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THE IMPACT OF EL NINO AND LA NINA ON SOME CLIMATE ELEMENTS AT SULAYMANIYAH STATION IN THE KURDISTAN REGION OF IRAQ DURING THE PERIOD (2008-2018)

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Abstract

This study analyzes the effect of fluctuations in El Nino and La Nina phenomena on the variability of precipitation and temperature levels at Sulaymaniyah station in the Kurdistan Region of Iraq, for the period 2008-2018. A number of statistical methods were used in the analysis process, such as arithmetic mean, correlation, and linear regression, in addition to extracting the confidence level. Through analyzing the data of temperatures, rain amounts, and El Niño and La Niña data for the mentioned period of the climate station in Sulaimaniyah, the study results revealed a direct correlation between the fluctuations of the El Niño and la Niña phenomena and similar fluctuations in temperatures and the amount of precipitation in the study area. As the amounts of precipitation increase and temperatures rise with El Nino seasons, while temperatures decrease and the amount of precipitation decreases with la Nina seasons in the study area**.**

Keywords: El Nino, la Nina, Sulaimaniyah, Kurdistan Region, correlation.

Introduction

El Nino and La Nina are among the phenomena affecting the global climate, it is possible that there will be a climate anomaly in the climate of every country and every year that exceeds the limits of the natural range of its climate and events and anomalies often arouse the curiosity of people and societies and take care of them. Especially in cases where what is happening is not natural.

The El Nino phenomenon affects the global climate through regional and local climate changes such as droughts and floods. The forecast of the El Nino phenomenon can provide decision makers with as much warning as possible of increasing the risk of such climate conditions occurring, especially as they have significant impacts in many countries of the world. It causes a delay in growth and development in many aspects of society, and the opposite may be in some countries of the world that increases agricultural activity and production, especially in arid and semi-arid regions, and accordingly, and because of the importance of these two opposite phenomena to each other, we have adopted in the study and research a descriptive and quantitative analysis method, and showing the extent of its impact On the climate of Sulaymaniyah Province in terms of temperature and rainfall amounts and their fluctuation for the period 2008-2019.

The location of the study area

The study area is located between the latitude (35□,19¯) and (35□,44¯)N. and longitude (45□,12¯) and (45□,46¯) E.

Sulaymaniyah station is located in the north-eastern side of Iraq and the eastern Kurdistan region of Iraq.

It is bordered by Iran to the east, Erbil Governorate to the north and northwest, Kirkuk Governorate to the west, and Garmyan Administration to the south. See Map (1) The area of the Sulaymaniyah is (885) km^2.

The study Problem

Determining the aspects of the problem is one of the basic conditions for research and study, which leads the researcher to pass all possible hypotheses and theories that can be investigated on the subject of the study to arrive at scientific results that are closest to reality, and therefore the study problem here lies in the following question:

(What is the extent of the influence of climatic elements represented by temperature and rainfall amounts in the study area, by the distant climate phenomena represented by the southern fluctuation ENSO)?

In addition, this question bears many sub-questions, from which correct and correct estimates are obtained, including:

1- Is the climate of Sulaymaniyah governorate affected by distant natural phenomena?

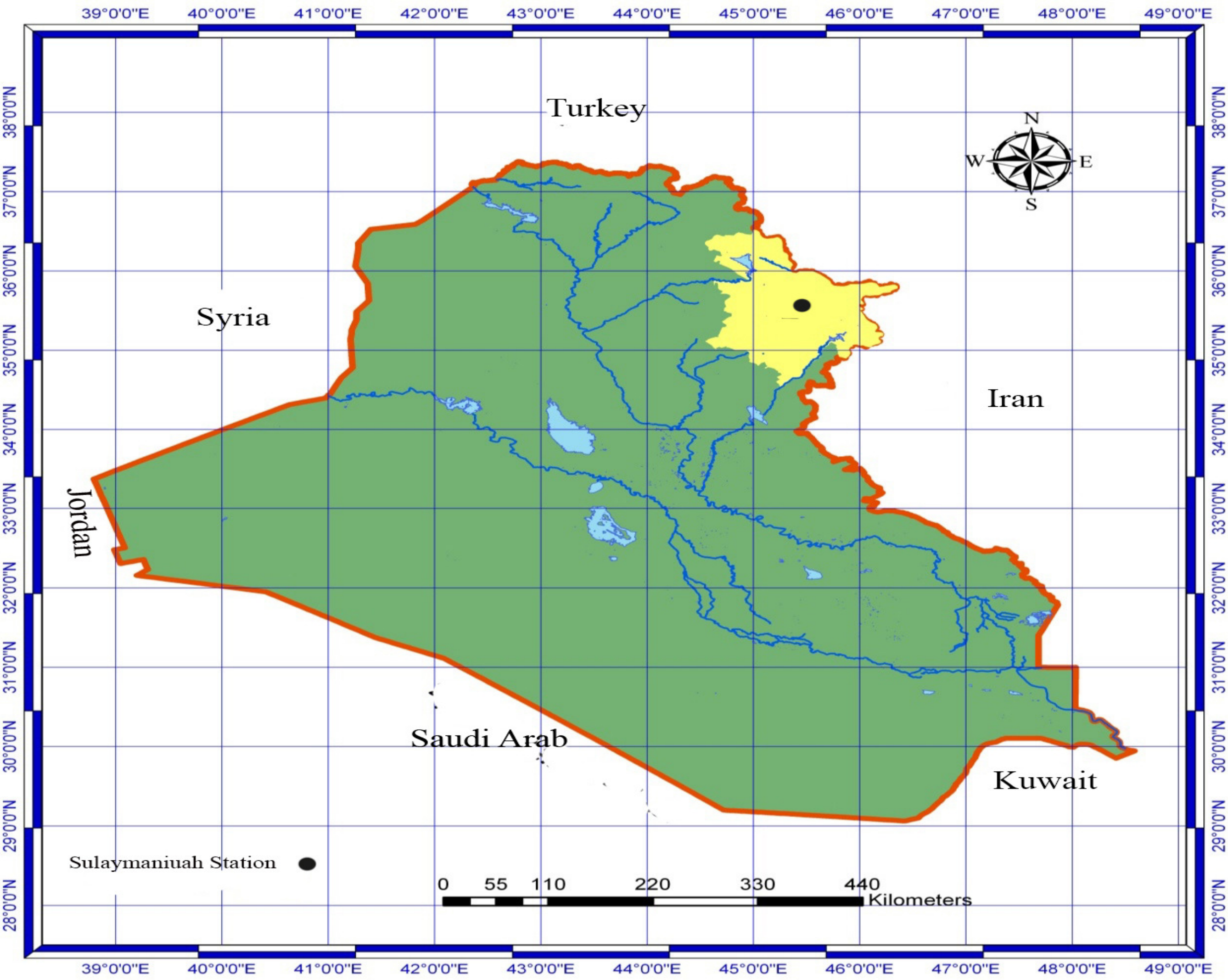
2- To what extent was the climate of the study area affected by the El Nino and La Nina phenomena?

