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Determining the Climate Type and Calculating the Drought Index during the Rainy Months for the Stations of Diwaniya, Samawa and Nasiriya in Southern Iraq

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Abstract: ***In this research, the climate type for the rainy months (January, February, March, April, May, October, November, December) was determined for three selected stations in southern Iraq (Diwaniyah, Samawah, Nasiriyah). By calculating the drought index for each of the rainy months mentioned above using Demarton's equation described in (Mohammed, 2020) Based on climate data including temperatures in Celsius and rainfall amounts for the above-mentioned stations for the period (2000-2021) which were obtained from the Iraqi General Commission for Meteorology and Seismic Monitoring. The results showed the mastery of arid and semi-arid climate in all study stations during most of the rainy months. Except for the months of December and January, where the climate is semi-humid in the stations of Nasiriyah and Diwaniyah, respectively. As for Samawah station, the climate is arid and semi-arid during all rainy months. The results of the statistical analysis using Excel program (2010) also showed a strong positive linear correlation between the values of the drought index and the amounts of rainfall during the rainy months at the stations (Diwaniya, Samawa, Nasiriya), where the values of the correlation coefficient reached (0.961, 0.953, 0.954) respectively. As for the linear correlation between the values of the drought index and the temperatures during the rainy months, the results showed a strong negative linear correlation between them, as the values of the correlation coefficient reached (-0.821, -0.836, -0.822) at the stations (Diwaniya, Samawa, Nasiriya) respectively.***

Keywords: Climate Type, Rainfall, Environment, Climate.

1. INTRODUCTION

The phenomenon of drought can be defined in general terms. It is the water deficit in the general climatic water budget for a specific region during a specific long or short period of time characterized by a significant decrease in the amounts of rainfall. And this phenomenon is

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widespread in arid and semi-arid areas (Kamal, 2014). Several types of drought can be distinguished, including: (Al-Qadiri, 2013):-

1- Climate drought, which means that the amount of rain falling on a particular area is much less than the general average of usual amounts as a result of high temperatures and increased evaporation rates.
2- Hydrological drought is defined as a very severe deficit in water resources resulting from scarcity of rain. In hydrological drought, a significant decrease in the flow of valleys and groundwater represented by springs and wells is observed.

The phenomenon of drought is a function of both temperature and rainfall. As a result of the interaction of these two climatic elements, it has become possible to divide the world into several climatic regions characterized by a great variation in the distribution of plant regions according to the variation in temperature and rainfall for each climatic region. Among these climatic regions is the dry region, which is defined as the region characterized by rainfall amounts being less than evaporation rates and irregularly distributed. This leads to repeated periods of drought during the plant growth season. This region is also characterized by rainfall being in the form of severe rainstorms for a short period (Al-Takrouni et al., 2022). The dry region is divided into several regions: the Hyper Arid region, the arid region, the semi-arid region, and the Sub-Humid region. Based on a set of equations, including the Demarton equation for calculating the drought index, according to which the type of prevailing climate is determined, in addition to determining the type of vegetation cover specific to each type (Al-Shaer et al, 1992). Based on the above, it can be said that drought is a recurring phenomenon, especially in the dry region, which represent more than 30% of the land area (Johan and others, 2000). Therefore, the phenomenon of drought cannot be considered an exceptional case that will disappear quickly. As for this research, it has dealt with determining the type of climate prevailing in three selected stations in southern Iraq, namely Diwaniya, Samawa, and Nasiriya, during the rainy months (December, January, February, March, April, May, October, November, December) based on the values of the drought index that were calculated using the Demarton equation, which includes the monthly averages of both temperatures and rainfall amounts that were obtained from which were obtained from the Iraqi General Commission for Meteorology and Seismic Monitoring. For the period (2000 - 2021), calculate the correlation coefficient and simple linear regression equations between the monthly average of temperatures and rainfall amounts. and based on that, it was concluded that changes in temperatures and amounts of rainfall greatly affected In the change in drought index values.
This means a change in the type of climate in the study stations. This requires taking all Necessary procedures and measures to reduce the effects of climate change in the study area to the least possible extent.

