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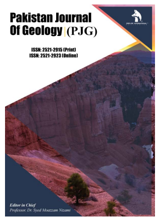

RESEARCH ARTICLE

SIMULATION ANALYSIS OF RAINFALL IN SELECTED AREAS OF NASARAWA STATE NIGERIA

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ABSTRACT

To evaluate the distribution rainfall more accurately, a model to daily data and simulate for long duration of data will be required. Before checking these simulated payouts against the observed payouts, it is recommended to perform a series of rainfall simulation models and trend analyses. The object is to predict the intensity of rainfall and compare its crop yield at different spots in Nasarawa state. The simulation was used and variant rainfall trend analysis was applied. The result indicates that there is a significant correlation between the rainfall at Nasarawa and Keffi. However, modern uses of pesticides, herbicides and fertilizers can lead to different crop performance and yields. Rainfall output in Nasarawa is higher than that of Keffi as compared based on the simulation result.

KEYWORDS

Simulation, Trend Analysis, Rainfall, Variation, crop yield, correlation

1. INTRODUCTION

Rain is the product of precipitation. It is liquid water in form of droplets that have condensed from atmospheric water vapor and then precipitated that is, become heavy enough to fall under gravity (Petrie et al., 2017). Rain is a major component of the water cycle and is responsible for depositing most of the fresh water on the Earth. Rainfall provide water resources useful to the environment as well as water for hydroelectric power plants and crop irrigation. Vegetation distribution and type of landmasses are a result of rainfall (Asfaw et al., 2018). The breeding season of animals is synchronized with the rainy season. Cultivation, yields and yields are affected by rainfall and are carried out according to each preferred season to ensure increased productivity (Soltani et al., 2016). Anthropogenic factor influenced precipitation through agriculture and burning of fossil fuel (Lee et al., 2002).

Trends are defined as general movements of the series over time, or long-term changes in dependent variables over time (Asfaw et al., 2018). Trends are determined by the relationship between the two variables temperature, precipitation, and their temporal resolution.

precipitation patterns. In other words, precipitation trends can be described as general trends, movements, or directions and patterns of movement of precipitation. For example, in the world scene, precipitation trend analysis on various spatial and temporal scales has been very important over the past century, as the scientific community is paying attention to global climate change. It is likely to be characterized by a negative tendency (Bernstein et al., 2008). (Conway et al., 2005) reported the largest reduction in precipitation (61%) in the fall (May) of southeastern Australia.

Precipitation patterns are best analyzed using trend analysis to show the durstion and period of rainfall in different places. In other words, precipitation trends can be described as general trends, movements, or directions and patterns of movement of precipitation. For example, in the world scene, precipitation trend analysis on various spatial and temporal scales has been very important over the past century, as the scientific community is paying attention to global climate change. It is likely to be characterized by a negative tendency (Bernstein et al., 2008). (Conway et al., 2005) reported the largest reduction in precipitation (61%) in the fall (May) of southeastern Australia.

Rainfall variability, on the other hand, is such that rainfall changes throughout the region or over time. Precipitation variability can be used to characterize the climate of a region. Precipitation in Nigeria is subject to significant temporal and spatial fluctuations. This volatility occupies a larger dimension as a result of climate change. According to (Yamusa et al., 2015), precipitation fluctuations increase from northwest to southwest, and annual (annual) precipitation fluctuations increase from north-central to southeast. The study further confirms that precipitation fluctuations over time follow spatial trends within certain arbitrary boundaries (Asfaw et al., 2018).

The major cause of rain production is moisture moving along three dimensional zones of temperature and moisture contrasts known as weather fronts. If enough moisture and upward motion are present, precipitation falls from convective clouds (those with strong upward vertical motion) such as cumulonimbus (thunder clouds) which can organize into narrow rain maximized within windward sides of the terrain at elevation which forces moist air to condense and fall out as rainfall along the sides of the mountains. The changes in seasonally affect the movement of the air masses such as the tropical continental air masses and maritime. The movement of the monsoon trough or inter-tropical convergence zone (ITCZ) brings rainy seasons to savannah climes (Petrie et al., 2017). Temperature also increases due to urban heat island. One of the consequent of climate change is the global warming that produces changes in precipitation intensity in Nigeria. These include wet conditions in the Eastern and southern tropical regions in Nigeria. Heavy rains can occur in mountainous areas.

