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Assessment of climatic changes for Temperatures and Rainfall, during Autumn Seasons at White Nile State, Sudan

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Abstract
The study aimed to monitor climatic factors trends such as average of monthly temperatures and autumn season rainfall (1960-2019) for White Nile State.. Climate data included autumn season rainfall, average of monthly temperatures obtained from Sudan Meteorological Authority (SMA).Descriptive and Trend analysis, regression were the main analytical tools used in this study. Trend analysis showed thatWhite Nile state is subjected to significant ($P<0.05$) increasing in annual rainfall at both stations (Kosti, Edduim). significant increasing in seasonal rainfall in (Edduim), While (Kosti) suffers from significant decreasing in seasonal rainfall,also White Nile state was subjected to non-significant increase in Temperature through over Autumn season for the period 1960-2019.Also the results reflected that The rainfall annual average was 247.0 mm for Edduim, and 358.3 mm for Kosti, while the seasonal (Jul-Oct) rainfall average was 217.7 mm for Edduim, and 297.5 mm for Kosti.Edduim rainfall showed increase of 09.799 mm per annual rainfall, while Kosti rainfall showed increase of 02.136 mm.The drought years showed decreaseof 06.206 mm in Edduimand increase – 02.04 in Kosti, while the flood years showed increase 03.592 mm in Edduimand increase 04.181 in Kosti, analyzing the average (avg.) of rainfall into periodical decadesshowed that the month of August has the highest average in both stationsfor the same period2010-2019,with the highest average in the month of August 120.90 mm in Edduimand 142.56 mm in Kosti, regarding the temperature (temp.) analysis for the same period, the results showed that the annual trend of Maximumtemp. avg. in study area was + 01.69 for Edduim and + 01.96 for Kosti, while the season trend was + 0.81 for Edduim, and + 01.20 for Kosti. The annual trend of Minimum temp.avg. in study area was + 04.72 for Edduim, + 02.72 for Kosti, and the season avg. trend was + 04.03 for Edduim, +01.93 for Kosti. Summarizing the average temperature in study area, the annual trend showed + 02.34 for Edduim, + 03.20 for Kosti, and the season trend was + 02.42 for Edduim and + 01.56 for Kosti. The study concluded that White Nile State is subject to climate change volatility, as resulted through the analysis showing while White Nile State under increase of annual average of rainfall, and both of study areas are affected by shorting the rainy season. Regarding the temperature average both of study areas are affected by increasing of the temperature average annually and due the autumn season. The studyrecommendingthat the State have to prepare a flexible staged strategy to face the climate change and volatility, and avoid the negative impact of it, includes offering the climatic information to the farmers directly within a suitable period to take action, offering the technical and extension services in affected areas, create a suitable finance for this sectors, declare the best adaptation methods to the farmers, specially water harvest techniques,
Keywords: Climatic factors, Climate Change, White Nile State,Sudan, Rain-Fed, Autumn Season, short rain season, Trend,Regression.

Introduction

There is no doubt that climate plays a significant role in shaping the face of the earth and in determining the types of economic activities that human can practice. Climate change refers to a change and variability of climate which affect directly or indirectly human activity, the clear main factors of climate change is temperature and rainfall, in recent times, human activities have caused, and are continuing to cause, great changes to the composition of the atmosphere. The findings of the Intergovernmental Panel on Climate Change (IPCC) have shown that climate change is already having strong impacts on human societies and the natural world, and is expected to do so for decades to come

(IPCC, 2007). Sudan is one of the most vulnerable to climate change and climate variability. (Box 1; and IPCC, 2007).

The State accommodates both rain-fed and irrigated farming dominated by the farmer under a mechanized mode having high growth. Traditional rain-fed agriculture has rather humble growth while irrigated farming has remained almost stagnant. The rain-fed crop mix has sorghum as the major crop, which together with sesame and millet, form about 97% of the total area under this system. Crops there are again dominated by sorghum that occupies close to three quarters of the area, followed by wheat (18%) and cotton (8%). Groundnut existed till the late 1970s but has almost vanished since then, in the state, major food security crops are sorghum, wheat and to a much lower extent millet. So, food security in the state depends mainly on rain-fed sector, Realization of the human - climate relationships has led to a growing interest in the science of climatology especially in the tropical areas where the impacts exerted by the various climatic factors particularly rainfall and temperature are vital and effective *(Noah, 2016)*

