



## Evaluation of Climatic Trends in Dass LGA, Bauchi State, Nigeria

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### Abstract

*The impacts of global climate change are increasingly being felt around the world. Rising temperatures, changing rainfall patterns, and the melting of glaciers are affecting ecosystems and human societies in different ways, while climate change is expected to create new opportunities in some parts of the world. The obtained data of Dass Local Government Area (LGA) of Bauchi State was analysed using Linear Trend Model (LTM). The findings of this research reaffirm that among the climatic parameters that influence the climate variability in the study area, minimum and maximum temperatures, rainfall and solar radiation are the most important ones. The research concludes that there is both positive and negative variation of climate parameters in the study area. It is recommended that more meteorological stations should be deployed in the area for more coverage.*

**Keywords:** Climate change; Dass LGA.; Linear trend model (LTM); Evaluation; Nigeria.

### INTRODUCTION

Climate change is a major threat to sustainable growth and development in Africa, and its achievement of the Millennium Development Goals (MDGs), despite the continent being one of the least responsible for its causes (Cutter, 2009). This calls for urgent actions regarding vulnerability, adaptation and mitigation. Issues of concern include reduced agricultural production, worsening food insecurity, increased incidence of both flooding and drought, the spread of disease and an increased risk of conflict over scarce land and water resources and migration because of the continent's weak adaptive capacity, limited finance and poor technological advancement. Africa is particularly vulnerable to climate change because of its overdependence on rain-fed agriculture (over 95% of Africa's agriculture is rain-fed), compounded by widespread poverty and weak capacity (Nwafor, 2007). The impacts of global climate change are increasingly being felt around the world. Rising temperatures, changing rainfall patterns, and the melting of glaciers are affecting ecosystems and human societies in different ways, while climate change is expected to create new opportunities in some parts of the world; it is also expected to cause considerable distress. The extent of the impact depends on the magnitude of climatic changes affecting a particular system (exposure), the characteristics of the system (sensitivity), and the ability of people and ecosystems to deal with the resulting effects (adaptive

capacities of the system). These three factors determine the vulnerability of the system (IPCC, 2007).

In Nigeria, the situation is the same, as no part of the country is safe from climate change adversities. In the Sahel zone of northern Nigeria, the most pronounced climate change-related forms of land degradation are drought, wind erosion and related sand dune formation, drought and desertification. In south-eastern Nigeria, sheet erosion, which is the complete removal of arable land, is a major threat to agriculture in the region. The low-lying nature of Nigeria's 800km coastline makes it prone to coastal erosion and flooding. These are all induced forms of land degradation, which are consequences of climate change (Ajani, 2012). The prevailing climate is critical in controlling the ecosystem structure. Forests play important roles in the functioning of the biosphere and indirectly affect the provision of other goods and services, like timber production, etc. Changes in the climatic and atmospheric composition will help to diminish Nigeria's forests. Given the sensitive nature of the forest ecosystems, forest resources have become highly vulnerable to slight changes in climate systems. Changes in temperature, precipitation and water cycle dynamics can therefore lead to remarkable forest-cover loss (Odjugo, 2010). The climate of Nigeria has shown considerable temporal and spatial shifts in its variability and change since the late 1960s and early 1970s, which has been proven through a careful study of meteorological data. Extreme weather and climate events

such as drought, flood, ocean surges, etc. have become more regular, even though the impacts of these extreme events may be gradual, but the vulnerability can be high (NIMET, 2012). This is because they are often accompanied by damage to infrastructures, disruption of socioeconomic activities, loss of lives and property, and the displacement of people in the affected areas. Flood, for example, has become an almost annual occurrence in the northern parts of the country with increasing intensity each year, leaving colossal losses and trauma on the victims. A significant proportion of the population in the northern parts of the country is vulnerable to the hazards of this extreme weather and climate event (NIMET, 2012).

