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Analytical Study of the Climatic Trend in the Niger Delta Region of Nigeria

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ABSTRACT

The study examined climatic trends in the Niger Delta region of Nigeria using 1951-2012 climatic data for five synoptic stations in the region. Rainfall, raindays and mean temperature were selected for this study. Second order polynomial, bivariate linear regression analysis and standardized anomalies were used to investigate the annual trends and deviations of climatic parameters from their respective mean. Correlation coefficient was used to ascertain the statistical significance of the trend, the result showed that annual mean temperature revealed an upward trend since 1951 up to 2012 in the region, the observed upward trend are statistically significant at 99% level of confidence (α = 0.01) while rainfall and raindays are not statistically significant. The result of the standardized anomalies of annual mean rainfall in the Niger Delta region clearly depicts a fluctuating rainfall pattern while the standardized anomalies of mean temperature indicated warming in the region, showing more positive deviation from the mean. Although statistical evidences were not enough to conclude that there is a climatic change in the region, it can be concluded that there are pieces of evidence of climate change in the Niger Delta region. Therefore, there is the need to develop the knowledge and skill for early warning about whether events, increasing the network of synoptic weather stations in the region so as to have adequate up to date record of climate and weather indicators available and accessible to researchers and the general public free.

Keyword: Climate Change, Niger Delta, Temperature, Rainfall and Climatic Trends.

1. INTRODUCTION

Climate change and variability is the most important phenomenon in recent times and studies have shown that both anthropogenic and natural factor is responsible for climate change. Some scientists have concluded that increasing human activities such as the use of fossil fuels, unsustainable agriculture, deforestation, forest fire amongst others have added millions of tonnes of green house gases such as carbon dioxide, methane, and nitrous oxide, and are responsible for climate change (Porbeni, 2004; Antilla, 2005;:Mwandosya, 2006; IPCC, 2007; Odjugo, 2007). While natural factor is as a result of natural changes that has occurred on earth over a long period (Ayoade, 2003; Kaser et al., 2004; CSPP, 2005; Akpofure, 2009). These changes have the potential of affecting all natural and human system and may be a threat to human development. Climate change is already impacting on the Niger Delta region of Nigeria as manifested by increased flooding due to rise in sea level, increased temperature due to greenhouse gases. Amid the impact of climatic change, the region is also faced with numerous environmental problems resulting from oil exploration and exploitation activities in the area. The practice of gas flaring in the Niger Delta region remains widespread, violating the rights of local population to healthy environment. This scenario has led to a huge issue in the region considering that gas flaring is a component of climate change that has raised the temperature of the region (Encyclopedia Britanica, 2011). However increasing levels of these gases is the cause of rising global temperatures, resulting in the most severe ecological crisis that the Niger Delta region has witnessed in the whole of human history. According to O'Hare (2002), increase in temperature will cause higher frequency and intensity of extreme weather events such as severe heat and drought, intense rainfall and serious flooding, excessive wind and storm. Increased flooding is already evident in the Niger Delta region and this recurring disaster has left thousands of people displaced in recent times. Though the imminent climate change across the globe which adversely affected Nigeria with the looming danger being posed by the inevitable and inescapable flood has put many Niger Deltans into

untold hardship which those in the coastal communities are grossly affected. Since the upsurge of the flood challenge, economic activities have been totally grounded without immediate solutions to it; over 75,000 Nigerians have been displaced while torrential rains have wrecked serious havoc in the Niger-Delta region thereby disrupting the people's occupation which is farming and fishing (Goodday, 2012). The devastating flood was caused by the discharge of water from Lagdo Dam in Cameroon due to prolonged and high rainfall intensity. As a result of the current trends in temperature and rainfall patterns and the effects outlined above which have been linked to ongoing climate change, various studies have been carried out on the nature of temperature and rainfall over Nigeria (Odjugo and Ikhuoria 2003; Mayowa and Omojola, 2005; Ayuba et a,l 2007; Odekunle, 2010; Odjugo, 2010; Okorie et.al, 2012; Ike et al, 2012), but the Niger Delta region have received little attention. Therefore, there is the need to examine the climatic trend in the region to see whether there is an upward trend or a significant downward trend. It is on this premise that this paper is structured to examine the trends of rainfall, raindays, temperature and the implications of the observed trends in the Niger Delta region

