases and their humidity condenses, which causes with rainfall of varying intensity (Khalaf, Jassim, lecturer in Iraq's Natural, Economic, and Human Geography' 1959, p. 50) (18). It is usual that winter depressions are heavier in rain than spring and autumn depressions. This type of rain varies widely from year to year. To another depending on the activity of the depressions and their strength. This affects its temporal and spatial distribution (Sharif, Abdul Aziz, Climate of Kuwait, 1980, p. 220) (19). The rainy season generally extends from mid-October to mid-May and reaches its maximum in January or February. However, the month in which it reaches its maximum also changes, as it may be December or March, and this may happen in some years, and there is a difference between the rains between the rains in the north and the north. Iraq and its south (Andreas, Farhat, Manahil Hanouna, and others, (2014)) (20) The rate of rainfall is linked to the height above sea level of the study stations, as well as the rise in average temperatures, see Table (2)

Table (2): Geographic distribution of the height of the study stations above the Earth's surface and average temperatures

Height m above mean sea leve	annual degree Celsius	latitude	station
331	24.59	35.46	Kirkuk
223	21.42	36.31	Mosul
34.1	22.87	33.23	Baghdad
202	23.14	34.3	Khanaqin
3	27.13	31.08	Nasiriyah
20.4	25.39	31.98	Diwaniyah
32	22.17	31.98	Najaf
15	26.05	32.16	Kut
2.4	27.22	30.56	Basra
615.5	20.84	33.03	AL-Rutba

Source: Republic of Iraq, Science and Technology, Space and Communications Department, Space Information and Disaster Management Center, Weather and Meteorological Data Section, 2021, p. 148, unpublished data.

7- Climatic drought

By studying the spatial distribution of the nuclear stations selected here, they were classified into four regions

Climatic data depending on the geographical data for each station, as follows:

1) The northern region (Mosul and Kirkuk(
2) The central region (Baghdad and Khanaqin)
3) The southern region (Najaf, Kut, Diwaniyah, Nasiriyah, and Basra)
4) The Western Region (Rutba)

Previous studies indicate that 95% of annual rainfall falls between November and April, and the concentration is greater during the winter, that is, from December to March. The other six months are dry and very hot, especially in the months of June, July and August. Given the climatic characteristics in which rainfall is scarce and temperatures rise significantly, such that the soil and plants quickly lose the moisture they obtain from rainwater due to high evaporation rates, crops cannot survive in Iraq without extensive irrigation operations, and thus the phenomenon of drought has become a burden on The development process in Iraq, as this phenomenon has affected large parts of Iraq in the current period, as Iraq has suffered from a severe, devastating drought.

The analytical study presented by the United Nations showed that changing rainfall patterns in Iraq is an important climate indicator for drought, as precipitation rates in the period 1981-2022 were adopted as a reference period to study precipitation trends and variations over a period of 31 years. The study included 42 weather monitoring stations. Distributed in different regions of Iraq. The map (2) shows the distribution of rainfall in Iraq on the basis of the average annual rainfall, which monitored the extreme variation in forty-two water stations (Annual Report on Water Harvesting in Wasit Governorate, Meteorology and Seismic Survey, 2016, Unpublished data(21)

The analytical study presented by the United Nations (Khalaf, Jassim, p. 105) (22) showed that the change in rainfall patterns for the time period 1980-2011 is an important climate indicator of drought, as precipitation rates were adopted as a reference period to study precipitation trends and variations over a period of 41 years, which included The study included 42 meteorological stations distributed in different regions of Iraq. Precipitation rates between the northern and southern parts of Iraq, with the average annual precipitation in the parts being 480 mm), while drought prevails in the southeastern parts with an average annual precipitation of (400) of less than (100 mm).

The year 1993 witnessed the highest precipitation rates, reaching 295 mm, a deviation from the average (-40), while the lowest was recorded.

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Precipitation rates in 2021, which amounted to 45 mm, with a deviation from the average (44.9). This is due to the deepening of the Indian monsoon low, as well as the repetition of the high on the Arabian Peninsula, as well as the recurrence of the Khamsin low, which reduced the amounts of moisture in the southeastern winds that are primarily responsible for rainfall, and causes the Indian monsoon low to have a role. The decline in Iraq's rains is mainly responsible for the heat waves that Iraq has suffered in general over the past years, and the selected stations have recorded varying annual precipitations and are heading towards climate drought

Table (3): Average annual precipitation during 41 years

year	Average rainfall/mm	std.deviation	year	Average rainfall/mm	std.deviation
2002	255	17	1981	200	72
2003	270	87	1982	270	87
2004	230	-43	1983	140	47
2005	200	7	1984	190	17
2006	280	-28	1985	155	97
2007	139	37	1986	220	-44
2008	145	-6	1987	177	-38
2009	155	47	1988	230	-28
2010	150	-3	1989	180	-33
2011	200	-23	1990	160	17
2012	139	72	1991	255	-44
2013	141.852	77	1992	260	-41
2014	143.328	112	1993	295	-40
2015	86.88	97	1994	280	-96
2016	78.28	17	1995	200	-105
2017	53.032	107	1996	290	-130
2018	144.163	82	1997	265	-39
2019	134.87	-3	1998	180	-48
2020	132.385	-13	1999	170	-51
2021	44.949	7	2000	190	-138
2022	85.764	-3	2001	180	-97
Average			183		

Source: Taha Raouf, Azhar Salman Hadi, annual deviations in the amounts of rain falling on Iraq for the period 1970-2000, Diyala Magazine, issue 54, 2012, p34..

