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CLIMATE CHANGE INDICATORS IN THE GUINEA SAVANNAH NICHE OF TORO, NORTH EASTERN NIGERIA: ANALYSIS OF TREND

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ABSTRACT

The study looks into changes in meteorological factors in the study area as well as annual trends of climatic variables. Temperature, precipitation, and sun radiation were examined as weather variables. The Nigerian Meteorological Agency provided meteorological parameters for the time period (1982–2017). The meteorological parameters that were acquired demonstrated patterns of variability for each parameter with regard to the given period when trends analysis of previous and contemporary variations were used. For the analysis of the collected data, a linear trend model was applied.The analysis's findings indicate that both the minimum and maximum temperatures gradually increased (from 200°C to 230°C and 320°C to 340°C, respectively), while rainfall steadily decreased (from 118.7 to 174.4 mm annually) during the study period and solar radiation gradually increased (21.8Mj/m2 to 19.4 Mj/m2) over the course of the time period.

Keywords: *Trend, Climatic variables, Analysis*

INTRODUCTION

The detection, estimation, and forecasting of trends, as well as their statistical and physical significance, are all included in the study of climate. Complex interactions between the ocean and land affect Africa's climate, resulting in a vast vsariety of climates across the continent, ranging from the humid tropics to the extremely dry Sahara (Odjugo, 2010). Climate has a significant impact on Africa's daily economic operations at the regional, municipal, and household levels, particularly in the agriculture and water resources sectors (Nwafor J.C., 2007). Observed temperatures in Africa have shown a higher warming trend during the 1960s (IPCC, 2007). Although these patterns seem to be the same all around the continent, the alterations are not always the same.In contrast to internal risk, which is created by people's or communities' sense of insecurity, external risk is established through scientific investigation, highlighting the importance of community-based participatory risk assessment while coping with natural disasters. In order to create and implement adaptation methods that strengthen and increase resilience when coping with climate-related hazards, it is essential to first determine current vulnerability to climate variability and extremes (O'Brien K., 2007). According to Scoones I. (2009), perceptions differ depending on socioeconomic, cultural, gender, environmental, and historical contexts and personal experiences, with risks playing a role in perception to some extent. As a result, the complexity of rural life cannot be fully understood through a single theoretical perspective.In a research published in 2010, H. Fünfgeld argued that in order to understand why views of Himalayan apple farmers in India are more accurate for particular types of weather and climatic changes, it is important to examine the ways in which weather effectsagricultural productivity. As a result, according to Fatile and Adejobi (2012), new perspectives and approaches are needed in order to comprehend public risk perceptions and risk-reduction measures. Early research on risk perception, for instance, demonstrated that people's concerns could not be attributed to only ignorance or irrationality. Instead, it has been discovered via research that a lot of people's responses to risks are brought on by their sensitivity to technical, social, and psychological aspects of hazards that are poorly reflected in technical risk assessments.Uncertainty in risk assessments, a sense of unfairness in the allocation of benefits and risks, and aversion to unintended, unforeseen, or feared dangers are just a few examples (Odjugo, 2010).

