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Aspects of Rainfall Characteristics in Awka Urban Centre

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Abstract

Aspect of rainfall characteristic in Awka urban centre for a period of 36 years was examined. The research considered mean monthly and annual rainfall; onset, cessation and length of rainy season (LRS). Months of high and low rainfall as well as the annual rainfall with high and low variability were identified. Analysis of rainfall variability and seasonality are attempted. The rainfall data was presented using tables and graphs; while smoothing graph of 3 years interval was used to check deviation of rainfall. The mean monthly rainfall, mean annual rainfall, mean onset, mean cessation and mean length of rainy season are 149.88mm, 1798.52mm, 21st March, 20th October and 223.44 respectively. Result showed that rainfall in Awka was markedly seasonal in character having 7 months of wetness and 5 months of dryness. The monthly rainfall was recorded highest in September (289.59mm) and lowest in December (6.23mm); while the year 1997 recorded the highest annual rainfall of 2470.5mm and the year 2007 recorded the lowest annual rainfall of 861.3mm.

Keywords: Rainfall, seasonality, variability, onset, cessation, LRS

1.0 Introduction

Rainfall has often been considered to be most erratic of all the tropical meteorological elements. This is due to its spatial and temporal fluctuations (Ayoade, 2004). In most parts of the tropics particularly those of Koppen's A.W (tropical semi-arid) climatic regions, rainfall characteristics exhibits certain distinctive features.

Firstly, rainfall is markedly seasonal in nature in which case, rainfall is available only during a certain period of the year, while the rest of the year remains dry.

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Moreover, because of its association with the convective overturning of most unstable cells of rising air currents rainfall is spotty and highly localized and as usual, only small areas are affected by these convective cells (Ojo.1977; Ojo, 2001). Also most of the rains falls from few relatively sever storms which are usually of enormous intensity and since they originate from meso-scale disturbances, these storms are generally brief in duration. Finally, there is high (and in some cases extreme) variability in the amount and distribution of rainfall (Ayoade, 1977; Anyadike, 1977).

The high reliance on rainfall as a source of soil moisture for crops by farmers in the study area could be largely detrimental to them in terms of low yield and crop failure, resulting from insufficient rainfall, bearing in mind the very erratic and unreliable nature of our rainfall complicated by changing global climatic patterns. Inspite of high rainfall intensities in our study area, crops fail because the probability of receiving certain specified amount is not reliable. As such this study specifically seeks to analyze rainfall characteristics in Awka through the following objectives:

i. Examine the temporal variation and trend in rainfall amount in Awka from 1977 – 2012.
ii. Determine the seasonality of rainfall in Awka.
iii. Determine the date of onset cessation and duration of the rainy season.

2.0 Study Area

Awka in pre-colonial time was famous for metal work and its black smiths. Awka, the capital city of Anambra State was carved out of Enugu, from old Anambra State on 27th August 1991. Awka is located on latitudes $6^{0}09^{1}$N, $6^{0}19^{1}$N and longitude $7^{0}01^{1}$E, $7^{0}12^{1}$E. The city centre is traversed by the old Enugu road (Ziks avenue). Awka is bounded with Nibo, Amawbia in the South West, Mgbaku and Okpuno in the North West, Mgbakwu and Okpuno in the North West, Amansea in the North East and Umuawulu, Isiagu, Ezinato in the South East. The town stretches to over a distance of 26 kilometers (UN-HABITAT, 2007).

The geological formation of Awka urban lie within the Imo Shale and Bende Amiki Formation – in the low laying areas particularly the plain, west of Mamu River (Ofomata, 2010). The underlying imperious clay shales cause water logging of the soil during rainy season.

The two main soil type found in the study area are ferruginous and hydromorphic soil. Ferruginous soil is rich free iron. However, they vary from the deep-red and brown porous soil derived from sandstones and shale to deep porous brown soil, derived sandstone and clay (UN-HABITAT, 2007). The soil sustains forest vegetation but on the low plains further away from the river they maintain good vegetation cover.