3- Are the temperatures affected in the study area higher or lower by the El Nino and La Nina phenomena?

4- Is the amount of rain falling in the region affected by the Southern Oscillation ENSO phenomenon?

5- Which is more influencing the region, El Nino or La Nina?

6- Which is more affected by the two phenomena, temperatures or the amount of rain in the study area?



Map 1 : The location of the study area in relation to Iraq and neighbouring countries

Source: From the work of the researcher depending on:

The Republic of Iraq, General Survey of Surveying, Baghdad, Administrative Map of the Republic of Iraq, 1988, scale 1:1000000.

Study hypothesis

It is right to lay down statutes that are solvable by the researcher and whose assets depend on the researcher's capabilities and capabilities for scientific analysis and the closest to reality, and therefore we can summarize the study hypotheses as follows:

There is a correlation between the climate of the study area and distant phenomena.

1- The climate of the study area is influenced by EN The climate of
2- the study area varies with the two phenomena.
3- The temperatures vary lower and higher with the events of El Nino and El Nina phenomena
4- The amount of rain in the study area is affected by increasing and decreasing with El Nino and Enina phenomena.
5- Each of the El Nino and La Nina phenomena influences the climate of the study area
6- The El Nino phenomenon has the greatest impact on the quantities of rainfall in the study area.

Purpose of the study

To determine the goal of the study, we must answer the questions that were posed in the study hypothesis.

1- Study the effect of El Nino and La Nina phenomena on the climate of the study area
2- Explaining the extent to which the study area was affected by the phenomenon of southern vibration
3- Analyzing the effect of the two phenomena on high and low temperatures in the study area
4- Analyzing the effect of the two phenomena on increasing rainfall in the region.
5- Finding and revealing the phenomenon that affects the climate of the region between the two phenomena.
6- Seek to know the most affected element in the climate of the study area (temperature, rain) in the two phenomena.

Reasons for choosing the search

Among the factors that prompted the researcher to study this topic are:

1- The study area lacks this type of climate studies, which is affected by remote phenomena (remote communication).

2- International and global interest in the Southern Oscillation phenomenon, and the attribution of most extreme and abnormal climatic extremes to the Southern Oscillation.

3- The researcher's desire to identify and then reach the reasons behind the annual and monthly variations and fluctuations in temperature and precipitation amounts in the region.

Previous studies

In her message, Rasha stressed the clarity of the impact of the Iraqi climate on the El Nino phenomenon, and indicated that there is a direct relationship between the seasonal thermal average and the years of the El Nino appearance, while there is an inverse relationship between the annual total of the rainfall in Iraq and the years of the El Nino emergence (Rasha-2000). Ahlam, indicated in her study of the impact of the El Nino context on the rain of Iraq that El Nino is among the most important reasons that led to the apparent changes in the rains for the Baghdad station in the period from 2013-1900 where it indicates that the temperatures decreased with the El Nino seasons and also accompanied by a decrease in the amounts of rain for the same period (Ahlam, 2014). Al-Mazrouei and Al-Rubaie confirmed the same result of the effects of El Nino on Iraq on the elements of heat and rain in the stations of Baghdad, Mosul, Basra and Al-Wetba in the period from 1971 to 2008, indicating a decrease in rain and a decrease in temperature (AL- Mazroui and AL-Rubaie, 2012).

Materials and Methods

Sources of study data

The study was carried out according to the following steps and methodology:

1- Data collection: The researcher approved the collection of data from various sources, namely temperature and rain data for the period 2008-2018 obtained from the Department of Weather in Sulaymaniyah. As for the data of the southern frequency, which was approved in the study for the period 2008-2018, it was obtained from the website of the World Meteorological Station.(http: www.cpc.ncep.noaa.gov).

2- The statistical methods used in the study to show the effect of El Nino and La Nina on the temperatures and rains and their fluctuations in Sulaimaniyah as follows:

A- Extracting arithmetic averages for months and years for the period 2008-2018

B- Calculating the standard deviation for each month for the same period.

C- Use Pearson's linear regression coefficient to indicate the extent of correlation.

D- To verify the hypothesis, that is, find the correlation factor for temperature and precipitation, a T-Test was used to indicate the level of confidence.