## REVIEW OF RELATED LITERATURE

Different combinations of processes in the Earth's climate system produce many variations in climate from place to place and from time to time. An area of the Earth's surface over which the combined effects result in an approximately homogenous set of climatic conditions, that is, a climatic type, is termed a climatic region IPCC (2007). To facilitate the description and mapping of climatic regions, it is necessary to identify and classify the respective types. Climatic classification therefore emerges from the need to synthesize and group similar climatic element in to climatic types from which climatic regions are mapped. The aim of it is to obtain an efficient arrangement of information in a simple and generalized form. This will give the framework for organizing climatic data and learning about the complex variation in the world climate (Osinem, 2005). The value of a systematic arrangement of climates is determined largely by its intended use; a system that suits one purpose is not necessarily useful for another e.g., a classification based on critical temperature and moisture limits for growth of a certain plant or animal organism might serve the needs of a biological study, but it is not likely to be satisfactory for weather forecasting, which relies more on such factors as the General Circulation, storm types and weather probabilities (Adger and Vincent, 2005). The United Nations Framework Convention on Climate Change (UNFCCC, 2009) defines climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global and/or regional atmosphere and which is in addition to natural climate variability observed over comparable time periods. IPCC (2007) defines climate change as a change in the state of the climate that can be identified (e.g. by using statistical tests) by a change in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Although the Earth's climate is constantly changing and global climate change occurs naturally, the rate of future climate change may be more rapid than at any time in the last 10,000 years (Cutter, 2009). The majority of the world's scientists who study this topic conclude that this expected climate change would differ from previous climate changes because of human activities. Therefore, climate change is the slow change in the composition of the global atmosphere, which is caused directly and indirectly by various human activities in addition to natural climate variability over time (Osinem,

2005). Koehler-Munro and Goddard (2010) further observed that the atmosphere has an effect like a greenhouse on the Earth's atmosphere. The energy from the sun reaching the Earth is balanced by the energy that the Earth emits back to space. Greenhouse gases (GHGs) trap some of this energy that the Earth releases to space. These GHGs in the atmosphere act as a thermostat controlling the Earth's climate. Without this natural greenhouse effect, the average temperature on the Earth would be  $-18^{\circ}\text{C}$  instead of the current  $+15^{\circ}\text{C}$  (Deswal and Deswal, 2017). Therefore, life as we know it would be impossible.

