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The Impact of Lake Merwi Dam On the Local Climate

Amir Hassan Abdullah Mohammed[1*], Mohammed Habib Ahmed Elkanzi[2]

[1]Department of Geography, Faculty of Arts, Omdurman Islamic University, Sudan.

[2]Department of Astronomy and Meteorology, Faculty of Science, Omdurman Islamic University, Sudan.

Email address:

Ah184012@gmail.com, *Corresponding author

Kanzi_sa@yahoo.com

Abstract: This study seeks to know the effect of Lake Merwi Dam on the local climate by knowing the climatic factors affected by the lake. The data of both maximum and minimum temperatures, rainfall, relative humidity, wind speed and solar radiation of a meteorological station were taken as data for minimum and maximum temperatures, The relative speed of wind and solar radiation from the Abu Hamad meteorological station of the Sudanese Meteorological Authority for the purpose of analysis and comparison to reach results to help to know the magnitude of changes in the two states because of Lake Merwi Dam, Monthly averages for nineteen years from 2000 to 2018 where the opening of the dam in 2009 They were computed and converted into annual averages. These data were then analyzed and plotted on graphic forms and the climatic elements were compared before and after the dam was opened. The results indicate a significant increase in the amount of relative humidity, high temperatures, a decrease in the number of hours of sunshine in the northern state, a rise in minimum and maximum temperatures and an increase in rainfall in the Nile state.

Keywords: Lake, Merwi, Dam, Local, Climate

INTRODUCTION

The problem of climatic change has recently become the focus of climate scientists and all those interested in the environment. These changes have become a real threat to human life because of the difficulty of adapting to these changes. It is therefore recommended that all climate scientists and researchers in ecology research and explore the causes and factors behind these climate changes and reduce them in an attempt to

restore the natural balance of the environment. The root causes of this problem are the so-called industrial revolution in the middle of the last century and the accompanying increase in energy use. All countries started producing fuel of all kinds, such as petroleum and its derivatives, coal and other energy resources. Greenhouse gases in the atmosphere as a waste of fuel, which led to higher temperatures and associated climate changes and environment. (Mahdi, 1974).

After years of using energy sources that are harmful to the environment, scientists noticed the dangers of these sources to the environment. Countries have turned to producing alternative energies that do not change the ecosystems. Solar and wind energy have been used as renewable and clean energy sources that do not produce any harmful emissions to the environment. However, despite the availability of these sources, their production costs are very high, so countries tend to produce hydropower as one of the renewable energies cheap compared with other types of energies. Huge dams (known as the dam, which is more than 15 meters high or the capacity of three cubic meters) been constructed to produce electricity as a primary goal, and to reduce flooding and irrigate farmland as secondary targets. But the question arises Are these dams do not occur any change in the environment?. Water lakes formed by these dams usually result in significant changes in land use and vegetation due to their multiple uses. The changes here were meant to be local mid-range changes ranging from 10 to 100 kilometers. One of these impacts of changes resulting from dams can be an adjustment to the rain system and may be a gradual change in the local climate system. (Quality, 1997).

As the dam expands the area of the irrigated land, the river runs down due to the low risks of flooding and increased supply of electricity and products. Studies on the effect of climate variability and changes on lakes formed by dams at the local or regional level have been conducted for some time. However, the impact of lakes on the local climate as an inverse effect is not detected at the same level. Knowing the impact of dams on the local climate is the key to establishing a concept The dams are a modification of a system in the river basin. In this research, an answer is being sought to the question. What is the effect of the Lake Merwi Dam on the local climate and the potential impact on the rainfall system? This is reflected in the changes in the environment of the region as well as the change in some factors that affect some elements of climate and the impact of these changes in general on the local climate of the region. It is noted that the issue of the impact of dams on the climate did not find sufficient attention from climate and environmental scientists,

This Research is to highlight these changes and their impact on the local climate.

RESEARCH IMPORTANCE:

The importance of research can be summarized in the following points:

1 / The research attempts to find an explanation for the changes in the values of some climatic elements (relative humidity - temperature - rain - wind) in the northern and the Nile states in the period following the formation of the Lake Merwi Dam during the analysis of these elements and compare their values before and after the dam and then determine the impact Change in the values of these elements on climate in the local region of the lake.

2 / Research helps to predict the future climate in the region by explaining the trends of some climatic elements, which affects the lake dam increase or decrease.

3 / The research shows the effect of climate change on some weather phenomena (dust storms - desertification - drought - environment).

4 / The importance of taking into consideration the disadvantages of the construction of dams in particular and the Sudan ahead of the implementation of a number of dams such as Kjbar.

RESEARCH PROBLEM:

The research attempts to determine the impact of the Lake Merwi in the local climate by analyzing the climatic factors affecting the Lake Merwi Dam.

1 / The effect of Lake Merwi Dam in increasing moisture ratio in the area.

2 / The impact of Lake Merwi Dam in the high temperature zone.

3 / The effect of Lake Merwi Dam in increasing evaporation and valley in the region.

4 / The impact of Lake Merwi Dam in increasing the amount of rainfall in the region.

RESEARCH GOALS:

1 / Identification of elements of the climate affected by Lake Merwi Dam in the local region of the lake.

2 / shows the impact of climate components on the environment and population.

3 / To know the impact of these climate changes on some of the weather, environmental and agricultural production in the region.

