ANALYSIS OF TEMPERATURE TRENDS AND ITS IMPACT ON RELATIVE HUMIDITY OVER LOKOJA LOCAL GOVERNMENT AREA, KOGI STATE, NIGERIA

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Abstract
Temperature is an important variable which affects man both directly and indirectly. This paper focused on the trends analysis of mean minimum temperature (^oC) and its impact on the mean relative humidity (%) at 0900 hours over Lokoja Local Government Area (LGA), Kogi State, Nigeria; 1971 – 2010 (40 years). The aim of the study was to look at the trends of mean minimum temperature (^oC) and its impact on the relative humidity (%) at 0900 hours, while the objectives include: to analyze the mean minimum temperature (^oC) of the study area, to determine the level of change in the mean minimum temperature over time, and to examine the impact of mean minimum temperature (^oC) on the mean relative humidity (%) 0900 hours. The data were obtained from the Nigerian Meteorological Agency, Lagos. The temperature data were subjected to analysis using the Statistical Package for the Social Sciences other wise called Statistical Product and Service Solutions (SPSS) 16.0 version to obtain mean, minimum, maximum, skewness, skewness std error, kurtosis, kurtosis std error, significant level, Pearson correlation coefficient (r), deviation from mean, variance, standard deviation (std) and range, while the coefficient of variability (CV) was also calculated. On the other hand, the relative humidity data (%) were used to calculate the lowest and highest annual and long – term mean as well as the lowest and highest decadal values. The results were shown in graphs and table. The results revealed that although, the mean minimum temperature over the study area is increasing; but it does not have any positive impact on the relative humidity (%) at 0900 hours. It was therefore recommended that other components of temperature such as the mean maximum temperature and the mean temperature be studied in relation to the relative humidity at 1500 hours and the entire relative humidity.

Keywords: Temperature, minimum temperature, relative humidity, global warming, harmattan

Introduction
Temperature, which is controlled by sunshine, rainfall, cloud cover and wind flow pattern over an area, is an important variable of weather and climate. For instance, Audu and Rizama (2012a) observed that rainfall moderates temperature. This explains why temperature reduces at the peak of wet season as rains, especially heavy and frequent rains serve as a coolant to the atmospheric, environmental and body temperatures. Temperature determines the heat and comfort of living things especially man in an area. Temperature is simply described as the extent to which a place is hot, warm or cold (Audu, 2012d). According to Audu (2012b), among the climatic variables, only temperature probably has short, medium and long term effects on both living organisms and the environment. Audu (2012d) also opined that in Nigeria; diurnal, minimum, maximum, mean, monthly, annual, seasonal and decadal temperatures are not static. The dynamic nature of weather with temperature inconsistency which at present has been confirmed to be increasing not only across Nigeria, but globally is a major source of concern to mankind. For instance, Audu (2012d) observed an increase of 0.34^oc in the mean decadal temperature of Lokoja, 1971 – 2010. According to Audu (2012b), reports of heat waves across the globe are on the increase. Temperature is a natural phenomenon, but controlled by a lot of physical and human factors. However, in recent time; man's activities are influencing the temperature of an area – local, regional and global positively. Audu (2012a), Ojoye and Yahaya

(2008) indicted gas flaring, use of generating sets, numerous vehicular movements and deforestation as contributing to a rise in temperature across Nigeria. Although, the study of macro temperature is very important, but the fact remains that the micro temperature of an area is more important because of its immediate and direct impact on living organisms (of which man is at the focal point) and the environment. Micro temperature is mostly affected by poor town planning, use of generating sets, heavy vehicular movements, high population concentrated in a small and enclosed area and so on, while the macro or global temperature is mostly affected by the atmospheric circulation of wind and ocean currents.
The alteration of temperature upwardly has culminated in what is known as global warming which is one of the global topical issues today thereby leading to climate variability and climate change. The implication is that, all the environmental factors, namely; hydrological system, atmospheric system, ecological system and carbon cycle among others are under going alteration because they are either directly or indirectly or even both controlled by temperature. The study of temperature is therefore important in relation to other atmospheric variables in order to abreast man with the impacts of its dynamism. It is on that note that this research tends to look at the mean minimum temperature (^{o}C) and its impact on mean relative humidity at 0900 hours over Lokoja Local Government Area (LGA), Kogi State, Nigeria.