First [the concept of El Nino and La Nina]

(i) ENSO

The term ENSO (Southern Oscillation) refers to three combined phenomena or three states that a large part of the globe exposed in the southern parts of the Pacific Ocean near the equator width circle. These three phenomena are EL NINO and represent the warm phase, while the cold phase is known as La Nina. Lanina added to the normal climate condition under natural conditions when there is no El Nino and La Nina. It is clear that the ENSO phenomenon is not considered a natural hazard, but it raises dangers such as droughts, fires, frosts, hurricanes and outbreaks of infectious diseases all over the world. This means that the predictions related to ENSO can provide the community with early warning of possible climate changes (Michael, 2000).

(ii) EL-Nino

It is part of the fluctuating weather pattern and in Spanish it means (little boy) and El Nino can be defined as the anomalous appearance of warm sea surface temperatures in the Pacific, Central and Equatorial Pacific Oceans from time to time, the southern oscillation indicates a pressure pattern similar to the swing in the western part of the Pacific Ocean Orbital In the period of Christmas and New Year's time, the surface water temperature of the southern Pacific Ocean rises to about (30º) along the coasts of Peru and Ecuador, and the total area over which warm water extends for about 1300 km with the equator north and south, and this works to raise the Yah warm up with a thickness of 150 m cold water and low down. Which consequently affects the surface water temperature, changes in pressure and wind system, and the amount of prevailing rain (Kousky, 1997).

(iii) La Nina

A climatic pattern that represents the cooling of the tropical eastern Pacific Ocean, which affects weather and climate conditions around the world. The phenomenon of La Nina is the opposite of her most famous sister, El Nino. The El Nino phenomenon follows the El Nino phenomenon, but not always. Usually, during normal years, there is no Nino or Nina. The El Nino events differ from El Nino from one year to the next and from one event to another, which is a decrease in the ocean surface temperature and this cooling process occurs because of the increase in the speed of the eastern trade winds around the equator. With the increase in pressure differences between the eastern and western Pacific orbital Pacific, the cold ocean water increases from below the surface and more cold water moves towards the west, and the strong eastern trade winds push it, causing rain in the western Pacific and the tropical equator. This cools the mean sea surface temperature averages in the eastern tropical Pacific Ocean. (AL Maqeli M .A.2003).

El Niño and La Nina in the past

The El Niño and El Niña phenomena are not a modern phenomenon, it is an old phenomenon and although it has been repeated many times in the old days, the specialists in this science could not understand this phenomenon only in the last decades of the last century (AL-Hayni, 2000). The automated records available to determine the El Niño and La Nina years before the mid-nineteenth century are very limited. Nevertheless, it was still possible to determine the phenomenon from the past and distant periods using anecdotal and historical information through reports of early settlers and explorers. In these areas, for example, and not limited to, the invasion of Francisco Bizar to Alaska between 1531-1532 coincided with the El Nino occurrence, as he discovered historical reports of heavy rains and the filling of river valleys with water, usually this happens in the El Nino years only in Peru, which called for the delay and progress of Francisco, which made it progress across the countryside on the other Road (Hoerling, and Kumar, 2001). The year 1876 is the year in which a phenomenon similar to the El Niño phenomenon was observed, but many scholars refer to the idea of recording the first incident around the middle of the fifteenth century. The year 1982-1983 in the twentieth century was one of the most severe years that witnessed the El Niño phenomenon, hitting the coasts of South America, where high temperatures were recorded (150 ° C). (Quinn.1992). The 1997-1998 El Nino phenomenon affected the lives of tens of millions of people around the world as it brought heavy precipitation and strong winds to parts of California, southeastern United States of America, eastern tropical Africa and Chile. She was responsible for severe droughts in Papua New Guinea, Indonesia, Central America and northeastern Brazil. (Barber and Chave, 1983).

Characteristics of the El Niño phenomena in terms of span, duration, intensity and impact:

El Niño and La Niña events generally last between 5-19 months. In the northern hemisphere, they develop during the winter season, and therefore they take extensions often to about two calendar years. It is noticeable that El Niño events during the last fifty years of the twentieth century occurred in 19 calendar years, while El Nina happened. During the same period in 15 calendar years, see Table 1, and for its spatial extent, the thermal rise of ocean surface water is not confined to the American tropical coasts, but rather takes a wide extension reaching up to the western Pacific Ocean for a 180□ longitude line or more, that is to say over a quarter of the Earth's circumference (Radi, 2004). The duration varies from one event to another. In the last decades of the last century, the years 1986 - 1988 continued for 18 years. One month, from September 1986 to February 1988, and El Nino events for the period 1991-1992 continued for 14 months, starting from April 1991 to May 1992 (Oscar *et al.*, 2014).

Table 1 : The beginning, size and duration of the El Nino phenomenon during the period between (1982 - 2016)

Years	The period of months	degree	Nino start	Nino end
1983-82	14	A strong	May 1982	June 1983
1988-86	18	medium	September1986	February 1988
1992-91	14	medium	April1991	May 1992
1995-94	7	weak	August1994	February1995
1998-97	13	A strong	May1997	May1998
2003- 2002	10	medium	June2002	March 2003
2005-2004	6	weak	August2004	June 2005
2007-2006	5	weak	September2006	June 2007
2010-2009	10	medium	July2009	April 2010
2016-2014	19	A strong	November 2014	May 2016

M-Modoki EL Nino,C-Canonical EL Nino, Darkershade represents Spring type (April- June) and alighter shade represents summer-fall type l (July-November)

As for the size of the two phenomena, it is determined by us on the high and low temperatures in the Pacific Ocean, despite the presence of many indicators available for classification of size, but there are four categories used to determine the characteristics of the phenomenon (El Niño-La Nina) depending on the indicator (Ocean EL Nino-La Nina). It is a derived indicator of the abnormal sea surface temperature in the Pacific Ocean, how much ocean surface it covers and the depth of warm water (Ahlam.2014). Note Table (2).

