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TRENDS AND VARIATIONS OF SOLAR RADIATION WITH RELATIVE HUMIDITY IN YOLA, ADAMAWA STATE, NIGERIA

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ABSTRACT

The trends and variations of two meteorological parameters in Yola were analyzed in this paper. The basic aim is to identify possible trends and variations, and examine the statistical characteristics of solar radiation with relative humidity for a period of ten years (2001-2010) for Yola, Adamawa State. Regression analysis was employed. The Validation of the results using person coefficient for monthly mean relative humidity was r = 0.901, r^2 = -0.811 and P- value of 0.001, while for yearly mean relative humidity, the values are r = 0.619, r^2 = -0.383 and P- value of 0.247. From the analysis, relative humidity is at its lowest peak in the month of March (29.4%) while solar radiation was at its highest peak of 21MJ/m^2/day. Humidity increases from the month of April due to the onset of raining season. This gradually increases as it attains its maximum peak between the month of July and September which is the raining season from the month of October solar radiation is seen to have increased and relative humidity decreased due to retreat of raining season.Based on the validated results, it is therefore clear that regression analysis can be used to estimate variations and trends of solar radiation with relative humidity in Yola and other locations with similar climatic factors.

Keywords: Variations, trends, solar radiation, relative humidity, regression analysis.

I. INTRODUCTION

Climate and weather information are important in agriculture, aviation, water resources management, health, electric power generation, road and marine transport etc. The profound influence of weather and climate over human activities can be regulated to a reasonable extent by how we live and nurture our environment. The classical approach to weather and climate studies focuses on those surface variables that affect our daily lives such as terrestrial solar radiation, minimum and maximum air temperature, wind speed and direction, rainfall, humidity, sunshine, aerosol concentrations and evapo-transpiration, etc. These are the variables mostly measured by a large number of weather stations around the world on daily basis. They represent an important step in understanding and predicting weather and climate changes.

Solar radiation is a radiant energy emitted by the sun from a nuclear fusion reaction that creates electromagnetic energy (Medugu, 2014).It is the dominant, direct energy input into the terrestrial ecosystem; and its affects all physical, chemical and biological processes. It is world most abundant and permanent energy source.The amount of solar energy received by the surface of the earth per minute is greater than the energy utilization by the entire population in one year. The sun is the driving force for all atmospheric processes. It provides a natural influence on the earths' atmosphere and climate (Austin *et al*, 199).A seasonal and spatial variation in energy exchange experience in climate depends on the variations in the interaction between the earth and the atmosphere (Stone, 1955; Sutchliffe, 1956).Though all aspect of the earth climatic indices such as rain, humidity, temperature, wind, cloud etc are the result of energy transfers and transformation within the earth (Green, 1956). The seasonal variation of the solar radiation and how the axis of the earth is tilted to the plain of its angle at which the solar radiation strikes the earth surface varies from season to season (Frohlish andLondan, 1985; Battan, 1979).

The Northern hemisphere receives more solar energy in June, July and August and therefore warmer than in December, January and February when it receives less (Budgko, 1963). Temperature, Relative Humidity and Rainfall are attributes of human environment most generally recognised by their important roles as determinants in climate and weather.Weather is generally considered as the state of the atmosphere at a given location (Barry and Chorley, 1976). It may also be referred to as the aspect of the atmospheric state which is visible and affect human activities. The weather condition of any given location is often described in terms of the meteorological elements

which include the state of the sky, temperature, precipitation, humidity etc. These factors initiate and influence the atmospheric processes (Ayoade, 1993).

A study of the trends under local climate is indispensable given the highly variable nature of climate in space and time. Different approaches abound in the literature on trend detection. Several researchers have used linear regression method to search for trends in many climatic time series (Hutchinson 1995; Subbaramaya and Bhanu-Kumar, 1987). However, the non-parametric test has been proved to be superior to the parametric tests in trend studies (Turkes*et a*l 2009; Zhihua*et al*., 2013; Brunetti *et al*., 2001; Eris and Agiralioglu, 2012, Karaburun*et al*.,2011; Ustaoglu, 2012, Karabulut*et al*., 2008).