Rainfall characteristics in Nigeria have been examined for dominant trend notably by (Olaniran & Sumner, 1989). It showed that there has been a progressive early retreat of rainfall over the whole country, the rainfall

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pattern has to do with movement of Intertropical convergence zone (ITCZ) and consistent with this pattern, they reported a significant decline of rainfall frequency in September and October are the harvesting periods in the Northern part of Nigeria and central parts of the country. The pattern of rainfall in northern Nigeria is highly variable in spatial and temporal dimensions with annual variability of between 15 and 20% (Abaje & Oladipo, 2019). As a result of the large variability of rainfall, it often results in climate hazards, especially floods and severe droughts with their devastating effects on food production and associated calamities and sufferings. Rainfall duration is very vital information to farmers as well as other individual in Nigeria. Animals and green plants utilised more water resources from the rainfall. It is believed to be a major determinant of the types of crops that can be cultivated in the area, when they are cultivated, and a practical agricultural system (Olayide et al., 2016).

Climate change is one of the major threats to precipitation patterns that directly or indirectly affect ecosystems. According to (Umar & Ismaila, 2017), climate change has increased the concentration of carbon dioxide and other heat-trapping gases in the atmosphere, warming the Earth and having a wide range of effects, including orientation of topography, melting of ice and snow ; more extreme heat events, fires, droughts. And more extreme storms, rains and floods. The purpose is to assess the rainfall trends in the study area and to monitor and investigate the rainfall needs of various crops. The objectives are to evaluate the rainfall trend in the study area, to monitor and examine the requirement of rainfall by different crops.

2. Methodology

2.1 Sources of Data

The data from this study were driven by the relevant agencies and field investigations. Both primary and secondary data were used in this study.

2.2 Study Area

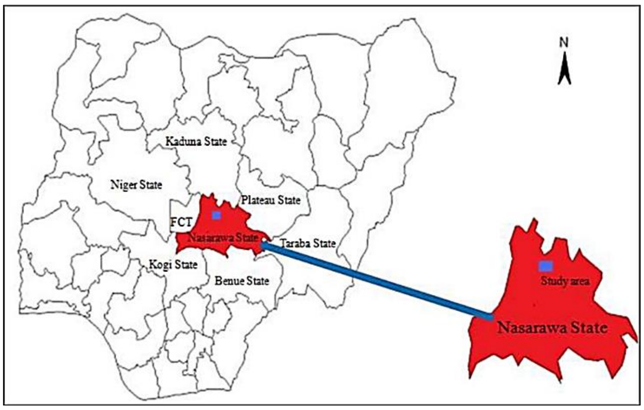

Figure 1: Study Area map

2.3 Location

The demarcation of the area surveyed will be conducted by using GIS software with the plotting of the coordinates using GPS. The Ground Control Points will be digitized and analyzed using Google Earth Pro. The following are points where survey will be conducted:

GCP 1 Lat 8°51'36.50"N, Long 7°50'2.01"E

GCP 2 Lat 8°48'43.57"N, Long 7°51'42.03"E

GSP 3 Lat 8°49'19.17"N, Long 7°55'36.48"E

GSP 4 Lat 7°55'36.48"E, Long 7°54'59.90"E

3. Method of Analysis

A trend analysis technique was used to represent precipitation events within the study area. However, to provide background information about the data, we examined the descriptive characteristics of the data using central tendency, variance, and distribution measurements such as mean, standard deviation, skewness, and kurtosis. In addition, estimates of the percentage of total precipitation in each state were calculated and bar graphs were used to represent some of these descriptive features of the data.

3.1 Time Series Analysis (TSA)

Mean monthly precipitation was estimated by dividing the cumulative rainfall for a month by the total number of rainy days in the month using the mean equation. This will be replaced by a total of 10 years (10 years) from 2010 to 2020. The analysis was performed using Minitab software.

3.2 Rainfall Anomaly Index (RAI)

Rainfall Anomaly Index (RAI) Annual Rainfall Anomaly Index (RAI) was used to simulate and analyze the frequency and intensity of the dry and rainy years. The annual RAI was also calculated for specific years of the rainfall event aiming to analyze the distribution of rainfall in the years of the greatest anomaly.

4. Result and Discussion

The 10 years records (data) of the rainfall were used as presented in Table 1.

Table 1: Rainfall simulation data from 2010-2020 in Keffi

Year	Rainfall
2010	2000.4
2011	1950.0
2012	1985.5
2013	2102.0
2014	1840.7
2015	2100.5
2016	2020.6
2017	1850.3
2018	2150.6
2019	2240.8
2020	2302.2

Table 1 is the data presented from 2010-2020 to analysis for the simulation. The curve regression line cut across the highest simulation rainfall with a mean average of 2100mm. the peak rainfall in keffi within 10 year period was simulated to be 2020 from the distribution period of 2010 to 2020.