2. MATERIAL AND METHOD

Mean monthly temperature (minimum and maximum) raindays and rainfall data for the following five synoptic meteorological stations in the Niger Delta region: Warri, Ondo, Port Harcourt, Benin City and Calabar were collected from the Nigeria Meteorological Agency (NIMET), Lagos. The climatic data used covered an average of sixty two years (1951 to 2012). The data of the stations were plotted as graph into which two types of trend lines were fitted i.e. the linear regression line and second order polynomial curve; the climatic data were subjected to testing for significance using the correlation coefficient, to ascertain if the climatic trends during the period under consideration are statistically significant. The correlation coefficient is given as;

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{(n\sum x^2) - (\sum x^2)\left(N\sum y^2 - (\sum y)^2\right)}}$$

To analyze annual rainfall and temperature variability, the standardize anomaly index was used.

It was calculated as:

$$z = \frac{x - \overline{x}}{S}$$

Where:
X = annual rainfall/temperature totals and
X = mean of the entire series
S = standard deviation from the mean of the series.
Z= Standardize anomaly index

3. RESULT AND DISCUSSION

(a) Annual mean rainfall in the Niger Delta

The trend of annual rainfall in the Niger Delta region between 1951 and 2012 is presented in figure 1.0. The result of the second order polynomial showed that the annual rainfall in the Niger Delta region experienced a declining trend since 1951 up to 1981 and upward trend thereafter till 2012. The simple bivariate linear regression used to ascertain the significance of the overall trend (1951-2012) as well as the two time slice suggested by the second order polynomial shows that the overall trend is not statistically significant for the entire period under study. Also the computed R^2= 0.004 shows that within the 62 years under study, rainfall decrease in the Niger Delta region is not statistically significant. This is, in line with the report of Schmidhuber and Tubiello (2007) that greater rainfall variability in semi-arid Africa will hinder efforts to enhance food security and combat malnourishment.

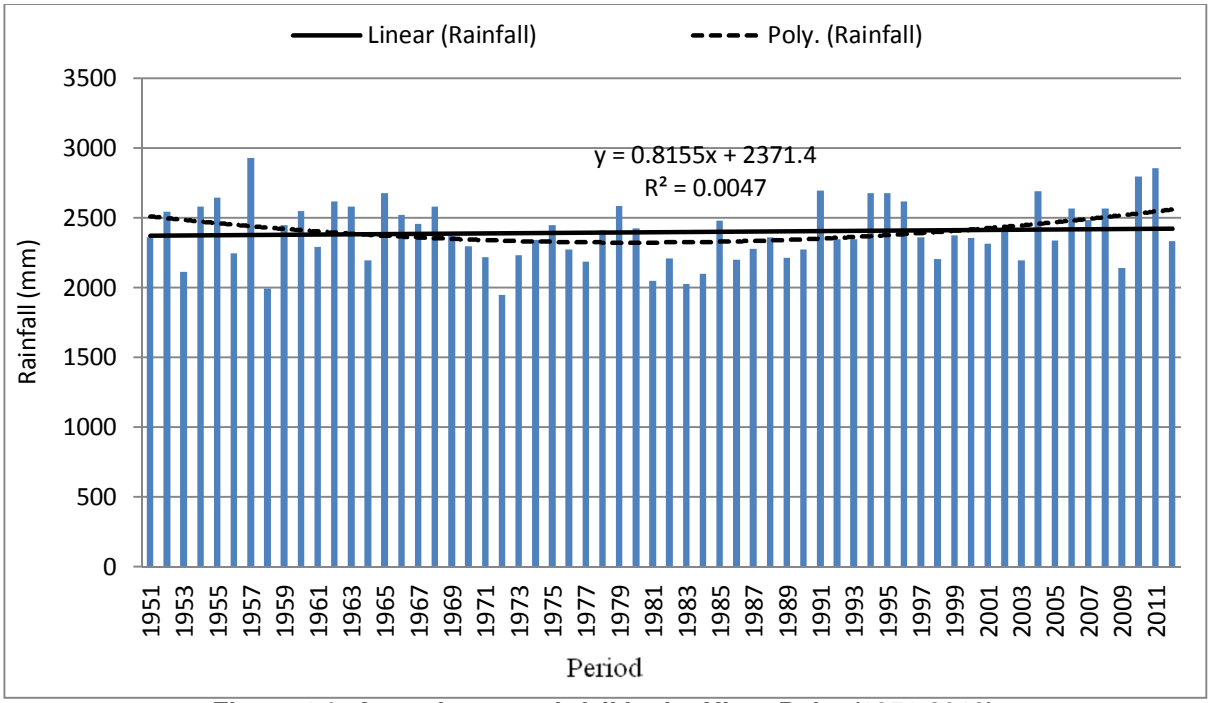

Figure 1.0: Annual mean rainfall in the Niger Delta (1951-2012)