In general Sudan's inherent vulnerability to climate change is captured by the fact that food security is mainly determined by rainfall, particularly in rural areas where more than 65% of the population lives. According to *(Sassi, 2012)* and *(Sudanese Ministry of Environment and Physical Development, 2007)*, rainfall supports the overwhelming majority of the Sudanese agricultural activities that constitute the main economic sector of the country. Almost all of the cultivated land, 95%, is under a rain-fed mechanized or rain-fed traditional farming system, which grow more than 70 % of the domestic cerealcrops production. These in addition to increase in temperature beyond the optimum level (high temperature of about 26-30 C° and low temperature of about 10-15 C°) might results decline in local cerealcrops production, On the other hand, agriculture and natural vegetation cover is often the first sector to be affected by the onset of drought due to the dependence on water resources and soil moisture reserves during various stages of crop growth *(Muna, 2012)*. Based on average seasonal rainfall, potential evapo-transpiration and according to the ratio of humid months to arid months and length of the growing season.

Materials and Methods

Study area: White Nile state: White Nile state is characterized by its strategic location in south of Sudan, it is bordered by Khartoum State in the north, North Kordofan State in the west, South Kodofan State and the Upper Nile State in the southeastern and Al-Gazira&Sinnar States in the east The state area is 39, 701 square kilometers, The geological formation of the state consists of six areas which shown in table (1), Fig. (1)

Table (1). The geological formation of White Nile state

	Acres	%
Plain Region	3,643,119	33%
Land area of sedimentary clay and sand	2,268,629	24%
Area of the Nile Valley	945,262	10%
Sub-Saharan sand area	661,638	7%
Agayzan sandy area	2,363,155	25%
Rocky hills area	94,526	1%
Total	9,976,329	100%

Source: Central Sector Commission and UNDP, 2010

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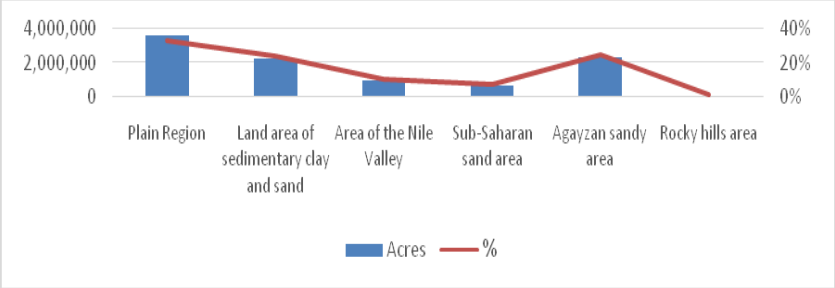

Figure (1). The geological formation of White Nile state

White Nile state may be divided into two agro-ecological zones, these zones arearid and semi-arid (Table 2). This study attempt to monitor climate factors trends such as seasonal rainfall, minimum and maximum monthly temperatures during autumn season.

Table (2). Agro-climatic zones of the White Nile state

Agro-ecological zone	Seasonal rainfall (mm)	Humid months(#)	Growing season length (days)
Arid	200-300	2-3	60-90
Semi-arid	350-750	3-4	90-120

Source: A. K. Osman et. al, 2012

Data sources

Two types of data from secondary sources were used in this study. The climate data include average of seasonal rainfall (in mm), monthly average of temperature (in C^{o}) during autumn season was obtained from the Sudan Meteorological Authority (SMA).
Analytical tools: Descriptive statistics, simple regression were main analytical tools used in this study. Simple regression analysis was used to estimate the trend of the historical climate data to detect whether there is a climate change in the study area as postulated by seasonal rainfall, monthly minimum and maximum temperatures during the period1960-2019 fortwo stations at White Nile State, kosti&Edduim, metrological stations, White Nile state,obtained from Sudan Meteorological Authority (SMA). The linear trend is simply represented by the following equation:

$Ty = a + bx$

Where:

Ty = trend values of the climate variables i.e., seasonal rainfall, minimum and maximum monthly temperature in the main weather station at White Nile states.

a = intercept or estimated value when *x* equal to zero *b* = slope of line or average change in *Y* per unit of time x = time factor (years) from 1960-2019.