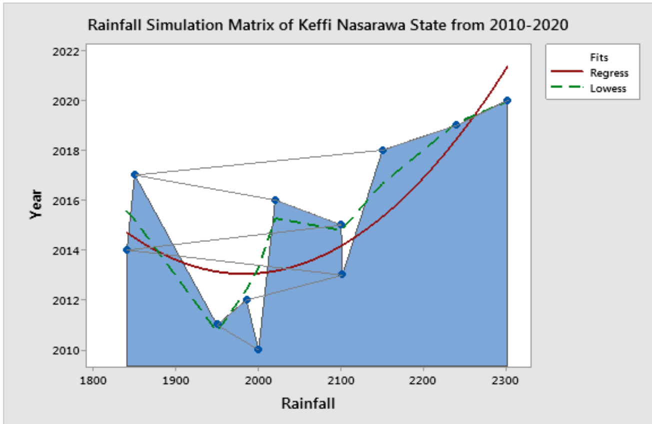

Figure 2: Rainfall Simulation in Keffi from 2010-2020

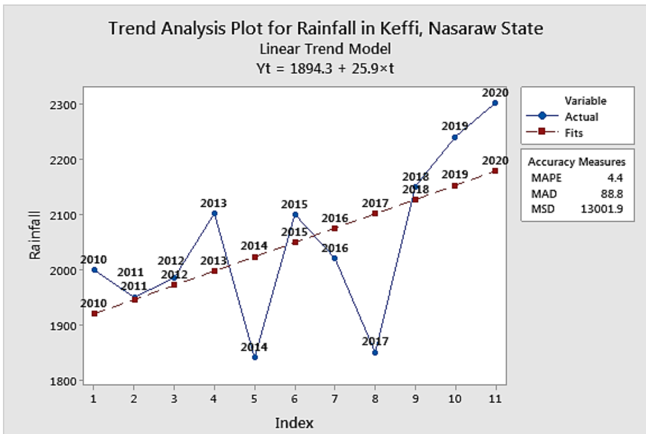

Figure 3: Rainfall Trend Analysis of Keffi

Figure 3 described the rainfall trend analysis with the lowest being 2014 and 2017. Rainfall increases due to climate change from 2018 to 2020. The high impact of rainfall intensity has allowed farmers to cultivate more pieces of land.

Table 2 presented the field surveyed data of Nasawara town which was also collected during the same rainy season at a different station.

Table 2: Rainfall Simulation data from 2010-2020 in Nasarawa

Year	Rainfall
2010	2010.6
2011	1880.3
2012	2010.4
2013	2200.0
2014	1950.8
2015	2015.2
2016	2021.7
2017	1966.5
2018	2015.1
2019	2248.6
2020	2261.3

The simulated results of rainfall in Nasarawa town have the highest matrix from 2019 to 2020 as shown in Figure 4. The wider gap of the data simulated has demonstrated a rectangular shape indicting uneven distribution with the year 2000 to have the less rainfall in the study area.

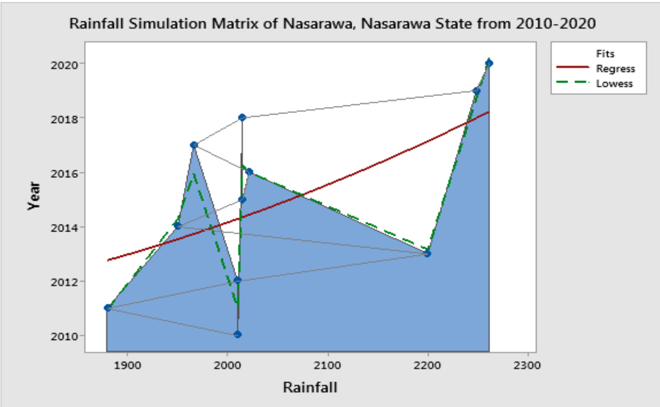

Figure 4: Rainfall Simulation in Nasarawa from 2010-2020

The simulated results of rainfall in Nasarawa town have the highest matrix from 2019 to 2020 as shown in Figure 5. The wider gap of the data simulated has demonstrated a rectangular shape indicting uneven distribution with the year 2000 to have the less rainfall in the study area.