On the whole, recent studies on climate change have focused mainly on long-term variability of temperature and rainfall which are, however, the most important climate change indicators. Other important climate factors controlling energy and mass exchange between terrestrial ecosystem and atmosphere such as relative humidity has received less attention. Relative humidity is incorporated in this work to study its potential trends or otherwise vis-à-vis the two most widely studied weather elements. The aim and objectives of the present study is to evaluate the seasonal and annual variations in the meteorological elements under study, identify trends and trend significance for the period under study using the Pearson correlation coefficient and give essential information on the descriptive statistical features of the parameters under analysis.

II. MATERIALS AND METHODS

Materials

Daily data of solar radiation and relative humidity for the area under study were collected for the period of 2001-2010 from the Nigeria meteorological Agency, National Weather Forecasting and Climate research Centre, Yola-Nigeria. Monthly mean of these parameter were then obtained from the collected data.

Methods of computation

After collecting the data and filling the statistical data gap, the climatic elements were monthly and annually calculated. To find out the trends associated with these parameters (variables), simple graphical methods were adopted to analyse the trends of variation and a time series correlation analysis was used.

Regression Analysis

A regression is a simple statistical analysis assessing the association between two variables. It is use to find the relationship between two variables, it is expressed as:

Regression eqn (y) = a + bx + e (1)

Where,

x = independent variable

y = dependent variable

b= the slope of the regression line

a= the intercept point of regression on the y-axis

e= error

Pearson Correlation Coefficient

Pearson correlation is a statistical formula that measured the strength between variables and relationships. In order to determine the relationship between the variables , a coefficient value must be produced. The value can range between -1 to +1. If the range value is -1, then the relationship between variables is negatively corrected or as the value increases the other decrease but if r is positive then it means that the relationship is positively correlated or both values increase or decrease together.

Pearson correlation r is expressed as:

$$r = \frac{n\Sigma xy - \Sigma x \Sigma y}{\sqrt{n\Sigma x^2 - (\Sigma x)^2} \times \sqrt{n\Sigma y^2 - (\Sigma y)^2}} \quad (2)$$

where:

r= Pearson Correlation Coefficient

x= Independent Variable

y= Dependent variable

n= no. of values or pairs of data.

III. RESULTS AND DISCUSSIONS

Table 1 shows the calculated value of Mean of Solar Radiation and Mean Relative Humidity across the months. The trend chart and correlation chart are shown in Figures 1.0 and 1.1 respectively.

Table 1: Calculated Mean of Solar Radiation and Monthly Mean Relative Humidity

Months	Mean Solar Radiation ($MJ/m^2/day$)	Mean Relative humidity (%)
January	18.3	37.1
February	20.1	32.4
March	21.0	29.4
April	20.3	46.1
May	18.0	65.0
June	17.0	76.2
July	15.6	80.2
August	14.6	84.3
September	16.5	84.1
October	18.9	77.1
November	20.1	55.4
December	18.8	43.1