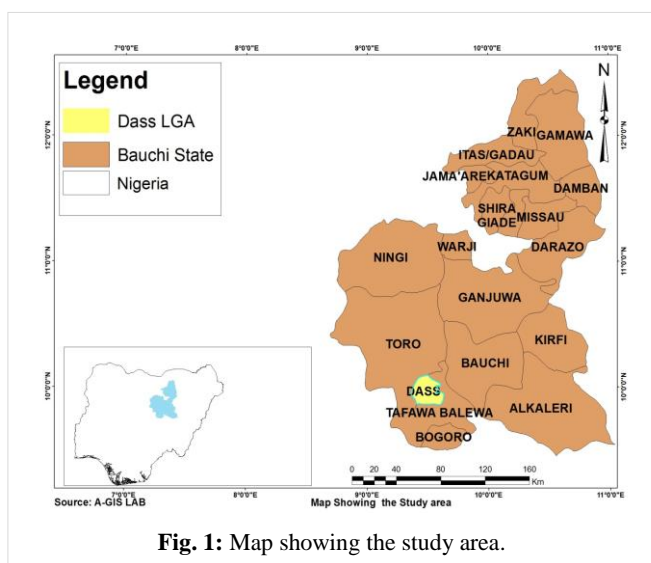
The environment can be likened to the biological system; a change in any component of a biological system will cause a distortion in the entire system (Nwafor, 2007). The ecological system behaves in a similar way, and climate is a fundamental element of the environment, thus any alteration in climate will consequently result in a change in the entire environment, affecting other elements of the environment (Nath and Behera, 2011). Global climate change has already had observable effects on the environment. Glaciers have shrunk, ice on rivers and lakes are breaking up earlier, plant and animal ranges have shifted, and trees are flowering sooner (IPCC, 2007). Animal ranges refer to the confinement of species to an area due to suitable survivable climatic and environmental conditions. The potential effects of global climate change include more frequent wildfires, longer periods of drought in some regions and an increase in the number, duration and intensity of tropical storms in opposite regions. Drought is a condition that results when the average rainfall for an area drops far below the normal amount for a long period of time (Osinem, 2005). Scientists predicted in the past that the effects of climate change would bring about drought, loss of sea ice, accelerated sea level rise and longer, more intense heat waves as well as increasing temperature. Increasing temperature will lead to changes in many aspects of weather, such as wind patterns, the amount and type of precipitation, types and frequency of severe weather events (Cutter, 2009). The global sea level could rise due to several factors, including melting ice and glaciers. Rising sea levels could damage coastal regions through flooding and erosion. The climate of various regions could change too quickly for plant and animal species found in that region to adjust and adjust. Harsh weather conditions, such as increased heat waves and droughts, could also happen more often and more severely. Such harsh changes could have far-reaching and unpredictable environmental, social and economic consequences. Taken as a whole, the range of published evidence indicates that the net damage costs of climate change are likely to be significant and to increase over time (Yohe and Tol, 2002). Basically, the noticeable outcomes of climate change are as follows: shrinking ice sheets, global temperature rise, acid rain, sea level rise, ocean warming and acidification, among others (UNFCCC, 2006; Deswal, 2025). Extreme precipitation events have produced more rain and become more common since the 1950s in many regions of the world. The Midwest and Northeast have seen the strongest increases in heavy precipitation events. Scientists expect these trends to continue as the planet continues to warm. Warmer air can hold more water vapour (Odjugo, 2010). For each degree of warming, the air's capacity for water vapor

goes up by about 7 percent. An atmosphere with more moisture can produce more intense precipitation events, which is exactly what has been observed. Increases in heavy precipitation may not always lead to an increase in total precipitation over a season or over the year. Some climate models project a decrease in moderate rainfall and an increase in the length of dry periods, which offsets the increased precipitation falling during heavy events (Madu, 2012). In Nigeria, Rainfall variation is projected to continue to increase. Precipitation in southern areas is expected to rise, and rising sea levels are expected to exacerbate flooding and submersion of coastal lands (Odjugo, 2010). Temperature is central to how climate influences the growth and yield of crops. The rate of many growth and development processes of crop plants is controlled by air or soil temperature. Over the last decade or so, the interests of the scientific community in the response of crops to temperature have been renewed as the evidence of a warming of global mean temperatures due to human activities. Temperature affects cereal production by controlling the rate of physio-chemical reaction and the rate of evaporation of water from crops and soil surface (Nath and Behera, 2011).

**MATERIALS AND METHODS**

Located in northern Nigeria, Dass Local Government Area (LGA) is one of the 20 local government areas of Bauchi state situated between latitude 9°45’ and 10°15’ north and longitude 9°15’ and 9°45’ east (Fig. 1). The Dass LGA covers a total land area of 535 square kilometers. It has a population of about 89,943 (NPC, 2006). The town is characterised by two distinct climatic seasons, dry and wet seasons. It is located within the Guinea savannah type of climate with 6-7 months of rainfall, usually starting from April and 5-6 month dry season from November to March every year respectively (Garba, 2006).