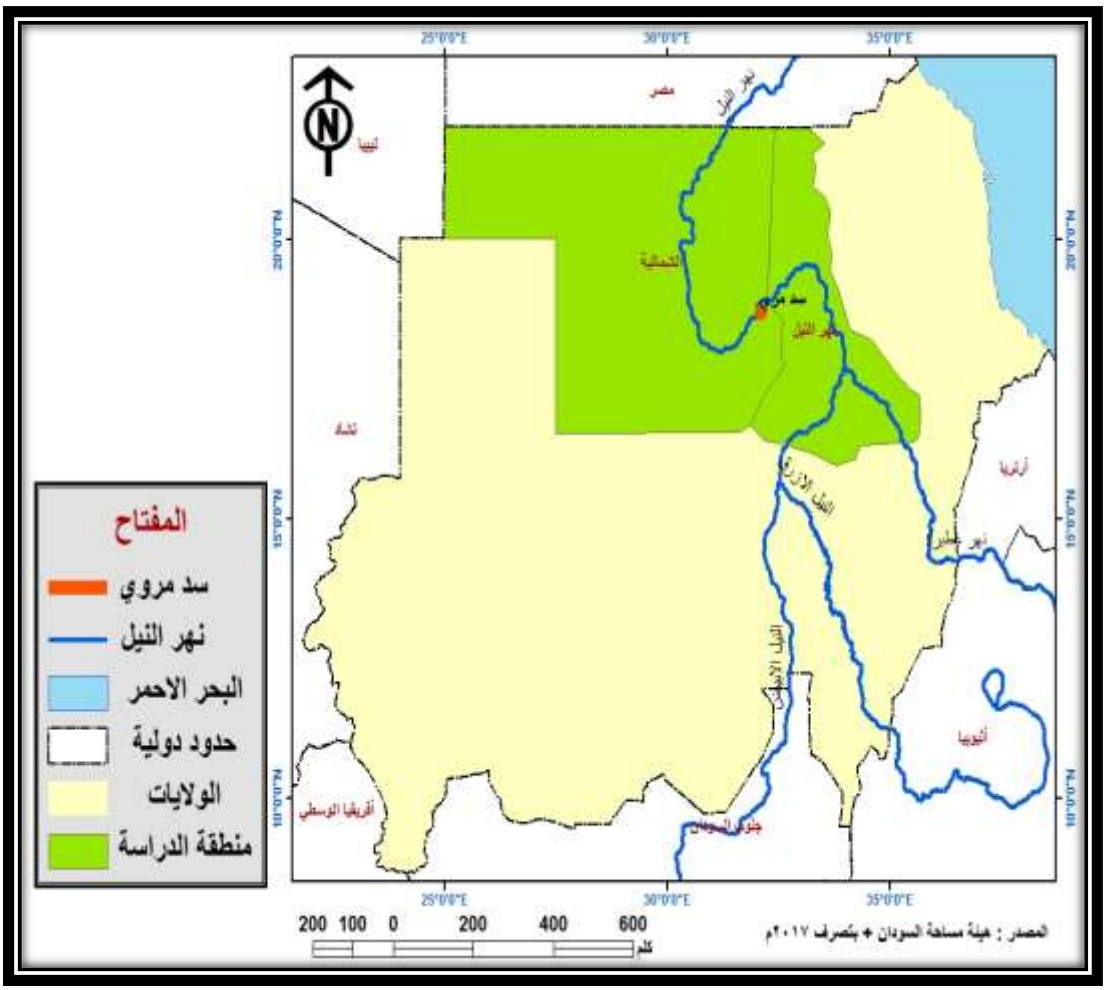
4 / Forecasting the future of climate in the lake region in light of changes in some climatic elements in the region.

THE LIMITS OF THE STUDY:

Spatial Boundaries:

This research was carried out on the territory of Lake Merwi Dam. The data was taken from the services department of the General Authority for Meteorology in Karima station as the nearest station of the Lake Merwi and Abu Hamad station in the Nile River State. The information of any meteorological station covers an area of 100 km.

Map (1) Location of study area



The Temporal Boundary: - The data represents a period of nineteen years from (2000 to 2018) to be nine years before the operating of Merwi Dam (2009) and the other nine years after the operating of Merwi Dam.

RESEARCH METHODS:

1 / Descriptive analytical approach:

In this research, the analytical descriptive method based on data collection, analysis and comparison was used. It is one of the most appropriate methods for such research. The research is based on data (rainfall, temperature, relative humidity and evaporation).

2 / Historical approach:

Using the historical approach to knowing the past of the local climate and understanding its present and predicting its future, the researcher used this approach to track the elements of the climate before and after the Merwi Dam.

3 / Statistical methodology:

This method was used in the collection, classification, analysis and presentation of data using various statistical methods. This method was used in the analysis of data obtained from the Meteorological Authority. It also assisted in the presentation of statistical

information on the method of graphs and tables using the SPSS program. (Safouh, 1999, p. 23).

CLIMATE CHARACTERISTICS IN THE STUDY AREA:

1 / Heat:

The study area is located in the desert climate, where temperatures rise in the summer. The average temperature is 33 degrees Celsius. Temperatures start to rise from April. The average temperature for this month ranges from 38 to 41 degrees Celsius. The average temperature is between 20 ° C and 24 ° C. Temperatures continue to rise, with the highest rates in months between May and October. In these months the average monthly average temperature is between 40 ° C and 45 ° C that the minimum temperatures are relatively low starting from November to March.

2 / Rain:

The northern state of the low-rainfall states is located within the desert region, which is characterized by low rain and high temperature. The seasonal and spatial distribution of rainfall is between the annual rainfall rate (0-3.5 mm / year), except for some abnormal rainfall values Years.

CONDITIONS FOR BUILDING DAMS:

If the dam is not built according to certain geological and geological foundations, it is a dangerous source, since when it collapses it leads to massive destruction and before any dam is constructed, the following studies must be carried out.

GEOLOGICAL STUDIES:

Area studies include studies of the nature of the tectonic zone and its seismic activity.

HYDROLOGICAL STUDY REGION: -

The amount of rainfall and surface water is to collect all rain precipitation in several sites of the studied area and for many previous years in order to analyze them statistically to know many things such as the volume of runoff over the basin flow of the valley...

TOPOGRAPHIC STUDY:

In order to represent all the natural and artificial details and phenomena of the dam area on the surface of the earth. This is done in special forms and drawings. The topographical study aims at exploiting the potential of the surface appearance in all analyzes and conclusions related to the dam.

GEOTECTONIC STUDIES: -

1/ Measuring soil permeability, measuring the properties of rocks.

2/ Calculate the storage capacity of the dam.

3/ Calculate the strength of the dam for water.

4/ Taking into account the engineering design and specifications of building materials.

5/ The different forces affecting the facilities of the dams, the self-weight of the installations.

6/ Hydrostatic water pressure, wind waves pressure, pressure of river sediments placed in front of the dam. (www.forum, stop55.com.).

EFFECT OF DAMS ON HUMANS:

It is known that the effect of dams on humans in a positive and negative is the following:

1/ Disease spread: -

With the great benefits of dams, but there are negative effects, the most important of which is the spread of diseases, because the reservoirs are a breeding ground for disease carriers, especially in the tropics, where mosquitoes breed the malaria and the snails that contain the germ of Schistosomiasis.

2/ Resettlement: -

Building dams and reservoirs requires the resettlement of large potential human groups especially if they are built close to residential areas. The dam affects society through three things: economic destruction, human trauma, and social disaster. (www.wikipedia.com).

IMPACT OF FLOODS ON WHICH THE ENVIRONMENT AND AGRICULTURE DEPEND:

The savannah and forest ecosystems of the floodplains in many developing countries depend on the seasonal floods of rivers, and dams mitigate floods affecting the environment and agriculture so the land benefits from residual soil moisture after flooding.

Impacts of land: -

Reservoirs may contribute to changes in the Earth's climate. Hot climate reservoirs generate methane, a greenhouse gas in class reservoirs, which are below the oxygen layers (ie, they lack oxygen), leading to degradation of biomass through aerobic processes, in some When water is flooded with large basins and the volume of biomass is high, it converts it into methane, so the potential pollution results are 3.5 times more than an oil-burning power plant. (Salah, p. 203).

ABOUT MEROWE DAM PROJECT:

The Merwi Dam project is a multi-purpose water project aimed primarily at generating hydroelectric power. The dam was constructed at the fourth waterfall on the Nile River

in Merwi. Several studies have been done on the project decades ago. The most recent of these studies was a study conducted by the Canadian company Monenco Agra in 1993 and a study prepared by the Hydro project Institute in September 1999, as the country was experiencing a major shortage of electricity. Economic and social development at risk. After the completion of the construction of the Merwi Dam, "which is 9.2 kilometers long and at an altitude of 67 meters, is the largest Sudanese dams established on the Nile and its tributaries in Sudan This dam was a lake covering an area of (467) km square," The dam produces electricity estimated at 1,250 megawatts, and will irrigate an area of about three hundred thousand acres, after the completion of the associated channels, and helps to protect agricultural land and urban areas from the risk of flooding, (Encyclopedia of Knowledge, 2019).