Table 2 : Degrees of the intensity of El Nio and La Nina

Degree	The level
0,5 - 0,9	weak
1- 1,4	medium
1,5-1,9	strong
2<	Very strong

ESCAP, UNITED Nations, Assessment of EL Nino, Associated Ristks, the step-wise process, p9.

The El Niño phenomenon shares similar characteristics with its counterparts, however, it has special characteristics for each event in terms of its intensity, the dominant field, the duration and the extent of its response, and the reason for this is the difference of the upper water response that depends on the longitudinal distribution of the force of the pressure of the eastern wind over the tropical Pacific Ocean. The disasters of the two phenomena are related to changes in air pressure and wind systems or the so-called Southern Oscillation (SO), also known as the Southern Oscillation, and are located as a cell within the Hadley Tropical Cycle cell, which extends from east to west. (Michal J Mcphaden, 2002). As the difference in pressure in the Hadley cycle causes the easterly trade winds parallel to the equator from East to west, that is to say, from South America to the islands of Asia. The distribution of pressure fluctuates every several years, which leads to the exchange of pressure sites, which results in what is known as El-Nino and its sister La Nina (AL-Samurai, 2008).

Reasons of evolution

El Nino phenomenon: It is a rise in the temperature of the tropical Pacific Ocean that occurs approximately every 3-7 years and lasts for approximately 19 months. It is linked biologically with dynamic fluctuation. The interaction of the ocean with the atmosphere results in a change in wind movement, particularly in the southeast between the continent of Australia, East Asia and the eastern tropical Pacific region (Kumar and Hoerling, 1998). The quiet, weak or windy trade winds allow warm, shallow waters to migrate from the western Pacific Ocean to the east. Currents loaded with cold water prevent altitude to the surface along the equator, and the coasts of western North and South America. This is what caused the ocean surface temperatures to rise to more than two degrees above their known average, and the sea level increased by about half a meter from the normal level. This is accompanied by conditions represented by the surface waters of the ocean in its other part being continuously warm (29 °C), while the situation in the eastern Pacific Ocean differs as it is colder. (21-26 °C) pressure is generally high with little rain (Musa.A.H,2000). So it has become a phenomenon that includes the western tropical Pacific and even its eastern. Without knowing and knowing when it will happen, but it often begins with mid-summer and ends with the beginning of summer in the following year, but its intensity is in December and January. (AL-Diziy, 2014) El Nino is evident in the Pacific Ocean. Especially in the southern orbital fraction between the latitudes 10-20 south of the equator. The difference in the values of surface air pressure is evident between the southeastern parts of the Pacific Ocean along a 150 □ longitude line, and the city of Darwin in northern Australia along a 130□ line east and 6500 km. The pressure fluctuation between the two sites is evidence of changes in the movement of surface water properties in the Pacific Equatorial Ocean, and the El Nino link to it. The El Nino becomes very clear when the pressure difference (southern Oscillation) becomes negative between the two locations Previously mentioned, (Abu Radi, 2004). As for La.Nina, it is a climatic phenomenon similar to the El Niño phenomenon, but with opposite differences in the Pacific Ocean. La.Nina is characterized by stronger commercial winds than moderate winds and cooler than normal tropical sea surface temperatures, and it is also characterized by unusual air pressure on the surface of the Earth In the eastern tropical Pacific and low surface pressure in the western tropical region, the abnormality of La Nina is not significant and its effects may be not noticeable as the temperature decreases at a small rate ranging between (1-2 □C) from the general average, and this decrease is concentrated in the eastern and central Pacific tropical region (J.Norton, elt). The effects of La.Nina on the global weather are almost inconsistent with the effects of El Nino, and accordingly it is often referred to as (El Nino, La Nina and Southern Oscillation), (see Table 3) which is a cycle that fluctuates from year to year between Warm and cold countries, tropical paotropical, and it is not possible to know what El Nina will bring with it, but it is possible to expect cooler and wetter climate conditions than the average (NCEP/ENSO, DEC, 2019)

Table 3 : Southern Frequency Index * monthly for the period (2007-2019)

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	OUG	SEP	OCT	NOV	DEC
2007	**0.7**	**0.3**	**0.0**	**0.2-**	**0.3-**	**0.4-**	**0.5-**	**-0.8**	**1.1-**	**1.4-**	**1.5-**	**1.6-**
2008	¯1.6	¯1.4	¯1.2	¯0.9	¯0.8	¯0.5	¯0.4	¯0.3	¯0.3	¯0.4	¯0.6	¯0.7
2009	¯0.8	¯0.7	¯0.5	¯0.2	0‹1	0‹4	0‹5	0‹5	0‹7	1‹0	1‹3	1‹6
2010	1‹5	1‹3	0‹9	0‹4	¯0.1	¯0.6	¯1.0	¯1.4	¯1.6	¯1.7	¯1.7	¯1.6
2011	¯1.4	¯1.1	¯0.8	¯0.6	¯0.5	¯0.4	¯0.5	¯0.7	¯0.9	¯1.1	¯1.1	¯1.0
2012	¯0.8	¯0.6	¯0.5	¯0.4	¯0.2	0‹1	0‹3	0‹3	0‹3	0‹2	0‹6	¯0.2
2013	¯0.4	¯0.3	¯0.2	¯0.2	¯0.3	¯0.3	¯0.4	¯0.4	¯0.3	¯0.2	¯0.2	¯0.3
2014	¯0.4	¯0.4	¯0.2	1‹0	3‹0	2‹0	1‹0	0‹0	2‹0	4‹0	6‹0	0‹7
2015	0‹6	0‹6	0‹6	0‹8	1‹0	1‹2	1‹5	1‹8	2‹1	2‹4	2‹5	2‹6
2016	2‹5	2‹2	1‹7	1‹0	0‹5	0‹0	¯0.3	¯0.6	¯0.7	¯0.7	¯0.7	¯0.6
2017	¯0.3	¯0.1	0‹1	0‹3	0‹4	0‹4	0‹2	¯0.1	¯0.4	¯0.7	¯0.9	¯1.0
2018	¯0.9	¯0.8	¯0.6	¯0.4	¯0.1	0‹1	0‹1	2‹0	0‹4	0‹7	0‹9	0‹8

www.cpc.cpc.noaa.gov
(ONI)* Based on warm periods(red) &cold periods(blue)**0.5 -/+** Abnormal
ERSST.v5 SST in an area Niño 3.4 (5 ^{o} N-5 ^{o} S ‹120 ^{o} -170 ^{o} W)] ‹Based on.