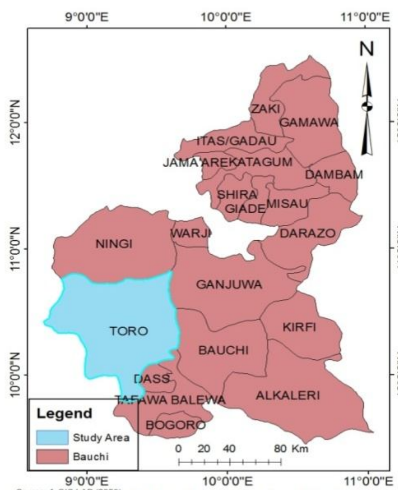
Factors that affect agricultural activities include rainfall, temperature (minimum, average, and maximum), pressure, humidity, sun radiation, visibility, evaporation, soil temperature at various depths, wind speed, and direction (Nanda, 2009). Humidity, temperature, wind (speed and direction), and precipitation and its mode of occurrence are all significant climatic factors that influence evaporation and transpiration. Evapo-transpiration and rainfall are influenced by solar radiation, which also influences soil temperature and controls crop productivity and other human activities (Koehler-Munro, & Goddard2010). Uneven rainfall results in environmental problems such flooding, gully erosion, drought, and desertification, all of which have a big impact on crop productivity and biodiversity loss (Odjugo, 2010).A rainfall trend is a significant shift in the temporal and spatial patterns of rainfall. To put it another way, a rainfall trend is the general tendency, movement, or pattern that rainfall exhibits (IPCC, 2007). Due to the scientific community's focus on global climate change, rainfall trend analyses on various spatial and temporal scales, for example, have been a major source of concern in the global scene over the past century. They show a small positive global trend, even though large areas are characterized by negative trends (IPCC, 2007). Rainfall variability is the degree to which rainfall amounts change over time or over an area.The variability of rainfall can be used to describe a region's climate; in Nigeria, rainfall varies greatly across both time and space (Odjugo, 2010). This fluctuation has gotten worse as a result of climate change. Rainfall variability rises from the northwest to the southwest, but between-year (yearly) rainfall variability rises from the north central to the southeast. This research also reveals that rainfall variability over time follows a regional trend within a given limit (Nanda, 2009). Rain is primarily formed as a result of moisture moving through weather fronts, three-dimensional zones of temperature and moisture variations.Convective clouds, or those with strong upward vertical motion like cumulonimbus (thunder clouds), are the source of precipitation. If sufficient moisture and upward motion are present, convective clouds, it can be organized into narrow rain bands. In mountainous areas, where upslope flow is greatest along windward sides of the terrain at elevation and forces moist air to concentrate, heavy precipitation is sometimes possible along the mountain sides (Nath & Behera, 2011).On the leeward side of mountains, a desert climate can exist because downslope flow produces dry air that warms and dries the air mass. The monsoon trough, also known as the inter-tropical convergence zone, moves across the savannah regions, bringing rainy seasons (Madu, 2012). Rainfall increases in amount and intensity downwind of cities due to the urban heat island effect. Global warming is also causing changes in precipitation patterns, with wetter weather in Eastern North America and drier conditions in the tropics (UNFCCC, 2014).

When Nigeria's rainfall patterns were investigated for a dominant trend, it was found that there was a progressive early retreat of rainfall across the nation as well as a notable decline in rainfall frequency in September and October, which correspond to the end of the rainy season in the northern and central parts of the country, respectively. The inter-annual variability of the rainfall pattern in northern Nigeria ranges from 15 to 20%, and it is highly variable in both the geographical and temporal dimensions. 2010's Odjugo. The enormous inter-annual variability of rainfall is frequently a contributing factor to climate hazards, particularly floods and severe droughts, which have catastrophic effects on the food supply and result in linked tragedies and suffering (Madu ,2012). One of Nigeria's most valuable climatic resources is rainfall. The majority of the water for crops and animals came from rainfall.It is the fundamental determinant of the sorts of crops that can be farmed in the place, as well as the length of time that these crops can be grown and the farming practices that can be utilized (Odjugo, 2010). The world's seas are so huge and can hold so much heat that even a little increase in the average yearly surface temperature demands a significant amount of heat energy. Even though the pre-industrial era (1880–1900) had a rise in global average surface temperature of roughly 2 degrees Fahrenheit (1 degrees Celsius), it reflects a massive increase in collected heat (Nath & Behera, 2011).It can seem weird to think about a worldwide average temperature. After all, the difference between the world's highest and lowest temperatures right now is probably larger than 100°F (55°C) (Enete 2011). The difference in temperature between the Northern and Southern Hemispheres varies from day to night and according to the seasons. As a result, some areas of the Earth are very cold and others are quite hot. Speaking of the "average" temperature may consequently seem absurd.On the other hand, the idea of a global average temperature is important for spotting and monitoring changes in Earth's energy budget over time, which is determined by how much sunlight the planet collects minus how much heat it releases into space (Nath&Behera, 2011).