2. RELATED WORKS

Many studies have been conducted related to determining the type of climate and calculating the drought index by applying the Demarton equation at the local and regional levels including the following:

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1- A study (Hidayat, 2020) that dealt with studying the values of the drought index and the type of climate during the rainy months in the governorates of Mosul, Baghdad and Nasiriyah in Iraq.
2- A study (Falah, 2012) that dealt with determining the general long-term trend of both temperature and rainfall in Lattakia Governorate in Syria by calculating Demarton's drought index.
3- A study (Shamkhi, 2018) that dealt with the prevalence of dry climate in Babylon Governorate in Iraq for a period of 6 months of the year, which concluded that Babylon Governorate is located within the dry desert climate zone, as the value of the drought index reached 0.290 when applying the Demarton equation
4- The study (Al-Jassani et al., 2023) dealt with modeling several equations, including the Lang equation, the Demarton equation, and the Thornthwait equation in the central parts of Iraq (Mosul, Khanaqin, and Kirkuk) and the southern parts (Samawa, Nasiriya, and Basra). It was found that the central parts of Iraq recorded the lowest values of the drought index as a result of the increase in rainfall and the decrease in temperatures, compared to the southern parts of Iraq, which recorded the highest values of the drought index as a result of the decrease in rainfall and the increase in temperatures.
5- The study (Ibrahim, 2021) dealt with the study of climatic elements in the Kalar station in northern Iraq. The study showed that the climate of the study area is semi-arid according to the Emberger equation. The value of the drought index according to the above equation reached 36.01. After calculating the evaporation-transpiration values using the Ivanov equation and Khosla's equation, subtracting the rainfall, it became clear that the region suffers from a water deficit that has a negative impact on the area of land planted with vegetables.

3. MATERIALS AND METHODS

The study was conducted to determine the climate type for the rainy months (January, February, March, April, May, October, November, December) for the stations (Diwaniya, Samawa, Nasiriya) whose height above sea level and geographical locations represented by longitudes and latitudes are shown in Table (1) as follows: -

Table (1) Height above Sea Level and Geographical Locations of Study Stations

Station Name	Station Number	Longitude	Latitude	Height Above Sea Level
Diwaniya	672	44 .57	31. 57	20
Samawa	674	45 .16	31. 16	11.4
Nasiriya	676	46 .14	31 .01	5

1 - 2 Using the monthly averages of temperatures in Celsius and rainfall amounts (mm) during the rainy months in Tables (2, 3) obtained from the Iraqi General Commission for Meteorology and Seismic Monitoring for the period from (2000 - 2021).

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Table (2) Monthly Averages of Temperature in Celsius during the Rainy Month for the Stations (Diwaniyah, Samawah, Nasiriyah) for the Period (2000-2021)

Station	**Rainy Months**							
	January	February	March	April	May	October	November	December
Diwaniya	**12.4**	**15.3**	**20**	**25.45**	**31.4**	**27.15**	**18.85**	**13.9**
Samawa	**12.05**	**14.95**	**20.15**	**25.22**	**31.9**	**27.75**	**19.35**	**14.10**
Nasiriya	**12.8**	**15.6**	**20.9**	**26.35**	**32.60**	**29.1**	**19.9**	**14.45**

Table (3) Monthly Averages of Rainfall (Mm) During the Rainy Months for the Stations (Diwaniyah, Samawah, Nasiriyah) for the Period (2000-2021)

Station	**Rainy Months**							
	January	February	March	April	May	October	November	December
Diwaniya	**20.8**	**12.1**	**8.2**	**14.6**	**3.4**	**5.1**	**23.0**	**14.8**
Samawa	**13.6**	**11.6**	**14.1**	**10.4**	**5.0**	**4.3**	**22.6**	**15.9**
Nasiriya	**14.4**	**11.8**	**15.6**	**14.6**	**3.7**	**6.4**	**24.0**	**22.1**

2-2 Calculate the drought index for each of the rainy months at the three study stations using the Demarton equation described in (Mohammed, 2020)

$$ID = \left(\frac{P}{T + 10}\right) \times 12$$

(ID) is the drought index for the month
(P) Is the Average rainfall during that month (mm)
(T) Is the Average temperature in Celsius during that month
The climate type is determined based on the ID values shown in Table (4) mentioned in (Fellah, 2012).

