IOSR Journal Of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861.Volume 13, Issue 4 Ser. I (Jul.–Aug. 2021), PP 50-56
www.Iosrjournals.Org

Variability of Rainfall in Awka, Anambra State Nigeria

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Abstract
The trend of rainfall in Awka from 2011 to 2020 was examined using monthly rainfall data collected from Nigerian Meteorological Agency (NIMET) Synoptic Station at Amawbia, Awka, Anambra State. The study considered monthly rainfall for each year, mean monthly rainfall from 2011-2020 and the annual rainfall from 2011-2020. It was found out that the month with the highest rainfall varies from June, July, August and September with September 2019 having the highest monthly rainfall of 906.00mm and February 2014 having the lowest monthly rainfall of 2.60mm. The result from the mean monthly rainfall has September with mean monthly rainfall of 475.37mm as highest and January as lowest with mean monthly rainfall of 11.33mm. The years 2019, 2018, 2017 and 2013 recorded the annual rainfall of 3863.40mm, 3636.40mm, 3616.00mm and 1639.40mm respectively. Thus the year 2019 has the highest annual rainfall whereas 2013 has the lowest. The trend of rainfall showed a decrease in annual rainfall from 2012 to 2014 and an increase from 2016 to 2019. Following the trend of variability of rainfall in Awka in recent times, 2019 is the wettest year among the ten-year period studied.

Keyword:*Rainfall, variability, Awka, Annual.*

Date of Submission: 18-07-2021 Date of Acceptance: 03-08-2021

I. Introduction

As Earth's climate has warmed, a new pattern of more frequent and more intense weather events has unfolded around the world. Nigeria is experiencing adverse climate conditions with negative impacts on the welfare of millions of people. The climate of an environment or a region is usually explained in terms of the prevailing climatic elements of temperature, rainfall/precipitation, relative humidity, evaporation, solar radiation etc. The description of these climate element or parameters in any region is known as climatic characteristics of that region. The most widely used measure of climatic description among all these parameters is the temperature, rainfall/precipitation and relative humidity (Oguntoyinbo, 1983 and Ayoade, 1992). Rainfall is one of the major factors affecting food security especially in countries largely or highly dependent on rain-fed agriculture, given that evaporation rate and soil characteristics controls the state of soil moisture. Changes in rainfall and other forms of precipitation will be one of the most critical factors determining the overall impact of climate change. A warmer atmosphere can hold more moisture, and globally water vapor increases by 7% for every degree centigrade of warming. How this will translate into changes in global precipitation is less clear cut but the total volume of precipitation is likely to increase by 1-2% per degree of warming. In a developing nation such as Nigeria, a lot of people are still in doubt of the existence of global warming by characterizing the signs to nature. A result of rise in water level of water bodies that lead to flooding experienced in some part of the country is, one of the signs of global warming (Matt, 2010). In a more recent study, (Ezenwaji*et al.,* 2013) observed that climatic elements (temperature and rainfall) were the greatest contributors of flooding in Abraka town, Nigeria during the period 2000 to 2009. Also, (Onell, 2009) isolated some climatic elements giving rise to flooding in the Awka which include, rainfall intensity, rainfall duration, high temperature and atmospheric humidity, and concluded that rainfall intensity and temperature were significant. Recent climatic variability, and most particularly rainfall variations are becoming increasingly of concern to researchers, institutions andgovernments. To predict futuredevelopments, paststatisticaltrendscan be considered along withphysically-based climate model projections (Bardossy, 2001). Some studies based on statistical examination (Odjugo, 2010) and climate model projections (Abiodun*et al.,* 2011) have shown that changes in precipitation behavior is already evident in Nigeria. Evidence is building that human-induced climate change (global warming), is changing precipitationand the hydrological cycle, and especially the extremes. According to (Gerhard, 2004 and Herath, 2011), the debates are human versus natural, small amount of warming versus unprecedented warming, and fossil fuel drivers versus natural drivers (largely solar and orbital). Put in a nutshell, the debate is whether human emissions of greenhouse gases cause extreme events of unprecedented intensity or nature is responsible for climate disturbances (Lupo, 2008). These show that the causes, effects and scale of global warming are controversial at present and will continue in the future. One side argues that currently global warming is caused

by human factors while the opposite side insists on natural induced factors. (Riebeek, 2007) points out that global warming is happening at present and scientists have evidence that humans are to be blamed. The natural variability and climate change fluctuations of the climate system have been part of the Earth's history however, there have been changes in concentrations of greenhouse gases(GHGs) in the atmosphere growing at an unprecedented rate and magnitudes in recent years (Crowley, 2000; Paehler, 2007).

