

ANALYSIS OF RAINFALL PATTERN IN ISHIAGU: A TIME SERIES APPROACH.

¹Okoroafor I. B., ¹Anuonye R. C., ²Nnabue I., ³Iwuagwu BenC. M. and ⁴Ohagwasi N. D.

¹Department of Statistics, Federal College of Agriculture, Ishiagu, Ebonyi State.

²National Root Crops Research Institute, Umudike, Abia State

³Department of Statistics, Abia Polytechnic Aba, Abia State

⁴Department of Accountancy, Federal College of Agriculture, Ishiagu, Ebonyi State.

Corresponding authors E-mail: ok.iykeben@gmail.com

ABSTRACT

This research work aimed at carrying out time series analysis of rainfall pattern in Ishiagu, Ivo Local Government Area, Ebonyi State from 2013-2017. Secondary data obtained from weather station, Federal College of Agriculture was used. The statistical package used was statistical packages for social sciences (SPSS). The graph of the original series showed that there were upwards and downwards movements which implied that the series were stationary. The statistical tool used was multiplicative model time series analysis using least square method. The result of the analysis showed that from December to March across the years considered (2013-2017) there were dry season. From April to July for the period, there were much rain and within August the rains dropped due to August break and on September it moves to peak. From November of the years under consideration it dropped to minimum. The result of the analysis also reveals that although there exist variations for the individual months in each year, yet the mean of cyclical-irregular variation for all the months was the same (0.8878) except for January (0.8889) February and March (0.887) and December (0) respectively this the rainfall in ishiagudo not follow a particular model and are not predictable.

Keyword: Time series, Trend, Seasonal, Cyclical Irregular, Rainfall

INTRODUCTION

Several literatures on climate change and its attendant effect abound, as climate change and weather fluctuations have greatly taken

top in the priorities of global environmental discuss. Dikko *et al.*, (2013) argues that the effect of rainfall to man is diverse ranging from designs of agricultural systems to

erosion control. The Gamma distribution was used to model the distribution of the quarterly rainfall amount. The Kolmogorov – Smirnov, One Sample test was employed to evaluate the model fit. The Gamma distribution according to the authors adequately fitted the quarterly rainfall data producing a suitable model base on the Kolmogorov – Smirnov One Sample test. Okonkwo and Mbajorgu (2010), analysed rainfall data and characteristics for locations in seven states of South Eastern Nigeria. Intensity-Duration-Frequency (IDF) curves were developed for the locations using two Graphical and Statistical methods. According to Okonkwo and Mbajorgu (2010), the locations were Onitsha in Anambra State, Enugu in Enugu State, Abakiliki in Ebonyi State, Umuahia in Abia State, Owerri in Imo State, Port Harcourt in Rivers State and Uyo in Akwa Ibom State. They employed the generalized accumulated rainfall patterns developed by United States Department of Agriculture (USDA) Soil Conservation Service and matched it with rainfall data for the locations of study. Their results show that the advanced pattern had the best fit with the observed characteristics and was used to break down recorded daily totals into shorter duration rainfall data. Obasi and Ikubuwaje (2012) conducted an analytical study of rainfall and temperature trends in some catchment States of Nigeria using the Benin- Owena River Basin as case

study. The study covers Climatic data for rainfall and temperature for 35years. Their study employed the Cumulative Summation (CU-SUM) and the rank-sum tests. Their trend analysis shows that as temperature increases there is a corresponding increase in rainfall. The trend also indicates that no significant departure of these climatic parameters occurred. Their least square regression (r^2) and the trend show that the temperature variation ranges from 0.4% in Delta to 3.5% in Edo, an indication that the temperature conditions in states under study are not uniform even though the trend shows an increase. The rainfall least square regression variation ranges between 0.2% in Zaria and 2.7% in Plateau states, implying that the rainfall is varying in an upward trend. Odoemene (2011) interrogated issues of interest in the concrete experiences of Niger Delta communities in Nigeria in relation to environmental change. The paper highlights the transition of the delta to its present state and explores the social consequences of this downturn in delta communities. Odoemene (2011) argued that while the destruction of traditional means of livelihood has forced Niger Delta peoples into an environment-related poverty, deteriorating living conditions, and massive underdevelopment, environmental change in the area has led to new patterns of adaptation and survival.