Table (4) Determining the Climate Type Based on the Values of the Drought Index (ID)

values of the drought index (ID)	**climate type**
Less than 5	arid
Between (5 - 10)	semi-arid
Between (10 - 20)	semi-humid
Between (20 - 30)	humid
More than 30	very humid

3-2 calculating the linear correlation coefficient between the values of the drought index with both the monthly average temperature in degrees Celsius and the monthly average rainfall (mm) during the period (2000-2021) for each of the study stations and obtaining simple linear regression equations using the program (Microsoft Excel 2010).

4. RESULTS AND DISCUSSION

4.1. Applying the Demarton equation to calculate the drought index and determine the type of climate during the rainy months for the stations (Diwaniyah, Samawah, Nasiriyah) using

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the data referred to in Tables (2, 3) that include the monthly averages of temperature in Celsius and the amount of rainfall (mm) for the period (2000-2021) as follows: -

4.1.1 Diwaniyah Station

Table (5) and Figure (1) show the values of the drought index and the climate type for the rainy months at Diwaniyah Station. The table shows that the climate type is semi-arid during the months (February, November, December) as the drought index values reached (5.739, 9.566, 7.430) respectively. While the climate type is arid during the months (March, April, May, October) as the drought index values reached (3.280, 4.942, 0.985, 1.647) respectively. As for January, the climate type is semi-humid as the drought index value during this month reached 11.142

Table (5) Drought Index and Climate Type for Rainy Months at Diwaniyah Station According to Demarton Equation for the Period (2000-2021)

Rainy months	**January**	**February**	**March**	**April**	**May**	**October**	**November**	**December**
drought index	11.142	5.739	3.280	4.942	0.985	1.647	9.566	7.430
climate type	semi-humid	semi-arid	arid	arid	arid	Arid	semi-arid	semi-arid

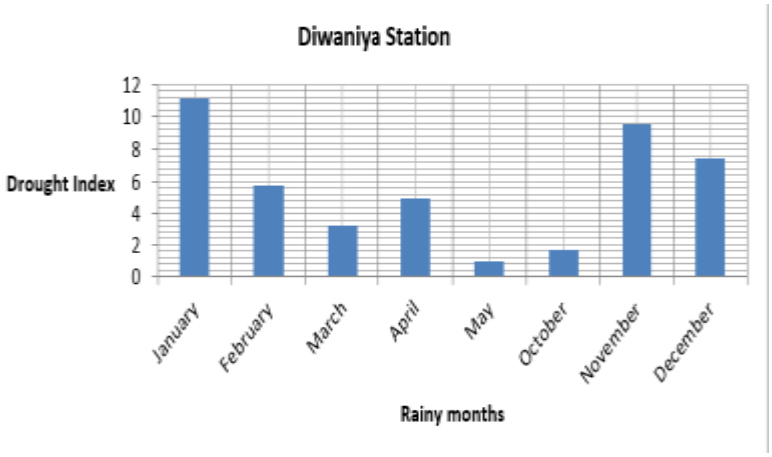

Figure (1) the Drought Index for the Rainy Months at the Diwaniya Station According to the Demarton Equation for the Period (2000 - 2021)

4.1.2 Samawa Station

Table (6) and Figure (2) show the values of the drought index and the climate type for the rainy months at Samawa Station. The table shows that the climate type is semi-arid during the months (January, February, March, November, December), as the values of the drought index reached (7.401, 5.579, 5.611, 9.240, 7.917) respectively. While the climate type is arid during the months (April, May, October), as the values of the drought index reached (3.543, 1.431, 1.366) respectively.

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Table (6) Drought Index and Climate Type for Rainy Months at Samawa Station According to Demarton Equation for the Period (2000-2021)

Rainy months	January	February	March	April	May	October	November	December
drought index	7.401	5.579	5.611	3.543	1.431	1.366	9.240	7.917
climate type	semi-arid	semi-arid	semi-arid	arid	arid	arid	semi-arid	semi-arid