Aim and Objectives of the Study

The aim of this study is to look at the trends of mean minimum temperature (^{o}C) and its impact on the mean relative humidity (%) at 0900 hours, while the objectives include:

(i) to analyze the mean minimum temperature (^{o}C) of the study area,
(ii) to determine the level of change in the mean minimum temperature over time, and
(iii) to examine the impact of mean minimum temperature (^{o}C) on relative humidity (%) 0900 hours.

Description and Geographical Location of the Study Area

The study area, Lokoja Local Government Area (LGA) is located between longitudes $6^{o} – 7^{o}$ east and latitudes $7^{o}14^{1} – 9^{o}$north. Lokoja derived its name from two (2) Hausa words, a tree and a colour. "Loko", which means "Iroko" and "ja", which means red. So, the name Lokoja means, Red Iroko (tree). Kogi is also a Hausa word which means a flowing river (Kogi Local Government Area brochure, 1993 cited in Audu, 2001; Neil, 1965). Lokoja is the administrative capital of Kogi state and the confluence town of not only Kogi state, but also Nigeria. The study area enjoys both wet and dry seasons with the total annual rainfall between 804.5mm – 1767.1mm, range is about 962.6mm while mean is about 1216.86mm (Audu, 2012c). Mean annual temperature is about 28.03^{o}c (Audu, 2012d) and a relative humidity of 30% in the dry season and 70% in the wet season (Audu, 2001; Yusuf and Agabe, 2010). Average daily wind speed is 89.9 km/hr. Wind speed is usually at its peak in March and April. The average daily vapour pressure is 26 Hpa (Kogi state statistical year book, 1997 cited in Audu, 2001). The most important hydro – geological feature at Lokoja is the River Niger and the confluence of Rivers Niger and Benue (Kogi LGA brochure, 1993 cited in Audu, 2001). At Lokoja, there is a wide flood plain along the lower Niger, which is more than 1,600m wide. The relief rises from about 300m along the Niger valley to between 300 – 900m above sea level in the uplands (Ajibade, 1993 cited in Audu, 2001; Yusuf and Agabe, 2010). The rocks fall within the Precambrian age as well as the various sedimentary rocks. The study area is found in Guinea Savanna with the presence of gallery forest along water courses (Iloeje, 1976 cited in Audu, 2001, Yusuf and Agabe, 2010). The dominant primary activities in the study area are fishing, farming, trading, hunting with low percentage of tertiary activities (Yusuf and Agabe, 2010). The area is another tourist haven in Nigeria, but only little attention is paid to this at present. The major means of transportation is by road. Although, the largest river in Nigeria is found here; but under – utilized for transportation. Due to the hilly nature of the area, cable car is also another possible means of transportation. In terms of population, the study area had a total population of 82, 483 in 1991 (NPC, 1991), while in 2006, the population stood at 196,643 (National Population Commission, 2006). Between 1991 and 2006, the study area observed an increase in population of 114, 160.

Lokoja LGA of Kogi State comprises of many indigenous ethnic groups such as the Hausa, Egburra, Nupe, Kupa, Kakanda, Ganagana, Oworo and Bassa.

Methodology

The data used were the mean minimum temperatures (^{o}C) and relative humidity (%) at 0900 hours of Lokoja LGA from 1971 – 2010 (40years) obtained from the Nigerian Meteorological Agency, Oshodi, Lagos. The temperature data were subjected to analysis using the Statistical Package for the Social Sciences other wise called Statistical Product and Service Solutions (SPSS) 16.0 version to obtain mean, minimum, maximum, skewness, skewness std error, kurtosis, kurtosis std error, significant level, Pearson correlation coefficient (r), deviation from mean, variance, standard deviation (std) and range, while the coefficient of variability (CV) was calculated using the formula:

$$\frac{\bar{X}}{SD} \times \frac{100}{}$$

Where:

$\bar{x}$ = mean

SD = standard deviation

100 = percentage

On the other hand, the relative humidity data (%) were used to calculate the lowest and highest annual and long – term mean as well as the lowest and highest decadal values. The results are shown in graphs and tables, while discussion of results was done with useful suggestions offered.