Ekpoh and Nsa (2011) examined some aspects of the climate of north-western Nigeria, focusing more on rainfall, its inter- and intra-annual variability and patterns of distribution. Ekpoh and Nsa (2011) adopted some statistical tools commonly used to describe climatic conditions. These tools include: the mean, the standard deviation and the coefficient of variability, the climate of north-western Nigeria was analysed for possible shifts in mean conditions and patterns. Their study found that climatic conditions in north-western Nigeria have altered substantially as four drought episodes took place within the last three decades of the 20th Century and, the 1984 drought-year rainfall was 58.8 percent lower than the long-term mean rainfall. The study further showed that the 1968 to 2008 mean rainfall shifted downwards by 8.8 percent from the long-term mean, although it cannot be said if the shift is permanent or temporary since recent rainfall trends tend to suggest a recovery. Possible options for stabilizing the regional climate are suggested. Ologunorisa and Tersoo (2006) conducted analysis of recent changes in the characteristics of extreme rainfall and their implication on flood frequency in Makurdi. They employed data on extreme daily rainfall, evapotranspiration and flood occurrences. They analyzed the annual rainfall for trends using spearman rank correlation coefficient and annual rainfall

variability using standardized rainfall anomaly index while recurrence intervals were analysed using Gumbell Extreme probability theory. Their results show among other things that there was a remarkable continuous downward trend in annual rainfall amounts; that the period between 1996 and 2001 witnessed the highest frequencies of extreme rainfall events and flood frequencies; that major floods were associated with high recurrence intervals, and that the seasonality of flooding in Makurdi occurs between May and October annually. Azuwike and Enwereuzor (2011) examined the effect of rainfall variability on water supply in Ikeduru L.G.A of Imo State. Data collected were analysed using regression analysis and analysis of variance. Their result shows that there is a strong relationship between rural water supply in the study area and the rainfall; and that there is a significant difference in the sourcing of water supply among communities. They further stated that at the onset of the rainy season, most of the water sources in Ikeduru L.G.A. are not reliable. Rainfall change points were detected to be 1991 and 1997. Reduction in rainfall amount as revealed by trends and variability patterns, adversely affects rural water supply. Adejuwon (2011) examined rainfall seasonality in the Niger Delta region of Nigeria, using both monthly and annual rainfall data from 1931 to 1997. The data

was collected on 9 synoptic stations in the region. The cumulative index analysis and the percentage of mean were employed for in study. The result indicated a wet season with over 95% of the total annual rainfall in the area. It also showed a long wet season from February/March to November and a short dry season from December to January/February. Their study also observed a northward increase in rainfall in part of the eastern side of the Niger Delta. They noted that variation of rainfall in the locality could probably be as a result of rainfall determinant factors different from the inter tropical discontinuity. Abaje *et al.*, (2012) examined fluctuations and trends in the rainfall regime of the Sudano Sahelian Ecological Zone of Nigeria so as to discuss the risks and opportunities involve. They employed Rainfall data for eight meteorological stations were used for this analysis. They sub-divided the rainfall series into 30-year overlapping sub-periods (1949-1978, 1959-1988, 1969-1998 and 1979-2008) and used the Cramer's (tk) test to compare the means of the sub-periods with that of the whole record period. Their results revealed that there was a change towards wetter conditions in the last 30-year period. According to Abaje *et al.*, (2012), the result of the linear trend lines shows an increase in rainfall supply over the period of study. Ogbo *et al.*, (2013) studied risk management and challenges of climate change in Nigeria,