Objectives of the Merwi Dam project:

1/ Production of electricity to meet the growing demand for economic and social development
2/ Provide a relatively cheap energy source to improve irrigated agriculture in the country.
3/ Use of electric power to exploit groundwater for expansion in agriculture.
4/ Establishment of industrial projects, food industries and mining projects that rely on electricity as the main source of energy.
5/ Enter the fish industry in the project lake.
6/ Protect the areas of the lower reaches of the Nile from devastating floods.
7/ Improving river navigation.
8/ Improving the standard of living for the residents of the project area by creating new investments and jobs.
9/ Reduce the burden on existing reservoirs, especially with regard to the conflict between the use of water in irrigation and energy production.

LOCATION OF THE DAM: -

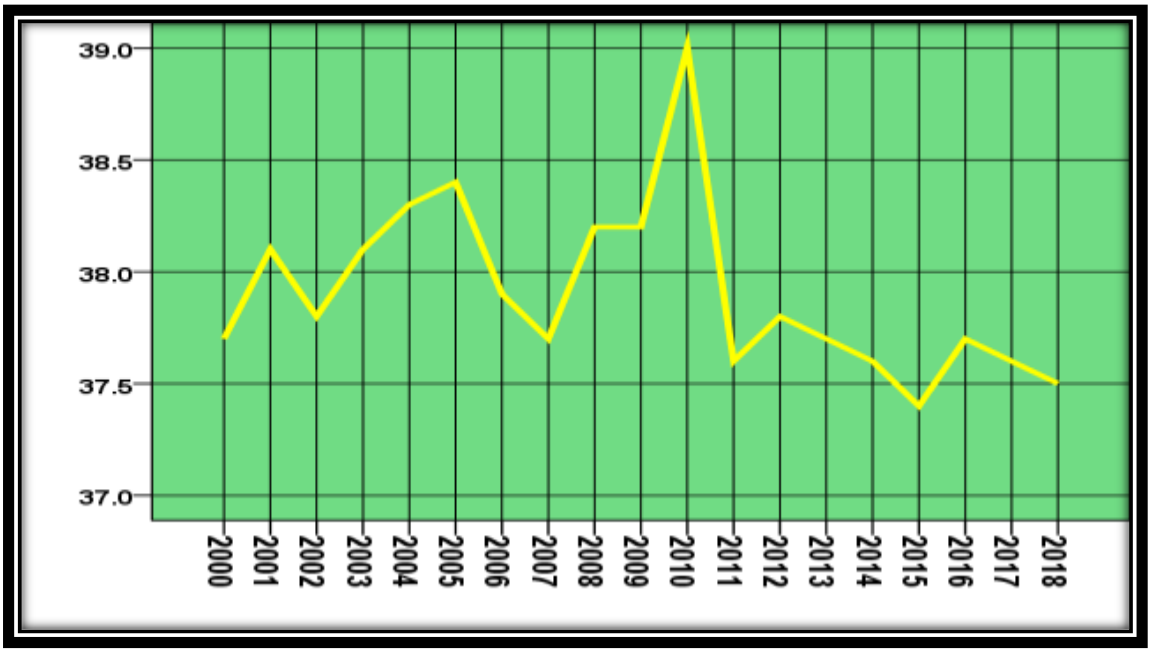
The dam is located about 350 km north of Khartoum and 600 km west of Port Sudan and 42 km north of Merwe city and 27 km from Karima. It is located on line 32 (east) and 19 (north). The axis of the dam cuts the island of Merwi from the west to the east and north of Hamadab Island. The dam is located in the southwestern part of Nubia in the desert of Biwadah in a flat area consisting mainly of granite and lava. (www.diu.gov.sd).

ANALYSIS OF CLIMATIC ELEMENTS:

Most of Sudan is located in the dry and semi-dry range and the study area is located entirely in the dry region. Therefore, climate components will be analyzed in the lake

region and the resulting impacts. The analysis includes rainfall, evaporation, relative humidity, heat, dew, sun and wind. It is also possible to say that the presence of the Lake Merwi Dam changes the values of these elements directly or indirectly, the expansion of the water surface of the dam lake and the growth of some plants on its edges, and the change in the nature of the region are all factors that change the climatic characteristics Which in turn may affect the overall climate of the two states. These data were taken from the station of Karima and Ahmed station as one of the nearest stations of the Merowe Lake for the period (2000 - 2018), which are monthly averages of the minimum temperature, maximum temperature, wind, rain, evaporation, relative humidity dew and sun brightness and then calculated the annual averages. After calculating the annual averages of these elements and then presented in the form of graphs to show the change in the value of these elements during the period before and after the opening of the dam, aims to identify the trends of these elements after the creation of Lake Merwi Dam and then identify the climate changes resulting from the change in values.

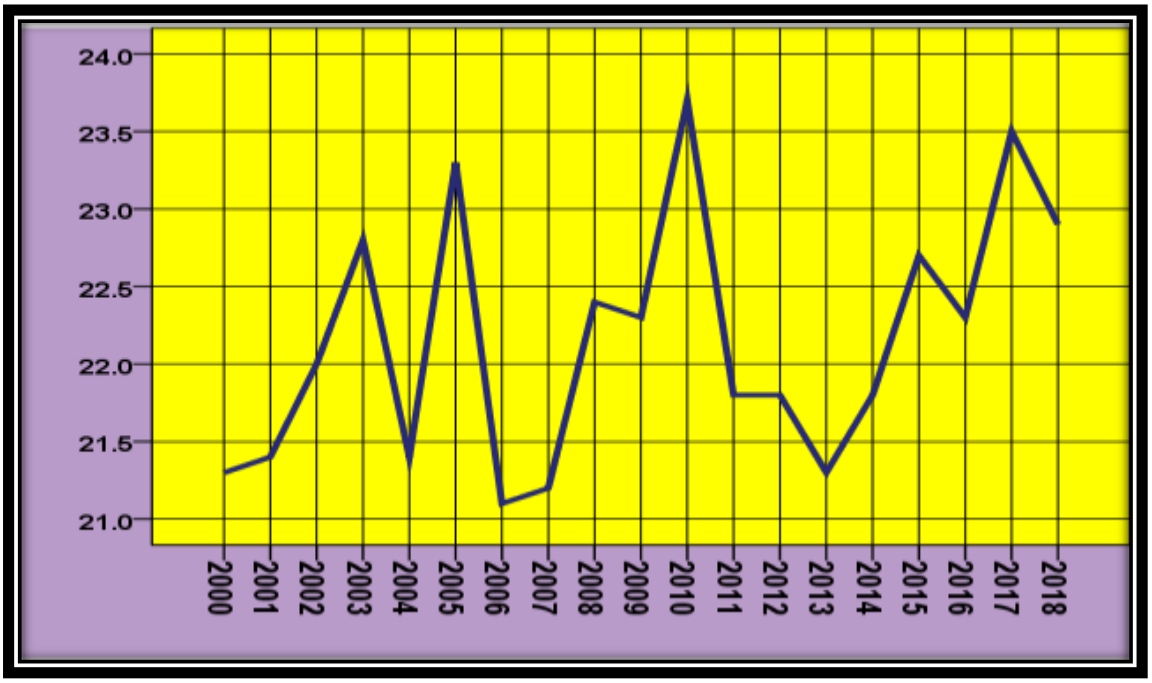
Figure 1: Annual averages of the maximum temperature during the period from 2000 to 2018 for a precious meteorological station.