Results and Discussions:

Theaverageannual rainfall was 247.0 mm atEdduim, and 358.3 mm atKosti, while the seasonal (Jul-Oct) rainfall average was 217.7 mm atEdduim, and 297.5 mm atKosti.
Edduim rainfall showed anincrease of 09.799 mm per annual rainfall (Fig. 2), while Kosti rainfall showedan increase of 02.136 mm (Fig. 3).
The drought years showed decrease 06.206 mm in Edduim (Fig. 4) and increase – 02.04 inKosti, (Fig. 5)
The flood years showedan increaseof 03.592 mm atEdduim (Fig. 6) andan increaseof 04.181 in Kosti (Fig. 7).

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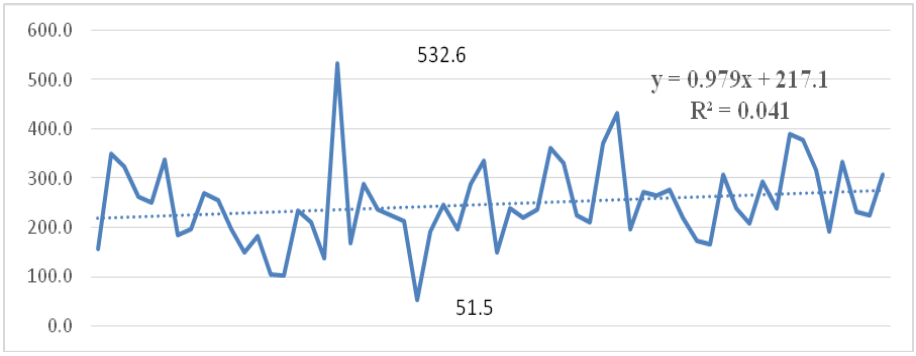

Fig. 2: Annual Rainfall atEdduim, White Nile state ،during (1960 – 2019)

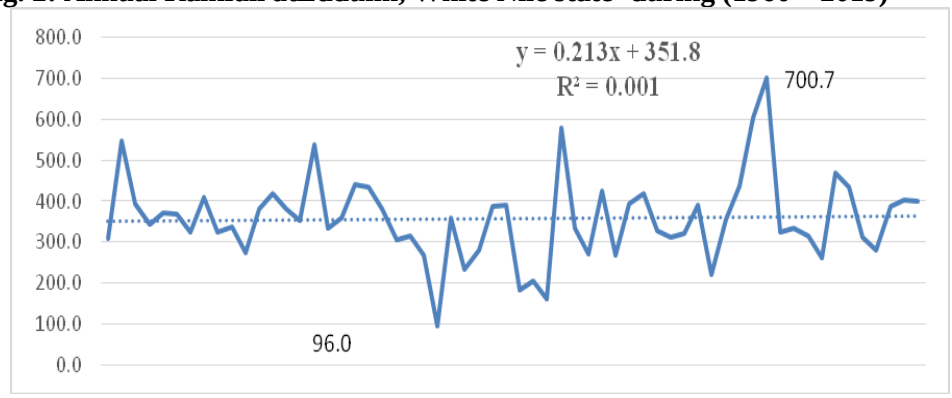

Fig. 3: Annual Rainfall atKosti, White Nile stateduring (1960 – 2019)

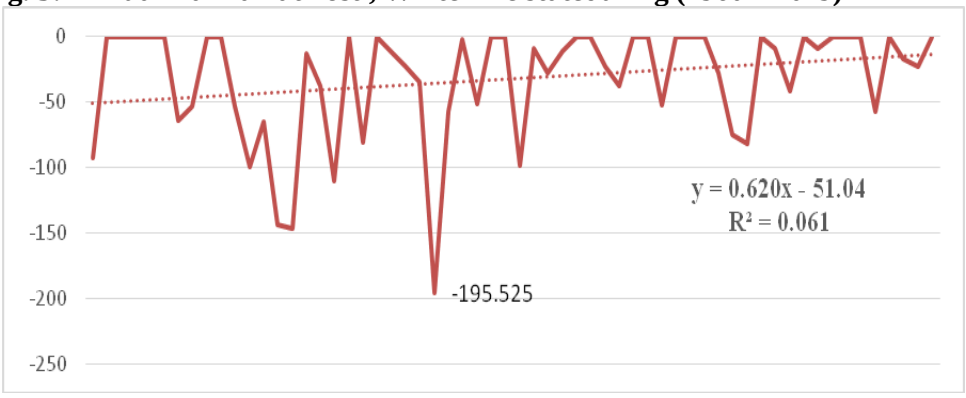

Fig. 4: Drought in Edduim, White Nile state during (1960 – 2019)