Soils around and on the hills are zonal soils, which are immature, having several layers with different structures that are said to have resulted from recent deposition of sediments, examples are alluvial soil and peat. Although soils like laterites are a typical example of a Zonal soil found in the area. The vegetation of the study area is the Guinea Savannah



**Fig. 1:** Map showing the study area.

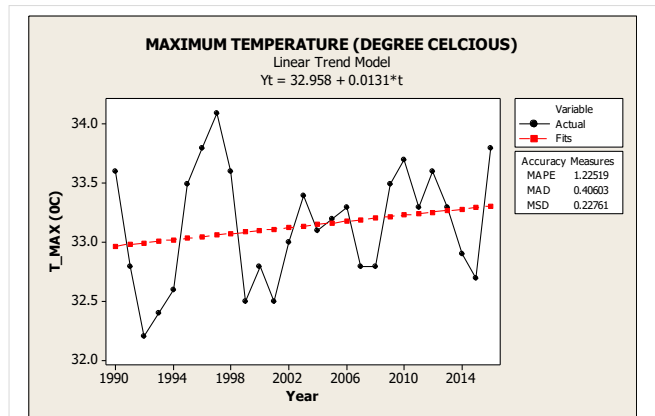
type, receiving rainfall for over six months. The vegetation is mostly green for the larger part of the year, showing fresh leaves and tall grasses (Garba, 2006)

**TREND OF CLIMATIC VARIABILITY**

The results are presented and discussed as follows:

**Trend in Maximum Temperature**

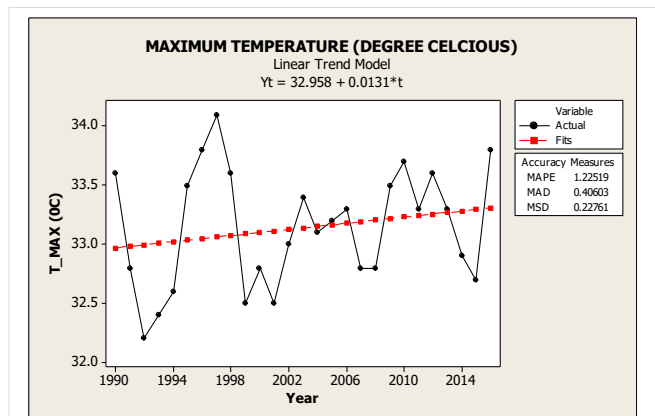
The mean annual temperature (maximum temperature) shows a little fluctuation of temperature between 32.0 – 34.0°C throughout the period 1990-2015. This could partially be explained by the fact that the area is located on hilly environment, it has some seasonal falls around the hill, which are the product of the relief of the area. The linear trend model (LTM) result for the maximum temperature in the study area for the study period is  $yt = 32.958 + 0.0131*t$ . The slope of the model is in the positive direction, which indicates that the mean annual maximum temperature increases in the study area throughout the study period. It could also be observed in Fig. 2.1 that 1997 recorded the highest mean annual maximum temperature of 34.1°C and 1992 had the lowest mean annual maximum temperature of about 32.2°C.



**Fig. 2:** Trend in maximum temperature in the study area for the period 1990 – 2015. (Source: Field work, 2023)

**Trend in Minimum Temperature**

The trend shows a sharp increase in the mean annual temperature (minimum temperature) from 18.5–22.0°C throughout the period 1990-2015. This could be as a result of



**Fig. 3:** Trend in minimum temperature in the study area for the period 1990 – 2015. (Source: Field work, 2023)

the hilly nature of the area. The linear trend model (LTM) result for the minimum temperature in the study area for the study period is  $yt = 19.074 + 0.0694*t$ . The slope of the model is in the positive direction, which indicates that the mean annual minimum temperature increases in the study area throughout the study period. It could also be observed in Fig. 3 that 2015 recorded the highest mean annual maximum temperature of 22.0°C, and 2001 had the lowest mean annual minimum temperature of about 18.8°C

### Trend in Mean Annual Rainfall

The rainfall in the study area shows high rate of variability throughout the period 1990-2015 as indicated by the Linear Trend Model ( $yt = 152.44 - 0.296684*t$ ), as shown in Fig. 4, and the trend line is in the negative direction showing a gradual decrease in the mean annual rainfall in the study area across the study period, but generally has a range of about 100 – 190 mm per annum, this explained the fact that the study area falls within the guinea savannah agro-ecological zone. The peak of the rainfall was observed in the year 1999 with a mean annual rainfall of about 196.4mm per annum, while the lowest was received in the year 2004, with an annual rainfall of about 108.2mm; this could be explained with respect to a major drought in that year.