they reviewed the incidence and consequences of climatic change and the vulnerability of Nigeria to climate change. They adopted the survey research technique. Their findings show that deforestation, industrial releases, improper disposal of sewage are human activities responsible for climate change. Furthermore, the authors found out that drought, erosion and flooding constitute the challenges resulting from climate change, and finally that government agencies in charge of environmental issues do not really help to reduce the risk of climate change in Nigeria. Ogbo *et al.*, (2013) concluded that gas flaring, over grazing, bush burning, CO₂ are factors responsible for climate change in Nigeria. The authors recommended that, Nigerian Government should provide solutions to manage development of biotechnology, afforestation programme, integrated climate risk management and technology that can capture at least 80% of carbon emitted by industries.

MATERIALS ANDMETHODS

The data for this research work were mainly secondary data obtained from the weather station of Federal College of Agriculture Ishiagu. The data collected were records of rainfall pattern in Ishiagu over a period of five years (2013 – 2017) in monthly basis. These data were therefore subjected to some

statistical analysis using Statistical Package for Social Sciences (SPSS).

METHODOLOGY

The main aim of this study is to analyse rainfall pattern in Ishiagu, Ivo Local Government Area of Ebonyi State using appropriate time series methods, in order to attain the aims of this work, the following methods were used: The data was first plotted graphically to examine the movement of the trend. If graph moves continuously upwards or downwards, then it suggests that the series is not stationary, otherwise it is stationary see Okoroafor et al. (2013), Gujarati and Porter (2009) and Greene (2008). Again, the data were analysed using multiplicative time series method to isolate the trend and seasonal components and finally, to forecast the volume of rainfall in 2018 on monthly basis. Multiplicative time series model was used to analyse the data. The model used in this work is given as follows:

$$Y_t = T_t \times S_t \times C_t \times I_t \quad (1)$$

T_t was obtained using OLS (Ordinary Least Square) given by

$$T_t = \alpha + \beta_t + e_i \quad (2)$$

Where T_t = Trend, t = Time, α = Intercept and β = Coefficient of time. The formula adopted for the calculation of trend T_t is given below

$$T_t = \alpha + \beta_t \quad (3)$$

Where

$$\beta_t = \frac{n \sum tx_t - \sum t \sum xt}{n \sum t^2 - [\sum t]^2} \quad (4)$$

For the Seasonal index, the formulae used in this work is given as follows:

$$SV = \frac{Y_t}{\hat{Y}_t} = \frac{Y_t}{MA} \quad (5)$$

$$Adj S_i = \frac{n}{\sum SI} \times S.I \quad (6)$$

$$= \frac{Y_t}{SI} \quad (7)$$

The formula for calculating the seasonal variation is given below;

$$\text{Seasonal Variation} = \frac{Y_t}{\hat{Y}_t} \quad (8)$$

To analyze the cyclical-irregular variation of rainfall, we adopted the formula below;