II. Study Area

Awka is the capital of Anambra state. It is a town situated in the South Eastern part of Nigeria under Awka South local government area in Anambra state. The town lies along roads leading from Owerri, Umuahia, Onitsha, and Enugu. The area is bounded by latitudes 6^{o} 9` N, $6^{o}$19` N and longitude 7^{o}11`E, $7^{o}$12`E. The city Centre is traversed by the old Enugu road (Zik's avenue). The town stretches to over a distance of 26 kilometers. Awka lies below 300m above sea in a valley on the plains of the Mamu River. Two ridges, both lying in a North-South direction, form the major topographical features of the area. Awka is sited in a fertile tropical valley but most of the original rain forest has been lost due to clearing for farming and human settlement. South of the town on the slopes of the Awka-OrluUplands (Ezenwaji*et al.,* 2013) are some examples of soil erosionand gulling. In recent times, the onset and cessation periods of the rain in the study area has been observed to vary over time.

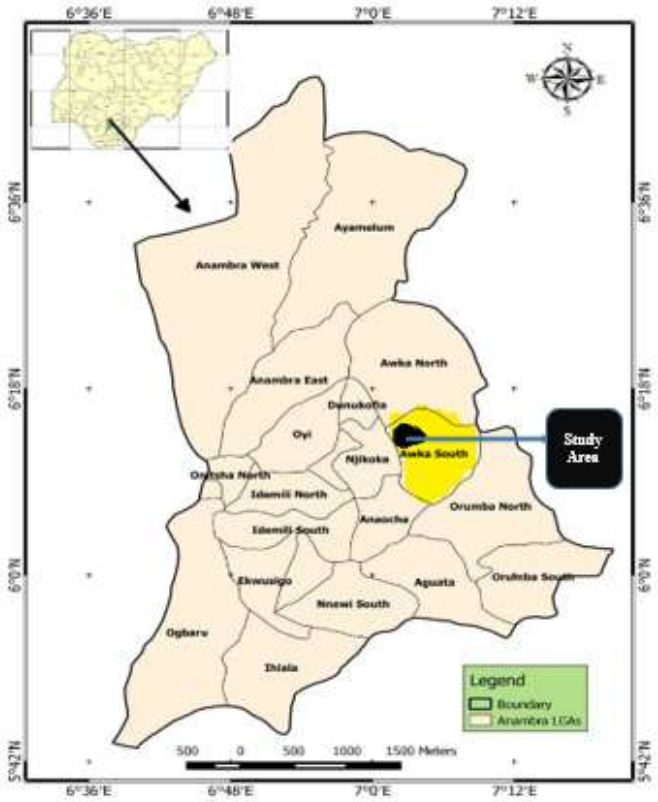

Fig 1: Map of Anambra State, showing Awka(Modified fromEzenwaji*et al.,* 2018).

III. Materials and Method

Data collection

The basic climatic database for this study, managed by Nigerian Meteorological Agency (NIMET) Synoptic Station at Amawbia, Awka, Anambra State is the monthly values of accumulated rainfall taken over a period of 10 years (2011 to 2020). The temporal variation in rainfall characteristics of Awka were evaluated using the data.

Data Analysis

The yearly, monthly mean and annual variation of rainfall values was evaluated using descriptive statistics which involves the mean, ranges and charts. The monthly values of the rainfall for respective months from 2011-2020 were averagedto obtain the mean monthly rainfall for each month. The monthly values of the rainfall for each year were averaged for the ten (10) years period to obtain annual rainfall values of the study area. The mean is mathematically expressed as:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

In this study, mean was used to determine average occurrence of variable of interest such as average volume of rainfall in the location. To demonstrate the rainfall trends, the yearly,mean monthly and the annual mean precipitation were computed for the years 2011 to 2020 using Microsoft excel spreadsheets and the result shown in Table 1. Thereafter, graphs were plotted to show the overall trends.