The risks and effects associated with the two phenomena worldwide

1- The effects of El Nino

The effects of El Nino are closely related to the risk profile. This is due to the conditions of pent-rain precipitation in wet areas that are subject to heavy floods every year. This could be concurrent for those regions for example (Northeast India). While the same is not the case for dry areas, such as those that depend on rainfall as areas (central India), and accordingly, the increased periods of rain in wet areas result in the risk of floods, such as the coastal region of southeastern Indian subcontinent and parts of Europe and Peru, this in the El Nino years, while It has positive effects in providing appropriate and favorable conditions for the arid and arid environment, such as the interior regions of the Indian subcontinent, especially southeast, and it can also have negative effects at possible hurricane frequencies due to the El Nino phenomenon of areas subject to cyclonic hazards and f doubt. L is greater and more dangerous compared to areas with lower hurricane risks (UN, 2018). And El Nino events have always had strong impacts on societies in general and in particular the poor and poor and vulnerable societies. According to the United Nations Office for Humanitarian Affairs (OCHA), the strong El Nino phenomenon in the period 1997-1998 left 21,000 victims and severely damaged global infrastructure estimated at 36 billion US dollars. (Nexus, 2016) The dry conditions caused by El Nino phenomenon caused the outbreak of forest fires in Indonesia in many places. Among the worst ever in the Far North in Vietnam was more than 83% affected The country was dehydrated, and a strong salt water leakage was observed, which affected the groundwater due to the decrease in the amount of rain in the Mekong River delta, which affected 43,000 hectares of agricultural crops (Echo, 2016).

2- The effects of La Nina

The effects of La NIna on the weather fluctuations in the world are similar to those of El Nion, although they are not completely identical. Except, it is opposite. (Philander,

2000) La Lanina is often associated with drier conditions than normal conditions in tropical East Africa, southern Brazil and Uruguay. Changes in atmospheric pressure patterns in the Pacific Northeast tend to be cooler and more stormy than usual, for example in Alaska, western and central Canada, and the northern United States. While the northward shift in semi-tropical waters leads to a greater drought than the usual conditions and situations such as the southern plains of the United States. (WOM, 2014) The La Lanina phenomenon affects the frequency, intensity, and geographic distribution of tropical cyclones through changes in sea surface temperature and extent in the atmosphere. Hurricanes and tropical cyclones are more restricted due to the cold sea surface. The hurricane season in 1995 is a good example of what happens during the two years that we have witnessed an increase in hurricanes by about (11) hurricanes, almost twice the usual number. There are social and economic effects of the El Nina phenomenon, as heat waves and droughts have formed that are associated with the phenomenon El Nina, summer in western and central America, in 1988, which is considered one of the worst summer disasters in the history of the United States. Agricultural losses amounted to about 40 billion dollars and caused the killing of 7500 people from heat stress, and the La Lanina phenomenon could be beneficial to some regions of the world. Seasonal rains increased and increased over the Indian subcontinent, the western Pacific Ocean and north-eastern Brazil helped to increase agricultural production and economic growth (Michael and Jone, 2009).

Results and Discussion

We cannot exclude the effect of these two phenomena on temperature and precipitation on Sulaymaniya climate, despite the distance between the center of the emergence of the two phenomena and the geographical scope of the study area in addition to climate changes, such as global warming and the hole in the ozone layer that consequently leads to imbalance and global climate change, and therefore the study of El Niño and La Niña It is extremely important to show the extent of its impact on the climate of the study area and its effects.

The effects of El- Nino and la- Nina phenomena on the temperature of the study area

These two phenomena are responsible for the high temperatures and droughts in one place and sudden and heavy rains elsewhere. In an attempt to find the relationship of the El Nino and La Nina phenomena and their impact on the Sulaymaniyah climate, we have studied the amount of fluctuation in the temperature of the study area and its relationship to El Nino and La Niña by adopting a number of mathematical statistical equations for 11 years, i.e. for the period between 2008-2018 for the Sulaymaniyah station, and pursuant to the relationship of remote connection (Teleconnection) It was found by the number of El Nino and La Nina repeats in the mentioned period and the degree of fluctuation of temperature values for the Sulaymaniyah station, increased and lower affected by the two phenomena. In order to facilitate and clarify the process, we have used the following methods to find the inter-relationship of the two variables.