(b) Annual raindays in the Niger Delta Region

Figure 2.0 shows the trend of annual raindays in the Niger Delta region between 1961 and 2012. The result of the second order polynomial showed that, there was a declining trend since 1961 up to 1981 and thereafter upward trend till 2012. The computed R^2= 0.086 showed that within the 62 years under study, raindays increase in the Niger Delta region is not statistically significant.

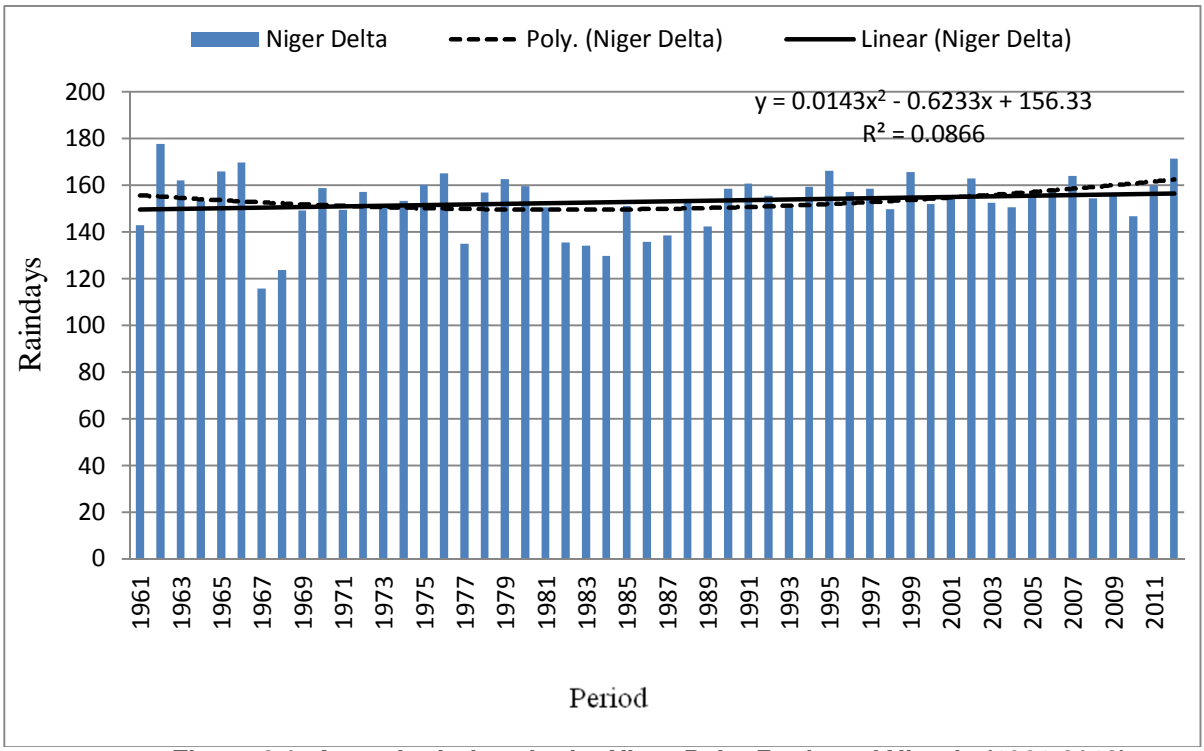

Figure 2.0: Annual raindays in the Niger Delta Region of Nigeria (1961-2012)