Table 1: Mean of Monthly and Annual Rainfall (mm) in Awka from 2011 to 2020

year	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
2011	0.00	18.50	59.90	100.70	281.40	190.90	214.70	186.90	512.10	216.20	13.70	25.10	1820.10
2012	28.30	66.50	16.50	206.30	236.70	327.80	232.00	363.50	167.40	266.70	49.80	0.00	1961.50
2013	20.20	0.00	93.30	164.00	254.10	348.70	127.70	128.20	261.70	197.30	1.90	6.30	1639.40
2014	61.40	2.60	107.20	130.20	187.50	140.30	290.40	173.30	329.70	142.60	93.50	19.00	1677.70
2015	0.00	161.60	107.60	54.90	289.10	264.60	550.90	261.70	586.70	202.10	64.50	0.00	2543.70
2016	0.00	26.00	122.60	187.00	229.20	282.20	239.60	419.00	221.60	264.80	42.70	0.00	2034.70
2017	3.40	0.00	33.40	519.80	299.50	680.80	651.80	407.40	598.20	331.60	90.10	0.00	3616.00
2018	0.00	17.40	39.60	322.90	240.00	438.70	689.20	447.70	887.80	412.00	141.20	0.00	3636.50
2019	0.00	96.10	118.20	160.20	494.70	709.30	539.50	489.10	906.00	252.00	98.30	0.00	3863.40
2020	0.00	0.00	203.50	215.50	435.50	324.90	660.60	100.80	282.50	443.10	2.10	69.00	2737.70
2011-2020	11.33	38.87	90.18	206.15	304.77	374.42	419.67	297.76	475.37	272.84	59.78	11.94	2553.07

IV. Results and Discussion

Monthly rainfall for each year

The plots of yearly rainfall (Figs. 2-6) indicates a high irregular nature in magnitudes of rainfall between the months of each year. The beginning of rains was found to be significantly in the month of March/April, while discontinuance was predominantly October/November. It was observed that the period of onset of rainfall is changing with this occurring also in January/February Between 2011 to 2020, while the discontinuance remains almost undeterred. Over Awka, the first peak is usually recorded in July followed by a short dry spell in August known as the 'August break', then follows the second peak in September.