Figure(2): Average annual precipitation over 41 years

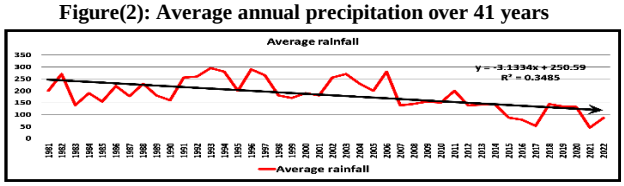
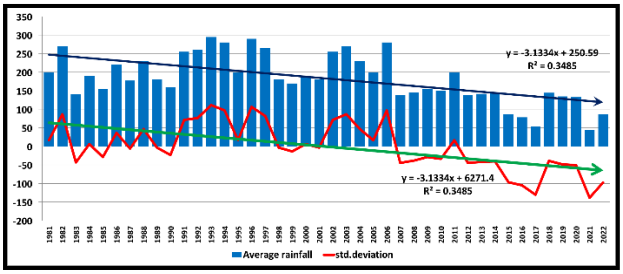


Table (3):

Figure (3) Moving average of rainfall amounts over 41 years



Source: Taha Raouf, Azhar Salman Hadi, annual deviations in the amounts of rain falling on Iraq for the period 1970-2000, Diyala Magazine, issue 54, 2012, p. 45[1](23).

Iraq went through drought conditions during the period 1992 - 2001 and wet conditions during the years 1993. It witnessed dry conditions during the years 1984, as the percentage of increase in average precipitation during that period reached about 04% of the total annual precipitation for the long recorded period. However, a decrease was observed. In rainfall during the period 2003-2011, which was followed by a significant decrease in rainfall during the period 2001-2008, it was a very dry period. Due to the limited frequency of frontal depressions responsible for rain in winter, as the data indicate that rainfall rates are decreasing as we advance to the year 2021. See table (3)

8-Climate changes: in Iraq

Since the early 1990s, the problem of global warming has worsened in the world as a result of air pollution and imbalances in the proportions of the components of the gaseous atmosphere in the upper layers, which led to a rise in global temperature. Which led to weather changes in pressures and then wind movement, which led to more drought and global warming. This problem will increase if its causes continue, and the world will witness climatic changes that will have negative and significant effects on the tropical and subtropical latitudes and warm temperate regions. In these regions, Iraq and its regional surroundings are located, which represent the sources of the Tigris and Euphrates rivers. These regions will witness more drought waves and scarcity and fluctuation of rain. . Perhaps the changes have become clear since 1999, as waves of drought and scarcity of rain continued, especially in the past three years. The countries of Southwest Asia competed in complaining about the severity of the drought, the scarcity of rain, the long summer months, and the intense heat waves (24). The effects of changes in the global climate will become clear. Through the following: - Scarcity and fluctuation of rain. During the last ten years, the phenomenon of drought and declining rainfall has recurred. This has become clear through the official reports and invitations of most officials in the countries of Southwest Asia, and the climatic stations in Iraq and some Turkish, Syrian and Iranian stations indicate a decline in the amount of annual rainfall. For example, but not limited to, the Turkish Erzurum station was receiving an annual total average of about 512. mm during the period from 1940-1980, but this annual average for the period from 1927-2000 began to decline, reaching about 410 mm. Also, the amounts of precipitation in Edirne, Muğla and Samsun stations decreased during the same period from 1927-2000, as it was 602 mm in Edirne and became 586 mm mm and mugla It was 1206 mm during the period 1940-1980 and became 1184 mm, Samsun was 735 mm and became 708 mm, and Malatya station was 387 mm and became 364 mm during the period 1927-2000 (13). This means a

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decrease in revenue The annual water supply began to occur in the most important sources of the Tigris and Euphrates, and this situation began to apply to... The amount of precipitation in Iraq. The amount of precipitation decreased in all Iraqi climate stations, especially in the last years from 1999 until 2012. Perhaps the scarcity of rainfall during the years 2007 and 2008 led to more drought and desertification, as dust and dust storms continued to strike Iraq from the north. To its south all year round, while its natural blowing seasons are in the spring and fall. • The most dangerous thing that will result from the repercussions of climate change is the encroachment in climatic zones and the transformation of marginal and semi-humid areas into semi-arid areas, and the problem of desertification will be exacerbated, whether through erosion or other methods. This is clearly evident in the dust storms that strike most areas of Iraq and throughout the year, as These storms extended for the first time to include the northern regions of Iraq, known for their mountainous nature. • One of the most prominent repercussions of global warming and climate change in arid, semi-arid and sub-humid regions is the significant increase in annual evaporation rates due to rising temperatures and their impact on other climate elements such as wind movement and solar radiation, which increase the total annual evaporation rates, which are among the highest rates in the world. The total annual evaporation at stations(25)