1- Extraction of mean for study years MEAN = $\sum X / N$
2- Extract the rate for the months in which El Niño and La Nina occurred.
3- Find the standard deviation for all the months in which the two phenomena occurred to find the rate of fluctuation and its deviation from its general rates. SD = $\sqrt{(\sum (X-\bar{X})^2) / N}$
4- Calculate the Pearson correlation coefficient by applying the following equation:
$$R = \delta \frac{\sum (X - X')(Y - Y') / N}{\delta X . \delta Y}$$
5- The adoption of (T. TEST) $T = (Y-M) / (S / (\sqrt{N}))$

To find the correlation and validity of the relationship between the two variables through a hypothesis to be imposed to reveal its statistically acceptable level with a confidence level of 5% which is the probability of error that can be accepted by the researcher when comparing the calculated T with the value of the tabular T and includes the hypothesis two possibilities and the first is called a hypothesis The nothingness, the result of which is due to the chance factor, if the value of the test is lower then that means acceptance of the hypothesis, meaning that there is a correlation between the two phenomena and the degrees of warming up and down by Sulaymaniyah station by an error rate of 5% as we have shown previously. From the note of Table (4), it is clear to us that the El Niño current was repeated during the period from 2008-2018 three times and the number of months in which it appeared 31 months and by comparing the arithmetic mean of the temperature in Sulaymaniyah station for the duration of the study, which amounted to 20.2 ºC with the average degree of temperature for the years that coincided With El Niño, it became clear to us that the temperature began to rise, reaching a general average of about 20.5 ° C, that is, it was 0.3 °C higher than the general average. It became clear to us that the average temperature recorded during the strong El Niño amounted to 21.5 ºC, i.e. a difference (1.1 ºC), which was represented in the 2010 season, while the average during the El Niño average amounted to about 20.8 meters for the 2015 season, with an increase rate of (0.6 °C). The weak intensity of the average temperature for the year 2018 reached (20.5 °C), with a difference of about 0.3 °C. However, the 2014 season in which the El Niño months were represented by about two months did not notice a rise in their rates, despite the fact that the month of December increased the monthly average temperature by 1.5 m. Generally, the frequency of El Niño years is interspersed with cold El Niña years, whose impact on the climate of the region remains for several months. And that the most visible and strongest El Nino lasted for 19 consecutive months, from November 2014 to May 2016. The highest monthly rate recorded for the 2016 season was in February, with a standard increase of (2,1°C) and it falls within the category of very strong degree. While the highest rate for the year 2015 was in the month of September, when the amount of deviation to the temperature reached approximately (1.9°C), then it was followed by the increase in the month of July, with an increase of (1.1°C). Although the 2015-2016 Ninewa years are the strongest globally in the last ten years, their intensity, strength, and negative impacts have brought them to the affected areas. However, the study area was affected, and as it becomes clear to us from Table (4) that the 2010 season is the strongest impact and intensity on the study area as it was affected by the El Nino phenomenon and high temperatures, where it rose in general for the months (January, February, March) in which the El Nino phenomenon occurred and rose The temperature increased by (3.4 °C) for the month of January than its general average, while the temperature increased in both February and March by (1.4 °C). From this it is clear to us that the study area is affected by its monthly rates by the El Niño World Index during the seasons of its occurrence, that is, during the El Niño months. It is noted that the total months in which the El Niño occurred amounted to 31 months and that the total months affected by the rise in temperatures between the strong, medium and weak reached 15 months. As for the case of La Nina, her rates are the same as her sister El Niño, which is fluctuating for the period between 2008-2018, they rise at their rates one time and take them down again, generally when comparing the general rates for the study area of (20,2 °C) with the general rate for the years in which La Nina occurred, which is (20,2 °C), meaning that it did not notice a decrease or an increase in its general annual rates. However, by reference to Table (4), it is clear to us that there were Nina seasons that crossed with El Nino seasons in 2009-2010 followed by La Nina season 2010-2011 that this overlap led to a rise in temperature in the months in which El Nino occurred, which led to a significant increase in the annual rate of Therefore, the detailed status of the study area is illustrated by clarifying the impact of La Nina on the months in which it occurred. Therefore, the total number of months in which La Nina occurred was about 41 months, and the total months that were affected by the events of La Nina in the study area amounted to 14 months, while the remaining months were marked by high temperatures over their general rates. That the lowest temperature recorded in the region was in the La Niña season in 2008 by (-3,8 °C) below the average for January, and in 2011 it recorded the lowest monthly rate of (3,2 °C) below the average for the month of November, while it recorded (-1.9 °C) below the average for the La Nina season in December 2017. By checking the table for the Nina season for the study area, the number of months in which the Nina represented a very strong intensity (3 months) and for the same degree The intensity was strong (2 months), while the months in which El Nina was weak were about (7 months). On this basis, we can say that the study area is located under the influence of the La Nina phenomenon in varying degrees from year to year and from month to month, and this is mostly due to the distance from the current area of origin or to other natural considerations affected by the climate of the study area, such as the impact of air depressions and the topography of the region. etc.

Table 4 : The values of temperatures and their deviation from their general average for the study area for the period between (2008-2018)