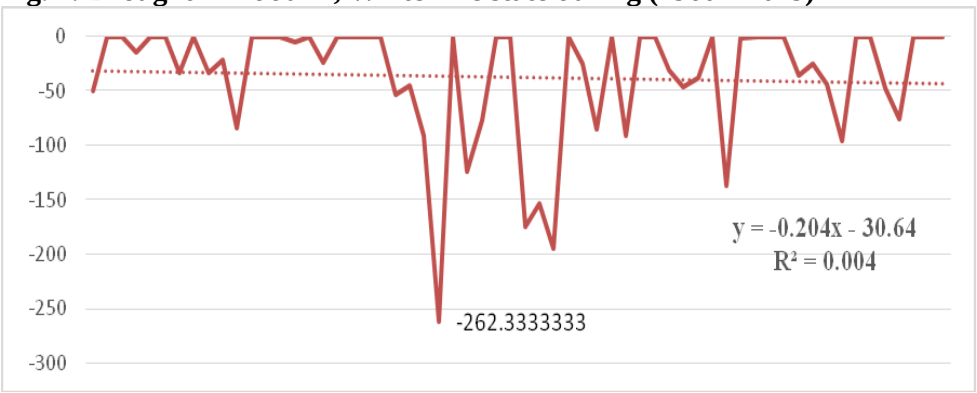

Fig. 5: Drought atKosti, White Nile state during (1960 – 2019)

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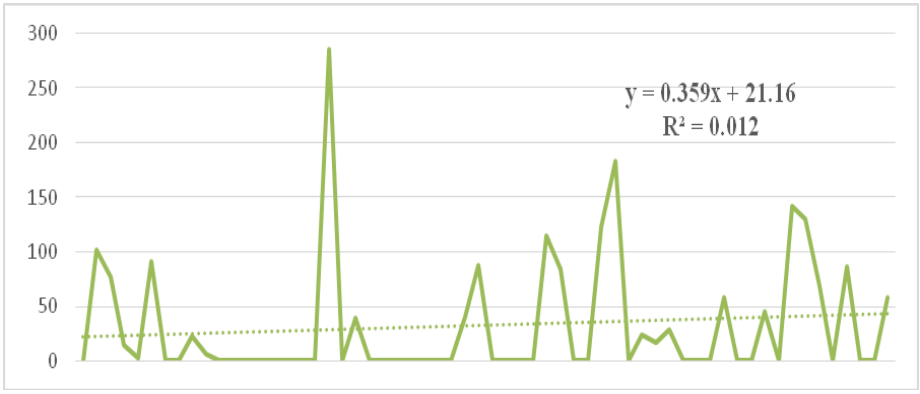

Fig. 6: Flood atEdduim, White Nile state during (1960 – 2019)

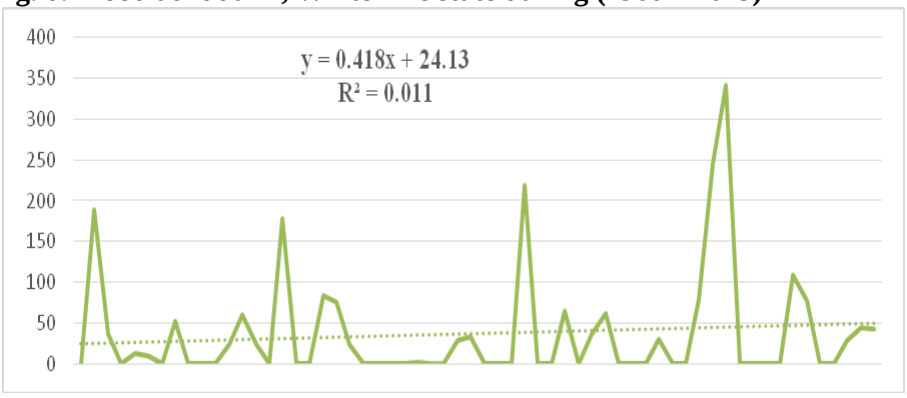

Fig. 7: Flood atKosti, White Nile state during (1960 – 2019)

When reflecting the annual months and seasonal months' average of rainfall into periodical decades the drawing showed that the last decade 2010-2019 has the highest average in the month of August with 120.90 mm atEdduim (Fig. 8) and 142.56 mm (Fig. 9) atKosti, Also the month of August has the highest average rainfall in both stations (Fig. 10& 11) for the same period.