Awka has seasonal climatic conditions, the rainy season and the dry season with a short spell of harmattan. The annual rainfall total is above 11,450mm for the eight months of the rainy season. The dryness of the climate tends to be discomforting during the hot period of February to May while the wet period of between June and September is very cool (Enete, 2004). The harmathan, which falls within December and February, is a period of cold weather when the atmosphere is generally misty (Enete, 2008).

3.0 Research Methodology

3.1 Data needs and Sources

The data acquired for this study was monthly rainfall for Awka from 1977 – 2012. The main source of data for this research was from the Nigeria Meteorological Agency, Amawbia Station (located within Awka capital territory).

3.2 Method of Data Collection

The rainfall observation and collection was done in every twenty- four hours by meteorological observers at the synoptic station, Amawbia, Awka. The measurement of rainfall was done by removing the funnel and emptying the collected rain in the container into a graduated cylinder measuring in millimeters (3.8cm or 1.5inches) diameter. The reading was done at eye-level to an accuracy of 0.25mm (0.01inch)

3.4 Method of Data Analysis

Descriptive statistics, trend analysis, correlation coefficient, mann-kendell rank, rainfall seasonality index and graphics were employed in the analysis.

4.0 Results and Discussions

4.1 Rainfall Distribution in Awka

The distribution of mean monthly and annual rainfall in Awka over the 36 year period (1977 – 2013) is shown in table 1 and is also represented in figure 1.

Table 1: Mean Monthly Rainfall

J	F	M	A	M	J	J	A	S	O	N	D	Mean
7.96	18.43	68.78	138.95	235.23	269.81	272.27	251.96	289.51	211.61	27.71	6.23	149.88

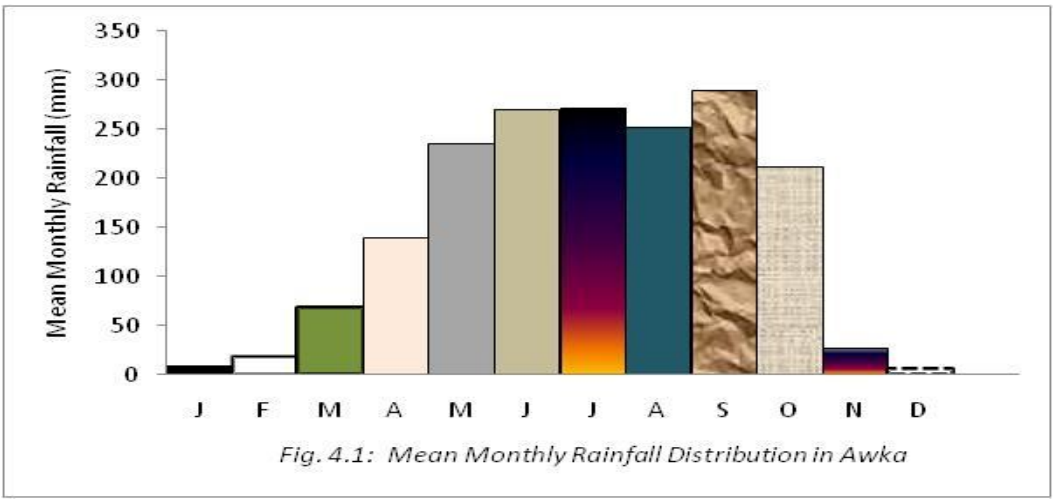


Figure 1: Mean Monthly Rainfall Distribution in Awka

From figure 1, the histogram shows a steady increase in mean monthly rainfall; January has (7.96mm), with first peak at July (272.27mm) and a first drop in August (251.96mm) which picked again, with its highest peak in September (289.59mm) and dropped with a considerable decline from October (211.61mm) to December (6.23mm) which has the lowest mean monthly rainfall. The noticeable drop of mean monthly rainfall in August shows the effect of the dry season. Thus, Awka experiences two rainfall maxima in July and September like any other city in southern Nigeria (Ayode,1974). The months of November (27.71mm), December (6.23mm), January (7.96mm), February (18.43) and March (68.78mm) months of dryness, as they lie below calculated climatological mean of 149.88mm. As such, Awka is said to have 7 months of rainfall and 5 months of dryness (Ugwu, 2014).

The distribution of annual rainfall in Awka over the study period (1977 – 2012) is shown in the table 2 and figure2.