Source: Annex 1 data

Figure (1) shows that there is fluctuation in max temperatures from year to year. And we find it reached in 2007 (37.7) degrees Celsius before the opening of the dam. And then the max temperatures after the opening of the dam, which reached in 2010 (39) degrees Celsius, the change in temperature due to the increase in humidity in the atmosphere due to evaporation of water from the lake dam.

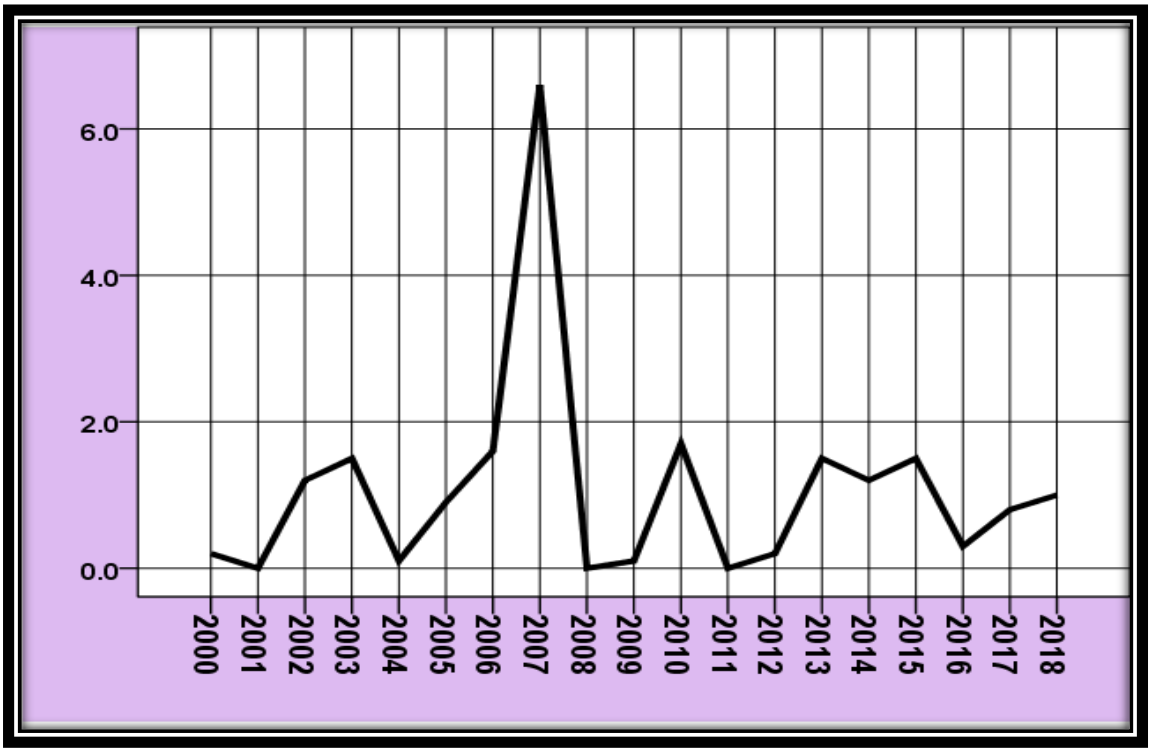
Figure (2): Annual averages of the minimum temperature during the period from 2000 to 2018.



Source: Annex 1 data

The rise in temperature is the hallmark of the dry desert climate. Figure (2) shows the rise in average mean temperatures in the period prior to the opening of Merwi Dam. The lowest temperatures in 2006 reached (21.2) ° C. And reached in 2010 (23.7) Celsius after the opening of the dam.

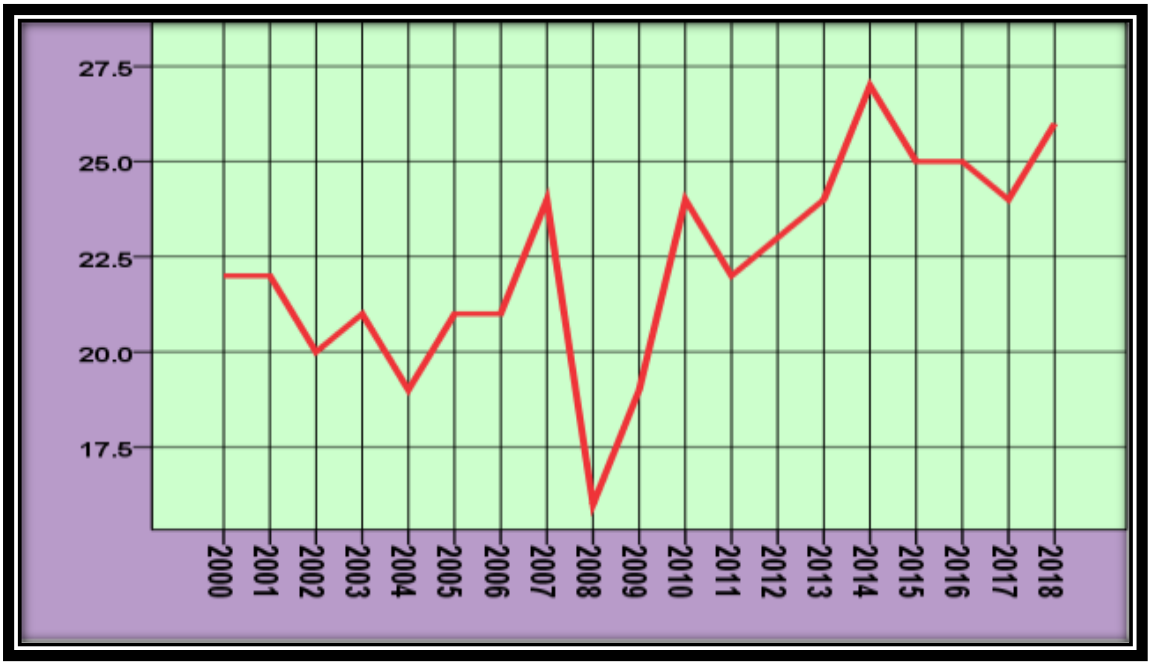
Figure (3) Annual rainfall during the period 2000 – 2018



Source: Annex 1 data

The northern state is located in the desert regions where it is noticed from Figure (3) there is fluctuation in the amount of rainfall from year to year. The highest rainfall in 2007 was the average annual rainfall amount (7) mm.