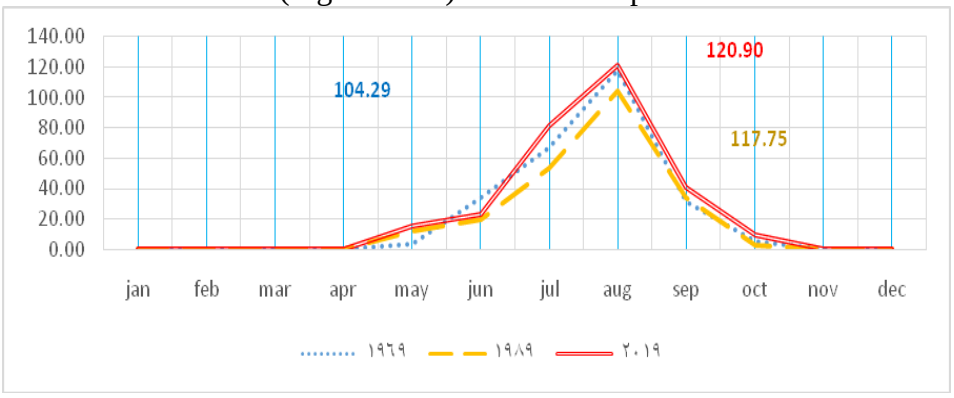

Fig. 8: Decades Average of Monthly Rainfall atEdduim, White Nile stateduring (1960 – 2019)

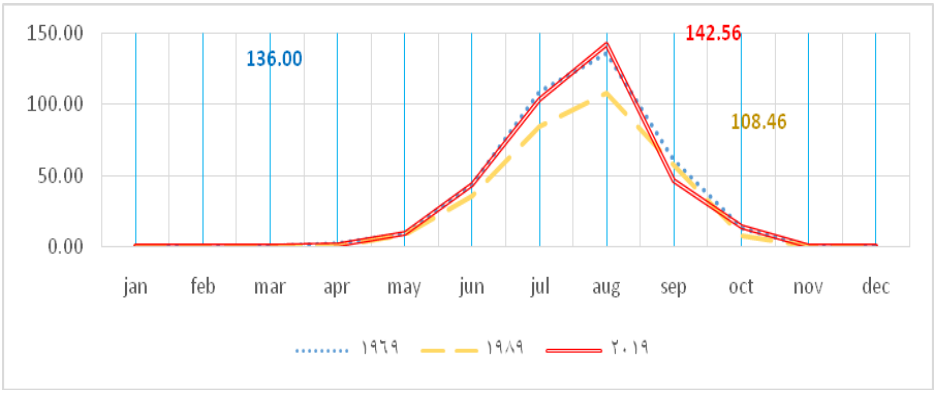

Fig. 9: Decades Average of Monthly Rainfall inKosti, White Nile stateduring (1960 – 2019)

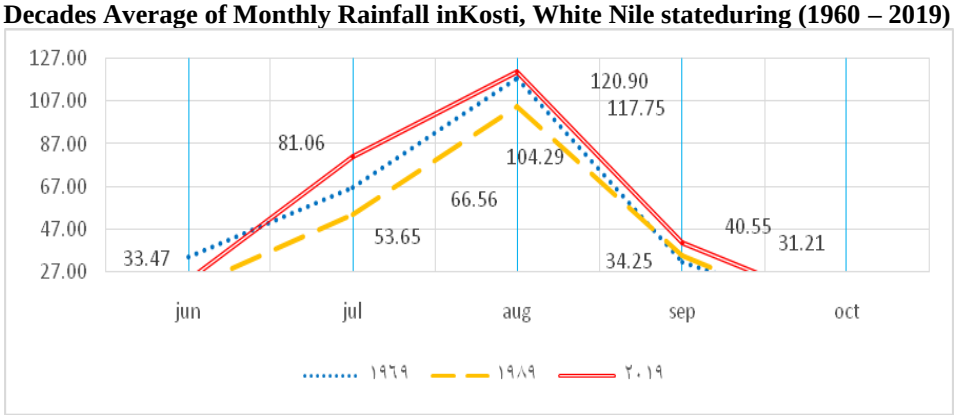

Fig. 10: Decades Average of Season Monthly Rainfall atEdduim, White Nile stateduring (1960 – 2019)