Table 2: Annual Rainfall Fluctuations in Awka

Year	Annual Total (mm)	Annual Mean (mm)	Standard Deviation (mm)	Coefficient of Variation
1977	1728.9	116.55	94.86	81.39%
1978	1797.7	172.21	116.07	67.40%
1979	1823.1	144.08	130.34	90.47%
1980	1678.4	149.81	116.51	77.77%
1981	1842.1	151.93	131.33	86.44%
1982	1717.7	139.87	108.91	77.87%
1983	1379.2	153.51	147.62	96.16%
1984	1687.2	143.14	108.21	75.60%
1985	1794.4	114.93	124.96	108.72%
1986	1617.9	140.6	121.17	86.18%
1987	1503.5	149.53	118.04	78.94%
1988	2008.2	134.83	123.08	91.29%
1989	1782.0	125.29	155.89	124.43%
1990	2009.6	167.35	179.04	106.98%
1991	2083.4	148.50	133.47	89.88%
1992	1804.9	167.47	153.40	91.60%
1993	1654.2	173.62	141.52	81.51%
1994	2081.7	150.41	155.13	103.14%
1995	2470.5	137.85	137.66	99.86%
1996	1826.7	173.48	146.94	84.70%
1997	1907.0	205.88	153.83	74.72%
1998	2086.2	152.23	133.08	87.43%
1999	1988.1	158.92	116.59	73.36%
2000	1674.8	173.85	167.08	96.10%
2001	1556.2	165.68	139.41	84.15%
2002	1777.3	139.57	119.29	85.47%
2003	1845.2	129.68	113.2	87.29%
2004	2087.9	148.11	132.24	89.28%
2005	861.3	153.77	147.36	95.84%
2006	1910.5	173.99	156.81	90.12%
2007	2026.8	71.78	71.82	100.06%
2008	1599.6	159.21	153.17	96.21%
2009	1845.5	168.90	149.61	88.58%
2010	1823.9	133.3	115.45	86.61%
2011	1845.0	153.79	131.94	85.79%
2012	2088.0	151.99	130.38	85.78%
Total	64746.7			
Mean	1798.52	149.88		
S.D	270.85			
C.V	15.06%			

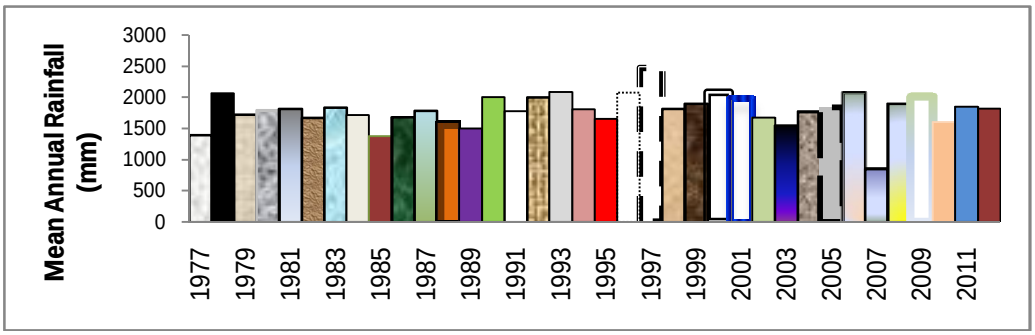


Fig 2: Annual Rainfall Distribution in Awka

The computed mean annual rainfall is 1798.5[2]mm. It means that the value is relatively high showing that Awka receives high amount of rainfall during the year. The year 1997 recorded the highest annual rainfall of 2470.5mm, while the year 2007 recorded the lowest annual rainfall of 861.3mm. However, since the long-term mean rainfall or amounts for the month, season or year hardly indicate the regularity or reliability with which given amounts of rainfall can be expected (Ayoade, 2004), the standard deviation and coefficient of variation of annual rainfall was computed. Thus, standard deviation was 270.85mm and coefficient of variance 15.06%. The value of the standard deviation (270.85mm) shows that the annual rainfall values are well dispersed away from the mean annual rainfall. The annual coefficient of variation (15.06%) was low (less than 20%). This means that there was a high degree of reliability/regularity at which the annual mean rainfall would be recorded each year. Therefore, the years 1977 – 2012 would record rainfall values that would equal or exceed average; this is because the less variable rainfall is the more regular/reliable it appears (Adefalalu, 1986; Ayoade, 2002; Ayode, 2004). Since the C.V shows that there is a high degree for annual rainfall amounts to reach or exceed average, we would therefore be expecting annual rainfall totals that would be 1798.52mm or more.