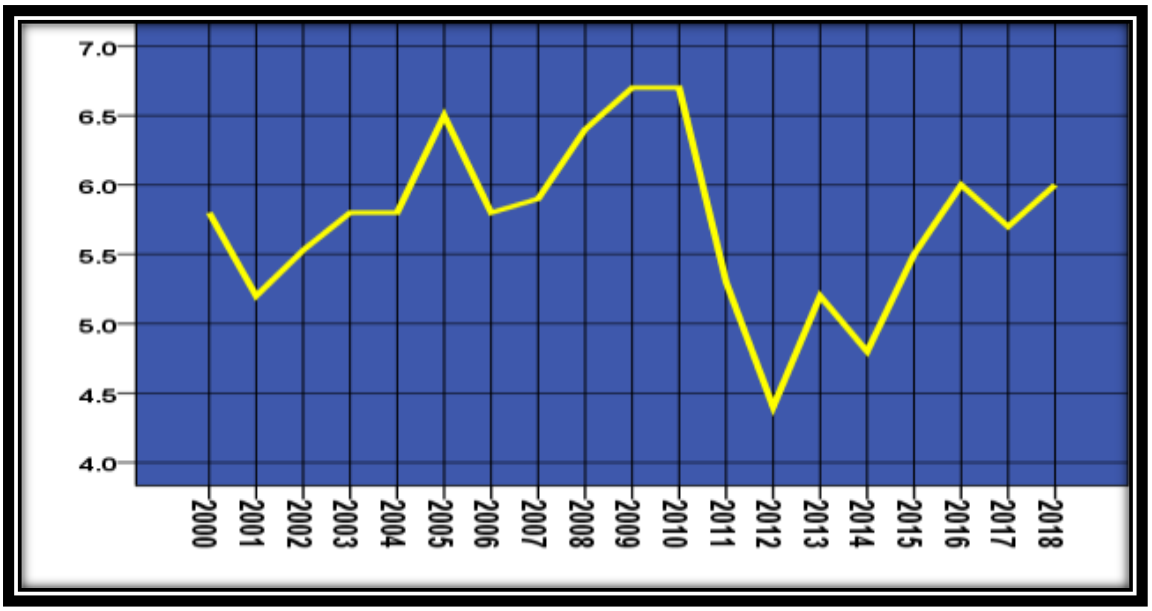
Figure (4) Annual averages of relative humidity during the period 2000 - 2018 m.



Source: Annex 1 data

It is known that the northern state climate is a dry desert climate so its relative humidity is always low. Figure (4) shows that the relative humidity has increased after the opening of the Merwi Dam before the opening of the dam, where we find in 2008 before the opening of the dam amounted to (15%) and in 2014 after the opening of the dam (26.9%). Note that the humidity before the opening of the dam did not exceed (25%) at its maximum height.

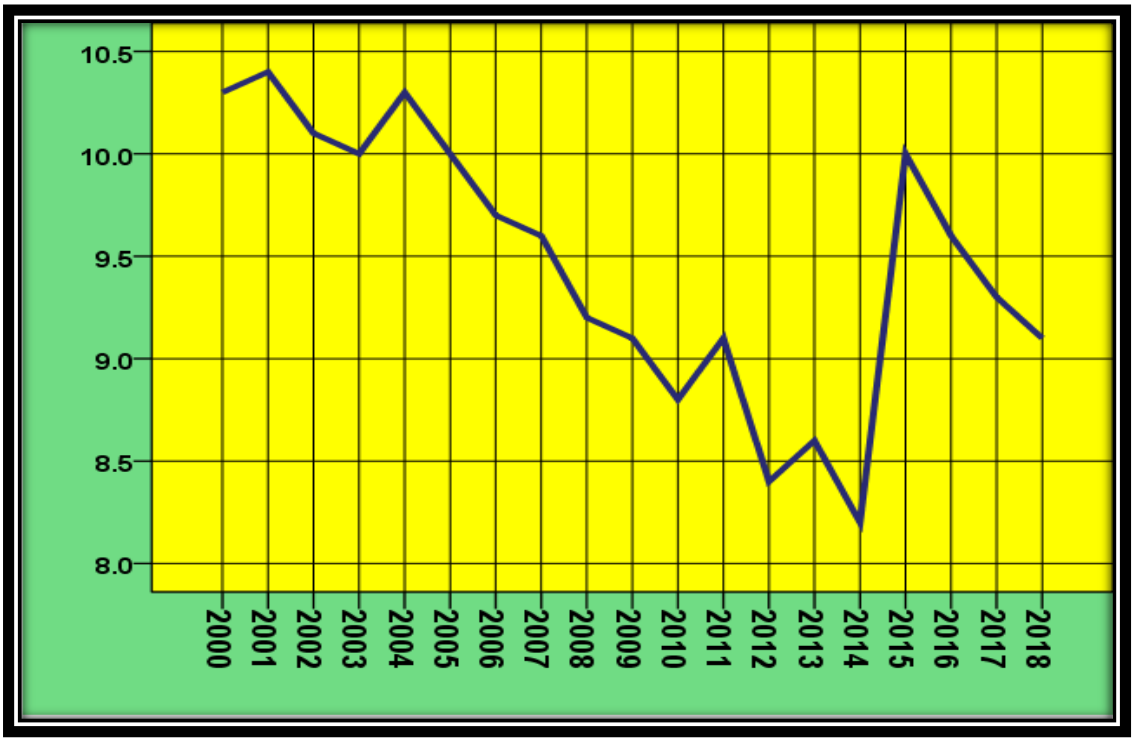
Figure (5): Annual averages of wind speed during the period from 2000 to 2018.



Source: Annex 1 data

Figure (5) shows that the lowest speed of wind before the opening of the dam was in 2001 at (5.2) km / h, then increased speed significantly increased in the year of opening the dam in 2009 (6.7) km / h.