$$C_t I_t = \frac{Y_t}{\hat{Y}_t \times S_t} \quad (9)$$

RESULTS AND DISCUSSIONS

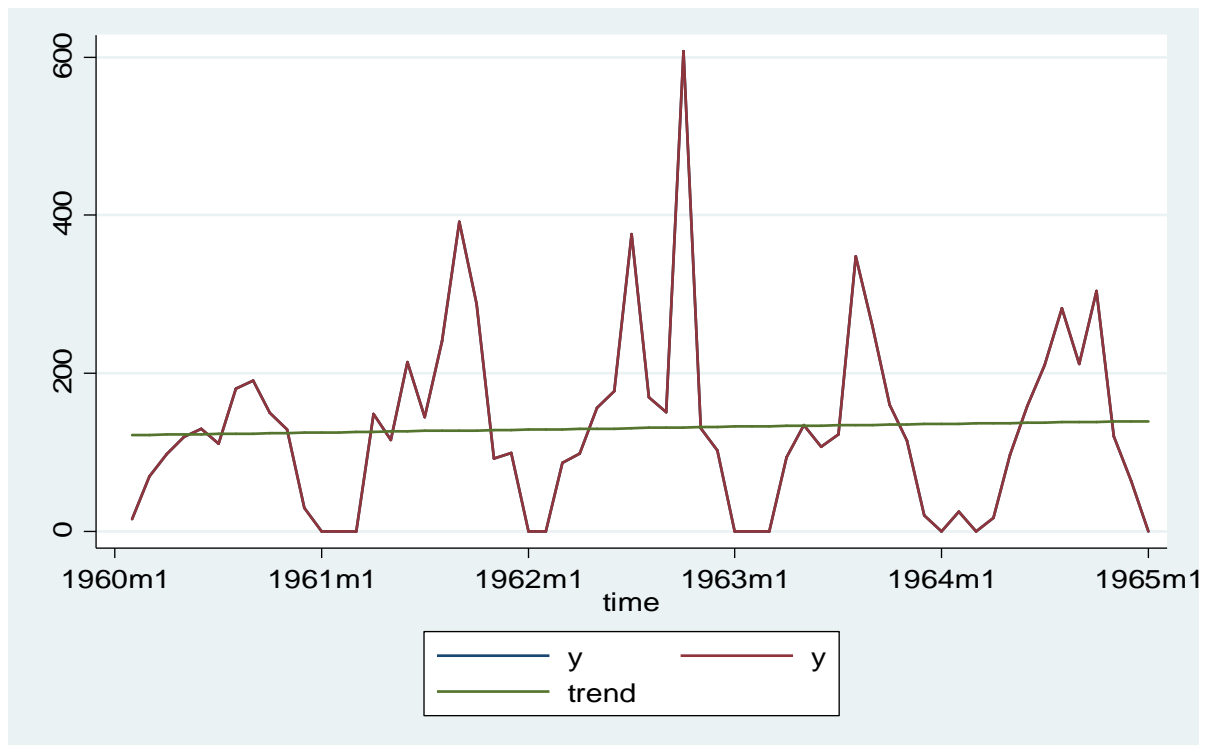


Figure 1: Graph of original annual rainfall and the trend in Ishiagu from 2013-2017

Figure 1 showed that there were sharp upwards and downwards movement of the series, which also suggested that the series is stationary. There also exist positive movement. This implied that the mean and

variance of the time series data are constant over time and the covariance between time periods depends only on the distance between the time periods.

Table 1 Trend of rainfall in Ishiagu for the year 2013 - 2017

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Y	16	70	98	120	130.2	110.9	180.4	190.6	150.4	129	30.6	0
t	-30	-29	-28	-27	-26	-25	-24	-23	-22	-21	-20	-19
t ²	900	841	784	729	676	625	576	529	484	441	400	361
ty	-480	-2030	-2744	-3240	-	-	-	-	-	-2709	-612	0
					3385.2	2772.5	4329.6	4383.8	3308.8			
T	122.10	122.39	122.68	122.98	123.27	123.56	123.86	124.15	124.49	124.73	125.02	125.32

The analysis on table 1 shows the trend values of the rainfall pattern in Ishiagu over

the years as from 2013 to 2017 on monthly basis. The table revealed that the rainfall for

the study area showed an increasing annual trend with average monthly values in bimodal mode and a double peak in May and September.

Table 2 Seasonal variation of rainfall in Ishiagu from 2013 – 2017

Month	2013	2014	2015	2016	2017	\bar{X}	Median
Jan	0.1222	0	0	0	0.0191	0.0283	0
Feb	0.5348	0	0.6632	0	0	0.2396	0
Mar	0.7487	1.1361	0.7564	0.7189	0.552	0.6991	0.7487
Apr	0.918	0.8824	1.1987	1.0291	0.7411	0.9536	0.9168
May	0.9947	1.6380	1.3561	0.8190	1.2155	1.2047	0.819
Jun	0.8473	1.0933	2.8749	0.9412	1.6090	1.4731	1.0933
Jul	1.3783	1.8435	1.2996	2.6587	2.1568	1.8674	1.8435
Aug	1.4562	2.9926	1.1552	1.9872	1.6212	1.8425	1.6212
Sep	1.1491	2.1988	4.6390	1.2277	2.3256	2.3080	2.1988
Oct	0.9856	0.7044	1.0008	0.8778	0.9191	0.8975	0.9191
Nov	0.2338	0.7587	0.7846	0.1597	0.4928	0.4859	0.1928
Dec	0	0	0	0	0	0	0