4.2 Rainfall Variation/Fluctuation and Smoothing Sequence

Figure 3 shows the annual mean rainfall fluctuation in Awka urban centre. From the above figure, the year 1995 had the highest annual mean rainfall of 2470.5mm while the year 2005 recorded the lowest annual rainfall of 861.3mm.

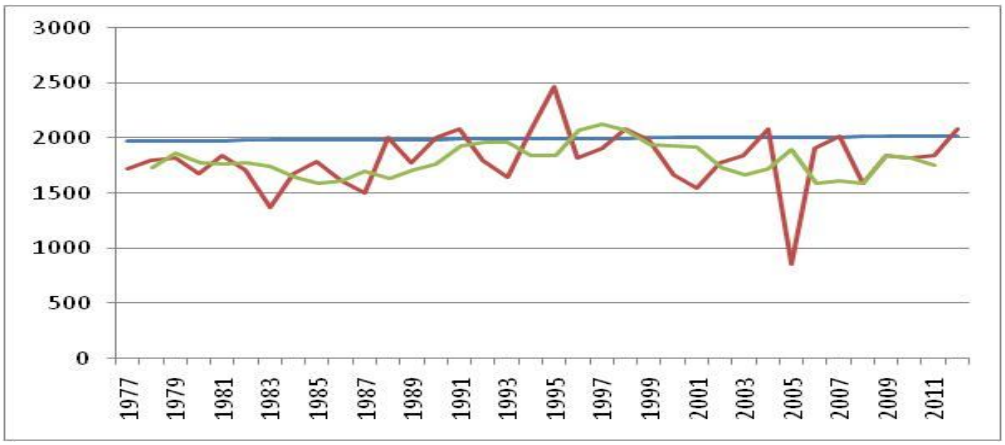
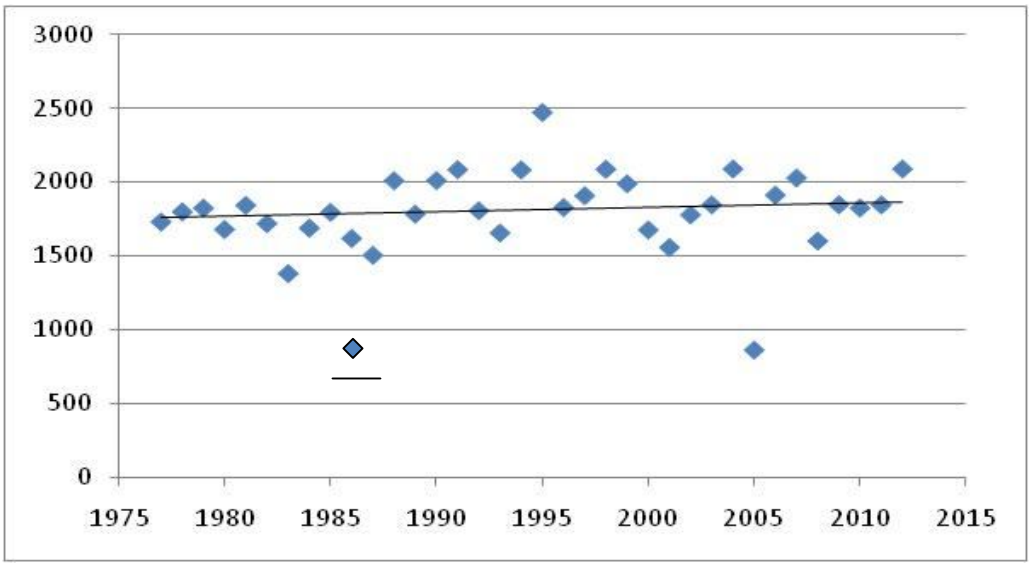


Fig. 3.: Fluctuation in Mean Annual Rainfall Over the Study Period (1977 - 2012) and Smoothed Sequence

A 3-year running mean was used to smoothen the noise. The period between 1978 to 1990 experienced rainfall below the climatological mean. Then between 1995 to 1999, had rainfall above the climatological mean, signifying an abundant rainfall throughout those years. Again, it falls below the climatological mean from 2000 to 2012. The year 2005 stands out as the year with the lowest mean annual rainfall probably due to drought.