9-The effects of drought on Iraq and its surrounding areas

Many regions in the Middle East and West Asia, including Iraq, Iran and Jordan, are suffering the brunt of severe drought. The amount of rain falling on the region has decreased by 25 percent in Iran, for example, where 18 of the country's 28 governorates are suffering from symptoms of severe drought. As for Iraq, water levels in the Tigris and Euphrates rivers have decreased to about 20 percent of their levels, which This has led to massive damage to agriculture, which depends on irrigation. This is evident from the fact that residents of some neighborhoods of the Iraqi capital, Baghdad, began digging wells in the gardens of their homes to benefit from groundwater. In Jordan as well, the agricultural sector suffered severe damage due to water scarcity since last year. This was stated in A special report prepared by the Food and Agriculture Organization of the United Nations warned that the water scarcity that many countries in South Asia suffer from is of increasing concern due to the increasing number of deaths it causes, and efforts have already begun in the affected countries to try to reduce the effects of drought. In Iran, the government recently approved an emergency program worth more than $180 million to help farmers affected by drought. The Iranian Parliament also called on banks to postpone their claims on farmers' debts. While several international organizations are visiting Iraq to assess the food situation in the country, as for Jordan, it is currently benefiting from an international food aid program that began operating last July, and Pakistan has not been spared from the harms of drought, as weather forecasters said that the possibility is very weak. With rain falling in the next three months, conditions are likely to deteriorate in the provinces of Balochistan and Sindh, as their residents are abandoning them in search of water and food. The Pakistani government says that 140 people have died as a result of drought, but unofficial statistics say that the number of deaths is much higher than that (26)

10-Applying drought evidence for the purpose of identifying wet and dry regions for some climate stations in Iraq

Climatic drought and determining the dry year for the period 1981-2022-:

A dry year is one in which the total actual rainfall for the rainy months that extend from October to May is less than the general average by a standard deviation variance, or less, without paying attention to the regularity and spatial distribution of rainfall, and regardless of the effect of evaporation and transpiration (27)

11-Climatic regions:

Climatic regions are defined as dividing the Earth's surface or part of it into climatically similar regions based on one or more climatic elements or linking these elements with phenomena present on the Earth's surface such as the natural vegetation, soil, or water definition system of the region, despite the difficulty of finding two completely similar regions. When it comes to climatic regions, however, general characteristics will prevail in defining these regions. It is known that no two regions are similar in their climate, no matter how small they are on the surface of the Earth, and this is due to the small local differences that give each region its distinctive character. Climatic regions in the geographical sense are all Climatically similar areas in one region (28)

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Thorn Thwaite Guide:

$$\sum_{12} 1{,}65\left(\frac{r}{T+12{,}2}\right)^{10/9}$$

Since:

r = rainfall for the total months of the year (mm).

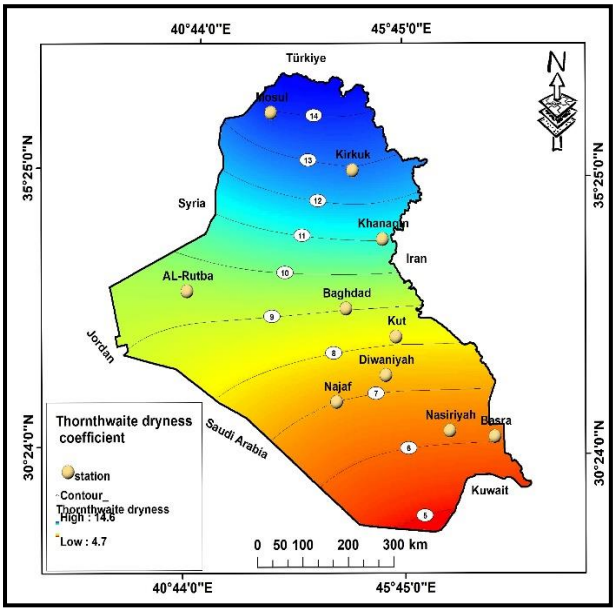
T = average annual temperature (°C)(29)

(table)4)Evidence of dryness by calculating the Thornthwaite coefficient

Presumption of drought	Degree of dryness
Over 182	very humid
182-64	wet
63-32	semi-humid
16-31	semi-dry
.Less than 16	dry

Source: Sabah Mahmoud Al-Rawi and others Applied Climatology Dar -wael for Publishing and Distribution, ed1, 2017, p. 91(30)

Map (2)of the arid and semi-arid regions according to the Thornthwaite Guide in Iraq for the period 1981-2022. According to Thornthwaite's Drought Manual



(table)(2-3-4)

11.1 Basra Station

We note at the Basra station that the time series over 41 years for the period 1981-2022 were dry years, as the period extending from the years 1981-2022 witnessed dry years over a period of (41) years characterized by drought. According to the Thornthwaite drought coefficient equation, while the drought coefficient according to the Lange equation was extremely dry over a period of 41 years.

