Trend Analysis of Rainfall and Temperature, in Ado-Ekiti, Ekiti State, Nigeria

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Abstract

This research work investigates rainfall and temperature trend in Ado – Ekiti, Ekiti State, Nigeria using temperature (^0C) and rainfall (mm) data from Nigerian Meteorological Agency from 2001 – 2011 (11years). The data were analyzed for the occurrence of a trend in temperature and rainfall values over Ado –Ekiti, Ekiti State, Nigeria. Mann Kendalls estimate was used to determine if there is a trend in temperature and rainfall values in the years of study. Analysis of rainfall data shows that 2001 has the lowest total rainfall over the11 year period with a total annual rainfall of 996.4mm while 2002 was the year with the highest annual rainfall record of 1549.4mm. Results further indicated that 2006 has the lowest total temperature over the11 year period with a total annual temperature of 280.4 ^0C while 2011 was the year with the highest annual temperature record of 319^0C.and air temperature in vast majority of the country. Analyses of rainfall and temperature data confirm that there is no particular trend in temperature and rainfall within the study period.

Keywords: *Trend, Temperature, Rainfall, Ado – Ekiti, Analysis*

Background to the study

Climate change seems to be the foremost global challenge facing humans at the moment, even though it seems that not all places on the globe are affected. World leaders, union leaders, pressure groups and others who have shown concern have been meeting to find a lasting solution to this challenge. The scientific community has not been left out as causes and solutions are being proffered and it is expected to linger on for a long time (Obot, *et al.*, 2010).

Two of the indicators of climate change are rainfall and temperature. Rainfall is a climate parameter that affects the way and manner man lives. It affects every facet of the ecological system, flora and fauna inclusive. Hence, the study of rainfall is important and cannot be over emphasized. Aside the beneficial aspect of rainfall, it can also be destructive in nature; natural disasters like floods and landslides are caused by rain (Ratnayake and Herath, 2005).

Climate variability is the variations of the normal state and other statistics of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may result from natural internal processes within the climate system (internal variability) or from anthropogenic external forces (external variability) (IPCC, 2005).

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 is present, precipitation falls from convective clouds (those with strong upward vertical motion) such as cumulonimbus (thunder clouds) which can organize into narrow rainbands.

Temperature is an objective comparative measure of hot or cold. It is measured by a thermometer, which may work through the bulk behavior of a thermometric material, detection of thermal radiation, or particle kinetic energy. Several scales and units exist for measuring temperature, the most common being Celsius (denoted °C; formerly called centigrade), Fahrenheit (denoted °F), and especially in science, Kelvin (denoted K). A climatological cycle of the total annual rainfall and temperature across Nigeria is believed to be regular in terms of wet and dry seasons in the 60s, 70s and parts of 80s from South to the North and to some extent from East to the West.

Rainfall is very crucial for the economic development of Ado – Ekiti, Ekiti State as the integral percentage of the people are involved in rain fed agriculture (crop and plantation). As a state whose economy is heavily dependent on productive rain fed agriculture, rainfall trends are often cited as one of the causes of socio-economic problems such as food insecurity. The changing climatic condition has been attributable to rainfall studies have also shown that the climate is changing based on the changing pattern of rainfall (Adger *et al.*, 2003, Owolabi *et al.*, 2013).

Rainfall is one of the key climatic resources of Ekiti State. Crops and animals derived their water resources largely from rainfall. It is considered as the main determinant of the types of crops that can be grown in the area and also the period of cultivation of such crops and then farming systems that can be practiced (Adebayo and Owolabi, 2009).

Studies of changing spatial pattern of annual and rainy season monthly rainfalls indicate a long run of dry years for sub-Saharan West Africa dating back to the 1940s (Gregory 1983). Climate classification system has been based majorly on the average annual rainfall to help differentiate climate regimes; examine the variability and uncertainty of rainfall across the globe amidst global warming (Ragab and Prudhomme, 2002).

Ogolo and Adeyemi (2009) in their work on variations and trends of some meteorological parameters at Ibadan see rainfall as the most variable parameter and air temperature as the least. The highly variable nature of rainfall as compared with the relatively stable nature of temperature appears to have imbued more relevance to rainfall as the major component in the study of climatic change.

Although many findings considering the long term structure of rainfall in Nigeria show significant trend in rainfall time series in the Northern part falling into Sahel climate and insignificant trend in the South and other Northern places outside the Sahel with steady regime of rainfall despite the wide growing evidence of global change with regards to rainfall and other climatic characteristics.

Obot *et al.*, (2011) posited that method adapted for analysis and period of study are two major factors to consider when studying the trend of rainfall. The past short term performance of

rainfall may give a better indication of the future scenario than that of past long term performance.