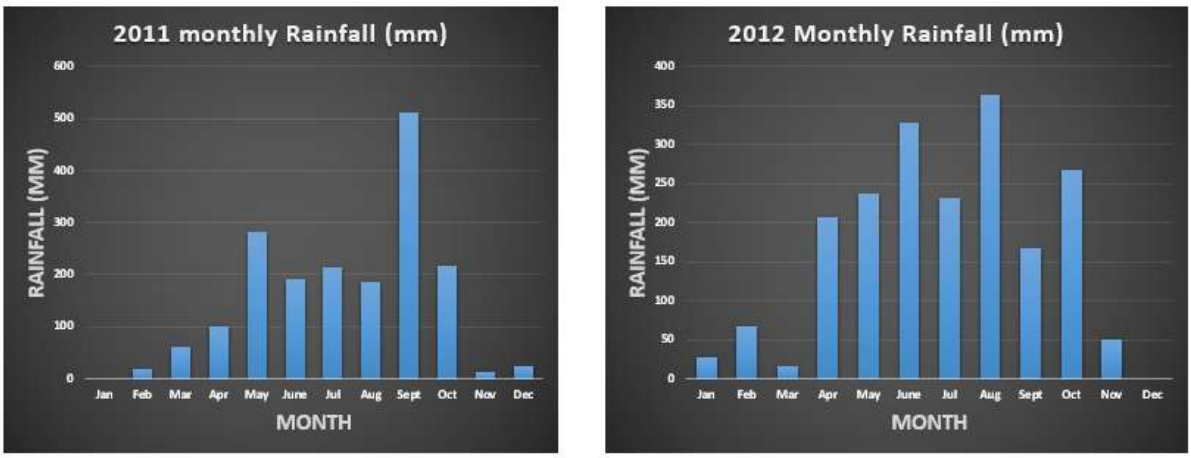

Fig 2: Monthly Rainfall for Awka in 2011 and 2012

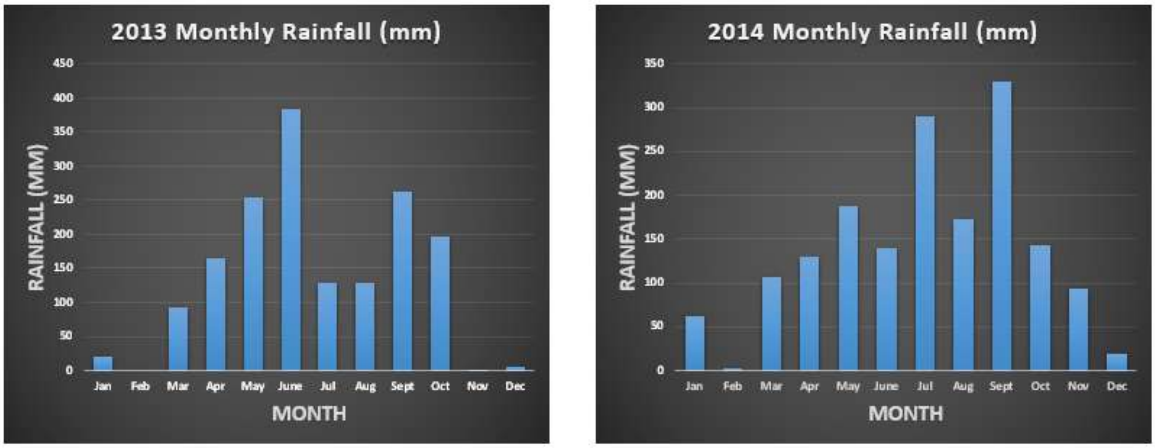

Fig 3: Monthly Rainfall for Awka in 2013 and 2014

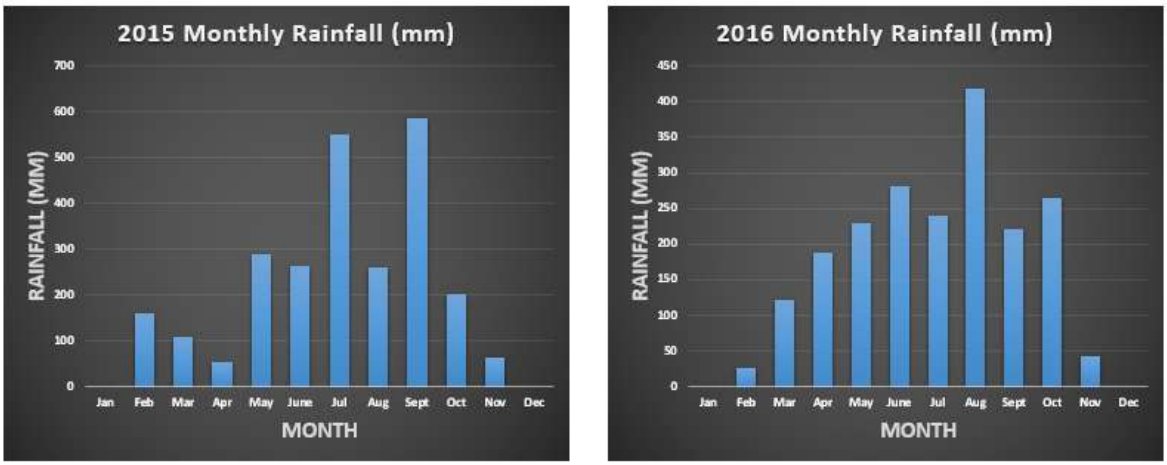

Fig 4: Monthly Rainfall for Awka in 2015 and 2016

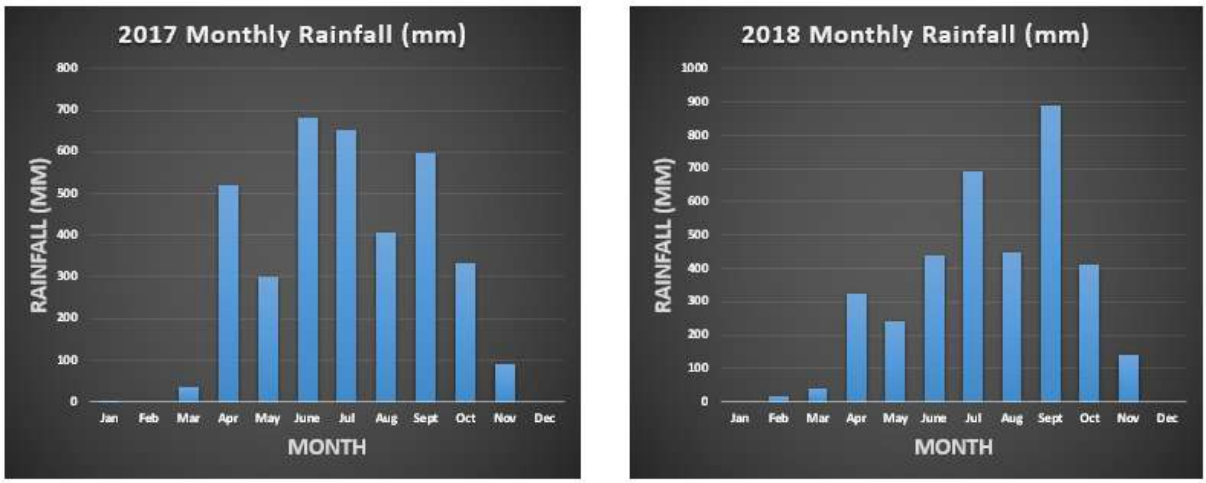

Fig 5: Monthly Rainfall for Awka in 2017 and 2018

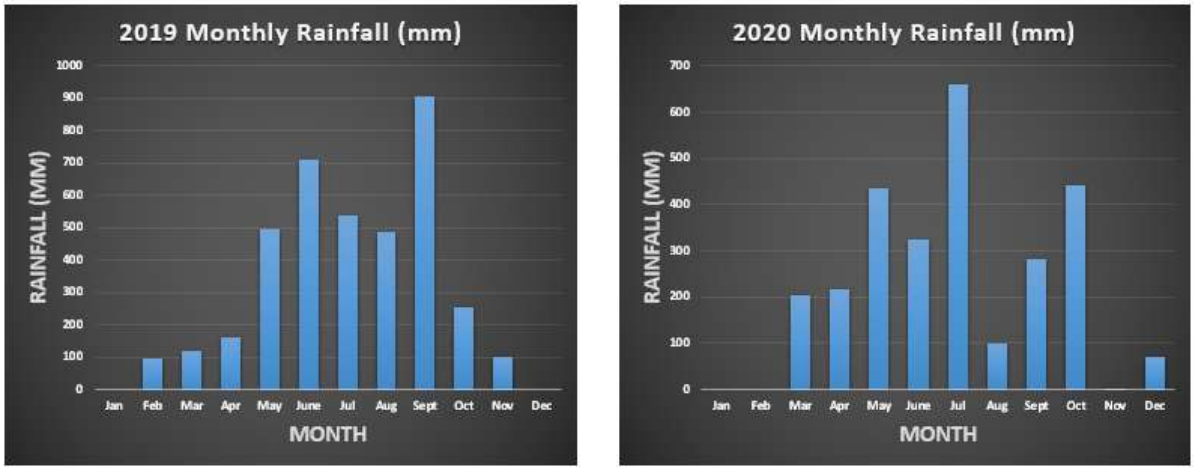

Fig 6: Monthly Rainfall for Awka in 2019 and 2020

Mean Monthly rainfall from 2011-2020

The mean of the monthly rainfall from 2011 to 2020 (Fig. 7) showed an increasing trend in the volume of rainfall from January to July, a decrease in august (august break) and another increase in September. The trend recorded September with 474.37mm as the highest and January with 11.33mm as the lowest.