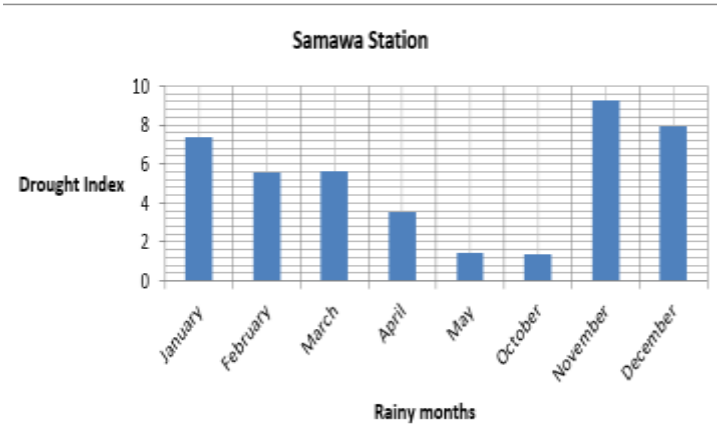

Figure (2) the Drought Index for the Rainy Months at Samawa Station According to the Demarton Equation for the Period (2000-2021)

4.1.3 Nasiriya Station

Table (7) and Figure (3) show the values of the drought index and the climate type for the rainy months at Nasiriya Station. The table shows that the climate type is semi-arid during the months (January, February, March, November), as the values of the drought index reached (7.578, 5.531, 6.058, 9.632) respectively. While the climate type is arid during the months (April, May, October), as the values of drought index reached (4.819, 1.042, 1.964) respectively. As for the month of December, the climate type is semi-humid, as the value of the aridity coefficient reached 10.846

Table (7) Drought Index and Climate Type for Rainy Months at Nasiriyah Station According to Demarton Equation for the Period (2000 - 2021)

Rainy months	January	February	March	April	May	October	November	December
drought index	7.578	5.531	6.058	4.819 8	1.042	1.964	9.632	10.846
climate type	semi-arid	semi-arid	semi-arid	arid	arid	arid	semi-arid	semi-humid

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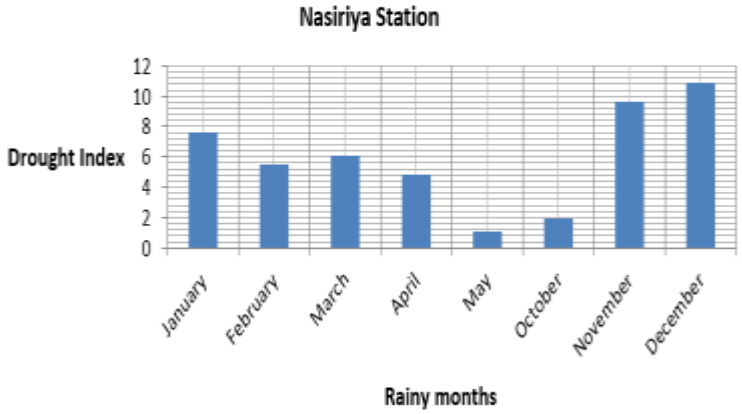

Figure (3) the Drought Index for the Rainy Months at Al-Nasiriya Station According to the Demarton Equation for the Period (2000 - 2021)

4.2. Calculating the correlation coefficient values and finding simple linear regression equations between the values of the drought index and the monthly average of both rainfall amounts (mm) and temperatures in Celsius during the rainy months at the stations (Diwaniya, Samawa, Nasiriya) for the period (2000-2021) using Microsoft Excel 2010.

4.2.1 Calculate the correlation coefficient and simple linear regression equations between the values of the drought index and the monthly average rainfall (mm)

Table (8) and Figure (4) show the values of the correlation coefficient and simple linear regression equations between the values of the drought index and the monthly average rainfall (mm) for the period (2000-2021) where it is clear from the table that there is a very strong positive correlation in the three stations (Diwaniya, Samawa, Nasiriya).