It can be measured according to the following equation:

Thornthwaite coefficient for calculating drought: It is in the following numerical form:

D=?1.65 (r/ (t+12.2))10/9 ……(1

Since

D= Dry coefficient (mm/m(

r= Fallfall for the total months of the year (mm)

t = average annual temperature (°C)

The average annual temperature and total annual precipitation will be extracted from the table above:

Average annual temperature = sum of monthly averages\12 for the years (1981-2022)

Total annual rainfall = total monthly rainfall values for the years We substitute the values as follows:

11.2-Lange coefficient

Lange coefficient, called the rain coefficient, depends on the relationship between the amount of rain and the average temperature in the following formula:

Drought coefficient=annual rainfall mm/average temperature in degrees Celsius See map(3)(4) (and table)(6)(7)(8)(9)(10)(11)

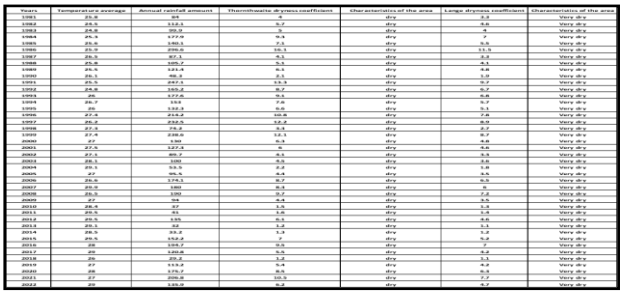
Table no(5)Determine the degree of dehydration according to Lange's conjecture

Characteristics of the area	Lange coefficient
Extremely dry	0-10
dry	10-40
Semi humid	40-160
wet	160- And more

Shaker Abdel Ayed Al-Zaidi, Estimating the water deficit using the drought and evaporation coefficient in Dhi Qar Governorate for the period (1980/1981 - 2016/2017) Applied Technologist), College of Education Journal, Issue 37, 2019, pp. 452-453(31)

11.3 Basra station

Table (6) of wet and dry years according to Thornth waite's guide and Lange's guide at Basra station for the period from (1981-2022).



The researcher's work was based on table (3)(4) (5)

Map (3)of the arid and semi-arid regions according to the Thornthwaite Guide in Iraq for the period 1981-2022

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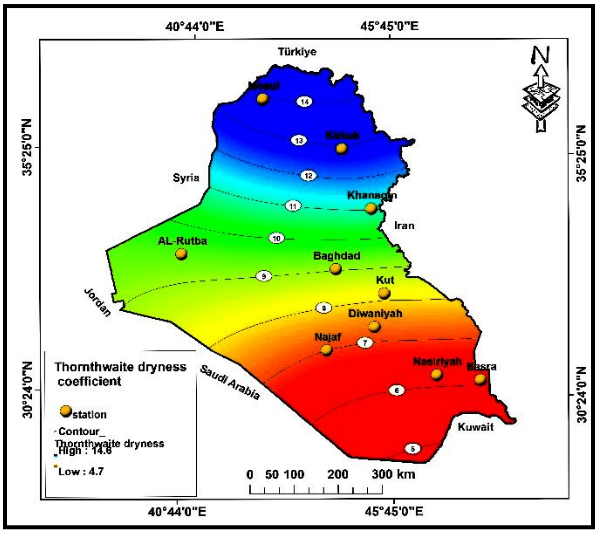
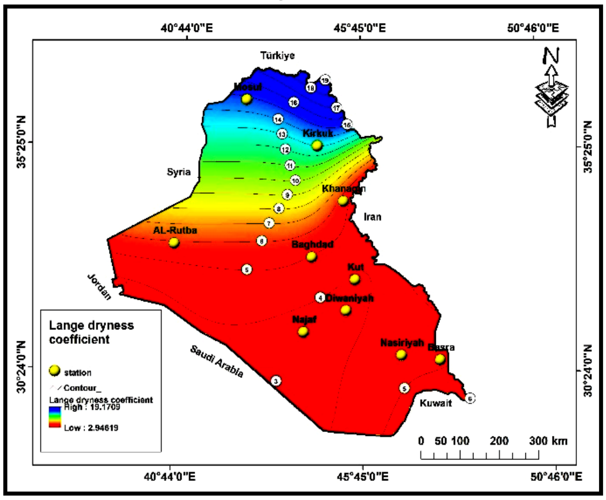


Source/from the researcher's work:Based on Thornthwaite evidence data using Are Gis 10.2.(32)

Map (4)of the arid and semi-arid regions according to the to lang's Drought Manual



Source/from the researcher's work:Based on Thornthwaite evidence data using Are Gis 10.2.