Objectives of the study

The objectives of this research are:

- To analyze trend of rainfall in Ado – Ekiti
- To analyze the trend of temperature in Ado – Ekiti, Ekiti State
- To analyze the effect of changes in rainfall patterns and temperature on agriculture in ado – Ekiti

The Study area

Ado-Ekiti is the capital of Ekiti State; Nigeria. Ado Ekiti is the administrative centre of Ekiti State, Nigeria. Ekiti State was created on the 1st of October, 1996 and its capital city, Ado-Ekiti has witnessed rapid population growth and urbanization (Awosusi and Jegede, 2010).

The land in Ado-Ekiti rises Northwards and Westwards from 335 metres in Southeast and attains a maximum elevation of about 730 metres in the Southwest (Adebayo, 1993). The low relief and gentle gradient characteristics of Ado-Ekiti region favour agricultural and construction activities, and make much of the region susceptible to erosion and flood hazards during the rainy season.

Ado-Ekiti is located between latitude $7^{o}3$ and $7^{o}49$ north of the equator and longitude $5^{o}7$ and $5^{o}7$ East of the Greenwich Meridian. Ado-Ekiti is bounded in the north and west by Irepodun/Ifelodun local government Areas, East and South by Gbonyin, Ikere and Ekiti South West Local Government Area.

Ado-Ekiti has a plan metric area of about $884km^2$. Geologically, the region lies entirely within the pre-Cambrian basement complex rock group, which underlies much of Ekiti State.

The temperature of this area is almost uniform throughout the year, with very little deviation from the mean annual temperature of $27^{o}C$. February and March are the hottest $28^{o}C$ and $29^{o}C$ respectively, while June with temperature of $25^{o}C$ is the coolest (Adebayo, 1993).

The mean annual total rainfall is 1367mm with a low co-efficient variation of about 10%. Rainfall is highly seasonal with well-marked wet and dry season. The wet season lasts from April to October, with a break in August.

Literature review

Several literatures on climate change and its attendant effect are abound, as climate change and weather fluctuations have greatly taken top in the priorities of global environmental discuss. Globally, lots of studies have been carried at different temporal scales and in different part of the globe on the topic as well.

In Nigeria, many studies consider the long term structure of rainfall characteristics, for example Olaniran (1990) considers the changing pattern of rainy-days in Nigeria between 1919-

1985, Omogbai (2010) studies rain days in South Western Nigeria between 1970-2006, while Obot *et al.,* (2011) also consider the trends of rainfall in Abeokuta, Nigeria between 1981-2002.

The overall result indicated that the trend in precipitation is downward, nonetheless, there are few stations that showed increasing trend. Increasing flood risk is now being recognized as the most important sectoral threat from climate change in most parts of the region which has prompted public debate on the apparent increased frequency of extreme, and in particular, on perceived increase in rainfall intensities.

Several studies have adduced extreme rainfall to be the major cause of flood worldwide. Such studies include Odekunle (2001), and Ologunorisa (2004). Other studies have identified the characteristics of extreme rainfall that are associated with flood frequency to include duration, intensity, frequency, seasonality, variability, trend and fluctuation. Adefolalu (1986) studied the rainfall trends for periods of 1911–1980 over 28 meteorological stations in Nigeria with 40 years moving average showing appearance of declining rainfall.

Eludoyin *et al.,* (2009) studied monthly rainfall distribution in Nigeria between 1985-1994 and 1995-2004 and noticed some fluctuations in most months within the decades. Ayansina *et al.,* (2009) also investigated the seasonal rainfall variability in Guinea savannah part of Nigeria and concluded that rainfall variability continues to be on the increase as an element of climate change.

Rainfall characteristics in Nigeria have been examined for dominant trend notably by Olaniran (1992). They showed that there has been a progressive early retreat of rainfall over the whole country, and consistent with this pattern, they 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.

Parida, *et al.,* 2005 are of the opinion that the global increase in temperature and changes of other climatic variables such as rainfall and evaporation are as a result of greenhouse gas emission. Once existing or potential climate change hazards have been identified, it must be demonstrated that these hazards pose a threat or risk to human populations and the systems on which they depend. It is therefore necessary to establish coping ranges and critical thresholds for proper adaptation interventions. Their research is aimed at determining the trend of this climatic variation with a view to finding out if rainfall and temperature have been influenced by internal or external factors. This is because precipitation is one of the key climatic variables that affect both the spatial and temporal patterns on water availability (De Luis *et al.,* 2000).

RESEARCH METHODOLOGY

Climatic variables such as temperature and rainfall are greatly affected by altitude, location in relation to the coast, rivers, desert, mountainous area and other such geographical features. Therefore, for analysis, it is difficult to consider the whole country as one region because different regions have different geography and microclimates. For the purpose of this research, Ado Ekiti an urban area in the South Western part of Nigeria and the capital of Ekiti State was used as a microclimate to determine the trend analysis of rainfall and temperature over a period of 10 years (2001 – 2011).