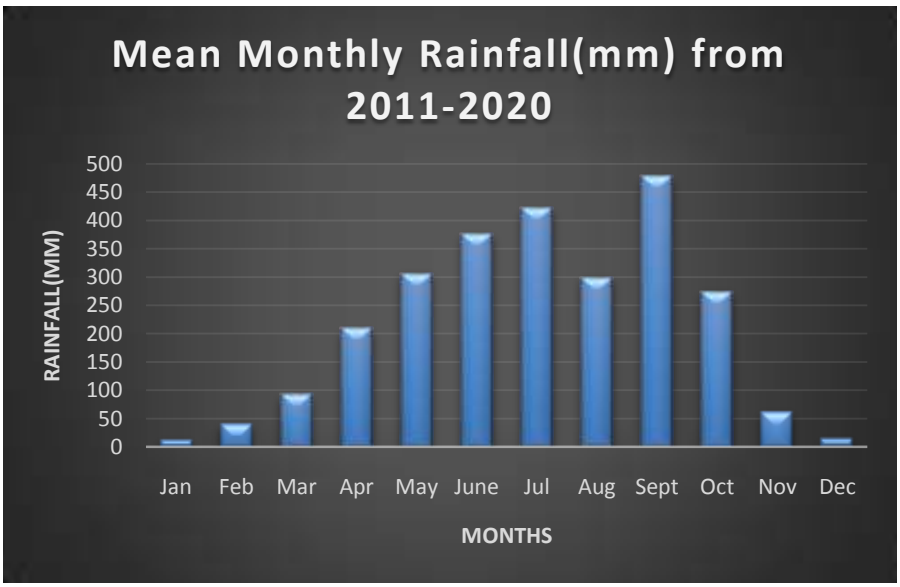

Fig 7: Trend of Mean Monthly Rainfall from 2011 to 2020

Annual rainfall analysis

The cumulative annual rainfall in Awka ranges from 1639.40mm to 3863.40mm for the ten (10) years period under this study (Fig. 8 and Table 1). It is recorded from the trend plot (Fig. 8) that over the years, the climate has been changing. The mean of the cumulative annual rainfall is 2553.07mm which is notably high when compared to what (Nzoiwu*et al.*, 2017) got from 1976 to 2015 and it provide an evidence to a more recent increase in the rainfall trend. The year, 2019 recorded the highest magnitude of rainfall with 3863.40mm followed by 2018 with 3636.50mm. The strongest decreasing trend occurred in 2020 while the strongest increasing trend occurred from 2016 to 2019.

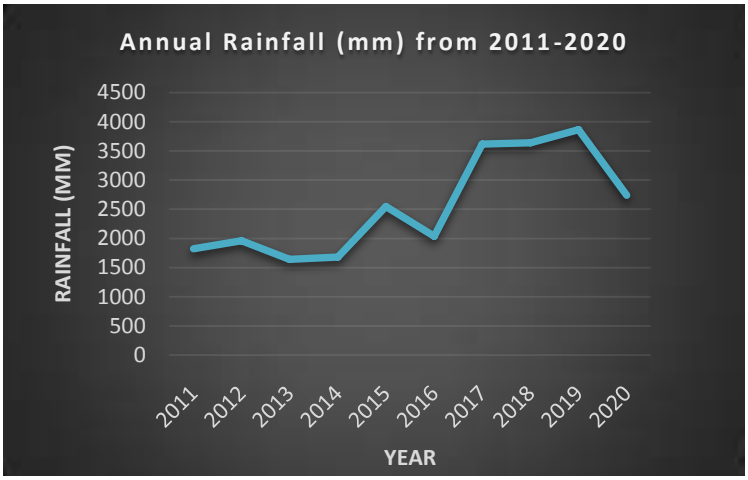

Fig 8: Trend of Annual Rainfall from 2011 to 2020

These increases is as a result of a substantial increase in rainfall amount during months of May, July, August and September of the ten (10) years. This changes in climate of Awka over the years is due to variation in temperature and humidity of the area and also due to adverse human impact on the ecosystem. It provides a reference to show the capability of global warming to stimulate changes in hydrological cycle.

V. Conclusion

The expected climate changes that could affect rainfall is ultimately caused by global warming. The evaluated results imply that both rainfall is not evenly distributed as it rains during the dry and rainy months. Thecalculatedannual rainfall varies between 1639.40mm to 3863.40mm which suggests an increasing trend in the climatic parameter in Awka. The weather and climatic variables can be seen as human exposures that directly or indirectly impact on human life. A resource-sensitive approach is needed to be taken base on the effect of global warming which may lead to higher temperatures and humidity as well as changes in precipitation due to global warming which are likely to alter the geographical range and seasonality of some climate sensitive vectors-potentially, extending the range and season of food insecurity, higher exposure to heat stress and ultraviolet radiation, more intense and frequent extreme weather events to the habitats of Awka as well as vector-borne diseases, contracting them for others. Moreover, these are not expected to remain constant, and overall likely to increase their impacts on humanity as the year goes by.

Acknowledgement

The authors are grateful to Nigerian Meteorological Agency (NIMET) Synoptic Station at Amawbia, Awka, Anambra State for provision of the data that was used for this research work.

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Omoja*et. al.*"Variability of Rainfall in Awka, Anambra State Nigeria."*IOSR Journal of Applied Physics (IOSR-JAP)*, 13(4), 2021, pp. 50-56.