Table (8) Correlation Coefficient Values and Simple Linear Regression Equations between Drought Index Values and Monthly Rainfall Rate (Mm) At Study Stations for the Period (2000-2021)

Station	**Correlation coefficient value**	**Correlation type**	**Simple linear regression equation**
Diwaniya	**0.961**	very strong positive	y=0.4982x-0.760
Samawa	**0.953**	very strong positive	y=0.4734x-0.507
Nasiriya	**0.954**	very strong positive	y=0.4696x-0.675

X= drought index Y= rainfall rate

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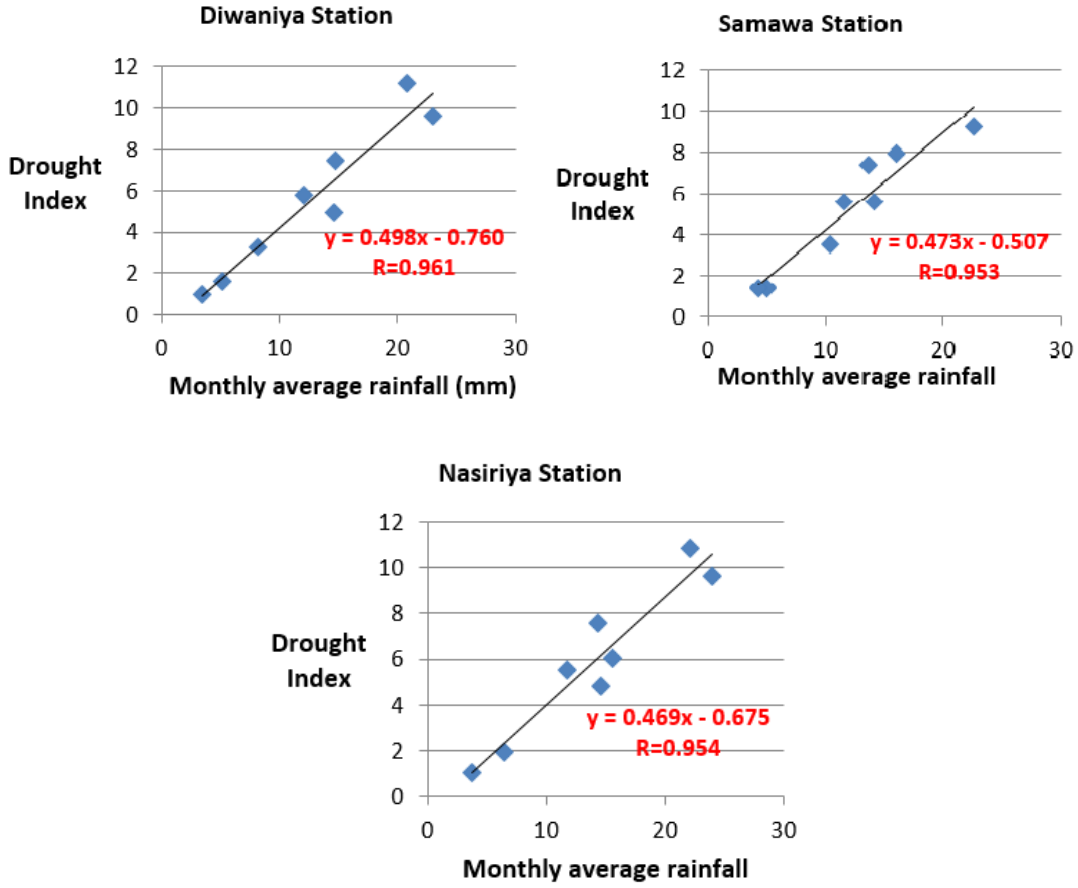

Figure (4) Values of Correlation Coefficients and Simple Linear Regression Equations between the Values of the Drought Index and the Monthly Average Rainfall Amounts (Mm) At the Stations (Diwaniya, Samawa, Nasiriya) for the Period (2000 - 2021)

4.2.2 Calculate the correlation coefficient and simple linear regression equations between the values of the drought index and the monthly average temperature in Celsius.

Table (9) and Figure (5) show the values of the correlation coefficient and simple linear regression equations between the values of the drought index and the monthly averages of temperature in Celsius for the period (2000-2021).The table shows a Strong negative correlation in all study stations (Diwaniya, Samawa, Nasiriya).

