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PREDICTING DROUGHT USING ARTIFICIAL INTELLIGENCE TECHNIQUES

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Abstract: The research dealt with climate drought, its types, the causes that lead to drought, and how to reduce drought. Drought in the city of Mosul, northern Iraq, was also analyzed and studied by obtaining monthly rainfall data for the Mosul climate station located within the study area for the period from 1981-2018.

Previous studies and research conducted to study drought in different regions of the world were taken into consideration. Most of these studies and researches use drought indices, which are among the most widely used indices in estimating the amounts of deficit, their use, severity, and their impact on the water balance. The standard rainfall index (SPI) is one of the most widely used indices in estimating climate drought. (SPI) is characterized by many characteristics that distinguish it from other indicators. The standard rainfall index (SPI) technique was used in analyzing rain records. The analysis principle using the standard rainfall index is statistically based on the principle of converting the gamma distribution of the data series to the normal distribution. Positive SPI values mean that there is an increase in rainfall above the average rainfall, i.e. wet years, while negative values mean that there is a decrease in rainfall below the average rainfall, i.e. dry years. SPI values for a period of 12 months were adopted in the analysis because they cover the annual rainfall amount falling on the station during a year. Using the MATLAB program, several networks were created and tested, and the network with the best performance was selected from among the networks. 30 annual rainfall values were used against the SIP values calculated using equations and the Excel program to train the neural network on the data. While the rainfall data for the remaining

8 years were used to verify the results of the neural network by comparing the results of the neural network with the actual values recorded at the measuring station. This network was able to obtain the index value by simply entering the annual rainfall value. By comparing the index value with the drought classification table, the drought class can be determined without resorting to the calculation method. The network with the 1-7-1 structure (input layer, hidden layer containing seven neurons, and output layer) with the TRAINLM training function and the LEARNGDM learning function gave the best performance, as the correlation coefficient between its results and the actual results (which were not included in the training) was equal to 0.99 and the square error rate was 0.014, meaning that the results of this network can be adopted for the purpose of calculating the standard rain index with high confidence in the outputs

Keywords: -.

Introduction

1 -1 The concept of drought: It is a natural disaster, with a complex structure, that is widespread in many places on the surface of the earth, and this phenomenon is closely linked to the balance between water and energy. Drought can also be defined as a deficit in the water wealth of certain areas, where this deficit occurs in a specific period of time, which leads to water scarcity, and a significant decrease in its percentage in various water resources. This disaster may lead to a decrease in the percentage of groundwater, which negatively affects humans, animals and plants due to the climate changes that occur in the drought region, as climate regions play an important role in the occurrence of drought. Drought is called by a number of names such as famine, drought and water retention, as drought means a severe shortage of water resources due to a decrease in the rate of rainfall from its normal rate during a specific period of time, which leads to huge losses in agricultural production and forces the population to migrate end masse. It can also be defined as a state of absence of rain and its absence during a long period of time, which leads to a shortage of water resources in the region and its inability to cover all the water needs of farmers and neighboring residential areas.

1-2 Reasons that lead to drought:

1. Low rates of sudden rainfall, as this rain is characterized by very high rates of rainfall, which helps to increase the speed of water flow in the valleys.
2. A significant increase in temperatures; which leads to an increase in water evaporation rates.
3. The nature of the soil is one of the main factors that contribute to water storage, and thus the amount of evaporated water increases.
4. The low rate of rainfall in general, which affects agriculture and agricultural crops in particular, which depend heavily on rainwater.
5. The emergence of drought in coastal regions in particular; due to the high rates of cold in the northern hemisphere.
6. The emergence of multiple patterns as a result of the occurrence of large atmospheric circulation in high pressure systems or hurricane sites.

7. Weak atmospheric processes that lead to a decline in the area of vegetation cover, especially in dry and semi-dry areas.

1-3 Classifications of drought

1. Permanent drought: This drought occurs in deserts and desert areas to a large extent.
2. Seasonal drought: This classification depends on the season in which rainfall occurs.
3. Emergency drought: It occurs due to irregular and fluctuating rainfall, especially in humid and semi-humid areas.
4. Unseen drought: This drought occurs as a result of a decrease in the humidity of the atmosphere in addition to the humidity of the soil, which leads to a decrease in the percentage of plants or their complete death.