MATERIALS AND METHOD

Study Area

With a landmass of 6,932 km2, Toro is a Bauchi State Local Government Area that is situated in the state's southern region. Hasan (Hassan, 2013). (Hassan, 2013). According to NPC, there are 350,404 people living in Toro LGA (2006). Seasonal variation in rainfall in the study area is influenced by the interaction of two air masses, the relatively warm and moist tropical maritime (mT) air mass, which originates from the Atlantic Ocean and is linked to southwest winds in Nigeria, and the relatively cool, dry, and stable tropical continental (cT) air mass, which originates from the Sahara Desert and is linked to the dry, cool, and dusty North-East Trades known as the Harmattan. These two air streams collide in the Inter-tropical Discontinuity (ITD). In the state as a whole, the rainy season begins in August with the ITD's passage northward across the state, while the dry season begins in February with its migration southbound across the state (Odekunle, 2006). The temperature is always high. The months of April and May see the highest air temperatures, which in certain areas can reach 380°C to 400°C, while December and January have the lowest air temperatures. Evapo-transpiration is often high year-round. The area's vegetation is of the Sudan Savanna type, which contains the traits and species of both the Guinea and Sahel Savanna, and the rate of evaporation is higher during the dry season (Olorode, 2002).



Source: A-GIS LAB (2020) **A Map Showing the Study Area**

Data Collection and Analysis

Climatic data which include among others both minimum and maximum temperature, mean annual rainfall and solar radiation were obtained from Nigerian Meteorological Agency (NIMET), and the study used Linear Trend Model for the analysis of data.

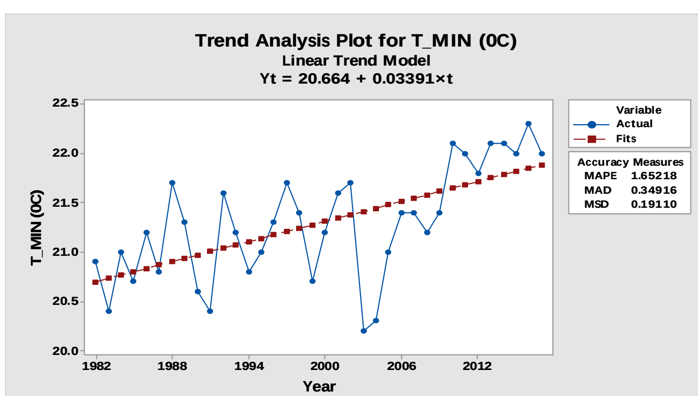


Fig1: Trend in Minimum Temperature in the Study Area for the Period 1982 - 2017

The trend indicates a considerable rise in the mean annual temperature (minimum temperature) for the period 1982–2017, from 20.0 To 22.3 C. yt = 20.664 + 0.03391*t is the linear trend model (LTM) result for the minimum temperature in the study area during the study period. The model's slope is positive, indicating that over the course of the study, the mean annual minimum temperature in the study area has risen.