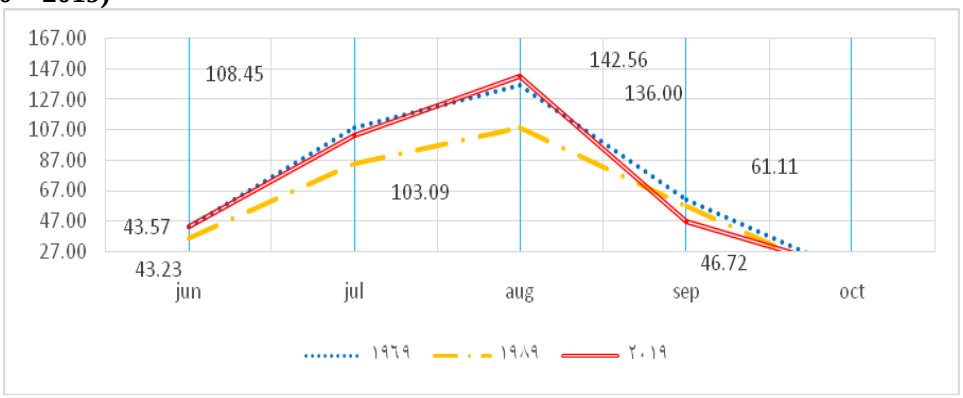

Fig. 11: Decades Average of Season Monthly Rainfall atKosti, White Nile state during (1960 – 2019)

1.1.1. Temperature variability in White Nile State:

This study monitored the average of maximum and minimum temperatures, White Nile state is subjected to non-significant increase through over Autumn season for the periodduring 1960-2019.

The Maximum temperature average showed that both of study areas were affected by increasing of the temperature average annually and due the autumn season, as in tables (3, 4, 5), (fig. 12,13, 14,15, 16,17), :

Tab. 3: Maximum temperature average at study areas

	Annual	Autumn	Annual Trend	Season Trend	
Edduim	36.60	36.40	+ 01.69	+ 00.81	(Fig. 13)
Kosti	36.70	35.40	+ 01.96	+ 01.20	(Fig. 14)

Source: Prepared by researcher

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Tab. 4: Minimum temperature average at study areas

	Annual	Autumn	Annual Trend	Season Trend	
Edduim	22.50	24.40	+ 04.72	+ 04.03	(Fig. 15)
Kosti	21.70	23.40	+ 02.72	+ 01.93	(Fig. 16)

Source: Prepared by researcher

Tab. 5:Average temperature at study areas

	Annual	Autumn	Annual Trend	Season Trend	
Edduim	29.60	30.40	+ 02.34	+ 02.42	(Fig. 17)
Kosti	29.20	29.40	+ 03.20	+ 01.56	(Fig. 18)

Source: Prepared by researcher

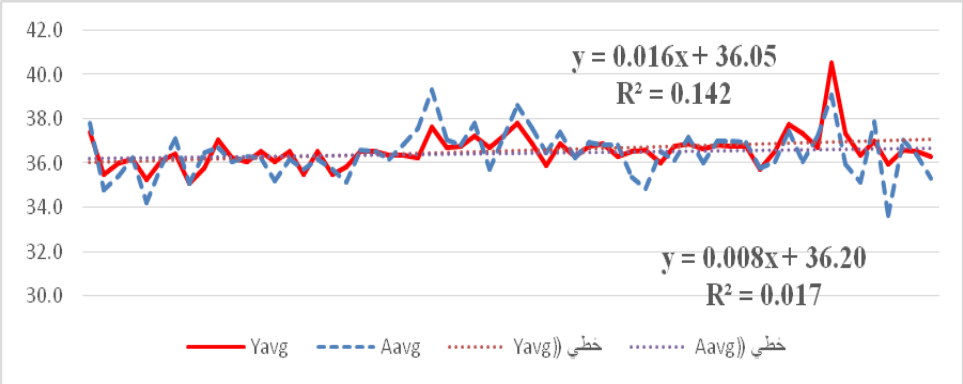

Fig. 12: Annual & Seasonal Maximum Temperature average atEdduim, White Nile stateduring (1960 – 2019)