1-4 Types of drought

1. Agricultural drought: This drought occurs due to a decrease in the humidity of the soil, and leads to a decrease in the quantity of agricultural crops, and thus a decrease in their production rate and a decline in their growth.
2. Climatic drought: Which means a decrease in the amount of rainfall in a certain area from its natural rate, as a result of high temperatures and an increase in the rate of evaporation.
3. Hydrological drought: It is a severe deficit in water resources resulting from a lack of rainfall, which leads to a decrease in the flow of valleys.
4. Physiological drought: Despite the availability of rain in certain areas, they are exposed to drought due to soil erosion and overgrazing, in addition to loading the pasture with large numbers of animals.
5. Agricultural drought: It is formed as a result of the incorrect and poor distribution of rain between the seasons of the year. This type of drought does not depend only on the amount of rain, but also on the extent to which this rain matches the water requirements of crops. This type of drought may be closely linked to climatic drought; as the withholding of rain for long periods leads to a decrease in the soil's water reserves, which leads to its drying out.

1-5 Effects of Drought

First. Economic Effects

- Reduces economic performance and growth and thus affects the standard of living of humans
- Reduces and may destroy crops and agricultural lands and reduces the number of livestock and fish
- Increases the prices of goods and foodstuffs
- Reduces agricultural production and thus reduces the income of farmers and those related to their work
- Decreases tax revenues due to decreased consumption
- Increases unemployment
- Harms tourism as no one wants to go to countries suffering from water shortages
- Increases desertification at the expense of agricultural lands

Second. Environmental Effects

- Increases the risk of fires and their disturbance
- Increases plant diseases
- Leads to soil erosion and stripping
- Leads to the extinction of various animal and plant species (biodiversity) through changes in environmental habitats.

Third. Social impacts

- Decrease in agricultural productivity and thus food shortages and thus food insecurity
- Increase in the number of deaths and diseases due to food shortages
- Increase in psychological, mental and physical pressures on humans and thus increase social problems
- Decrease in the standard of living
- Migration and pressure on infrastructure, which leads to increased poverty and social imbalance
- Drought affects human health
- Increase in conflicts over water, which may lead to political conflicts
- Decrease in usable water resources
- Reduces the quality of air and water
- Shrinkage of green areas and increase in desertification

1-6 Things that must be followed to reduce drought

The problem of drought still threatens the lives of many living organisms in various parts of the world, so it is necessary to contribute to finding appropriate and radical solutions to get rid of this phenomenon. We will mention below some of the most important of these solutions:

1. Rainwater harvesting through the construction of dams and underground reservoirs and collecting rainwater through special channels that will provide for the various needs of the population.
2. Adopting the drip irrigation method in irrigating plants; as this method results in not wasting large amounts of water, which contributes to solving the problem of drought radically.
3. Resorting to air condensation and obtaining significant amounts of water that help in some agricultural activities in the country.
4. Increasing work on recycling organic waste, which results in the soil retaining water for longer periods, which helps maintain soil quality.
5. Expanding the vegetation cover by planting trees, as this helps to humidify the atmosphere, cohesion of the soil, and rainfall in greater quantities.

2-2: Review of previous research and studies

Drought occurs as a result of rainfall in low quantities and for unusually long periods, especially those that greatly affect growth or living conditions and have a significant impact on agricultural, hydrological, economic, environmental and social systems. Understanding these effects is of utmost

importance for planning for drought risks, mitigating their severity and responding to them, and it also helps decision-makers in determining the appropriate decision.

There are many studies and researches conducted to study drought in different regions of the world, and most of these studies and researches analyze drought using drought indices, which are among the most commonly used indices to estimate the amounts of deficit, its sustainability, severity, and its impact on the water balance. The Standard Precipitation Index (SPI) is one of the most commonly used indices currently used in studies to evaluate climate drought. The Standard Precipitation Index (SPI) is characterized by many characteristics that distinguish it from other indices, along with its simplicity and flexibility.

In Turkey, researchers Sirdas and Sen (2003) studied and analyzed the temporal and spatial characteristics of climate drought using the Standard Precipitation Index (SPI) based on rainfall records for four climate monitoring stations for the period 1931-1991. The values of both drought period and severity were found, and then the relationship between drought period and severity was drawn by drawing digital maps that show the cumulative deficit rates and drought severity in the region.