Rainfall and temperature data covering the years under study was obtained from the Nigeria Meteorological Agency. The data was analysed and their trends, fluctuations and variations were observed in order to have an insight to the problem under investigation and use the findings to present useful information about the topic.

The primary source of data is from the archives of the Nigerian Meteorological Agency (NIMET) (i.e. temperature and rainfall which ranged from 2001-2011).

Availability and reliability of the annual rainfall and temperature data was considered hence Data from NIMET was used because of their longstanding operational stations, standard equipment and personnel. The data gathered therefore is of high grade. The period of the study has been chosen as long as possible in function of data availability.

The Mann-Kendall Trend test was used to determine if there was a significant change in rainfall and temperature patterns over time. The Mann-Kendall test is a non-parametric test for the detection of trend in time series data. The test was used because it is simple, robust, can cope with missing values, and seasonality and values below detection limit.

RESULTS

Figure 1:

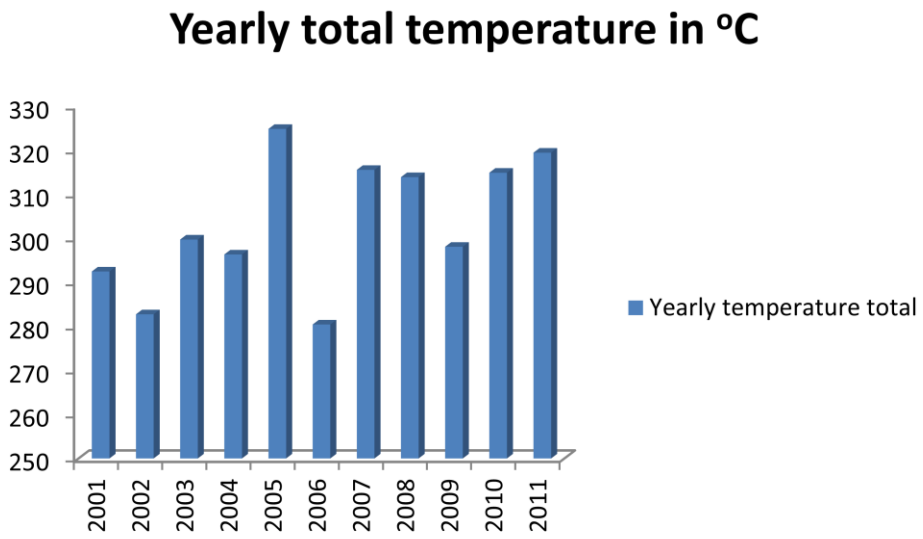
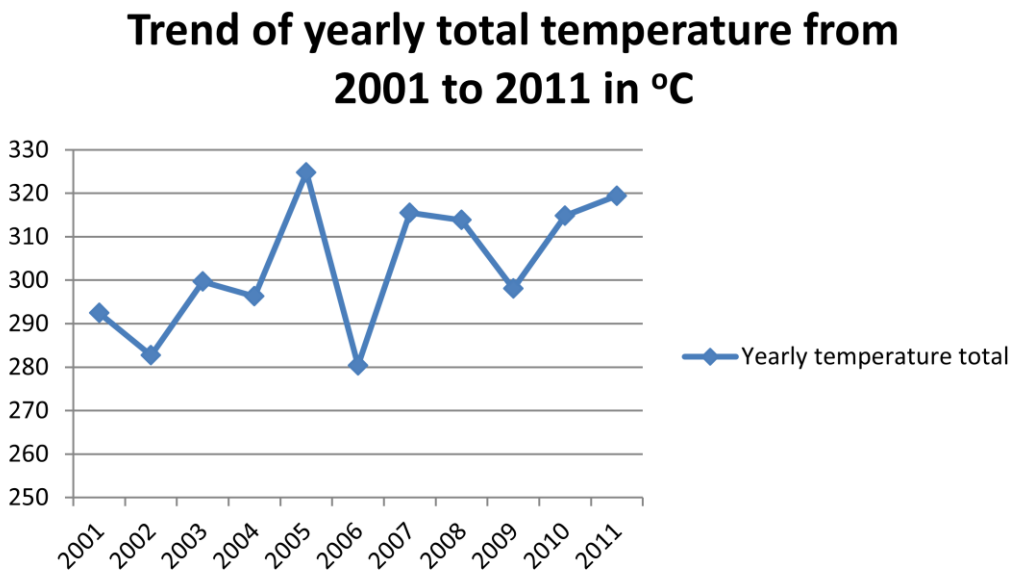


Figure 1 above shows the graph of yearly total temperature in Ado – Ekiti from 2001 to 2011. As is evident from the figure above, the rainfall yearly total temperature increases from 2002 till it reaches a peak in 2005 with about 325^{o}c. It falls sharply to the lowest in the following year, 2006 to about 312^{o}c and almost remains steady except in 2009 when it drops to 298^{o}c.