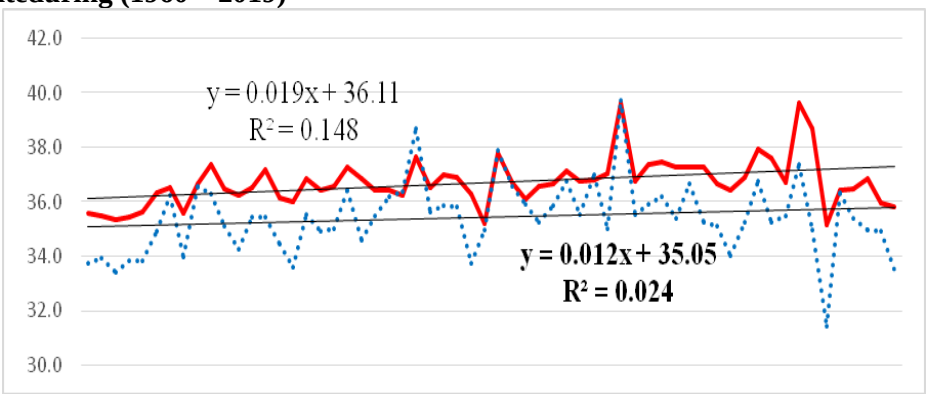

Fig. 13: Annual & Seasonal Minimum Temperature average atKosti, White Nile state during (1960 – 2019)

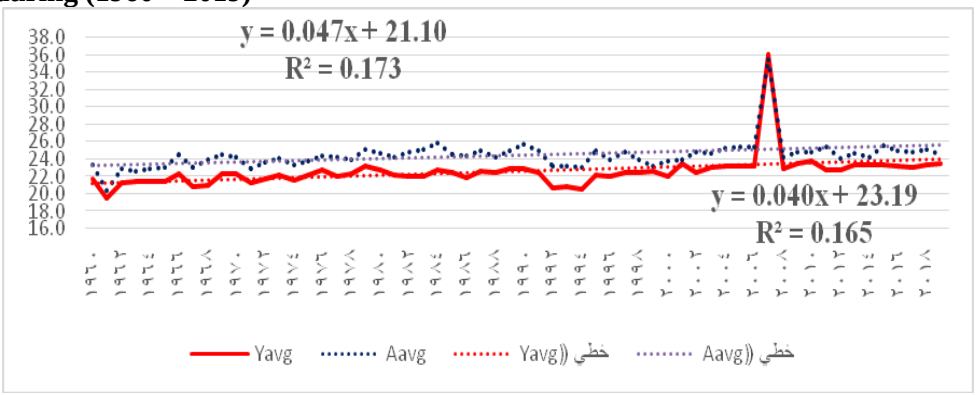

Fig. 14: Annual & Seasonal Minimum Temperature average atEdduim, White Nile state during (1960 – 2019)

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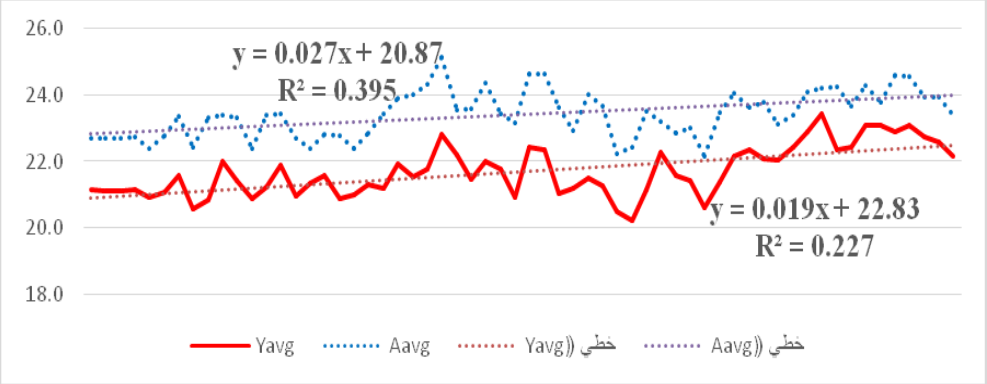