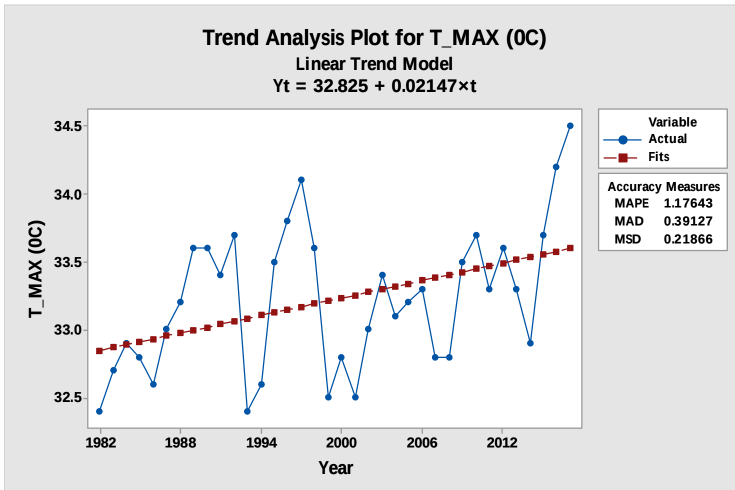


Fig2: Trend in Maximum Temperature in the Study Area for the Period 1982 - 2017

The mean annual temperature (maximum temperature) between 1982 and 2017 shows a positive temperature variation between 32.4 and 34.5 C. The highest temperature in the study area for the study period is represented by the linear trend model (LTM) result yt = 32.825 + 0.02147*t. The model's slope is positive, indicating that over the study period, the mean annual maximum temperature increased in the study area. This suggests that the minimum and maximum temperatures in the study area increased during the course of the research period. Climate scientists have known for some time that minimum temperatures, which are typically measured around sunrise, are rising more quickly over time than maximum temperatures, which has the effect of narrowing the daily temperature range between maximum and minimum temperatures, according to Cutter (2009). Similar studies by Galloping, G. (2006) indicated that while warmer nighttime temperatures are particularly concerning for heat stress in summertime animals, they can also have an impact on the growth of specific crops, such as maize.Warmer temperatures can also trigger a cascade of other changes around the planet. Greater temperatures indicate that heat waves are likely to stay longer; additionally, heat waves can be deadly, resulting in illnesses like heat cramps and heat stroke, or even death. That's because rising air temperatures also have an impact on plants, animals, weather patterns, snow and ice, and oceans. The effects on people and the environment will worsen as the temperature rises. Storms, heat waves, floods, and droughts are just a few of the disasters that are getting worse as a result of rising temperatures.The outcome also supports the findings of Denton, F. (2014), who found that warmer climates produce an atmosphere that can hold onto and release more water. This alters weather patterns so that wet areas get wetter and dry areas get drier. Increasing temperatures increase the likelihood that heat waves may occur more frequently and last longer. Heat waves can be deadly, resulting in conditions like heat cramps and heat stroke as well as actual mortality. That's because rising air temperatures also have an impact on plants, animals, weather patterns, snow and ice, and oceans.Similar findings showing the temperature in Nigeria has increased dramatically since the 1980s were published by the Nigerian Meteorological Agency (NIMET, 2012). According to climate predictions, temperatures will rise significantly throughout all ecological zones in the ensuing decades. This quick review summarizes the data on how climate change is affecting Nigeria. Increased temperatures and drier conditions would certainly make floods, droughts, and heat waves worse and hinder agricultural production, especially rain-fed agriculture, which is vital to the livelihoods of many Nigerians.

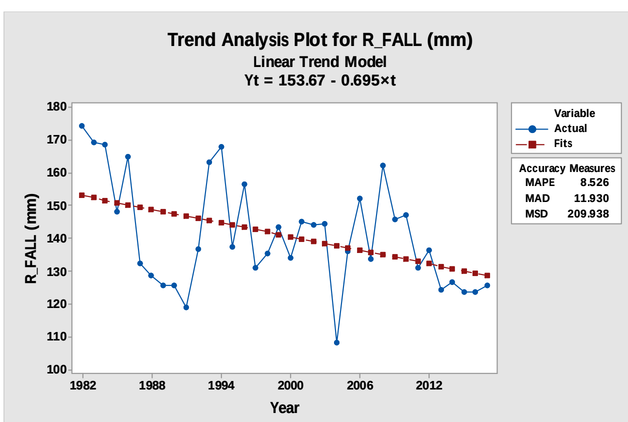


Fig3: Trend in Mean annual rainfall in the Study Area for the Period 1982 - 2017

According to the Linear Trend Model (yt = 153.67 - 0.695*t), the mean annual rainfall in the study area decreased gradually over the period of 1982 to 2017. The range of the mean annual rainfall in the study area is generally between 1174.4 and 1123.4 mm per year, which explains why it is located in the guinea savannah agro-ecological zone.