Figure 2:



The trend of yearly total temperature in the study area from 2001 to 2011 could be seen in Figure 2. As is evident from the trend, the rainfall yearly total temperature increases gradually from 2002 till it falls sharply to the lowest in the year 2006 (to about 312^{o}c) and then started rising steadily until in 2009 when it drops to 298^{o}c. However, it is observed to increase steadily from 2010 to 2011

Figure 3:

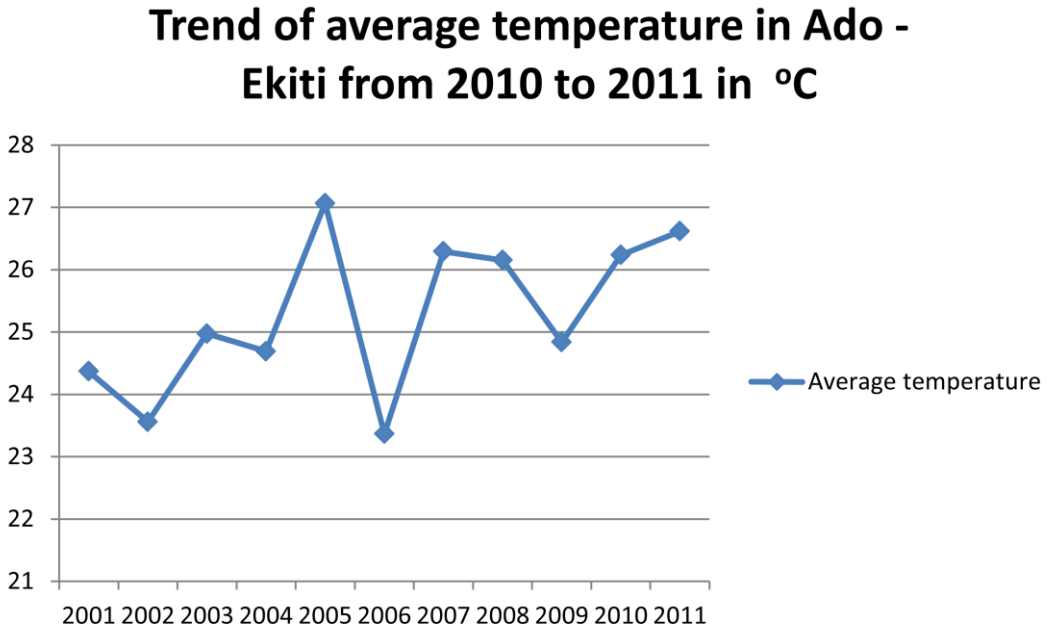


Figure 3 shows the trend of average total temperature in Ado – Ekiti from 2001 to 2011. The trend shows that yearly average temperature increases from 2002 till it falls sharply to the lowest in the year 2006 to about 23.6^{o}c and rises steadily until in 2009 when a drop in temperature was observed. There is an increase in temperature for the last two years of the study

Figure 4:

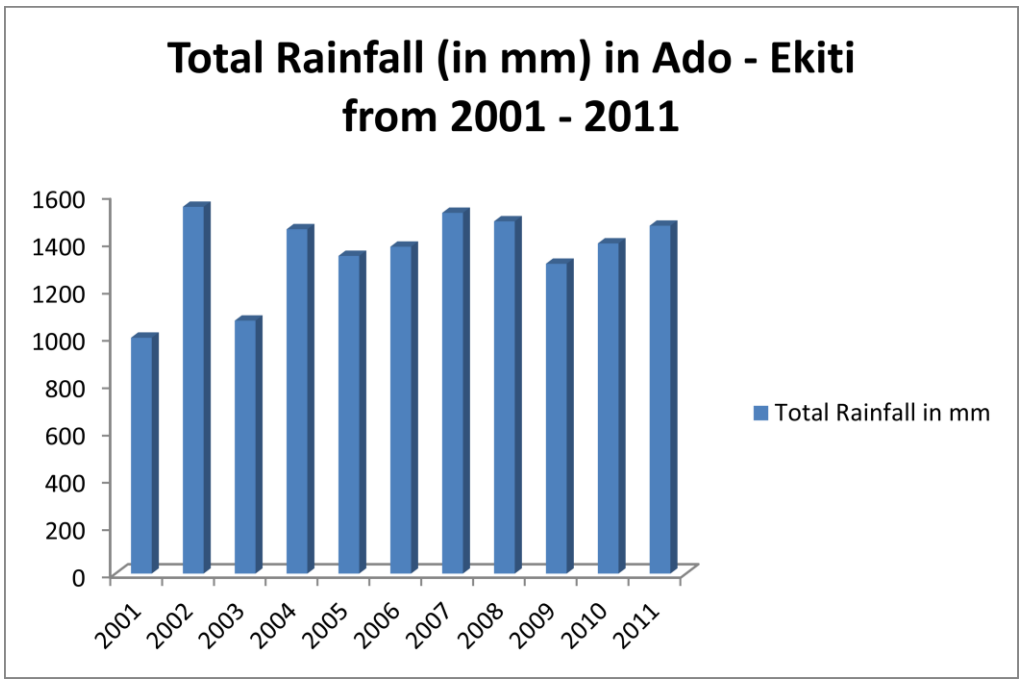


Figure 4 depicts the yearly total rainfall (mm) in the study area from 2001 to 2011. The yearly total rainfall did not follow a particular trend except for year 2003 with a sharp decline in the total amount of rainfall. However, the highest amount of rainfall in the study area was in year 2002 with about 1580 (mm) total rainfall.

Figure 5:

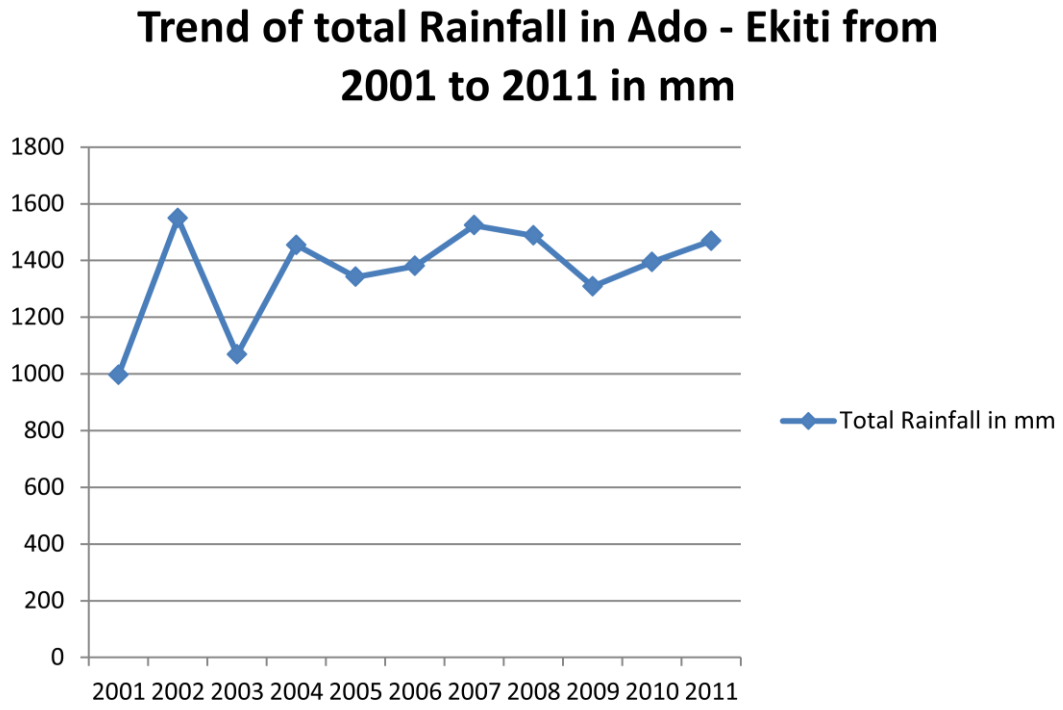


Figure 5 shows the trend of total rainfall across the years (2001 to 2011) in the area under study. It is immediately obvious that year 2002 has the highest total amount of rainfall with a sharp decline in year 2003 while there is no particular trend in the remaining years (2004 – 2011).

Figure 6:

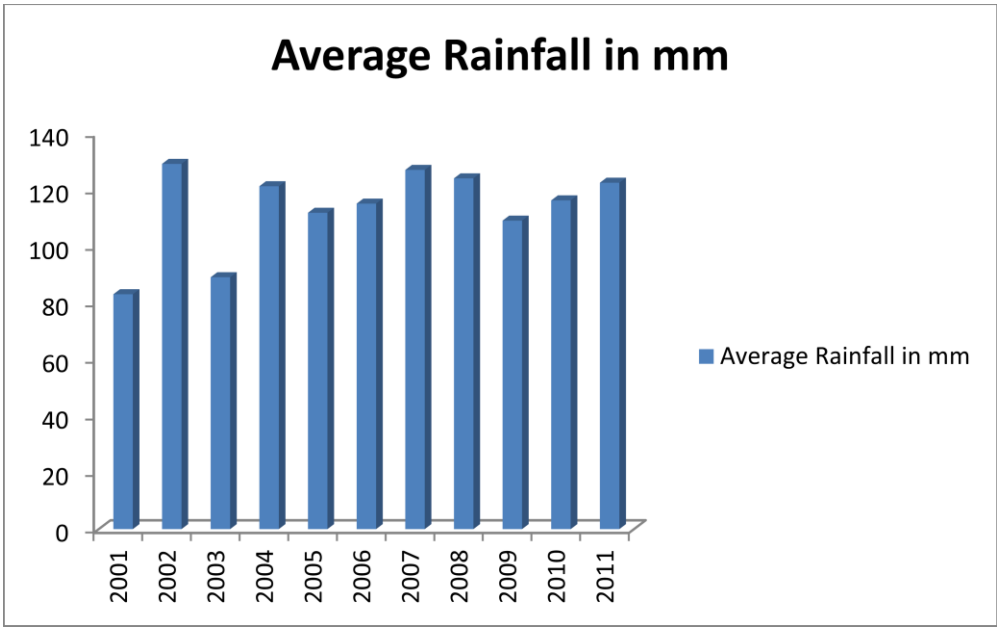
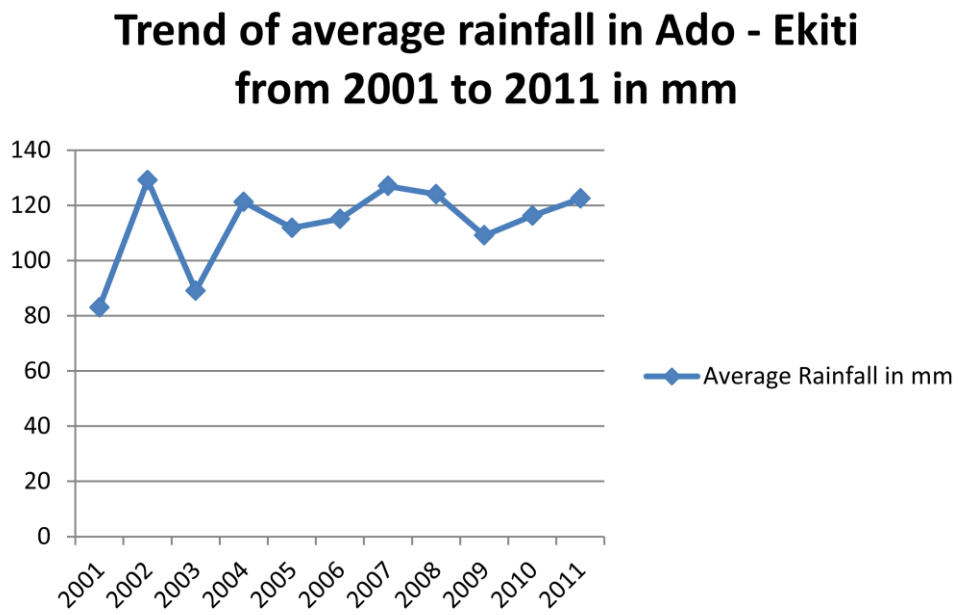


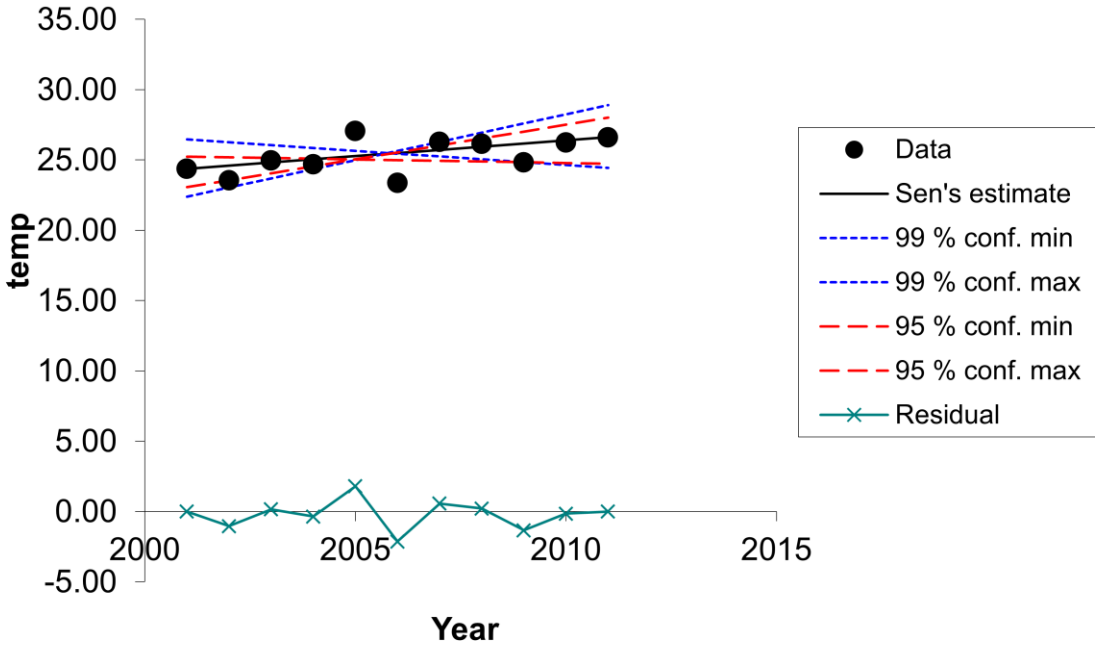
Figure 6 shows the trend of total rainfall from year 2001 to 2011 in the area under study. It shows that year 2002 has the highest amount of total rainfall with year 2003 having the lowest amount of total rainfall. The years 2007 and 2008 have almost the same amount rainfall with another decline in year 2009 which increases again in years 2010 and 2011.