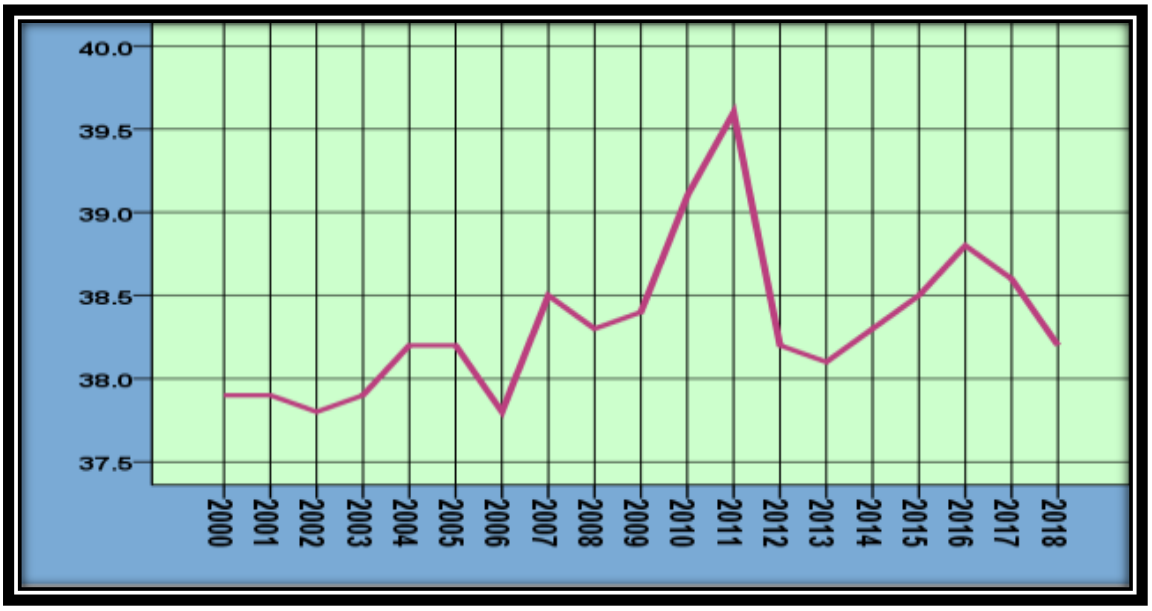
Figure (6): The percentage of solar brightness during the period from 1992 to 2015.



Source: Annex 1 data

Figure (6) shows that the percentage of the sun's brightness before the opening of the Merwi Dam was in a continuous decline, and the percentage after the opening of the dam declined significantly in 2014 (8.2%). This is due to the spread of clouds in the area after the dam Merwe.

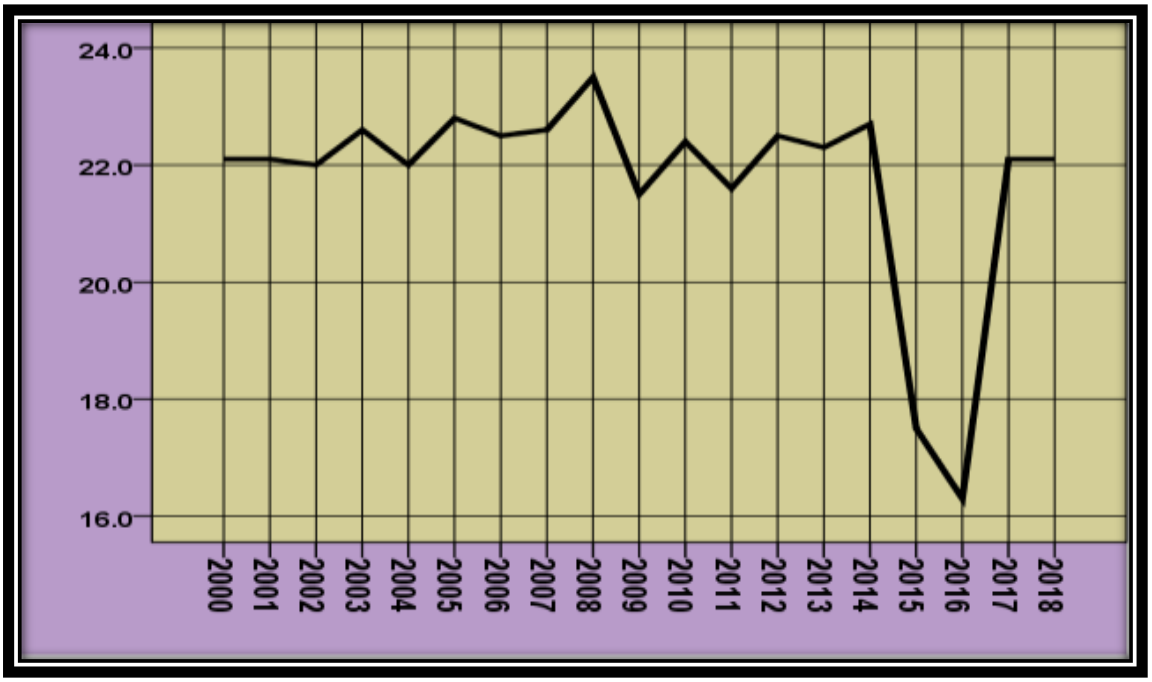
Figure (7): Annual averages of the maximum temperature during the period 2000-2018M Abu Hamad meteorological station



Source: Annex 2 data

The situation applies to the max temperature as it continued to rise in the state of the Nile River Abi Hamad station, which we have reached in 2007 (38.5) degrees Celsius before the opening of Merwi Dam. And then the high temperatures after the opening of the dam, which reached in 2011 (39.6) degrees Celsius, the change in temperature due to the increase in the percentage of moisture in the atmosphere due to evaporation of water from the lake dam.

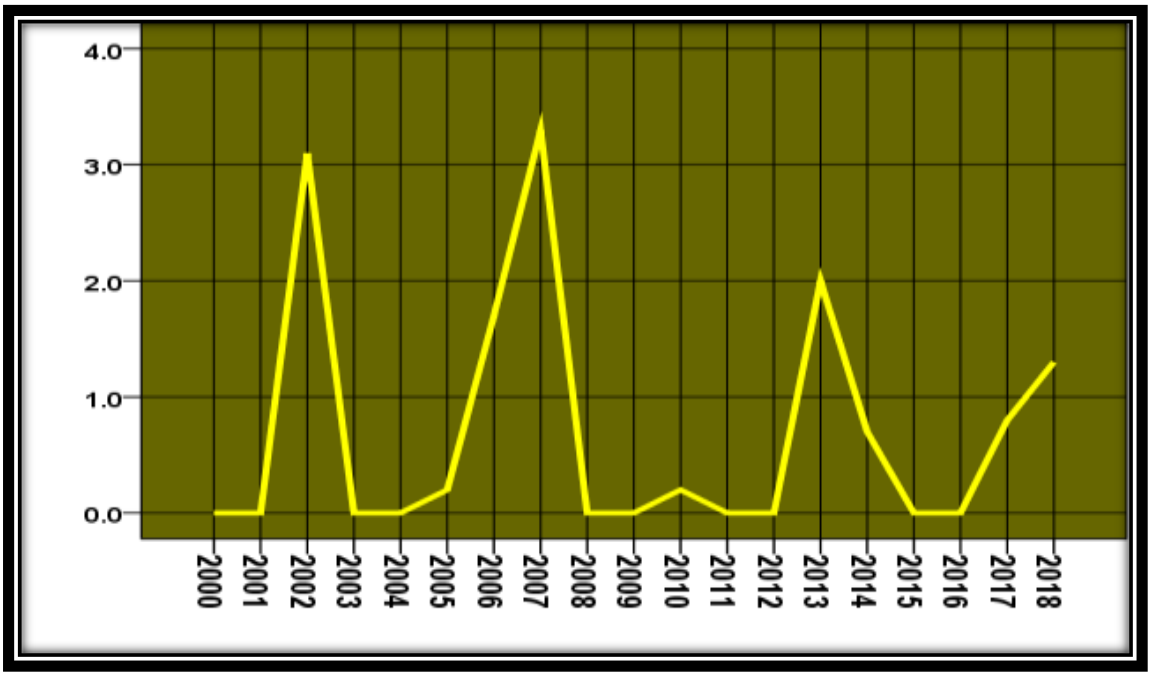
Figure (8): annual averages of minimum temperature during the period from 2000 to 2018 Abu Hamad Meteorological Station



Source: Annex 2 data

Figure (8) shows that the average annual mean temperature values are very large if compared to the average of the minimum temperatures in the rest of the other climatic regions. The annual average temperature of the minimum temperatures in the period preceding the opening of the Merwi Dam is observed from the figure. In 2008, the minimum temperature reached 23.2 ° C. And the minimum temperature in 2016 after the opening of the dam, which reached (16.5) degrees Celsius.