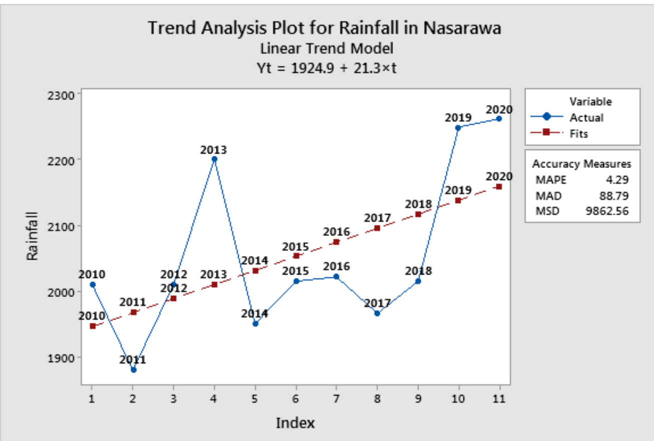

Figure 5: Trend analysis of Rainfall in Nasarawa

5. Conclusion

The 10-year rainfall anomaly of both Keffi and Nasarawa from 2010-2020 was simulated. The rainfall has the highest simulation of 2100mm while rainfall in Nasarawa town was simulated with 22500mm. these indicated that rainfall intensity is higher in Nasarawa local government area than in Keffi. This might be a result of a change in elevation and topography of the area. The rainfall trend analyses of the two different stations were computed. Rainfall trend analysis and simulation have shown an increase in the trend of rainfall in Nasarawa town than in Keffi. and the crop yield is also high. Most local farmers prefer to cultivate crops during the wet season in Nasarawa as the region was characterized by fertile agricultural soils.

References

Abaje, I. B., & Oladipo, E. O. (2019). Recent changes in the temperature and rainfall conditions over Kaduna State, Nigeria. *Ghana Journal of Geography*, *11*(2), 127–157.

Akinremi, O. O., McGinn, S. M., & Cutforth, H. W. (1999). Precipitation trends on the Canadian prairies. *Journal of Climate*, *12*(10), 2996–3003.

Asfaw, A., Simane, B., Hassen, A., & Bantider, A. (2018). Variability and time series trend analysis of rainfall and temperature in north-central Ethiopia: A case study in Woleka sub-basin. *Weather and Climate Extremes*, *19*, 29–41.

Bernstein, L., Bosch, P., Canziani, O., Chen, Z., Christ, R., Davidson, O., Hare, W., Huq, S., Karoly, D., & Kattsov, V. (2008). *Climate change 2007: Synthesis report: An assessment of the intergovernmental panel on climate change*. IPCC.

Conway, D., Allison, E., Felstead, R., & Goulden, M. (2005). Rainfall variability in East Africa: implications for natural resources management and livelihoods. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *363*(1826), 49–54.

Lee, M., Nakane, K., Nakatsubo, T., Mo, W., & Koizumi, H. (2002). Effects of rainfall events on soil CO 2 flux in a cool-temperate deciduous broad-leaved forest. *Ecological Research*, *17*(3), 401–409.

Nicholson, S. E. (2000). The nature of rainfall variability over Africa on time scales of decades to millenia. *Global and Planetary Change*, *26*(1–3), 137–158.

Olaniran, O. J., & Sumner, G. N. (1989). CLIMATIC CHANGE IN NIGERIA: Variation in rainfall receipt per rain-day. *Weather*, *44*(6), 242–248.

Olayide, O. E., Tetteh, I. K., & Popoola, L. (2016). Differential impacts of rainfall and irrigation on agricultural production in Nigeria: Any lessons for climate-smart agriculture? *Agricultural Water Management*, *178*, 30–36.

Petrie, M. D., Bradford, J. B., Hubbard, R. M., Lauenroth, W. K., Andrews, C. M., & Schlaepfer, D. R. (2017). Climate change may restrict dryland forest regeneration in the 21st century. *Ecology*, *98*(6), 1548–1559.

Rimbu, N., Lohmann, G., Lorenz, S. J., Kim, J.-H., & Schneider, R. R. (2004). Holocene climate variability as derived from alkenone sea surface temperature and coupled ocean-atmosphere model experiments. *Climate Dynamics*, *23*(2), 215–227.

Soltani, M., Laux, P., Kunstmann, H., Stan, K., Sohrabi, M. M., Molanejad, M., Sabziparvar, A. A., SaadatAbadi, A. R., Ranjbar, F., & Rousta, I. (2016). Assessment of climate variations in temperature and precipitation extreme events over Iran. *Theoretical and Applied Climatology*, *126*(3), 775–795.

Umar, A. T., & Ismaila, A. (2017). Analysis of monthly rainfall variations: further evidence of climate change in Sokoto state, Nigeria (1926-2015). *Ethiopian Journal of Environmental Studies & Management*, *10*(6).

Yamusa, A. M., Abubakar, I. U., & Falaki, A. M. (2015). Rainfall variability and crop production in the North-western semi-arid zone of Nigeria. *Journal of Soil Science and Environmental Management*, *6*(5), 125–131.