(c) Annual mean temperature in the Niger Delta

Fig 3.0 shows the trend of annual mean temperature in the Niger Delta region between 1951 and 2012. The result of the second order polynomial shows that the annual mean temperature experienced an upward trend between 1951 and 2012. The computed R^2= 0.78 shows that within the 62 years under study, the temperature increase in the Niger Delta region is statistically significant. The mean temperature between 1951 and 1981 was 26.56^{0}C while the mean between 1982 and 2012 was 27.18^{0}C. This indicates an overall mean increase of 0.62^{0}C for the two climatic periods in the Niger Delta region. This is slightly lower than the global increase of 0.74^{0}C since instrumental global temperature measurement started in 1860 (IPCC, 2001) and also lower than the temperature increase of 1.7^{0}C in Nigeria (Odjugo, 2011). The reason for lower increase in temperature in this study could be attributed to the duration of the study period. While this study looks at 62 years 1951-2012, others listed looked at longer period of over 105 years covering at least 3 climatic periods of which the late 1800s and early 1900s experienced cooler climate. If this current trend persists, it could lead to climatic change over a long period of years. The observed temperature increase can also be attributed to the growth of cities and increasing human activities in the Niger Delta region of Nigeria.

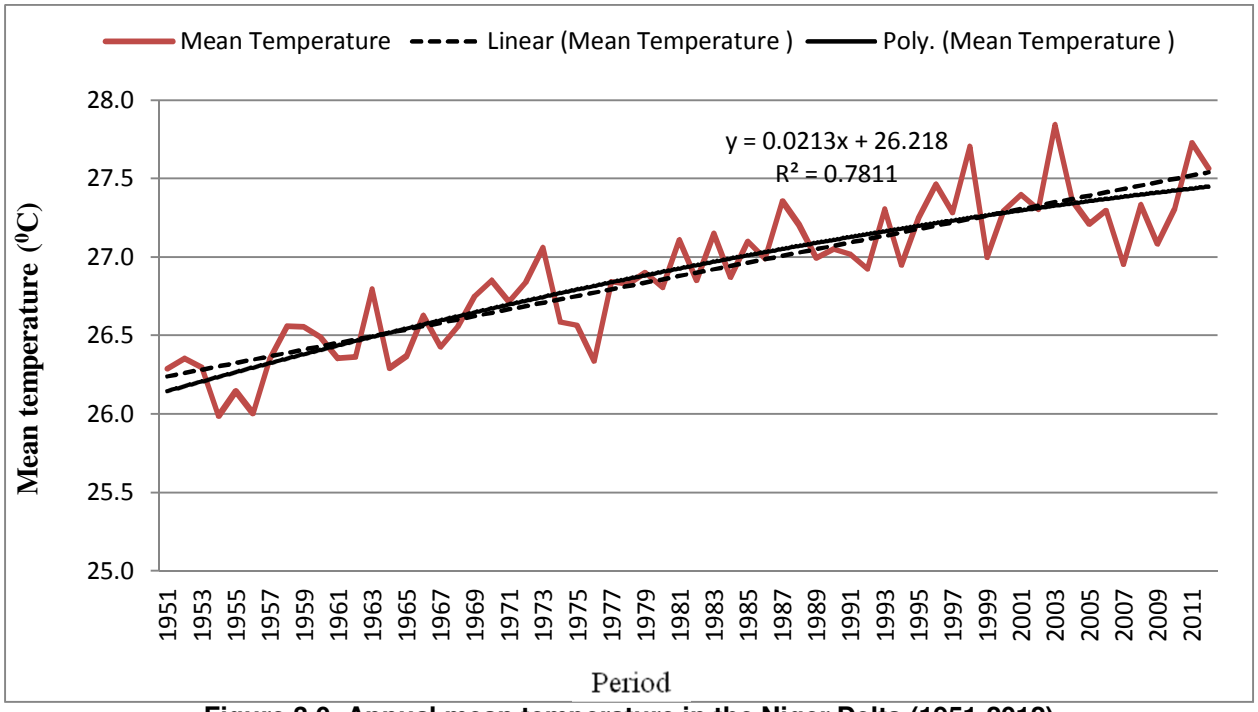

Figure 3.0: Annual mean temperature in the Niger Delta (1951-2012)

(d) Standardized anomalies of annual mean rainfall

The standardized rainfall anomalies for the Niger Delta region as presented in figure 4.0 shows that the first climatic period 16 years were above the mean and 15 years were below the mean while in the second climatic period, 11 and 19 years were above and below the mean. The standardized anomalies revealed that a total of 27 years were above the mean and 34 years below the mean with one year equal the mean. The rainfall trend shows an increasing trend in figure 1.0 which is an indication that rainfall intensity has increased in recent years in the Niger Delta region. This is a clear evidence of climate change because a notable impact of climate change is increasing rainfall in the coastal region (Odjugo, 2005, 2007).