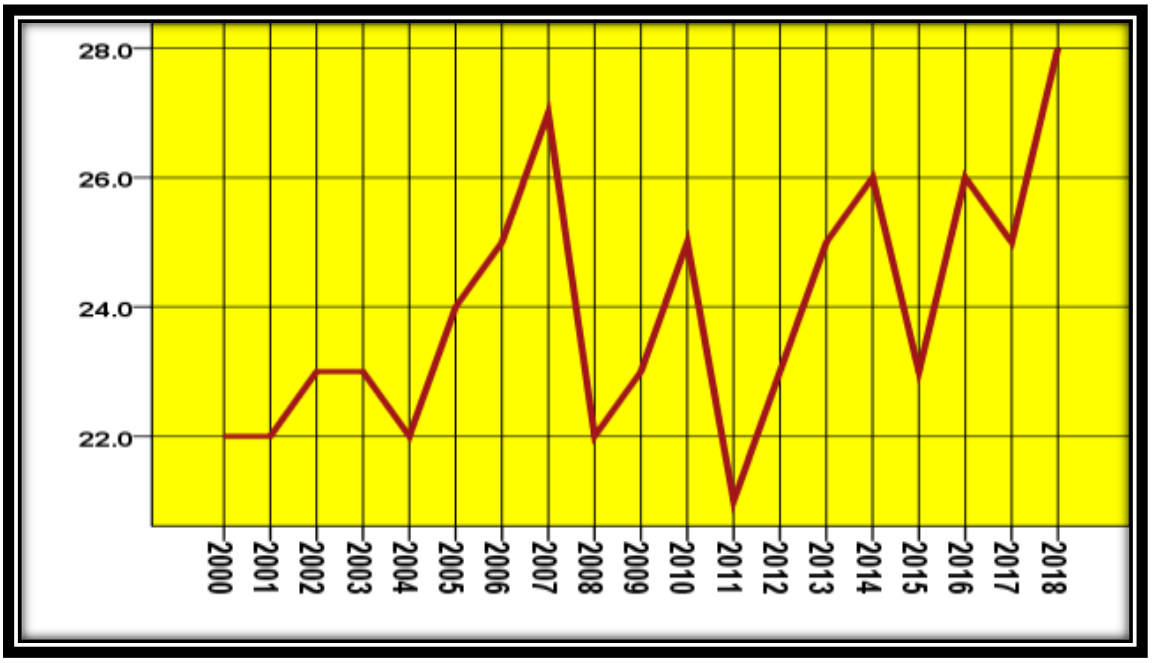
Figure 9: Annual rainfall averages during the period 2000-2018 Abu Hamad meteorological station



Source: Annex 2 data

Figure (9) The highest rainfall in 2007 (3.2) mm before the opening of Merwi Dam, and then the amount of rain from year to year. Then increased the amount of rainfall in 2013 m (2) mm.

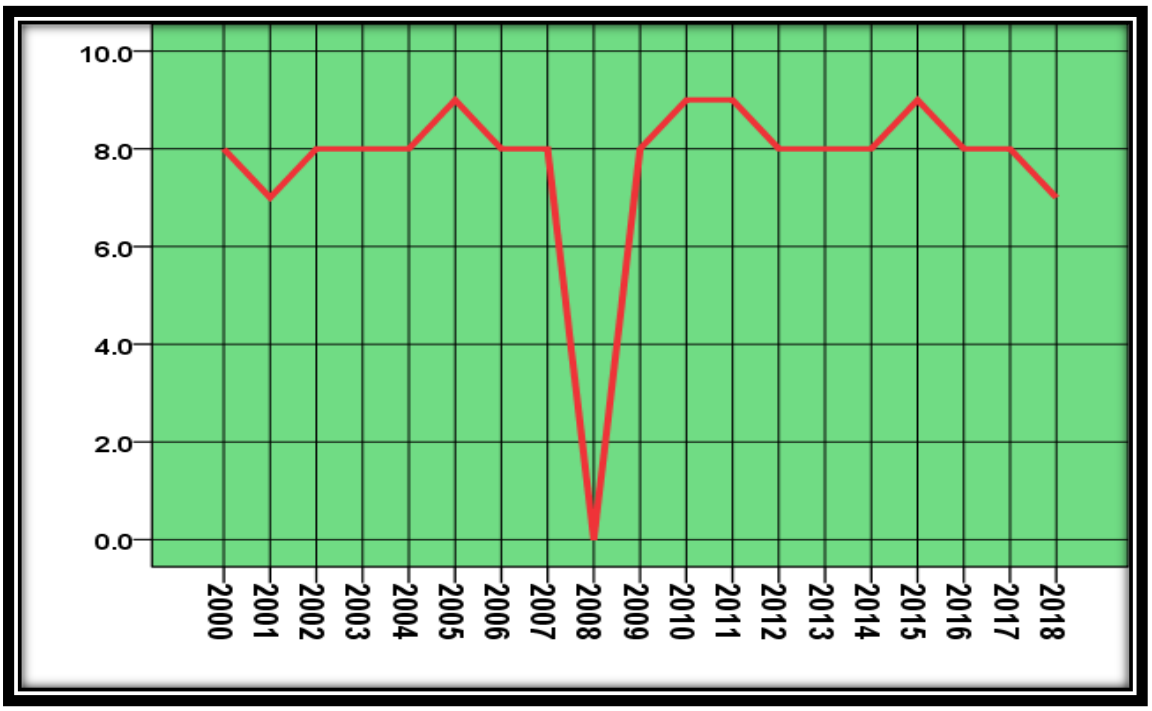
Figure (10) Annual averages of relative humidity during the period from 2000 to 2018 AD Abu Hamad Station.



Source: Annex 2 data

It is known that the state of the Nile River is a semi-desert climate, so that the relative humidity is always low. Figure (1) shows that the relative humidity has increased after the opening of the Merwi Dam before the opening of the Dam. (26.9%) and in 2018 after the opening of the dam (28%). Note that the humidity before the opening of the dam did not exceed (27%) at its maximum height.