Figure 7

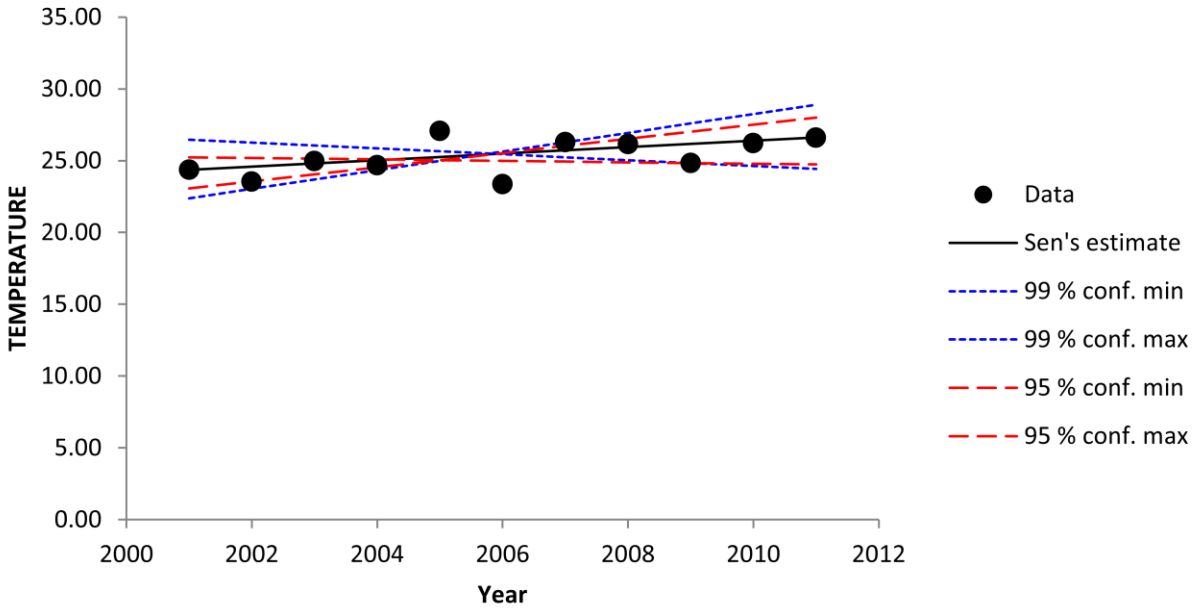


It could be seen from Figure 7 the trend of average rainfall from year 2001 to 2011 in the area under study (Ado – Ekiti, Ekiti State. The trend shows that year 2002 has the highest amount of average rainfall with year 2003 having the lowest amount of rainfall. The is an increase in the average amount of rainfall in the years 2007 and 2008 with another decline in year 2009 which increases again in years 2010 and 2011.

MANN-KENDALLS ESTIMATE FOR TEMPERATURE IN ADO - EKITI 2001 – 2011



MANN-KENDALLS ESTIMATE FOR RAINFALL IN ADO EKITI (2001 – 2011)



Discussion of findings

From the analysis of temperature data as shown in figures 4.1, 4.2 and 4.3 and figure 4.4, it was observed that 2006 has the lowest total temperature over the11 year period (2001 - 2011) with a total annual temperature of 280.4 ^{0}C while 2011 was the year with the highest annual temperature record of 319^{0}C. The trend analysis reveals that there is no particular trend in temperature over the period of study in Ado – Ekiti.

From the analysis of rainfall data as shown in figures 4.5, 4.6 and 4.7 and figure 4.8, it was observed that 2001 has the lowest total rainfall over the11 year period (2001 - 2011) with a total annual rainfall of 996.4mm while 2002 was the year with the highest annual rainfall record of 1549.4mm. The trend analysis reveals that there is no particular trend in rainfall over the period of study in Ado – Ekiti although there is an increase in the total rainfall values of the last two years (2010 and 2011) under study.

Also, According to figure 4.9 and figure 5.0, analysis of data with the Mann Kendalls estimate and Sens estimate for temperature and rainfall in the years of study (2001 – 2001) confirm that there is no particular trend in temperature and rainfall.