Table 2 above showed the seasonal variation of rainfall in Ishiagu. From the table we can deduce that;

$$\sum SV = 11.9997$$

$$K = \frac{12}{\sum SV} = \frac{12}{10.6532} = 1.1264$$

$$S.I = k \times SI(\bar{x})$$

Table 4.4 Sum of Seasonal variation of rainfall in Ishiagu from 2013 – 2017

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
S.I	0.0318	0.2699	0.7875	1.074	1.3569	1.659	2.103	2.0754	2.5997	1.0109	0.547	0

Table 3 Cyclical-irregular variation of rainfall in Ishiagu from 2013-2017

Month	2013	2014	2015	2016	2017	\bar{X}
Jan	3.8240	0	0	0	0.6006	0.8889
Feb	1.9815	0	3.4570	0	0	0.8877
Mar	0.9508	1.4426	0.9605	0.9129	0.1717	0.8877
Apr	0.8536	0.8215	1.1160	0.9581	0.6899	0.8878
May	0.7331	1.2072	0.9994	0.6036	0.8958	0.8878
Jun	0.5106	0.6589	1.7326	0.5673	0.9697	0.8878
Jul	0.6553	0.8756	0.6178	1.0254	1.2640	0.8878
Aug	0.7016	1.4419	0.5566	0.9575	0.7812	0.8878
Sep	0.442	0.8458	1.7844	0.4723	0.8946	0.8878
Oct	0.9749	0.6968	0.9900	0.8684	0.9091	0.8878
Nov	0.4272	1.3862	1.4336	0.2918	0.9004	0.8878
Dec	0	0	0	0	0	0

The analysis on table 3 showed the cyclical-irregular variations of rainfall in Ishiagu from 2013 – 2017 on monthly basis (Jan – Dec). A look at the table, revealed that although there exist variations for the

individual months in each year yet the mean of cyclical-irregular variation for all the months were the same (0.8878) except for January (0.8889) February and March (0.887) and December (0) respectively.

Table 4.7: Forecasting of the quantity of rainfall for each month in 2019

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Vol.	4.1	34.5	100.7	137.7	174.3	213.5	271.2	268.2	336.6	131	71.1	0

The table 4 shows the forecast volume of rainfall in 2018. From the table above, it was revealed that the peak of rains 2018 will be observed in September and July. However, from January the rains will start coming and keep increasing up to July and by August, it drops as a result of “August break”. The maximum annual rainfall will be observed in September as usually but this time with

336.6m³ and in December there will be no rain at all. This indicates the rainy season in Ishiagu starts from April and gets to the peak in July and September and by November it starts stopping.

CONCLUSION AND

RECOMMENDATIONS

The rainfall for the study area showed an increasing annual trend with average monthly values in bimodal mode and a double peak in May and September. Because of the popular August break which occurs mostly in the southern part of the country, there is a depression or low rainfall during the period. Temperature follows the same pattern as rain with a sinusoidal movement from January to December annually, while the relative humidity is highest between June-September. The analysis on table 4.5 of the study revealed that although there exist variations for the individual months in each year yet the mean of cyclical-irregular variation for all the months were the same (0.8878) except for January (0.8889) February and March (0.887) and December (0) respectively. However, this paper therefore, recommend that an integrated water-resources management as well as sustainable agriculture especially during the 'little dry season' in Ishiagu.

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