Results and Discussion

According to the results, the lowest annual mean minimum temperature in the study area occurs in December (19.37^{o}c), while the highest occurs in March (25.55^{o}c). The mean annual range is 6.18^{o}c which indicates moderate variability of mean minimum temperature. Figure 1 shows the mean annual minimum temperature (^{o}c) and relative humidity (%). The graph shows an increasing temperature from January to March with a little decline in April following the onset of the rains and continues to decline as the rains become more regular and intense until October when it increases a little due to the cessation of the rains and starts declining from November due to the advent of harmattan until it gets to its lowest ebb in December when harmattan becomes more intense. Both the mean annual and long term mean is 22.85^{o}c. On the other hand, the lowest relative humidity is observed in February (59.20%), while the highest is recorded in September (81.63%). Therefore, annual mean minimum temperature (^{o}C) has no positive impact on the annual mean relative humidity (%) at 0900 hours.

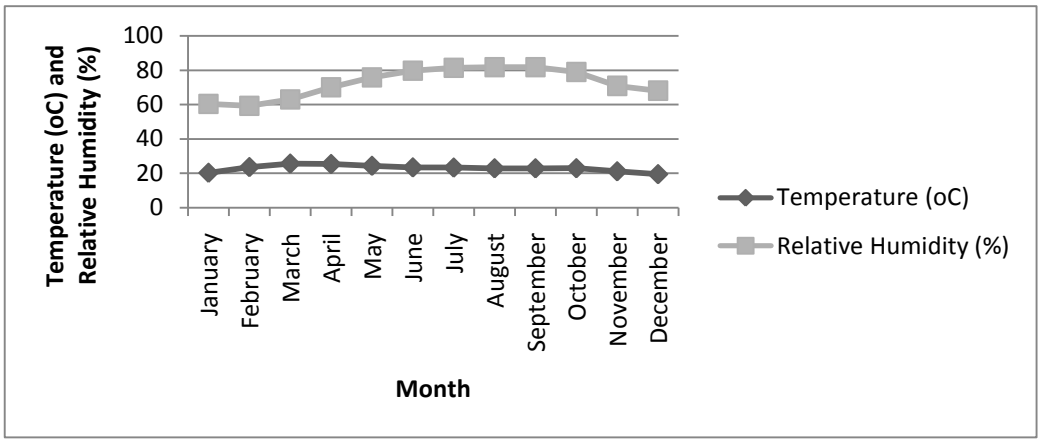

Figure 1: Mean annual minimum temperature (^{o}c) and Relative Humidity (%) of Lokoja from 1971

– 2010

Source: Authors' computation (2013) from NIMET data

Further, the long term lowest mean minimum temperature is about 21.38°C recorded in 1989, while the highest is 24.26°C and occurred in 2001. The long term range is as small as 2.88°C which indicates low variability over a long period of time. The linear trend also confirms that for the greater part of the year, temperature is above the trend.

The variance is 0.33, std is 0.57; skewness is 0.092; skewness std error is 0.374; kurtosis is 0.534; kurtosis std error is 0.733; CV is 2.45%; the correlation coefficient (r) is 0.47 meaning medium relationship and 2 – tailed significant (at 0.01 level) is 0.002. The model summary results show that r is 0.47; r^2 is 0.22; adjusted r^2 is 0.20 and std error of the estimate is 10. 466. These values are small so confirmed medium variability in the mean minimum temperature of the study area. Figure 2 confirms low variability over time series with a decline in 1989 when the long term lowest mean was recorded and a peak in 2001 when the highest was recorded. Again, from 1971 to1989, temperature values were mostly between 22°c and 23°c; but from 1990, the values were between 22.5°c and 24°c except for the sharp decline in 2007. There is also an upward trend in long term mean minimum temperature mostly from 1991 to 2010 attributable to human activities which are on the increase. The relative humidity (%) attributes show that 1992 recorded the lowest of 62.33%, while 2009 recorded the highest of 76.50 (%). These analyses have also shown that the long term mean minimum temperature (°C) has no positive influence on the relative humidity (%) at 0900 hours over the study.