This implies that the mean annual rainfall in the studied area decreased over the course of the research period. The results demonstrated an overall drop in the dry season's contribution to yearly rainfall, which is in contrast to Abdullahi, U. (2016)'s findings, which indicated a large rise in rainfall over nine sites in northern Nigeria between 1953 and 2002. The outcome is consistent with Odekunle, T. (2006)'s findings that there has recently been a gradient of falling precipitation amounts from south to north. Strong rainfall events occur often in the southern parts throughout the rainy season, which lasts from March to October. Annual rainfall amounts in the region are typically above 2,000 mm and can exceed 4,000 mm in the Niger Delta.A single, clearly defined rainy season (April to September) and dry season regulate the central regions (December to March). The Harmattan wind from the Sahara has an impact on the dry season. In coastal areas, there is a brief dry season, with the majority of the rain falling from March to October. Rainfall on average each year might be as high as 1200 mm. Just 500 to 750 mm of rain, or less, fall in the north from June to September. It's hot and dry the remainder of the year. The significant degree of annual variation in rainfall in northern regions causes flooding and droughts.

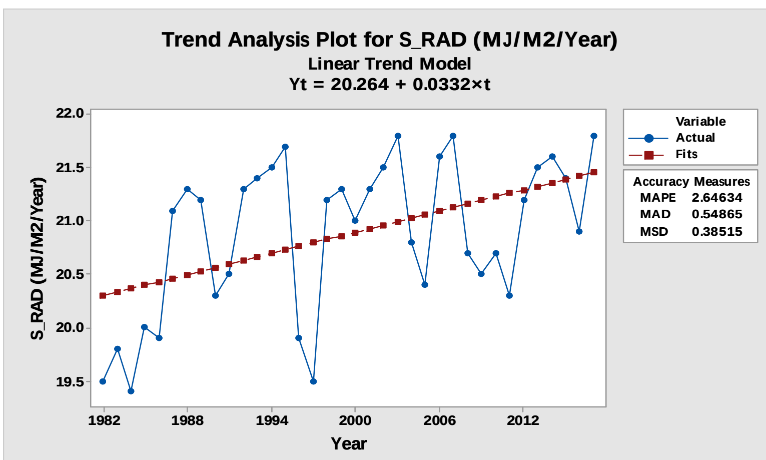


Fig4: Trend in Mean annual solar radiation in the Study Area for the Period 1982 - 2017

The study area's solar radiation trend gradually increased from 1982 to 2017, with the greatest radiation measured at 21.8 Mj/m2 and the lowest at 19.4 Mj/m2. This might have something to do with the area's uncontrolled tree-cutting for fuel wood. yt = 20.264 + 0.0332*t is the linear trend model (LTM) result for the mean yearly solar radiation in the study area during the study period. The model's slope is positive, indicating that over the study period, the mean annual solar radiation increased in the study area.

This reveals that the mean yearly solar radiation increased in the study area during the course of the study period. The findings support NIMET's 2012 report, which found that as greenhouse gas concentrations rise in the atmosphere, massive deforestation, particularly in Nigeria's north, ongoing declines in rainfall and cloud cover, and mean annual solar radiation rise, these factors combine to raise surface temperatures, increase the atmosphere's ability to hold more water, increase evaporation, and produce more water vapor. The results support Koehler-Munro & Goddard's (2010) finding that ozone is a significant component of our atmosphere and that higher levels of ozone absorb more UV.Ozone levels have been seen to fall globally since the ozone hole over the Antarctic was discovered in the early 1980s, which has led to an increase in the amount of solar UV reaching the earth's surface. Since the atmosphere has a lower likelihood of absorbing the entering UV, UV increases at higher altitudes. Every 300 meters of elevation gain results in an up to 4% increase in UV exposure. Solar UV can be scattered by minute particles in the atmosphere. Despite being small, the effect can nonetheless have an impact on the UV levels that reach the earth's surface.

CONCLUSION

The minimum, maximum, and solar radiation all gradually increased throughout the course of the study period, and this was accompanied by a drop in rainfall in the study area. The research area's agro-meteorological stations are woefully insufficient. Throughout the study period, the highest and lowest minimum temperatures were 22.30C and 20.00C, respectively. The highest temperature observed during the research period was 34.50C, while the lowest was 32.40C. The highest and lowest average mean annual rainfall records for the research period, respectively, were 118.7 and 174.4 mm per year.While for solar radiation, the highest radiation record was 21.8Mj/m^2 and the lowest was 19.4 Mj/m^2 during the period of study.

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