Years	Jun		Feb		Mar		Apr		May		June		July		Aug		Septem		October		November		December		Avg.
	T	S	T	S	T	S	T	S	T	S	T	S	T	S	T	S	T	S	T	S	T	S	*T	*S	
2008	3,1	3.8-	7‹2	1,7-	16‹6	3,3	21‹5	3,3	23‹9	0,1	30	-0.1	33‹4	-0,3	34‹7	1	28‹9	0,3	22	-0,3	14‹1	0,2	9,4	0,5	20,4
2009	6,8	-0,1	9‹8	0,9	12	-1,3	16	-2,2	23‹9	0,1	29,9	-0,2	32,4	-1,3	31‹6	-2,1	26‹2	-2,4	22‹5	0,2	13‹2	-0,7	9,8	0,9	19,5
2010	10,3	3,4	10‹3	1,4	14,7	1,4	17‹5	-0,7	23‹2	-0,6	31	0,9	33‹8	0,1	34‹6	0,9	30‹7	2,1	23‹3	1	17	3,1	11,7	2,2	21,5
2011	6,6	-0,3	8	-0,9	12‹7	-0,6	17‹2	-1	22‹9	-0,9	29‹3	-0,8	34	0,3	32,8	-0,9	27‹9	-0,7	20‹7	-1,6	10‹7	-3,2	9,2	0,3	19,3
2012	6	-0,9	6‹9	-2	9‹3	-4	19‹6	1,4	24,8	1	30‹9	0,8	33‹5	-0,2	33‹5	-0,2	29‹4	0,8	23‹3	1	15‹6	1,7	9,6	0,7	20,2
2013	7,5	0,6	10,3	1,4	13‹9	0,6	19‹2	1	23‹5	-0,3	30‹5	-0,05	33‹2	-0,5	32,6	-1,1	27‹3	-1,3	20‹8	-1,5	14‹8	0,9	6,9	-2	20
2014	7,7	0,8	9,05	0,15	13‹4	0,1	17‹7	-0,5	24‹5	0,7	30	-0,1	33‹4	-0,3	33‹8	0,1	28‹1	-0,5	21,4	-0,9	13‹2	-0,7	10,4	1,5	20,2
2015	7,8	0,9	9‹7	0,8	12‹8	-0,5	17,05	-1,2	24‹5	0,7	30‹1	0	34‹8	1,1	34‹7	1	30‹5	1,9	22‹7	0,4	3‹13	-0,6	7,9	-1	20,8
2016	6,7	-0,2	11	2,1	12‹7	-0,6	17‹8	-0,4	23‹5	-0,3	29,9	-0,2	34‹1	0,4	34,9	1,2	28	-0,6	23‹2	0,9	14‹4	0,5	7,05	1,9	20,3
2017	6,6	-0,3	5‹8	-3,1	12‹3	-1	18	-0,2	24,3	0,5	30‹1	0	34‹8	1,1	34‹6	0,9	28,4	-0,2	22,6	0,3	13,2	-0,7	7,3	-1,6	19,8
2018	8	1,1	10‹3	1,4	16	2,7	18‹2	0	22‹6	-1,2	29‹8	-0,3	33‹7	0	33‹1	-0,6	29,5	0,9	22‹3	0	13‹7	-0,2	9	0,1	20,5
.Avg	6,9		8,9		13,3		18,2		23,8		30,1		33,7		33,7		28,6		22,3		13,9		8,9		20,2

Source: From the work of the researcher, based on

1- Temperature and rain data from Sulaymaniyah Meteorological Station, Weather Forecast Directorate

2- Adopting the standard deviation equation to extract the values of temperature deviation from their annual rates.

* T = temperatures and S = values of heat deviation from their overall rang

The effect of El Niño and La Niña phenomena on the amount of precipitation in the study area

There are many factors and they have great importance in controlling the amounts of rain fall in the study area and the decrease in its amount from the general (annual) average. One of the factors that can be the cause of increased amounts of rain or their retention is the El Niño and La Niña phenomena by finding the correlation between the rain variable and the two phenomena, which It shows us the degree of vulnerability and to calculate the process and prove the research hypothesis, which is the correlation factor of high rainfall in the two phenomena under study. Through the extraction of the mean of the rainfall amounts for the period 2008-2018, the rate of deviation for each month was calculated in terms of the monthly rainfall from its general rates and to prove the hypothesis, the correlation factor was found and validated by T.Test extraction of the amount of rain for the mentioned period.

Table 5 : Precipitation values, rates, and deviation values from their overall average for the period 2008-2018

Years	Jun		Feb		Mar		Apr		May		June		July		Aug		Septem		October		November		December		Avg.
	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	
2008	59	-37,8	121,1	10,7	48,3	-52	17,5	-51	0,2	-28,4	0	-0,4	0	0	0	0	5,2	0	96,8	47,5	12,4	3و83-	21,5		379,3
2009	39,5	-57,3	67,2	--43	87,1	-13,2	97,6		2,9		0,6		0	0	0	0	10,1	7,6	72,9	23,6	136,4	40,7	98,3	-98,1	612,6
2010	68,6	-28,2	161,9	51,5	93,2	-7,1	77,1		80,8		0	-0,4	0	0	0	0	0	-2,5	0,6	-48,7	1	-94,7	59,5	-21,3	542,7
2011	146,3	49,5	44,6	-66	60,7	-39,6	214,8	146,3	37,3		3,7	3,3	0	0	0	0	0,20	-2,3	26,6	-22,7	48,7	-47	65,7	-51,1	648,6
2012	109,2	12,4	94,6	-15,8	175	74,7	19,6		34,8		0		0	0	0	0	0		32,3	-17	150,2	54,5	103,6	-53,9	719,3
2013	171,5	74,7	54,4	-56	15,0	-85,3	22,1		30,3		0	0		0		0	0		0,5	-48,8	166,4	20,7	186,6	-16	646,8
2014	98	1,2	12	-98,4	174,1	73,8	56,9		8,5		0			0			0		64,4	15,1	153	57,3	118,3	67	685,9
2015	119,6	22,8	82,1	-28,3	112,9	12,6	29,3		20	-8,6	0	-0,4		0		0	14,10	11,6	132,6	83,3	194,1	98,4	86,3	-1,3	791
2016	110,2	13,2	91,5	-18,9	156,8	56,5	36,8		5,5	-23,1	0	0	0	0	0	0	0	-2,5	2,50	-46,8	33,2	-62,5	185,8	-33,3	622,3
2017	53	-43,8	85,3	-52,1	144,7	44,4	58		25	-3,6	0	0		0		0	0	-2,5	28,4	-20,9	41,8	-53,9	74,1	66,2	510,3
2018	89,4	-7,4	400	289,6	34,3	-66	123,5		69,6		0		0	0		0	0		84,6	35,3	116,7	21	316,1	-45,5	1234,2
.Avg	96,8		110,4		100,3		68,5		28,6		0,4		0	0		0	2,5		49,3		95,7		119,6	196,5	672,1

Source: From the work of the researcher, based on

1- Rain data from Sulaymaniyah Meteorological Station, Directorate of Air Ports

2- Adopting the standard deviation equation to extract rain deviation values from their annual rates.