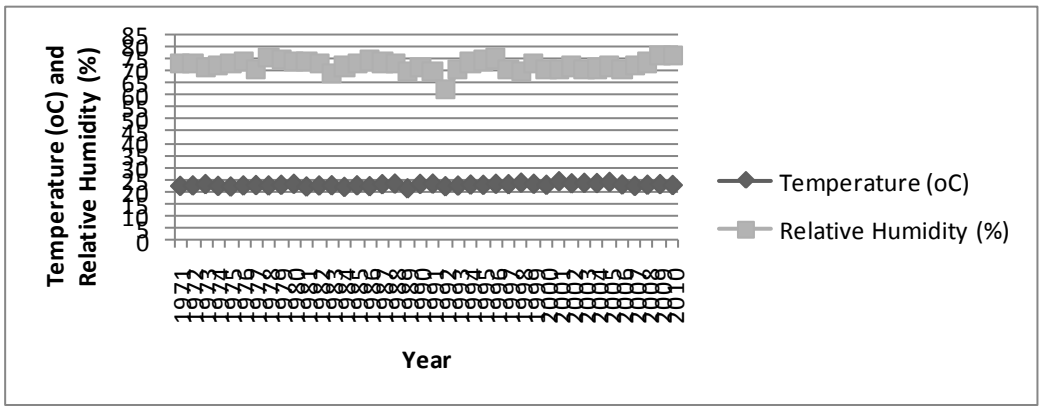

Figure 2: Time series of mean minimum temperature (°C) and relative humidity of Lokoja, 1971 –

2010

Source: Authors' computation from NIMET data.

The annual deviation from mean temperature shows that March has the highest positive value of 2.69°C meaning that, it is the hottest month; October's value is 0°C meaning indifference; while December has the lowest negative value of -3.49°C signifying the coldest month considering only the mean minimum temperature. On the other hand, the relative humidity shows that September has the highest positive deviation from mean while February has the lowest (Figure 3). Hence, there is no positive relationship between these two (2) variables.

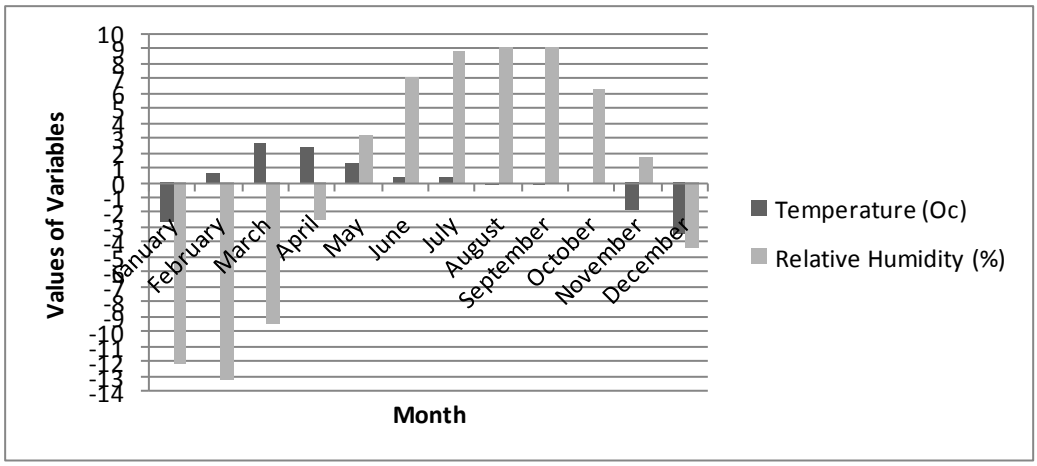

Figure 3: Annual Mean Temperature Deviation from Mean in Lokoja, 1971 – 2010
Source: Authors' computation from NIMET data

The highest temperature (^{o}C) long – term negative deviation from the mean which is -1.48^{o}C was recorded in 1989, while the highest positive deviation of 1.40^{o}C was recorded in 2001. From these two (2) values therefore, the value for the highest negative deviation from mean is higher by -0.08^{o}C than the highest positive deviation. Further, within the series, twenty – two (22) years had negative deviation from the mean, while eighteen (18) years had positive deviation from the mean. Also, years of negative deviation from mean seems to occur in sequence in most cases but broken by positive deviation. In other words, the negative and positive deviations occurred alternately over few years depicting variability in mean minimum temperature (Figure 4). From 1994 to 2010, the deviation is mostly positive. For instance, out of seventeen (17) years (1994 - 2010), thirteen (13) years experienced positive deviation from the mean while only four (4) years had negative deviation. On the other hand, the highest long term negative deviation from mean for relative humidity occurred in 2009 with the value of 4.01%, while the lowest occurred in 1992 with the value of -10.16%. Within the forty (40) years of study, only 1977, 1983, 1984, 1989, 1992, 1993, 2000 and 2007 recorded negative deviations in both variables, but even at that; the values are not close at all. Further, 1978, 1980, 1987, 1994, 1995, 1996, 1999 and 2009 recorded positive deviations in both variables and again the values are not close. Other years have their positive and negative deviations differently with their values varying considerably. This again confirms that the minimum temperature of the study area has no positive influence on it's the relative humidity at 0900 hours.