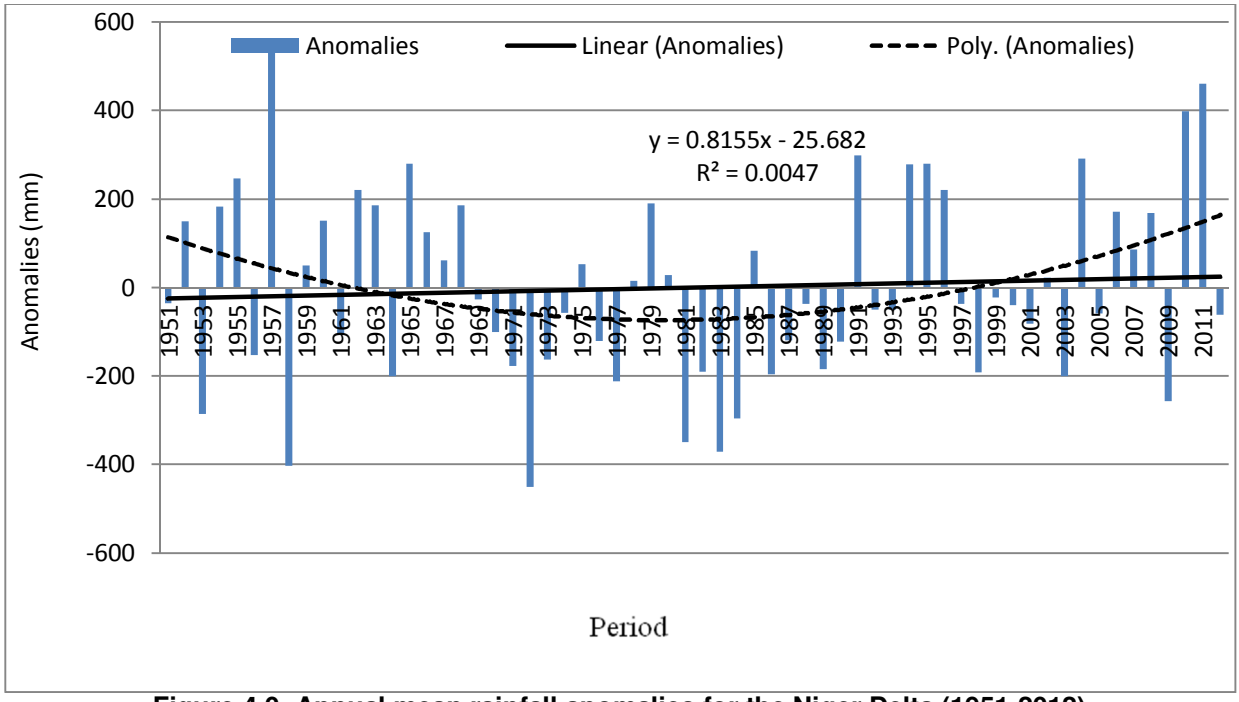

Figure 4.0: Annual mean rainfall anomalies for the Niger Delta (1951-2012)

(e) Standardized anomalies of annual mean temperature

The standardized anomalies of annual mean temperature in the Niger Delta region as presented in figure 5.0 shows that the first time slice was marked with below long term average, while the second time slice was marked above long term averages which indicates warming. In the first climatic period, 2 years were above the mean and 28 years were below the mean while in the second climatic period, 29 and 2 years were above and below the mean temperature. The standardized anomalies revealed that a total of 31 years were above the mean and 30 years below the mean temperature. Between 1951 to1981, time slice temperature was below the 1951-2012 normal temperature in most years and was above normal between 1982-2012 in most years. The temperature anomalies point to the fact that climate change signal is stronger from the 1980s in the Niger Delta region.