Fig. 15: Annual & Seasonal Minimum Temperature average atKosti, White Nile stateduring (1960 – 2019)

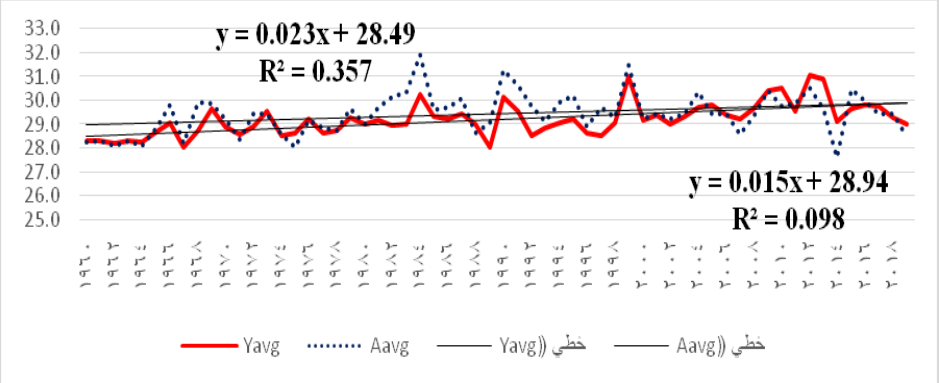

Fig. 16: Annual & Seasonal Average Temperature average atEdduim, White Nile stateduring (1960 – 2019)

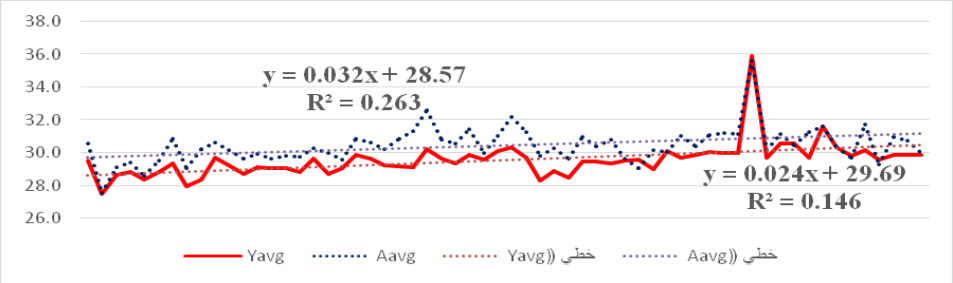

Fig. 17: Annual & Seasonal Average Temperature average atKosti, White Nile stateduring (1960 – 2019)

Conclusion

The study concluded that White Nile State is subjected to climaticchange volatility, as resulted through the analysis showing that while White Nile State underan increase of annual average of rainfall, and both of study areas were affected by shorting of the rainy season. Regardingto the temperature averages both of study areas were affected by an increasing of the temperature average annually and due the autumn season.

Recommendations

The State have to prepare a flexible staged strategy to face the climate change and volatility, and avoid the negative impact of it, includes offering the climate information to the farmers directly within a suitable period to take action, offering the technical and extension services in affected areas, create a suitable finance for this sectors, declare the best adaptation methods to the farmers, specially water harvest techniques,

References

Central Sector Commission and UNDP, 2010.Socio-economic and Opportunity Mapping Assessment Report for White Nile State, 2010.

IPCC (Intergovernmental Panel on Climate Change) 2007.Synthesis report.An Assessment of the Intergovernmental panel on climate change. IPCC, Geneva. Available at: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf.

Sassi M. (2012). Impact of Climate Change and International Prices Uncertainty on the Sudanese Sorghum Market: A stochastic Approach. Paper prepared for presentation at the 1st AIEAA Conference 'Towards a Sustainable Bio-economy: Economic Issues and Policy Challenges' 4-5 June, 2012 Trento, Italy.

Sumaya Ahmed Zakieldeen, (2009), Adaptation to Climate Change: A Vulnerability Assessment for Sudan, gatekeeper (142), Nov. 2009.