Conclusion

Analysis from quantitative and qualitative data provides evidence that there are fluctuations in the rainfall and temperature trend in the study area. Rainfall is fluctuating at an increasing trend within the last two years of the study while temperature is also fluctuating at an

increasing trend within the last two years of the study. The two variables determine the production trends of crops and thus are important factors that should constantly monitored to prevent famine as the majority of people in the study area are farmers.

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APPENDIX

TABLE 1: MONTHLY TEMPERATURE RECORDINGS OF ADO EKITI FROM 2001 - 2011

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
2001	26.22	26.86	27.8	28.4	26	24.42	24.02	21	21.2	21.5	21.8	23.22
2002	22.3	20.1	23.4	28.26	24	25.62	21.32	21.4	23.1	24.6	27.4	21.22
2003	24	25.32	28	25.9	26.52	28.34	26.52	22.4	20.2	23.6	27.4	21.49
2004	26.35	27.45	28.7	27	24.45	24.65	24	20.7	21.3	21.6	21.1	29
2005	16.7	23.1	30.3	29.9	29.3	28.3	27.2	27	27.1	27.5	28.8	29.6
2006	23.1	23.4	22.2	21.8	21.8	21.4	21.8	24.25	24.85	24.85	26.15	24.8
2007	25.35	28.4	28.65	27.95	26.75	25.55	24.9	24.45	26.1	25.15	26.5	25.75
2008	26.8	24.75	27.6	27.05	27.05	25.45	24.9	24.5	25.6	26.2	27.15	26.8
2009	28.25	26.05	11.85	27.05	26.15	25	24.6	25.3	25.3	25.35	26.1	27.05
2010	25.85	25.85	28.2	27.35	26.3	26.1	24.7	24.85	25.45	26.65	25.95	27.6
2011	25.65	28.15	28.65	27.45	27.4	26.55	25.25	24.85	26	26.25	27.65	25.55

Source: NIMET

TABLE 2: YEARLY TOTAL TEMPERATURE OF ADO – EKITI FROM 2001 TO 2011

YEAR	TOTAL TEMPERATURE (^{o}C)
2001	292.44
2002	282.72
2003	299.69
2004	296.3
2005	324.8
2006	280.4
2007	315.5
2008	313.85
2009	298.05
2010	314.85
2011	319.4

Source: NIMET

TABLE 3: AVERAGE TEMPERATURE PER YEAR IN ADO – EKITI FROM 2001 TO 2011

YEAR	AVERAGE TEMPERATURE (^{o}C)
2001	24.37
2002	23.56
2003	24.97416667
2004	24.69166667
2005	27.06666667
2006	23.36666667

2007	26.29166667
2008	26.15416667
2009	24.8375
2010	26.2375
2011	26.61666667

Source: NIMET

TABLE 4: MONTHLY RAINFALL VALUES IN ADO - EKITI FROM 2001 TO 2011

YEAR/ MONTH	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
2001	TR	0.0	70.7	225.0	106.6	125.9	155.1	52.0	185.4	74.5	1.2	0.0
2002	0.0	40.7	121.3	130.1	80.6	272.8	255.6	204.7	236.9	125.5	78.8	2.4
2003	1.1	44.5	30.5	87.3	115.3	158.9	77.4	58.7	320.8	114.0	60.0	0.0
2004	70.4	60.9	12.6	165.9	234.8	183.8	168.2	222.8	177.4	132.7	25.0	0.0
2005	0.0	TR	186.4	85.0	211.4	252.8	219.2	49.5	178.5	113.6	14.2	31.4
2006	31.2	3.6	120.9	108.8	213.7	146.9	192.6	186.5	243.5	126.0	7.0	0.0
2007	0.0	54.1	59.6	58.0	208.4	182.0	179.8	247.1	279.6	200.2	52.2	2.8
2008	0.0	0.0	166.4	48.7	83.8	256.0	258.9	192.1	237.5	196.4	22.5	25.7
2009	27.7	48.9	154.7	227.4	143.0	151.5	198.9	100.5	60.1	136.7	59.4	TR
2010	63.0	25.6	56.7	123.7	147.9	121.2	169.5	287.5	220.5	120.7	58.3	0.0
2011	0.0	88.1	96.1	113.9	144.9	158.2	176.3	172.4	326.0	167.8	25.8	0.0

Source: NIMET

TABLE 5: YEARLY TOTAL RAINFALL IN ADO EKITI FROM 2001 – 2012

YEAR	TOTAL RAINFALL (mm)
2001	996.4
2002	1549.4
2003	1068.5
2004	1454.5
2005	1342
2006	1380.7
2007	1523.8
2008	1488
2009	1308.8
2010	1394.6
2011	1469.5

Source: NIMET