Researchers Loukas and Vasiliades (2004) used the Standard Precipitation Index to study the characteristics of drought using rainfall data Monthly recorded data from 50 meteorological stations located in Thessaly district in Greece for the period 1960-1993, where values of both drought intensity and persistence were found for monthly and annual data, and spatial and temporal maps of drought were drawn. The study showed that the area covered by the study falls within the classification of medium and severe drought. In another study, Alktari et al. (2008) used rainfall data recorded from 30 meteorological stations located in the northeastern part of Iran for the period 1965-2000 to study the characteristics of regional drought and formulate intensity, area and frequency curves by using the standard rain index for a period of 12 months. Also in Germany, researchers (2009) Khadr et al used the Standardized Rainfall Index (SPI) technique at time periods of 3, 6, 9, 12, and 24 months, and based on the rainfall data record recorded at seven meteorological stations for the period 1961-2007, to study the effect of daily rainfall amounts within the Ruhr River Basin in Germany on the amount, sustainability, frequency, and intensity of drought, in addition to finding the drought rate and the general trend of the time series of SPI values, as well as the prevailing drought types in the study basin. Researchers (2012) conducted. Juan Du et al. studied using the Standardized Rainfall Index (SPI) to identify the wet and dry areas of the Human sections in China using rainfall records recorded at stations within the study area. The study showed that the upper sections of the major rivers in this area are drier than the middle and lower sections over the past 57 years. The study indicated that the dry climate prevails during spring and autumn and the wet climate prevails during summer and winter, in addition to concluding that there is a strong relationship between the recorded discharges and the Standardized Rainfall Index series.

As for the researchers (2019), Aradhana et al., they indicated that drought monitoring is a key element in drought preparedness and that the SPI is a very flexible tool for drought analysis at different time scales. The study relied on the use of the Standardized Rainfall Index (SPI) to study the characteristics of drought in the Wainganga sub-basin in India using rainfall data recorded at meteorological stations (IMD). The study showed that 1972 was the driest year at the time scales under study. Researchers

(2020) Wang et al. conducted a study on the impact of drought on vegetation. Naturally growing plants often suffer from the effects of drought. A wide range of drought indices exist to assess the impact of drought on the growth of crops and naturally occurring plants. Evaluating the suitability of these indices over a large scale and over vegetated areas has been shown to be problematic due to the lack of sufficient spatial information. In this study, researchers compared six drought indices. The study area covers a drought classification from forest to desert along a 2,400-km transect across Inner Mongolia, China. The Standardized Rainfall Index (SPI) was most appropriate for assessing drought in steppes and deserts at an annual time scale. Self-calibration of the Palmer Drought Severity Index showed the greatest sensitivity during summer, but not during other seasons and at a monthly time scale, as well as greater sensitivity for different vegetation zones (i.e., forest, steppe, and desert) in June and July. Further analysis results showed that summer drought had a different effect on plant growth, ranging from one to six months depending on the specific vegetation cover.

The researcher Rashid (2009) analyzed the drought periods in northern Iraq using the Standard Rainfall Index (SPI), for a series of recorded rainfall data for nine climatic stations for the period 1941-2002. He found through it the characteristics of drought in terms of intensity, sustainability, maximum and minimum drought value for each rainfall station within the study area. Then he used Geographic Information Systems (GIS) to draw digital maps that show the characteristics of drought in the study site. The research showed that the percentage of dry years that the region went through constitutes approximately 56% of the study period. The researchers (2014) AL-Timi and AL-Jiboori conducted a study on drought in Iraq, as they used the Standard Rainfall Index (SPI) to investigate climatic drought based on monthly rainfall data for 39 climatic stations recorded in the study area for the period 1980-2010. The results showed that the worst drought year was 2008, where 30% of the area was affected by the extreme drought category, 36% of the area was affected by the severe drought category, 22% of the area was within the moderate drought category, and 12% of the area was affected by the moderate drought category. The maximum drought duration was 32 months, lasting from December 1998 to November 2010, with a drought intensity of 1.44 mm/month.

Conclusion

Drought is a complex natural phenomenon that greatly affects human life in terms of economy and health. The analysis of the research results showed that the city of Mosul is exposed to a climate that varies between humidity and drought in successive periods. It was found that the percentage of dry years constitutes 50% of the study period, while wet years constitute 50% of it. The most common classification within the SPI classification is moderate humidity and moderate dry. From the research results, we find that it is necessary to conduct an integrated study of the water balance of the region so that all the advantages provided by wet years are taken advantage of, such as the increase in rainfall rates and the discharges of rivers and valleys in the region, and thus harvesting them by constructing dams on the main rivers or on the courses of large valleys and benefiting from them in dry years, with the development of supplementary irrigation methods in the cultivation of wheat and barley crops in the region using modern irrigation methods, especially the expansion of the sprinkler irrigation method in its various types. An artificial neural network was also created using computer programs, where several tests were conducted for several neural networks, and one of them was chosen after being trained and taught well to predict and calculate the standard rain index and obtain results that match the real results to a high degree

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