11.5 Baghdad Station Table (7)

Years	Temperature averag	Annual rainfall amou	Thornthwaite dryness coefficient	Characteristics of the area	Lange dryness coefficient	Characteristics of the area2
1981	22.6	109.9	5.9	dry	4.9	Very dry
1982	21.6	160.7	9.3	dry	7.4	Very dry
1983	22.1	57.8	2.9	dry	2.6	Very dry
1984	22.2	118.1	6.5	dry	5.3	Very dry
1985	22.8	91.5	4.8	dry	4.0	Very dry
1986	22.9	158	8.8	dry	6.9	Very dry
1987	23	49.9	2.4	dry	2.2	Very dry
1988	22.4	182.9	10.5	dry	8.2	Very dry
1989	22.8	145.6	8.0	dry	6.4	Very dry
1990	22.7	123.8	6.7	dry	5.5	Very dry
1991	22.8	51.8	2.6	dry	2.3	Very dry
1992	21.3	88.2	4.8	dry	4.1	Very dry
1993	22.2	192.5	11.2	dry	8.7	Very dry
1994	23.2	152.9	8.4	dry	6.6	Very dry
1995	22.6	96.7	5.1	dry	4.3	Very dry
1996	23.6	98	5.1	dry	4.2	Very dry
1997	22.3	113.8	6.2	dry	5.1	Very dry
1998	23.7	115.8	6.1	dry	4.9	Very dry
1999	23.8	58.5	2.8	dry	2.5	Very dry
2000	23.1	67.6	3.4	dry	2.9	Very dry
2001	23.7	82.1	4.1	dry	3.5	Very dry
2002	23.4	96.5	5.0	dry	4.1	Very dry
2003	23.7	100	5.2	dry	4.2	Very dry
2004	24.1	95	4.8	dry	3.9	Very dry
2005	23.4	108.2	5.7	dry	4.6	Very dry
2006	23.7	162.3	8.8	dry	6.8	Very dry
2007	24.1	100	5.1	dry	4.1	Very dry
2008	23.8	123	6.5	dry	5.2	Very dry
2009	24.2	100	5.1	dry	4.1	Very dry
2010	25.5	96	4.7	dry	3.8	Very dry
2011	25	113	5.7	dry	4.5	Very dry
2012	25.3	100	4.9	dry	4.0	Very dry
2013	25.4	156.6	8.1	dry	6.2	Very dry
2014	25.3	66	3.1	dry	2.6	Very dry
2015	25.5	97.4	4.7	dry	3.8	Very dry
2016	22.9	170.3	9.5	dry	7.4	Very dry
2017	23	202.7	11.5	dry	8.8	Very dry
2018	25	75.4	3.6	dry	3.0	Very dry
2019	24	114.7	5.9	dry	4.8	Very dry
2020	26	114.2	5.6	dry	4.4	Very dry
2021	27	108.4	5.1	dry	4.0	Very dry
2022	25	263	14.5	dry	10.5	dry

The researcher's work was based on table (3)(4) (5)

Baghdad station is no different from the rest, as it witnessed the period extending from the years 1981-2022, which was dry years over a period of (41) years characterized by drought. According to the Thornthwaite drought coefficient equation, while according to the Lange equation, it was very dry for the previous forty years, while the year 2022 was a dry year, different from the previous one, due to the high total record rainfall rates**.**

3- Al-Rutba Station: Table (8)-

Years	Temperature averag	Annual rainfall amou	Thornthwaite dryness coefficient	Characteristics of the area	Lange dryness coefficient	Characteristics of the area2
1981	19.6	139.9	8.6	dry	7.1	Very dry
1982	16.8	63.7	4.0	dry	3.8	Very dry
1983	18.8	206.6	13.6	dry	11.0	dry
1984	18.7	69.8	4.1	dry	3.7	Very dry
1985	19	87.1	5.2	dry	4.6	Very dry
1986	20	122.1	7.3	dry	6.1	Very dry
1987	20.2	89.9	5.1	dry	4.5	Very dry
1988	19.5	91.5	5.4	dry	4.7	Very dry
1989	19.8	263.8	17.2	Semi dry	13.3	Very dry
1990	19.8	65.2	3.6	dry	3.3	Very dry
1991	19.8	96.1	5.6	dry	4.9	Very dry
1992	18.4	84.1	5.1	dry	4.6	Very dry
1993	19.7	114.5	6.8	dry	5.8	Very dry
1994	20.4	130.6	7.7	dry	6.4	Very dry
1995	20	175.4	10.9	dry	8.8	Very dry
1996	20.6	230.2	14.4	dry	11.2	dry
1997	19.5	133.4	8.1	dry	6.8	Very dry
1998	21.2	236.9	14.5	dry	11.2	dry
1999	21	80.9	4.4	dry	3.9	Very dry
2000	20.4	62.6	3.4	dry	3.1	Very dry
2001	21.2	84.4	4.6	dry	4.0	Very dry
2002	19.8	103.3	6.1	dry	5.2	Very dry
2003	20.3	103.5	6.0	dry	5.1	Very dry
2004	23.7	123	6.5	dry	5.2	Very dry
2005	19.9	134	8.1	dry	6.7	Very dry
2006	22.7	136	7.5	dry	6.0	Very dry
2007	20.8	123	7.1	dry	5.9	Very dry
2008	21.3	200	12.0	dry	9.4	Very dry
2009	20.5	245	15.5	dry	12.0	dry
2010	22.7	231	13.5	dry	10.2	dry
2011	22.7	100	5.3	dry	4.4	Very dry
2012	22.5	200	11.6	dry	8.9	Very dry
2013	21.3	58.74	3.1	dry	2.8	Very dry
2014	22.4	23.59	1.1	dry	1.1	Very dry
2015	22.5	176.18	10.0	dry	7.8	Very dry
2016	22	139.1	7.8	dry	6.3	Very dry
2017	21	104.53	5.9	dry	5.0	Very dry
2018	23	33.72	1.6	dry	1.5	Very dry
2019	23	63.7	3.2	dry	2.8	Very dry
2020	22	64.4	3.3	dry	2.9	Very dry
2021	24	99.88	5.1	dry	4.2	Very dry
2022	25	99.22	4.9	dry	4.0	Very dry