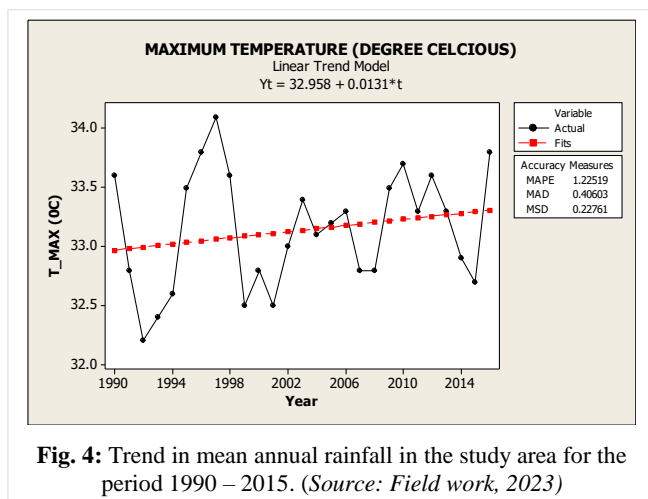


Fig. 4: Trend in mean annual rainfall in the study area for the period 1990 – 2015. (Source: Field work, 2023)

### Trend in Mean Annual Solar Radiation

There was a gradual increase in the trend of solar radiation in the study area across the period 1990-2015, with the highest radiation recorded 23.0Mj/m<sup>2</sup> in the year 2004 and the lowest 20.9 Mj/m<sup>2</sup> in 2014 (Fig. 5). This may not be unconnected with the indiscriminate cutting down of trees for fuel wood in the area. The linear trend model (LTM) result for the mean annual solar radiation in the study area for the study period is  $yt = 21.672 + 0.0217*t$ . The slope of the model is in the positive direction, which indicates that the mean annual solar radiation increases in the study area throughout the study period.

### CONCLUSION AND RECOMMENDATION

The findings of this research reaffirm that among the climatic parameters that influence the climate variability in the study area, minimum and maximum temperatures, rainfall and solar radiation are the most important ones. It also reveals that while some parameters are exhibiting positive fluctuation,

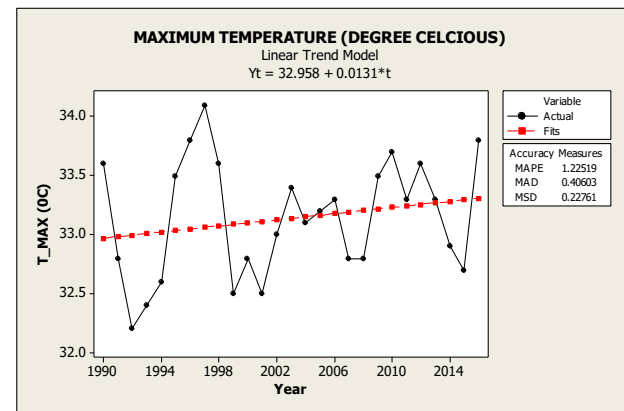


Fig. 5: Trend in mean annual solar radiation in the study area for the period 1990 – 2015. (Source: Field work, 2023)

some, on the other hand, are exhibiting negative fluctuation. The research concludes that there is both positive and negative variation of climate parameters in the study area. Temperature, rainfall, and solar radiation are having unusual transformations in the study area. It is recommended that more meteorological stations be deployed in the area for more coverage. Frequent monitoring and evaluation of whether in the area should be adopted for proper planning of whether and climate related activities.

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The present study did not receive any financial support.

### Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/ or submission, and redundancy, have been completely observed by the authors.

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