*R = rain S = rain deviation values from their overall mean.

From the note of Table (5), it becomes clear to us that the study area was actually affected by the two phenomena in terms of its effect on the amount of rain by increasing and decreasing, and the amount of rain varied according to the intensity of the two phenomena from year to year, it is noticed that the amount of general and monthly rain increased in general with the El Niño seasons, where the general rate reached (672.1 mm) In the seasons in which the two phenomena occurred, we notice an increase in precipitation with the intensity of the El Niño phenomenon, however, in spite of this, we note that in 2018, which remained under the influence of La Nina, which occurred since 2016, the impact on the amount of rain fall in the study area is clearly evident, so this is The year is a wet year more than the rest of the years The duration of the study, where the amount of precipitation reached (1234.2 mm) and with a deviation of (562.1 mm) from the general rate. In addition to the years in which the El Nino occurred 2014-2015, the amount of precipitation also increased and deviated from its general average, and this period is the strongest of the years in which the El Nino phenomenon occurred and affected a lot of Countries of the world, as it was found to have a clear impact on the climate of Sulaimaniyah by increasing the amount of rainfall, so November was the beginning of the El Nino phenomenon and it lasted for 19 months, and its season ended with the end of May 2016. While the amount of precipitation reached (685 mm) in 2014 with a deviation (13.8 mm) from its general average, and increased to more than (791 mm) in 2015 with a deviation of values (118.9 mm) from the general average. For the sake of clarity more, we adopted to show the relationship between the El Nino and La Nina phenomena by comparing them monthly, between the amount of precipitation and the months of the El Nino and La Nina events. It started with the month of July, according to the Southern Oscilloscope, and continued until March 2009. It is noticeable that the effect of La Nina is counterproductive to the amount of rain in the study area. With lower temperatures and the arrival of La Nina, the amount of precipitation falls, the total precipitation in the study area for 2008 was approximately (379.3 mm), which is much lower than its overall average of (672.1 mm). The dry year was classified according to the accreditation of the Dimarton coefficient * (1). The drought index, as follows:

$$S = m \mid H + 10$$

Where: s = drought index

M = amount of annual precipitation (mm)

H = annual average temperature (m)

10 = fixed rate

As a result, it became clear to us that the year 2007 is a dry year and the drought continued with the year 2008, in addition to that it did not exceed the wetest month (121.1 mm), which was represented in February, and by comparison with the same month of 2009 we notice a significant decrease in the amount of precipitation amounting to (67.2 mm) i.e. With a difference of (-43 mm) from the general average, but it started to increase with the months of March and April, it seems that it is a transitional period between El Nina and El Nino that occurred in the same year, which led to a rise in precipitation to reach (612.6 mm) and at a monthly rate of about (51, 05 mm), (5 mm) above its overall average. Therefore, we can say that La Nina as a global phenomenon has an impact on the climate of the study area, where the amount of precipitation increases with the period of rainy concentration of the region represented by months (January, February, March) and decreases with the rest of the months significantly from their overall rates. As for the El Niño opposite, the occurrence of El Niño is directly proportional to the amount of precipitation on the study area. With the beginning of its occurrence, precipitation will increase with increasing, and it often begins with the autumn months and continues until the end of spring until precipitation takes another curve in the increase. The highest value of the amount of precipitation recorded in December and reached then (316.1 mm), with an average average difference of (196.5 mm) in the year 2018, and to prove the validity between us, February of the same year recorded the highest monthly amount for the total number of months registered for the period 2008-2018, which amounted to (400 mm) and an average difference of (289.6 mm) That is, the La Nina phenomenon has a greater impact with the winter months in the study area and weakens or Decay with the summer and autumn months.To diminish suspicion and ascertain the correctness of the analysis, we used the correlation equation and validated the hypothesis (the remote correlation hypothesis) using the T.Test equation and its acceptance at the level of significance (5%) which are high correlations between El Nino and La Niña and the amount of monthly and annual precipitation. That is, the correlation rate between the two variables is 95% and the error or not is only 5%.

Conclusions and Recommendations

1- The El Nino and La Nina phenomena are responsible to some extent for the changes in the climate of Sulaymaniyah Governorate.

2- The 2010 EL Nino season is the strongest impact on the climate of the region during the study period, where the temperature in the month of January of the year in question mentioned about (3.4 ºC) above its average and rose by (1.4 ºC) for the months of February and March of the same year.

1. 3 - The total number of Nineveh months for the mentioned period was about 31 months, and the total number of months affected in the study area amounted to 15 months.

3- The total months of La Nina was 41 months, and the total months affected by the phenomenon in the study area were 14 months.

4- The lowest temperature recorded in 2008 coinciding with the La Niña phenomenon reached (-3,8 ºC) below the average for January, while the month of November recorded the lowest rate in 2011 (-3,2 ºC) during the period specified for the study.

5- The increase in the amount of rain in the study area coincided with the El Nino phenomenon and the highest recorded amount during the study period was about (1234.2 mm) in 2018.

6- The lowest amount of recorded rain in the study area coincided with the La Nina phenomenon in 2008, when it reached (379.3 mm), which is much less than its general average by (292.8 mm).

7- After testing the confidence factor and verifying the validity of the correlation between the two phenomena and the climate of Sulaymaniyah Governorate in terms of the elements of heat and rain, it was found that the level of significance reached 95% and the error rate of only 5%, this means accepting the hypothesis.

Recommendations

1- Increasing interest in anomalies and trying to link them to the region's climate by scientific methods.

2- Carrying out intensive studies on the southern vibrations and their correlation with recent climate changes in the study area and regions in general.

3- Studying the climatic elements as a whole to ensure their relevance to these two phenomena.

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