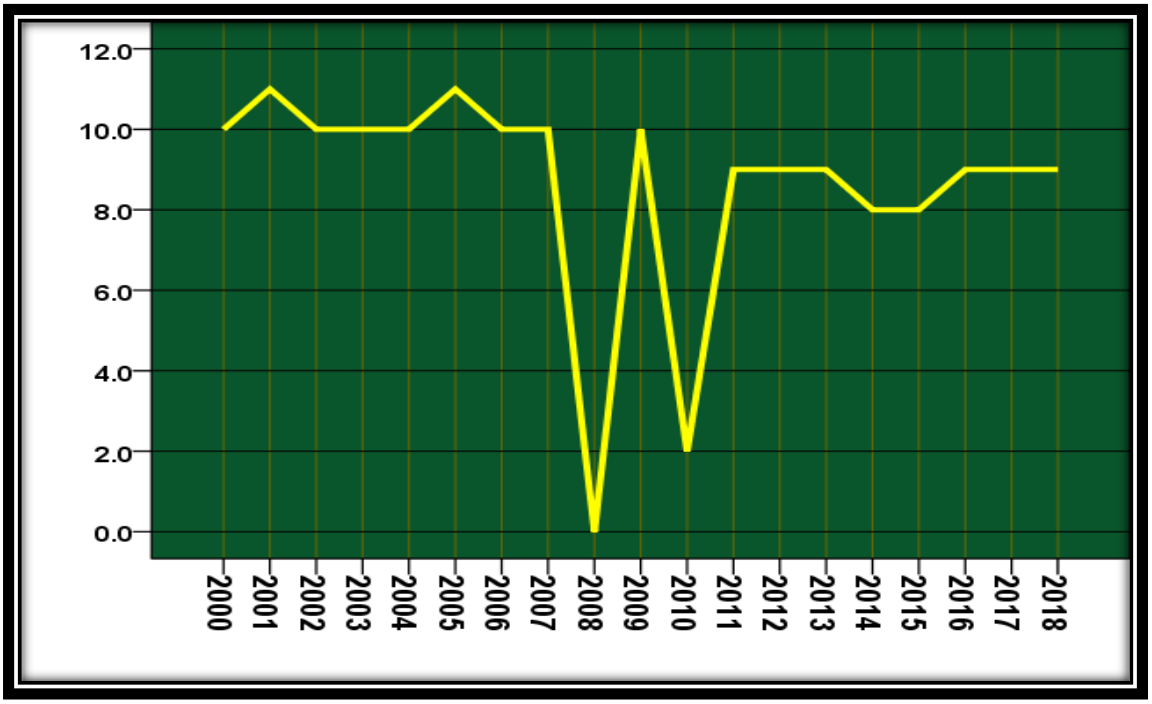
Figure (11) Annual averages of wind speed during the period from 2000 to 2018 AD Abu Hamad Station.



Source: Annex 2 data

Figure (11) shows that the minimum speed of wind before the opening of the dam was in 2008 at (0) km / h, and then increased speed significantly in 2015 at (9) km / h.

Figure (12) Annual averages of solar radiation during the period from 2000 to 2018 AD Abu Hamad Station.



Source: Annex 2 data

Figure (12) shows that the percentage of sun brightness before the opening of the Merwi Dam was in a particularly low state in 2008 and reached zero. The percentage increased in 2009 to reach (10%). Then it fluctuated from year to year. And then increased in 2018 (9%).

RESULTS:

1 / There has been a significant change in the elements of the local climate in the period following the Lake Merwi Dam.

2 / The climatic elements that were affected by the formation of the Lake Merwi are (temperature, rainfall, relative humidity, brightness of the sun, dew, wind).

3 / Relative humidity is one of the most affected by the formation of Lake Merwi Dam, where the region witnessed a significant increase in relative humidity after the completion of storage.

4 / It also observes the decrease in the percentage of sun brightness during the year for the period following the dam lake due to the spread of clouds in the region.

5 / The Merwi Dam in the northern state may have a clear effect on changing the crop composition to change some elements such as relative humidity, temperature and dew.

6 / Merwi Dam may indirectly affect the reduction of the phenomenon of desertification because it contributes to the increase in the relative humidity, and increases the amount of annual rainfall and also changes the dam from the topography of the region as a result of the lake dam all these factors would reduce the phenomenon Desertification The impact of the dam on desertification remains limited in a small area, especially in the first years following the dam.

RECOMMENDATIONS:

1/ Follow-up research in this field with a view to determining the spatial extent in which the Lake Merwi affects the climate.

2/ Look for the causes of climate change and try to reduce them.

3/ Expanding the scope of the research to include the study of the impact of the dam on all elements of climate and environmental phenomena, air and climate.

4/ Use the laws of the calculation of evaporation to know the amount of evaporation from the lake dam in order to predict the amount of rain in the future.

5/ Follow up and monitor these climate changes annually to know the future of climate in the two states.

6/ Research the impact of climate changes resulting from the dam lake on agriculture and industry and various aspects of economic life.

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SUPPLEMENTS: -

1 / Annual averages of the elements of the climate station observable during the period from 2000 to 2018

Relative humidity	Solar radiation	Wind speed	Rain	Minimum temperature	High temperature
22	10.3	5.8	0.2	21.3	37.7
22	10.4	5.2	0.0	21.4	38.1
20	10.1	5.53	1.2	22.0	37.8
21	10.0	5.8	1.5	22.8	38.1
19	10.3	5.8	0.1	21.4	38.3
21	10.0	6.5	0.9	23.3	38.4
21	9.7	5.8	1.6	21.1	37.9
24	9.6	5.9	6.6	21.2	37.7
16	9.2	6.4	0.0	22.4	38.2
19	9.1	6.7	0.1	22.3	38.2
24	8.8	6.7	1.7	23.7	39.0
22	9.1	5.3	0.0	21.8	37.6
23	8.4	4.4	0.2	21.8	37.8
24	8.6	5.2	1.5	21.3	37.7
27	8.2	4.8	1.2	21.8	37.6
25	10.0	5.5	1.5	22.7	37.4
25	9.6	6	0.3	22.3	37.7
24	9.3	5.7	0.8	23.5	37.6
26	9.1	6	1.0	22.9	37.5

Source: world meteorological organization (2018)

2 / Annual averages of the elements of climate at Abu Hamad meteorological station during the period from 2000 to 2018

Relative humidity	Solar radiation	Wind speed	Rain	Minimum temperature	High temperature
22	10	8	0.0	22.1	37.9
22	11	7	0.0	22.1	37.9
23	10	8	3.1	22.0	37.8
23	10	8	0.0	22.6	37.9
22	10	8	0.0	22.0	38.2
24	11	9	0.2	22.8	38.2
25	10	8	1.7	22.5	37.8
27	10	8	3.3	22.6	38.5
22	0	0	0.0	23.5	38.3
23	10	8	0.0	21.5	38.4
25	2	9	0.2	22.4	39.1
21	9	9	0.0	21.6	39.6
23	9	8	0.0	22.5	38.2
25	9	8	2.0	22.3	38.1
26	8	8	0.7	22.7	38.3
23	8	9	0.0	17.5	38.5
26	9	8	0.0	16.3	38.8
25	9	8	0.8	22.1	38.6
28	9	7	1.3	22.1	38.2

Source: world meteorological organization(2018)