Time Series Model and Analysis On Rainfall In Oshogbo Osun State, Nigeria

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Abstract— **This research work statistical analysis of rainfall is aim to fit an appropriate model on the time series data on monthly distribution of rainfall in Osogbo Metropolis , to describe the behavior of rainfall on a monthly basis and to determine the variations that characterized rainfall data. The data on the monthly amount of rainfall between (2004-2015), were collected from Nigeria Meteorological Agency. The data were then subjected to time series analysis. The first step was to obtain the time plot in order to describe the observations under study. The time plot reveals that the rainfall data show high level of volatility characterized by seasonal and irregular variations. The series moves up and down.In order to remove the seasonal variation, the researchers subjected the data to seasonal decomposition or deseasonalization. The seasonal adjusted data were then used to plot Autocorrelation function plot method (ACF) and Partial Autocorrelation function plot (PACF). This series show a more stable series and the data was then model. The logistic model shows to be better and then used to forecast the rainfal for the next 2 years.**

Index Terms—**Osogbo, rainfall, ACF, PACF.**

I. INTRODUCTION

Water resources are essential renewable resources that are the basis for existence and development of a society. Proper utilization of these resources requires assessment and management of the quantity and quality of the water resources both partially and temporally. Water crises cause by shortages, floods and diminishing water quality, among other, are increasing in all parts of the world. The growth of population demands for increased domestic water supplies and are the same time, results with a higher consumption of water due to expansion in agriculture and industry[2]. Mismanagement and lack of knowledge about existing water resources and the changing climatic conditions have consequences of an imbalance of supply and demand of water. The problem is pronounced in semi-arid and arid areas where the resources are limited.

Surface water being easy, direct and therefore less expensive to exploit in compassion to other sources like ground water or desalination makes it the major source of water supply for irrigation, industry and domestic uses. The surface water, in form of lakes and river discharge (runoff) is predoming obtained from rainfall after being generated by the rainfall runoff processes [4]. The primary source of water agricultural production for most of the world is rainfall. Three main characteristics of rainfall are its amount, frequency and intensity, the value of which way from place to place, day to day, month to month and also year to year. Precise knowledge of these three main characteristics is essential for planning its full utilization. Information of the amount, intensity and distribution of monthly or annually rainfall for the most important places in the world is generally available. Long-term records of daily rainfall have been compiled for years, norm and standard deviations have been worked out, floods and droughts have been defined and climate zones of potential evaporation less precipitation have been mapped from rainfall pattern and crop studies. Investigation using electronic computer are continuous in progress and effective are being made to predict future trend in order for refine planning.[1]

Most rain water is used in agriculture for crop production. Therefore, the first point which arises is whether the available rainfall adequate and well distributed for crop-raining. This new water rate structure encourages water conservation. Preliminary calculations done by city staff confirmed the advantages of the new billing system. However, a specific water forecast model is required for a more precise estimation of the influence of the new rate structure on water consumption and on revenue collection. Such a model will allow testing of different rate structures and different conditions affecting water use and therefore revenue (water price, conservation programs, and weather conditions).

The water forecasting system is very powerful decision support tool. The precise estimation of the future water consumption is essential for determining the water management policy including the efficient water use and for the water purchase planning. The revenue projections are necessary for budget preparation. The knowledge of the future water production is indispensable for utility planning and management[3].

Method of Measuring Rainfall

Rainfall is usually measured by first collecting it in a rain gauge. These special drums are then used to record the depth of the water inside. Rain gauge is usually about 50cm tall and is place on the ground just high enough to avoid splashes. Rain water that is caught in a funnel on top runs down into a measuring cylinder below where it can be recorded.

Review of Literature

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 [1]. 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

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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[3]. 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. The importance of the knowledge of rainfall pattern has necessitated many researchers to carryout studies on the subject.

There has been much work done on "time series analysis on topics like road accident, petroleum, precipitation temperature, internally generated revenue, health e.t.c in such studies, the time series analysis was used to analyze the data and used also to forecast future events[1].

II. RESEARCH METHODOLOGY

When observations form a time series, it is natural to take the dependence between neighboring observations into account (regression assume that the deviations from the trend are independent). We will use the method of moving averages. Assume we observe the time series $Y_1, Y_2, \ldots, Y_T$.

DESEASONALIZATION OF DATA

Deseasonalization of the data simply means removing the estimated seasonal components present in the data.

Recall that $Y_t = T_t * S_t * C_t * I_t$.

Thus let Y_{tt} be the deseasonalized values at time t.