The researcher's work was based on table (3)(4) (5)

We note at Rutbah station that the time series over 40 years for the period 1981-2022 were dry years, with the exception of 1989, which was a semi-dry year according to the Thornthwaite drought coefficient equation, while the drought coefficient according to the Lange equation was very dry over the years (1983-1996-1998- 2009-2010) were dry years due to the high total rainfall rates in those years

-Mosul Station-: Table(9)

Years	Temperature averag	Annual rainfall amou	Thornthwaite dryness coefficient	Characteristics of the area	Lange dryness coefficient	Characteristics of the area2
1981	19.4	371.9	25.5	Semi dry	19.1	dry
1982	19.1	415.4	29.2	Semi dry	21.8	dry
1983	19.4	251.9	16.6	Semi dry	13.0	dry
1984	20.0	422	28.8	Semi dry	21.1	dry
1985	19.8	301.4	19.9	Semi dry	15.2	dry
1986	20.3	373.1	24.8	Semi dry	18.4	dry
1987	20.0	343.4	22.9	Semi dry	17.1	dry
1988	19.6	576.1	41.2	Semi humid	29.4	dry
1989	20.2	329.2	21.7	Semi dry	16.3	dry
1990	20.1	256.6	16.5	Semi dry	12.8	dry
1991	20.3	404.6	27.2	Semi dry	20.0	dry
1992	18.3	577.1	43.3	Semi humid	31.5	dry
1993	19.2	633	46.5	Semi humid	33.0	dry
1994	20.5	439.6	29.6	Semi dry	21.4	dry
1995	19.9	296.2	19.5	Semi dry	14.9	dry
1996	20.6	528.7	36.2	Semi humid	25.7	dry
1997	19.3	360.7	24.7	Semi dry	18.6	dry
1998	21.2	222.2	13.6	dry	10.5	dry
1999	21.4	165.1	9.7	dry	7.7	Very dry
2000	20.9	272.8	17.2	Semi dry	13.1	dry
2001	21.2	262.4	16.3	Semi dry	12.4	dry
2002	19.7	405.7	27.9	Semi dry	20.6	dry
2003	20.0	227.6	14.5	dry	11.4	dry
2004	22.5	357.1	22.0	Semi dry	15.9	dry
2005	24.9	294.5	16.5	Semi dry	11.8	dry
2006	20.8	511.2	34.7	Semi humid	24.6	dry
2007	20.9	193.8	11.8	dry	9.3	Very dry
2008	22	216.3	12.8	dry	9.8	Very dry
2009	21	223.801	13.7	dry	10.7	dry
2010	19	240.6	16.0	dry	12.7	dry
2011	21	294.701	18.7	Semi dry	14.0	dry
2012	22	282	17.2	Semi dry	12.8	dry
2013	19	158.4	10.0	Semi dry	8.3	Very dry
2014	23	70.2	3.6	dry	3.1	Very dry
2015	21	237.2	14.7	dry	11.3	dry
2016	21	96.5	5.4	dry	4.6	Very dry
2017	22	116.4	6.4	dry	5.3	Very dry
2018	23	200	11.4	dry	8.7	Very dry
2019	19	140.7	8.8	dry	7.4	Very dry
2020	22	200.1	11.7	dry	9.1	Very dry
2021	24	218.7	12.2	dry	9.1	Very dry
2022	23	231	13.3	dry	10.0	dry

The researcher's work was based on table (3)(4) (5)

We note at the Mosul station that the time series over 41 years for the period 1981-2022 are divided into (5) semi-humid years (1988-1992-1993-1996-2006), in which 21 years were semi-arid, while the drought years were 16 years, while the coefficient Drought, according to the Lange equation, was extremely dry over a period of 11 years, while 31 years were dry

Diwaniyah statio/ Table(10)

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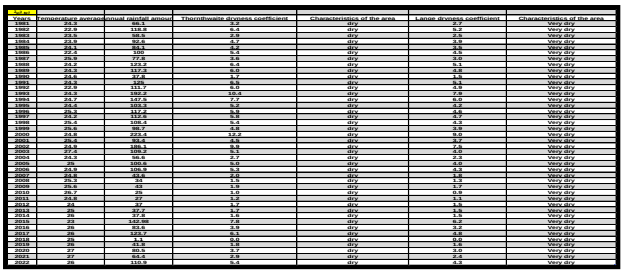
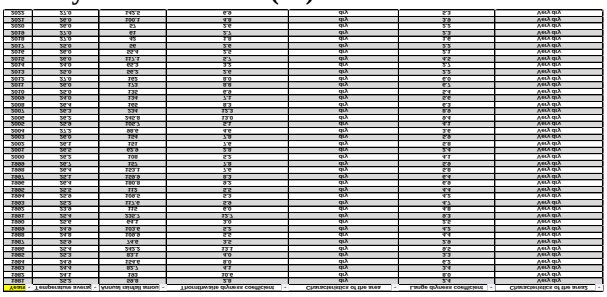


The researcher's work was based on table (3)(4) (5)

Also, the Diwaniyah station is no different from the rest, as it witnessed the period extending from the years 1981-2022, which was dry years over a period of (41) years characterized by drought. According to the Thornthwaite drought coefficient equation, while according to the Lange equation, it was very dry for the previous 41 years.