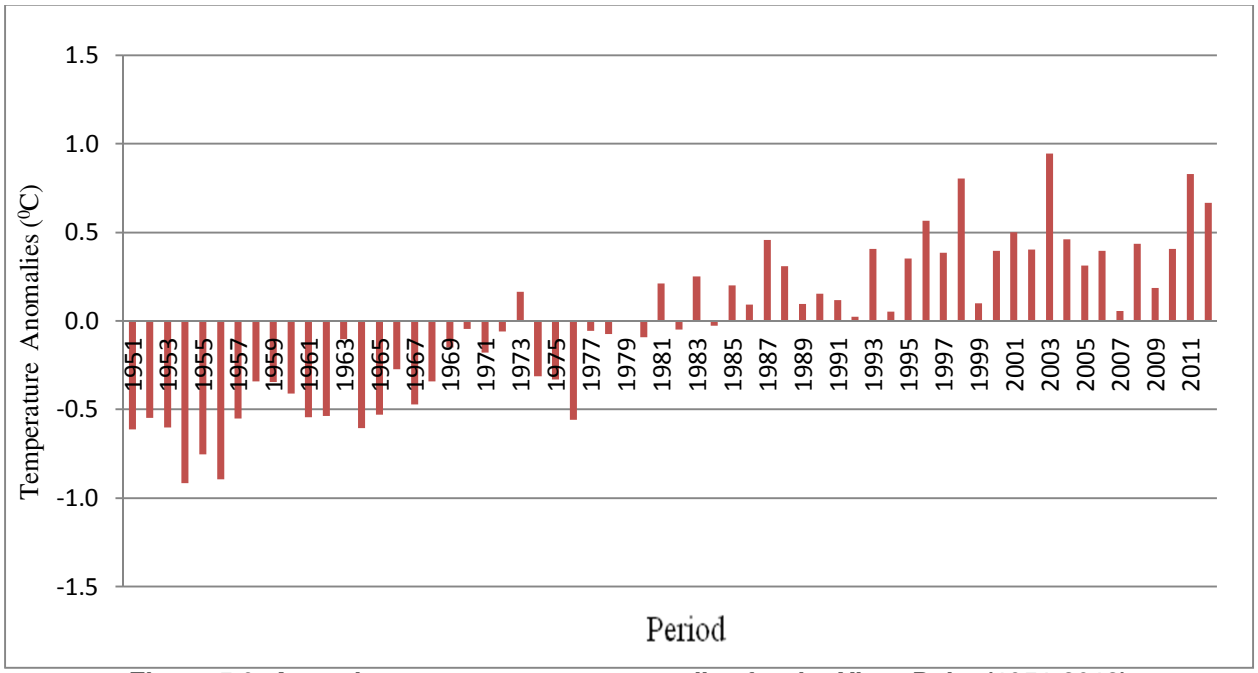

Figure 5.0: Annual mean temperature anomalies for the Niger Delta (1951-2012)

(e) Correlation coefficients of annual trends

Mean rainfall, raindays and temperature series was further subjected to testing for significance using the correlation coefficient. The result in Table 1 shows that there are significant warming trends for Annual Mean Temperature in the period 1951-2012.

Table 1: Correlation coefficients of annual trends of climatic parameters in the Niger Delta

S/N	Climatic parameter	Warri	Ondo	Port Harcourt	Benin City	Calabar
1	Rainfall	-0.207	0. 062	-0. 121	0.214	0.086
2	Raindays	-0. 368**	-0.066	-0. 104	0.094	-0.069
5	Mean temperature	0.533**	0.856**	0.696**	0.757**	0.766**

** Correlation is significant at the 0.01 level (2-tailed).

(IV) CONCLUSION

The trend analysis of annual rainfall and raindays showed a decrease and an increase at different rates in the region while temperature has been on the increase with no sufficient statistical evidence. These climatic fluctuations over the Niger Delta region in the past years could lead to climate change if the current trends persist. The current climatic trends have contributed to climate change, the impact of which are already being felt in the Niger Delta region with the attendant food insecurity, increasing risk of disease, and the rising costs of extreme weather damage such as flooding, sea level rise, land degradation, constant loss of forest cover and biodiversity.

Although, this study has been designed to cover some part of the Niger Delta region, the result obtained which have been highlighted can still be regarded as inadequate for any conclusive generalization to be made about climate change in the region. Hence, it will be more reliable if further consideration is given to more stations in the region and the use of wide range of climatic parameters can still be included in other studies.

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