Table (9) Correlation Coefficient Values and Simple Linear Regression Equations between the Drought Index Values and the Monthly Average Temperature in Celsius at the Study Stations for the Period (2000-2021)

Station	Correlation coefficient value	Correlation type	Simple linear regression equation
Diwaniya	**-0.831**	Strong negative	y=-0.437X+14.58
Samawa	**-0.836**	Strong negative	y=-0.348x+12.46
Nasiriya	**-0.822**	Strong negative	y=-0.387X+14.25

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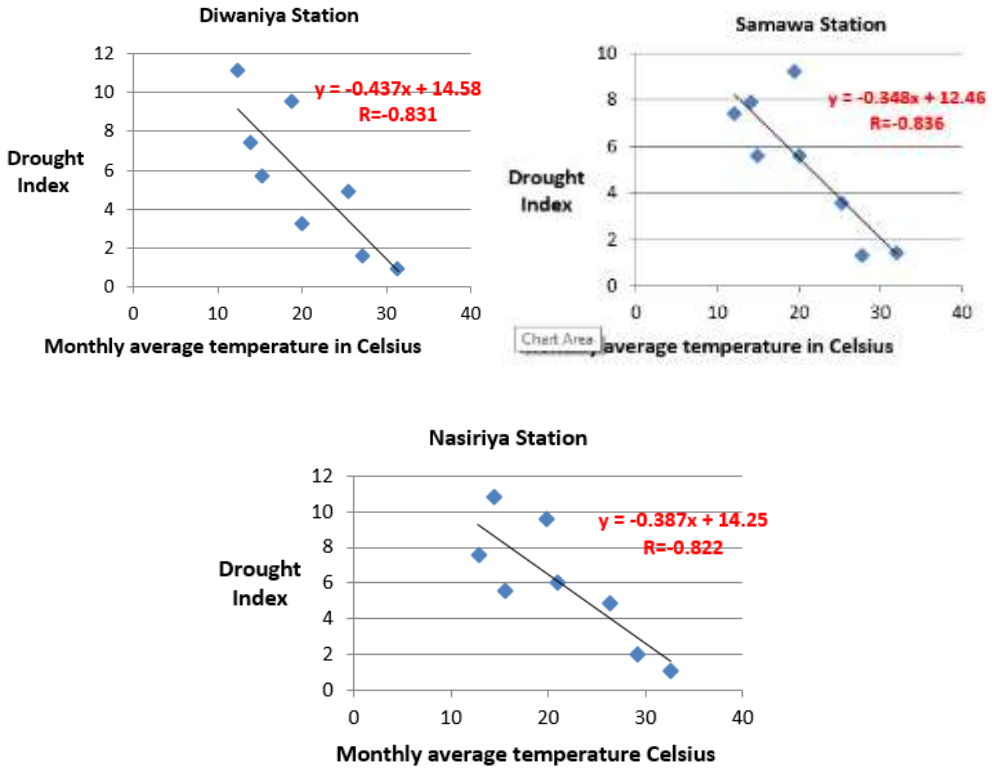

Figure (5) Values of Correlation Coefficients and Simple Linear Regression Equations between the Values of the Drought Index and the Monthly Averages of Temperatures in the Stations (Diwaniyah, Samawah, Nasiriyah) for the Period (2000 - 2021)

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1- The highest value of the drought index calculated according to Demarton's equation was at the Diwaniyah Station during the month of January, reaching 11.142, while the lowest value was during the month of May at the same station, reaching 0.985
2- The mastery of arid and semi-arid climate during most of the rainy months in Diwaniyah and Nasiriyah stations. Except for January in Diwaniyah station and December in Nasiriyah station where the climate is semi-humid.
3- The mastery of arid and semi-arid climate during all rainy months at Samawah station.
4- There is a very strong positive correlation between the drought index and the monthly averages of rainfall. While the correlation is strongly negative between the drought index and the monthly averages of temperatures in Celsius.

5.2 Recommendations

1- This research studied the phenomenon of drought in the three study stations by calculating the values of the drought index according to the Demarton equation based on the monthly average of rainfall and temperatures in Celsius for the period (2000-2021). Therefore, it is necessary to expand the study of this phenomenon in the study area by using other

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indicators that include new climatic elements in addition to rainfall and temperatures to identify the most important negatives of the drought phenomenon and find appropriate solutions.

2- Increasing the density of vegetation cover in the study area by expanding forestation operations and caring for the natural vegetation cover, planting the soil with drought and salinity tolerant crops with relatively low water requirements, and using highly efficient irrigation methods such as sprinkler irrigation. These measures will reduce the intensity of solar radiation reaching the soil surface, reduce the effect of winds, which leads to reducing evaporation rates to the lowest possible level.

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