Nasiriyah/station/Table(11)

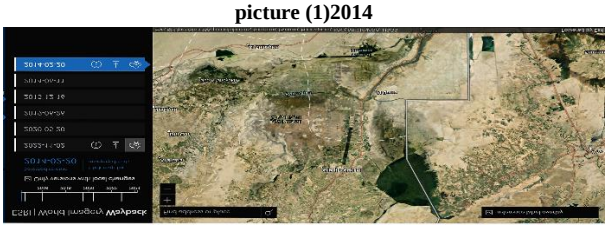


The researcher's work was based on table (3)(4) (5)

Also, the Nasiriyah station is no different from the rest, as it witnessed the period extending from the years 1981-2022, which was dry years over a period of (41) years characterized by drought. According to the Thornthwaite drought coefficient equation, while according to the Lange equation, it was very dry for the previous 41 years

The dryness of the marshes area between the years 2014-20222014

picture (1)2014



https://livingatlas.arcgis.com/wayback

picture (2)2022

https://livingatlas.arcgis.com/wayback

Conclusions

Climate change affected drought conditions in the location of the study area during the period (1081-2022). The reason for this is that Iraq is characterized by a flat surface in the central and southern regions, which makes it enjoy fast wind movement.

Stations in southern and central Iraq recorded the highest frequency represented by the dominance of (south-easterly) winds in the summer, while stations in the northern region recorded the lowest frequency of this type of wind in the (winter) season, which had an impact on the drought conditions in the region and this increased the incidence of climatic drought. The reason for the rise in temperatures in the summer and spring is the dominance of the phenomenon of convection, which is active during these seasons due to the rise in the Earth's temperature. In addition to the increase in pressure gradient as a result of the deepening of the seasonal thermal depression, and since the trend of drought and the rise in global temperatures has negatively affected drought conditions in Iraq, causing a scarcity of rain amounts throughout Iraq due to the decline in the frequency of weather depressions in the winter,

In addition to controlling air heights. This causes a decrease in rainfall and a decrease in the humidity level or its variation from one region to another. Using statistical methods and the SPSS program, it was found that Iraq is going through varying periods of drought, which affected climate conditions over a period of 41 years and during three secondary climate cycles and one major climate cycle.

1. **Recommendations**
2. -Work to prepare scientific cadres and adopt them by the state, and work to build specialized national cadres that work to transfer the experience and technology necessary to exploit these resources and find ways of scientific cooperation with countries of the world to learn about their resources. expertise.
3. -We are developing these solutions and mechanisms to confront the problems mentioned above, some of which are beyond human control, such as climate change that leads to drought and scarcity, and we work to protect and preserve them and demonstrate their importance in life. So that we can make the younger generations and children realize the importance of water from now on. Media:

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visual, audio, written and read programmes, pages, programs...etc. To clarify the dimensions of the problem and emphasize not wasting water to confront this problem.

4. -Realizing the seriousness of the problem in the short and long term, and this requires media efforts by employing part of the efforts or preserving current resources. Therefore, all parties (official, popular, academic, media, intellectuals and educated people, old and young) must bear responsibility for the sake of development and goodness. In embodiment of the Almighty's saying ((And We made from water every living thing)) God Almighty has spoken the truth, and this means that wasting water is killing the life of a being, for water to It is largely a plant or animal neighborhood, and the Ministries of Culture and Information and the Endowments Departments must spread awareness of water culture and emphasize the legal importance of preserving the source of life and agriculture to coordinate their work in a detailed and precise manner, because most of the water is consumed in the Ministry of Agriculture.
5. -Iraq must be covered with an effective system of climate stations, so that more than 200 climate stations are installed throughout Iraq, with one station in each district, and most areas of Iraq are small in area, and more than three stations in areas of a large area, and climate stations were installed after a year 2003. Other stations must be installed to cover the problem of climate drought in Iraq.