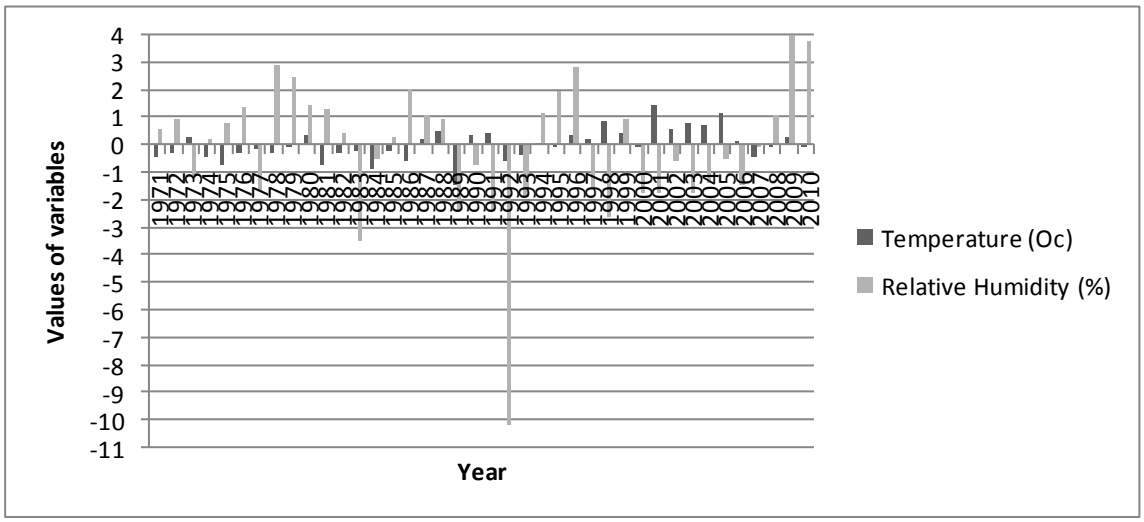

Figure 4: Long – term deviation from mean Temperature (^{o}C) and Relative Humidity (%) of Lokoja, 1971 2010.

Source: Authors' computation (2013) from NIMET data

Table 1: Mean Decadal Minimum temperature (^{o}C) and Relative Humidity at 0900 hours for Lokoja, 1971 - 2010

Decade	Range	Temperature (^{o}C)	Relative Humidity (%)
1st	1971 – 1980	22.65	73.23
2nd	1981 – 1990	22.51	72.38
3rd	1991 – 2000	22.98	71.13
4th	2001 - 2010	23.29	72.63

Source: Authors' computation (2013) from NIMET data

From table 1, it could be observed that the decadal mean minimum temperature is increasing especially from the 3nd decade which is attributable to human activities such as rapid urbanization, heavy vehicular movement, diminishing vegetation, massive road construction among others occasioned by the creation of Kogi State in 1991 with Lokoja as the Capital. The highest decadal mean temperature was recorded in the 4th decade, while the lowest occurred in the 2nd decade. On the contrary, the highest decadal mean relative humidity was recorded in 1st decade, while the lowest was recorded in 3rd decade.

Conclusion

In conclusion, it has been established that the mean minimum temperature (^{o}C) of Lokoja LGA, Kogi state, does not have any positive impact on the mean relative humidity (%) at 0900 hours because both the increases and decreases recorded in both variables occurred at different times.

Recommendations

The increase in temperature across Nigeria is expected to influence weather variables. Hence, it is highly recommended that further researches should be conducted on the impact of mean maximum temperature (^{o}C) of the study area on the mean relative humidity (%) 1500 hours to observe if there is any positive relationship. Also, studies should look at the influence of mean temperature of the study area and its impact on the mean relative humidity. It is only through this holistic approach that a perfect conclusion can be drawn on which components of temperature has positive impact on relative humidity.

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