Then $Y_{tt} = \frac{Y_t}{S_t} = T_t * C_t * I_t$

Where St = seasonal movement(variation)

Y_t = Original data

T_t = Trend

logistic regression

Logistic regression generates the coefficients (and its standard errors and significance levels) of a formula to predict a *logit transformation* of the probability of presence of the characteristic of interest:

$$logit(p) = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \ldots + b_kX_k$$

where p is the probability of presence of the characteristic of interest. The logit transformation is defined as the logged odds:

$$odds = \frac{p}{1-p} = \frac{probability\ of\ presence\ of\ characteristic}{probability\ of\ absence\ of\ characteristic}$$

and

$$logit(p) = \ln\left(\frac{p}{1-p}\right)$$

In this case it is; p= probability of presence of rain

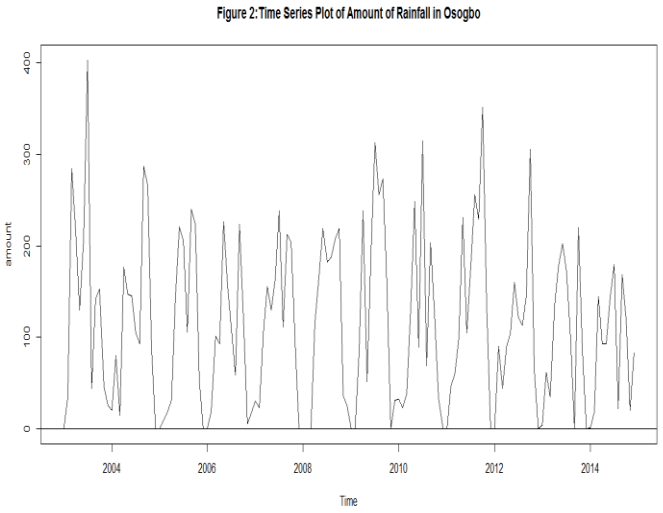
1-p= probability of absence of rain

Rather than choosing parameters that minimize the sum of squared errors (like in ordinary regression), estimation in logistic regression chooses parameters that maximize the likelihood of observing the sample values.

III. DATA ANALYSIS

ANALYSIS

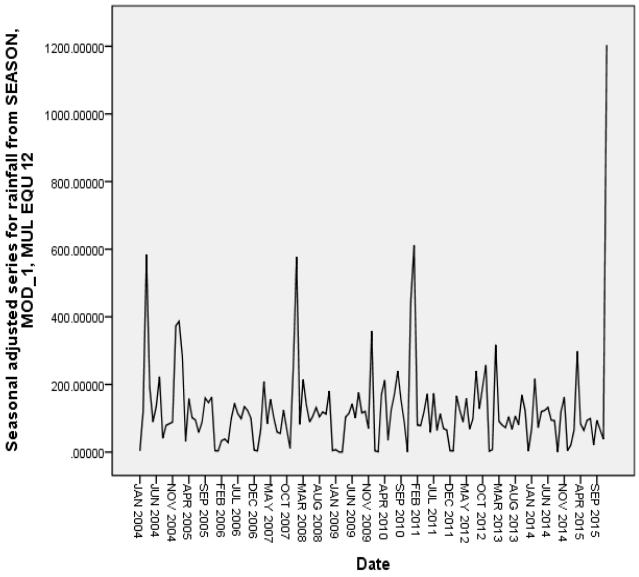
Fig 1: Time Series Plot on Amount of Rainfall in Oshogho, Osun state



The above chart shows the pattern of movement on monthly distribution of rainfall between 2004- 2014 the level of volatility is characterized by seasonal and irregular variations. The series wander up and down through out. Aside this there is nothing unusual about the series hence it appears stationary. However , there is need to subject the series to stationary test in order to verify this assertion.

Interpretation

The above analysis shows a p-value for the Dickey-Fuller Test = 0.01<0.05, we reject Ho and conclude that the data is stationary. Which lead to fitting Autoregressive Moving Average (ARMA) model Table 4.2 : Table showing seasonal decomposition of the series Seasonal Decomposition



Seasonal adjusted series of rainfall

The seasonality adjusted series shows no trend. A number of peaks are evident, but they appear at random intervals, showing no evidence of an annual pattern.

The autocorrelation function shows a significant peak at a lag of 1 with a long exponential tail. The significant peal at a lag of 12 suggests the presence of an annual seasonal component in the data. Examination of the partial correlation function will allow a more definitive conclusion.

Table 1

Coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Case Sequence	1.002	.003	1.043	322.148	.000
(Constant)	.013	.003		3.855	.000

The logistic regression is given by: logit(p)= 0.013+1.002rain
The logistic model is then used to forecast for future rain and the result is shown in the table below.

IV. SUMMARY

Result of the analysis reveals that the rainfall show high level of volatility characterized by seasonal and irregular variations. The series wander up and down through out.in order to remove the seasonal variation, the researcher subjected the data to seasonal decomposition or deseasonalization. The seasonal adjusted data were then used to plot Autocorrelation function plot method (ACF) and Partial Autocorrelation function plot (PACF). This series show a more stable series and the data was then model. The logistic model shows to be better and it can be use to forecast for the future rainfal .

V. CONCLUSION

Based on the result of the analysis it can be concluded that seasonal variations always characterized the amount of rainfall. This is understandable as there is particular months in every year when rains usually fall. It is then pertinent on the researcher to take care of this seasonal variation in order to obtain a robust analysis. Also for the purpose of this study, logistic is found to be more appropriate and can be use to forecast.

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