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The References

1. Ali Shalash, Ali, H, "The Climate of Iraq" Amman, Jordan, 1966, P10.
2. Muhammad Ahmad Al-Khalaf Bani Doumi, Holistic and Spatial Characteristics of Drought Years in Jordan, PhD thesis, (unpublished), University of Baghdad, College of Arts, 1997.
3. Shahla Adnan Mahmoud Al-Rubaie, The frequency of high altitudes and their impact on the climate of Iraq, Master's thesis, (unpublished), University of Baghdad, College of Education (Ibn Rushd), 2001.
4. Faten Khaled Abdel Baqi, The phenomena of the upper atmosphere and their impact on shaping the climate of Iraq, doctoral thesis, (unpublished), University of Baghdad, College of Arts, 2001.
5. Khamis Dahham Musleh Al-Sabhani, Factors Influencing the Recurrence of Dry and Wet Years in Iraq, Master's Thesis, (unpublished), University of Baghdad, College of Arts, 2002.
6. Diya al-Din Abdul Hussein al-Quraishi, Thermal characteristics of the central and southern part of the alluvial plain in Iraq, Master's thesis, (unpublished), University of Baghdad, College of Education (Ibn Rushd), 2008.
7. Qusay Abdel Majeed Al-Samarrai, Joan Samin Ahmed, The impact of the increase in the amount of rain falling on northern Iraq, Al-Ustad Magazine, No. 71, 2008.
8. Laith Mahmoud Al-Zangana, The location of the jet stream and its impact on the rains and depressions of Iraq, 1st edition, Kurdistan Center for Strategic Studies, 2008.
9. Sarah Muhammad Abd al-Wahab al-Khazraji, Climate controls and their impact on the advance or delay of the beginning of the rainy season in Iraq, Master's thesis, (unpublished), University of Baghdad, College of Education (Ibn Rushd), 2012.
10. Ali Hussein Al-Shalash. The actual value of rainfall and its impact on determining the vegetation regions in Iraq. Journal of the College of Arts, University of Basra, Issue 1, Year 9, 1976, p. 42.
11. Sabri Mustafa Al-Bayati and Ahlam Ahmed Jumaa Al-Douri, Drought in Iraq, Journal of the Iraqi Geographical Society, No. 4, 2002, p. 299.
12. John F. Griffiths & Dennis M. Driscoli, Survey of climatology. U.S.A. 1982.P 304
13. World Metrological Organization. Climate. Drought & desrtification. No. 869.Geneva. Switzerland. 1998.P6.
14. Qasim Abdullah Al Fakhri. Destructive agriculture in northern Iraq. A study of agricultural production sources and trends. Scientific development. University of Al Mosul. faculty of Agriculture. 1979. p. 24
15.)https://reliefweb.int/report/iraq/iraq-droughtk2022(
16. Iraqi General Authority for Meteorology, Climate Department, unpublished data, Iraqi Ministry of Transport, General Authority for Meteorology and Seismic Monitoring, 1981-2022
17. Cordon Husted. The natural foundations of the geography of Iraq. First edition. Arab Press. Baghdad. 1948 p. 9
18. Jassim Muhammad Khalaf. Lecturer on the natural, economic and human geography of Iraq, Al-Bayan Al-Arabi Committee Press. League of Arab States, Institute of Higher Arab Studies, 1959, p. 50 1.
19. Abdul Aziz Tareeh Sharif, Climate of Kuwait. University Culture Foundation, Alexandria, first edition, 1980, p. 220
20. Andreas Locke, Lubna Farhat, Manahil Hanouna and others, 2014, The National Framework for Integrated Management of Drought Risks in Iraq (SC/2014/report/h/I). An analytical study. United Nations Educational, Scientific and Cultural Organization, Iraq Office, unpublished data
21. Annual report on water harvesting in Wasit Governorate, meteorology and seismic survey, 2016, unpublished data.
22. Jassim Muhammad Khalaf. 1959, Lectures on the Natural, Economic, and Human Geography of Iraq, Arab Bayan Committee Press. League of Arab States, Institute of Higher Arab Studies, p. 105.
23. Source: Taha Raouf, Azhar Salman Hadi, annual deviations in the amounts of rain falling on Iraq for the period 1970-2000, Diyala Magazine, issue 54, 2012, p. 45
24. Data from the General Authority for Meteorology and Seismic Monitoring, Climate Department, Baghdad, 2011, unpublished data. As well as an analysis of the maps of the Middle East region published on the website: vortex. plymoth. edu://http
25. Ministry of Water Resources, General Authority for Dams and Reservoirs, Hamrin Project Management https://acwua.org/images/2_tawfiq_mohammad.pdf as well as the SITE website gov.ment.worldweather://http 2 - Nicola Ziadeh et al., Atlas of the World, Library of Lebanon, Beirut, 1996, pp. 14 and 38

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26. http://news.bbc.co.uk/hi/arabic/news/newsid_74 5000/745580.stm 7455 BBC Online, 2016

27. Taha Raouf Sher, Variations and Annual Probabilities of Rainfall in the Wavy Region in Iraq, Journal of the College of Arts, No. 90, 2009, 268.

28. Hassan Sayed Abu Al-Enein, The Origins of Climatic Geography, University Culture House 1995, pp. 394-393.

29. Adel Saeed Al-Rawi and Qusay Abdul Majeed Al-Samarrai, Applied Climate, University of Baghdad, 1990, p. 114.

30. Source: Sabah Mahmoud Al-Rawi and others Applied Climatology Dar-wael for Publishing and Distribution, ed1, 2017, p. 91

31. Shaker Abdel Ayed Al-Zaidi, Estimating the water deficit using the drought and evaporation coefficient in Dhi Qar Governorate for the period

32. .Applied Technologist), College of Education Journal, Issue 37, 2019, pp. 452-453.

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