4.3 Trend in Annual Rainfall



The trend line (straight line graph) above show a gradual increase in annual rainfall over the study period (1977 – 2012). The result in figure 4 shows that y = 2.16x – 2505.28. The value 2.16 (i.e. 'b') is the regression coefficient or slope of the regression line. Since 'b' is positive, the trend line is positive; hence the relationship would be positive. The regression coefficients indicates that a unit increase in x (which is the year) would lead to 2.16 increases in y (which is the annual rainfall); other factors being constant. It means that as a new year unfolds, there is an expected 2.16mm increase in annual rainfall total. To determine the strength of the trend, correlation coefficient was utilized. The result showed that r = 0.08. This is a very weak and almost negligible positive relationship. There is a necessity to compute the Mann-Kendall Rank Statistic (τ) in order to determine whether there is a presence or absence of trend in the data series. The result shows that $\tau/\sqrt{\delta\tau}$ = 8.55. Since 8.55 do not line within the limit of +1/-1.96, there is a presence of trend in the data series at 95% level of confidence.

The implication of this result suggests that, there tend to be an insignificant positive trend in the data series. And since the strength of the trend is very weak, a 2.16mm increase in annual rainfall per year cannot be strongly supported. But, in general, a positive trend exists and would, thus be assumed that an increase in annual rainfall per year be expected.

4.4 Rainfall Seasonality Distribution in Awka

The calculation of rainfall seasonality was done. The result shows that Awka has a seasonality index of 70%. Therefore, rainfall in Awka is markedly seasonal in character having 7 months of wetness and 5 months of dryness. This finding contradicts earlier study by Ayode (1983) who had seasonality index of 0.30 (30%) for Southwest. This view is supported by Walsh and Lawler (9181); Olairan (1981); Bellow (1999) and Enete (2004). The location and Climate change may have caused the deviation and total change. Whereas, Ayode (1983) studied southwest, this study was done in Southeast. A plausible reason for this finding could be that the impact of climate change is manifesting; thus forcing rainfall pattern in the South-east to be seasonal.

4.5 Rainfall -Onset, Cessation and Duration

The calculation of the onset cessation and length of the rainy season was done. The result is shown in the table 3.

Table 3: Date of Onset, Cessation and Length of Rainy Season in Awka (1977 - 2012)

Year	Onset	No. of Days	Cessation	No. of Days	LRS (Days)
1977	17th March	14	28th October	28	225
1978	22nd February	6	26th October	26	246
1979	31st March	30	10th November	10	224
1980	3rd March	28	14th November	14	256
1981	3rd April	27	28th October	28	208
1982	18th February	10	25th October	25	249
1983	18th March	12	12th October	12	207
1984	16th March	15	23rd October	23	221
1985	7th March	24	21st October	21	228
1986	11th March	20	9th November	9	253
1987	5th May	26	25th October	25	173
1988	13th March	18	25th October	25	226
1989	7th April	23	28th October	28	204
1990	6th April	24	1st December	1	239
1991	4th March	27	27th October	27	237
1992	11th April	19	3rd November	3	206
1993	8th April	22	30th October	30	205
1994	2nd April	28	3rd November	3	215
1995	25th January	6	31st October	31	279
1996	11th November	20	25th October	25	228
1997	13th March	18	2nd November	2	234
1998	1st April	29	27th October	27	209
1999	6th March	25	1st November	1	240
2000	3rd March	28	24th October	24	235
2001	1st April	29	21st October	21	203
2002	2nd March	29	28th September	28	210
2003	1st March	30	27th September	27	210
2004	3rd March	28	29th September	29	210
2005	5th May	26	14th October	14	162
2006	12th March	19	28th October	28	230
2007	5th April	25	5th November	5	214
2008	27th March	4	28th October	28	215
2009	22nd March	9	29th October	29	221
2010	1st April	29	30th October	30	212
2011	4th April	26	13th November	13	223
2012	10th February	19	23rd November	23	287
Total					8044
Mean	21-March		20-October		223
S.D					24.29
C.V					10.89%

