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TREND ANALYSIS OF RAINFALL PATTERN IN ENUGU STATE, NIGERIA.

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ABSTRACT: *Rainfall distribution pattern has been a major concern to Climatologists, Penologists, Agriculturist hydrologist and even to the ordinary man in the street. Rainfall is a critical index of climatological investigation and has major impacts on flora and fauna, as well as ecological setting and water resources management of any area. Following the current moves by the governments to improve on agriculture; the pattern of rainfall is essential for indigenes of Enugu state since they are predominantly farmers. As the moves to encourage agriculture to ensure food security continues to gain ground and acceptability, information on rainfall probabilities is vital for the design of water supply and supplemental irrigation schemes and the evaluation of alternative cropping and of soil water management plans. This study has examined the pattern of rainfall in the state and observed some irregularities in the pattern. For government's efforts towards improving agriculture to be fruitful, a more advanced technology of ensuring constant rain source is very vital.*

KEYWORDS: Agriculture, Enugu State, Food security, Rainfall, Trend.

INTRODUCTION

Rainfall is the most important natural factor that determines the agricultural production in Nigeria, particularly in the South Eastern part of Nigeria. The variability of rainfall and the pattern of extreme high or low precipitation are very important for agriculture as well as the economy of the state. It is well established that the rainfall is changing on both the global and the regional scales due to global warming (Hulme et al, 1998, Kayano, 2008). As the moves to encourage agriculture to ensure food security continues to gain ground and acceptability, information on rainfall probabilities is vital for the design of water supply and supplemental irrigation schemes and the evaluation of alternative cropping and of soil water management plans. Such information can also be beneficial in determining the best adapted plant species and the optimum time of seeding to reestablish vegetation on deteriorated rangelands. Much as long rainfall records are mostly available in many countries, little use is made of this information because of the unwieldy nature of the records.(Mina and Sayedul, 2012). The current pattern of rainfall in Enugu State has been a source of concern to the inhabitants, especially those who rely on it for their economic activities. Therefore, it is on this basis that this study seeks to examine the trend of rainfall in Enugu state with the view to ascertain the feasibility of government's effort towards improved agriculture; to enhance food security in the state.

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LITERATURE REVIEW

The importance of the knowledge of rainfall pattern has necessitated many researchers to carryout studies on the subject. (Babatolu (2002) studied spatial distribution of rainfall in Ondo State, (Olaniran, 1990) investigated climate change in Nigeria, variation in rainfall receipt per rain-day and observed that there has been a progressive early retreat of rainfall over the whole country, and consistent with this pattern, reported a significant decline of rainfall frequency in September and October which, respectively coincide with the end of the rainy season in the northern and central parts of the country. Chukwukere (2005) carried out a research on monthly rainfall at Isunjaba Imo State from (2000-2004), he revealed that there exists a trend for the period considered and it showed a regular cyclical movement. Climate variability has been noted to arise as a result of changing rainfall pattern, some regions have experienced marked decline in rainfall patterns depending on the location. For state whose economy largely depends on efficient and productive rain-fed agriculture, rainfall patterns and trends are often quoted as one of the major causes of several socio-economic problems like food insecurity in the state. (Ekwe et al ,2014).

Study by Enete and Ebenebe (2009) showed that the trend suggested a general decline in rainfall values in recent times. Rainfall values for the years under study suggested values between 265.37mm and 320.21mm. This supports the findings of Olaniran & Summer (1989, 1990) in their study; they found that there was a progressive early decline of rainfall over the country. Following the pattern, they reported a noticeable and significant decline of rainfall frequency in September and October which coincide with the end of rainy season in almost every parts of the country especially in the Northern and Central parts of Nigeria.

Profile of the Study Area

Figure 1 Map of Enugu state showing other neighboring states

Enugu is located in a tropical rain forest zone with a derived savannah.

The city has a tropical savanna climate. Enugu's climate is humid and this humidity is at its highest between March and November. For the whole of Enugu State the mean daily temperature is 26.7 °C (80.1 °F). As in the rest of West Africa, the rainy season and dry season are the only weather periods that recurs in Enugu. The average annual rainfall in

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Enugu is around 2,000 millimetres (79 in), which arrives intermittently and becomes very heavy during the rainy season. Other weather conditions affecting the city include Harmattan, a dusty trade wind lasting a few weeks of December and January. Like the rest of Nigeria, Enugu is hot all year round. (Wikipedia, 2015)

METHODOLOGY

The data on the monthly amount of rainfall from 2000 to 2013 were collected from Nigeria Meteorological Agency, Airport, Enugu State. The data were as presented on table 1below:

Table 1: Monthly Rainfall Data

Month / Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	0.5	0.5	0	181.5	89.7	279.4	508.3	359.1	317.5	318.8	2.3	25.8
2001	0	37.6	62.4	198.7	346.4	244.8	319.2	264.3	230.5	253.5	2.5	0.7
2002	0	0	111.5	200.9	192.4	354	313	149.3	249.7	105.3	28.8	0
2003	0	5.1	61.7	148.9	109.9	263.7	186.7	390	243.5	72.9	82.9	11.6
2004	38.8	0	9.7	144.5	211.2	140	216	187.2	331.9	181.6	0	0
2005	1.6	0	90.2	194.1	263.7	356.7	340.2	432.1	192.4	261.7	35	0
2006	0	26.7	48.6	160.9	277.2	289.6	368.3	268.4	176.3	303.4	0	0
2007	0	0	111.6	261.3	376.1	344.9	226.8	235	392.3	242.2	68.1	4.1
2008	0	6.1	25.8	161.1	188.7	285.9	259.2	96.2	256.6	217.4	0	0
2009	18.2	15.7	30	103.6	223.8	316.8	206.4	100.2	195.1	313.4	24.3	0
2010	32.4	0	32.3	202	357.5	206.1	298.5	331.8	339.7	226.5	0	0
2011	0	28	72.5	305.5	273.8	188.8	152	130.6	407.9	118.1	0	0
2012	0	46.5	10.4	159.1	219.7	296.4	263.3	121.6	270.7	332.5	0	0
2013	0	0	2.9	74	234.3	286.9	400.4	290.2	334.4	227.4	39.8	0

Source: Nigeria Meteorological Agency, Airport, Enugu State.

In addition, data were equally collected on the amount of precipitation, and the monthly amount of Precipitation recorded in Enugu state is as shown on table 2 below:

Table 2 Monthly amount of Precipitation in Enugu State

Month	Mean Precipitation, mm (inches)	Mean Precipitation days
Jan	19(0.75)	1
Feb	15(0.59)	1
Mar	70(2.76)	4
Apr	130(5.12)	7
May	217(8.54)	12
Jun	252(9.92)	14
Jul	242(9.53)	16
Aug	237(9.33)	15
Sep	292(11.5)	18

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Oct	201(7.91)	12
Nov	12(0.47)	1
Dec	8(0.31)	1
Year	1,695(66.73)	102

Source: The Weather Network Retrieved 2010-06-23

Table 2 above shows significant amount of precipitation from the month of April to October.

To determine the trend of rainfall in Enugu state, sequential plot using Time series analysis was used. This can be mathematically denoted using the functional relationship below:

$$Y = f(t) \qquad (1)$$

Where Y is the value of the variable under consideration at time t.

Suppose that $\hat{y}_t$ is the estimated value of the dependent variable Y_t at time t, then Y_t can be predicted from the simple linear equation.

The model can be written as

$$Y_t = a + b_t \qquad (2)$$

Alternatively, (2) can be written as

$$Y_t = \beta_0 + \beta_{1t} + \varepsilon_t \qquad (3)$$

Taking the estimate of the model, it becomes

$$\hat{Y}_t = \hat{\beta}_0 + \hat{\beta}_{1t} \qquad (4)$$

Where

$\hat{Y}_t$ = the estimated value of the dependent variable being used for prediction,

β_0 = the intercept measuring the value $\hat{Y}_t$ at time t

$\hat{\beta}_{1t}$ = the slope of the line measuring the change in the variable Y_t that results from a units change in time t.

t = the independent variable t=1, 2, 3, 4, …..14

ε_t = Random error term $\sim$ NID (0, δ^2)

However, using a SPSS package, the trend obtained is as shown in fig 2 below:

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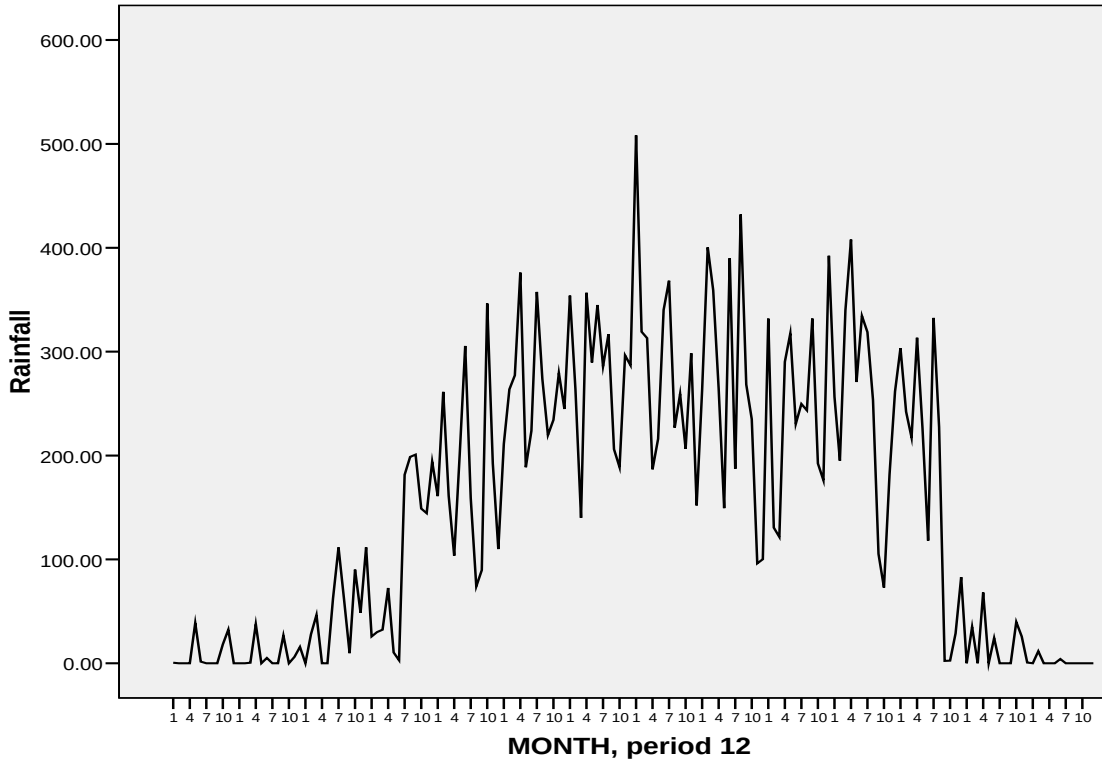

Figure 2. Sequence Plot showing the Pattern of rainfall in Enugu state

RESULTS

From fig 2 above, the graph indicates clear presence of trend in rainfall in Enugu State. There was a clear case of decline in pattern of rainfall from the year 2000 to 2001; it showed a slight increase from 2002 to 2003. The trend increased remarkably from 2004 to 2010; with a peak being observed in 2006. The pattern was observed to decline from 2011 to 2013; this decline was sharp in 2011 with clear evidence in the month of August. From the graph over the years, month of April (4) is seen to be the starting period while month of October (10) is observed as the period of retreat. This also corresponds with the data on the amount of precipitation as shown on table 2. In 2004, the Pattern of rainfall increased from the months of July (7) to October (10); while 2012 recorded a remarkable decline for the months of July (7) and August. This irregularity does not encourage farmers in planning their planting processes. As such they most often depend on trial and error to achieve maximum output; sometimes they run out of luck and it results to period of food scarcity.

DISCUSSION

The result of the trend analysis shows clear fluctuations in the pattern of rainfall for the period under study. Based on this study, the month of April(4) was seen as the period of onset of rainfall while the month of October(10) was observed as the period of retreat. Considering the period under study, current years from 2011 to 2013 show decline in the pattern of

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rainfall as against the previous years; from 2010 downwards. Since the result shows inconsistency in the pattern of rainfall, it will be difficult to rely on the pattern for any process that depends on rainfall for economic activity, particularly agriculture. This irregular pattern does not encourage the current moves by government to improve on food security in the state. Hence there is serious need for alternative source of rain for agricultural processes.

IMPLICATION TO RESEARCH AND PRACTICE

This irregular pattern of in rainfall in the state has negative implication such that farmers experience some difficulty in planning for the suitable time to plant their crops. Sometimes they use the previous year's rainfall pattern as a yards stick; which makes them to run into the problem of miscalculation in some cases thereby having serious negative effect on their yield. The consequences of this have some negative implications on the growth of the economy ranging from food scarcity to reduction in Gross Domestic Product (GDP) for the years affected. This always poses a serious challenge to the economy as the battling to gain stability keeps lingering for some period of time.

CONCLUSIONS

This study therefore advocates for an alternative technology by way of advanced irrigation process; to ensure regular pattern for a more reliable rainfall. This will go a long way to ensure that government's effort to improve on agriculture to ensure food security and economic development will not be a fruitless venture.

FUTURE RESEARCH

Further work should look into other factors that affect agricultural yield should rain source be improved on. This will ensure that government's effort to improve on agriculture to ensure food security and economic development will achieve a maximum success.

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