The table 3 above shows the dates of onset, cessation and length of rainy season over the 36 years in Awka. Result shows that there was a low degree of variation (10.89%) in the LRS over the years in Awka, with an annual average of 223 days, beginning from March 21st to October 20th. Thus, rain generally begin in March and ends in October. This means that the months from November to April would be generally free from rainfall and dry.

5.0 Conclusion

This present study has helped us to understand the temporal variation in daily, monthly, seasonal and annual rainfall amounts in Awka urban area. The wettest and driest month and year in Awka urban area for the period of study has enabled us identify the sequence and probability of occurrence of onset, cessation, length of rainy season (LRS) as well as pattern of rainfall and seasonality index in the study area.

The study revealed a significantly high value of mean annual rainfall over Awka urban area within the study period (1977 – 2012) with a value of 1798.52mm; which encourages agriculture as well as water resource planning. The strength of the trend appears very weak, a 2.16mm increase in annual rainfall per year cannot be strongly supported. But, in general, a positive trend exists and would, thus be assumed that an increase in annual rainfall per year be expected. Finally, it can be concluded that rainfall is seasonal and every aspect studied showed a great latitudinal influence.

6.0 References

Adefolalu, D.O. (1986). "Rainfall, Climatology and Agricultural Extension Service". Lecture Series (WMO Training) 93 – 3, Pp 1 – 15, Annex 1-3.

Anyadike, R.N.C. (1977). "West Africa, Rainfall: Its Synoptic and Dynamic Climatology". Ph.D Thesis, University of Sheffield.

Ayoade, J.O. (1974). "Statistical Analysis of Rainfall over Nigeria", Journal of Tropical Geography, pp 11-23.

Ayoade, J.O. (1977). "The Role of Climate and Agriculture in Nigeria". Papers of the WMO/FAO Conference in the Application of Meteorology to Agriculture in Africa. IITA, Ibadan. p. 7.

Ayoade, J.O. (1983). Introduction to Climatology of the Tropics, London and Basing Stroke: Macmillan Publisher Ltd.

Ayoade, J.O. (2002). Introduction to Agro-Climatology Ibadan. Nigerian Vantage Publishers Ltd.

Bello, N.I.(1999). Evidence of Climate Change Based on Rainfall Records in Nigeria. Weather in Press

Enete, I.C. (2004). A Study of Enugu Rainfall Patterns from the Viewpoint of Precipitation Dynamics. "Nigeria Journal of Research and Production", Nigerian Researchers Forum Enugu, 5(4):98-108.

Enete, I.C and Okolie, T. (2008).Managing Aviation Operations during Harmattan in Nigeria for maximum operations Tourism Results, National Institute for Hospitality and Tourism, Abuja,2:82-90.

Ofomata,G.E.K and Uwazurike, C. (2010). A Survey of the Igbo Nation, Mason and Kpuff Publishing Group.

Ojo, O. (1977). The Climates of West Africa: Ibadan Heinemann Publisher.

Ojo, O. (2001). Fundamentals of Dynamics and Physical Climatology Edited by A. Ojo, Onif, Ojo K, Sedec Publishers, Lagos, Nigeria pp. 276 – 280.

Oladiran, O.J (1981). The Monsoon Factor and the Seasonality of Rainfall Distribution in Nigeria. Malaysian Journal of Tropical Geography,7:28-45.

Ugwu, J (2014).Aspects of Rainfall Characteristics in Awka.Unplished B.Sc Project, Nnamdi Azikiwe University, Awka.

UN-Habitat (2007). Enhancing Urban Safety and Security: Global Report on Human Settlements 2007. London: Earthscan Publications.

Walsh, P.D. and Lawler, D.N. (1981). Rainfall Seasonality Distribution Spatial Pattern and Change through Time Weather 36(7), 20 – 2.