Source: NMA, Yola

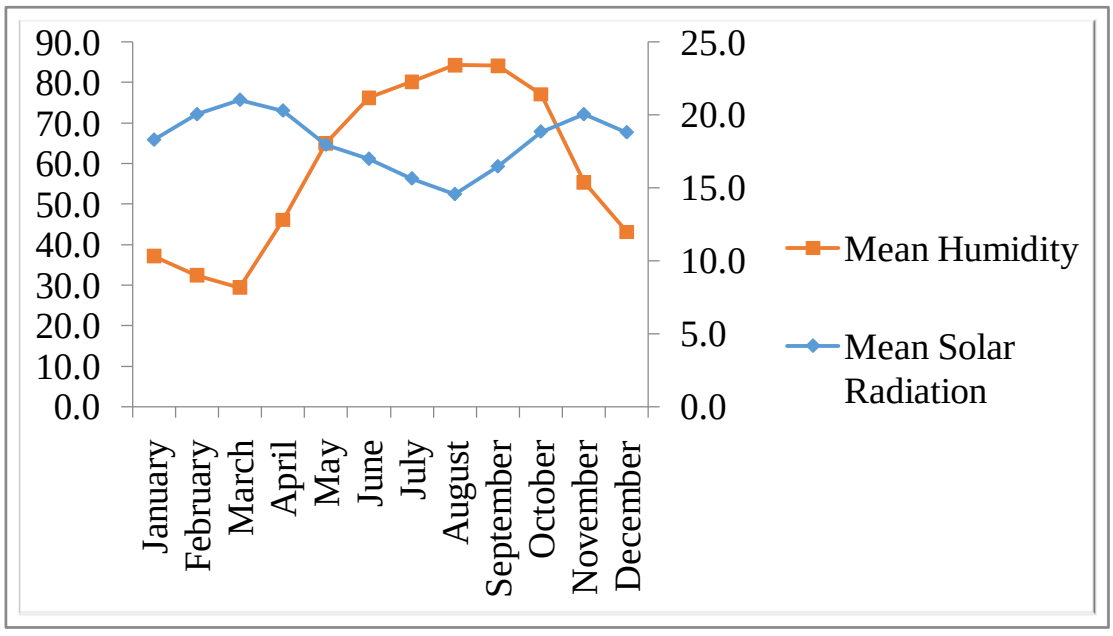

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Figure 1: Monthly Mean of Solar Radiation and Mean Relative Humidity

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Table 2: Calculated Value of the Mean of Solar Radiation and Yearly Mean Relative Humidity

Year	Mean Solar Radiation (MJ/m2/day)	Mean Relative Humidity (%)
2001	20.3	58.42
2002	20.0	59.17
2003	19.2	58.33
2004	18.6	59.25
2005	17.4	59.92
2006	17.8	57.83
2007	17.5	61.25
2008	17.2	60.92
2009	17.7	57.83
2010	17.0	59.08

Source: NMA, Yola.

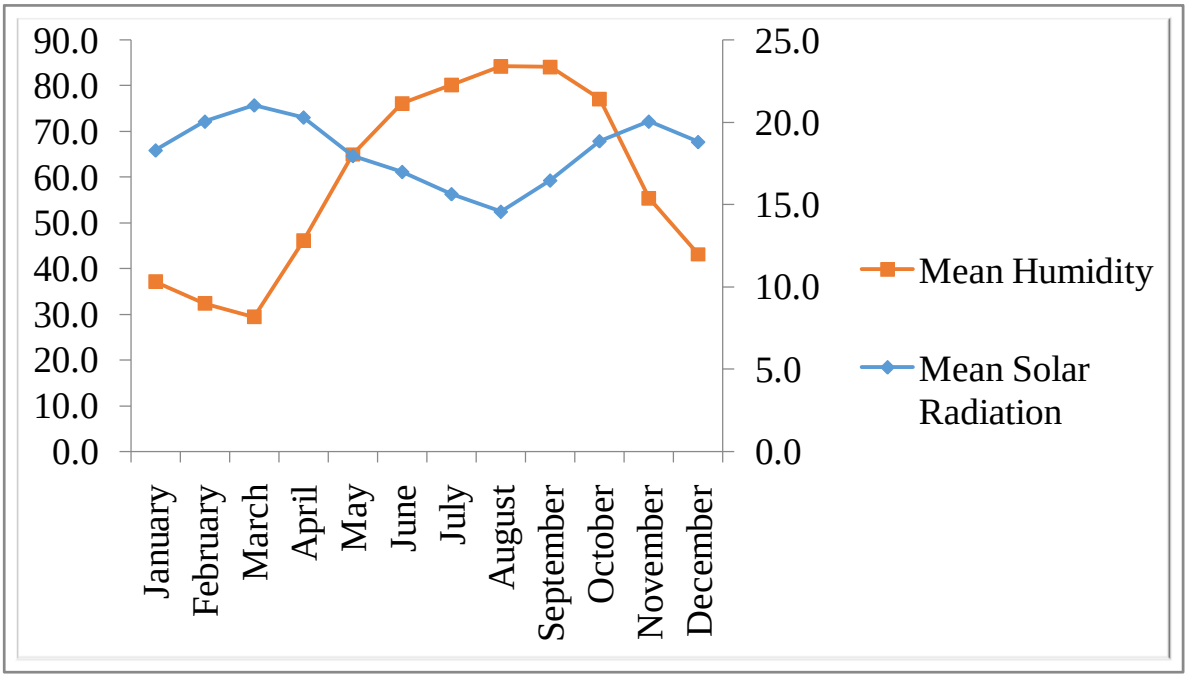

Figure 2: Yearly Mean of Solar Radiation and Mean Relative Humidity

Table3: Correlation between Mean Solar Radiation and Monthly Mean Relative Humidity

Meteorological Parameter	Mean Solar Radiation (Pearson Correlation value) r	Mean Solar Radiation (Pearson Correlation Coefficient) r^2	P-Value
Mean Humidity	0.901	-0.811^{**}	0.001

Table4: Correlation between Mean Solar Radiation and Mean of Relative **Humidity(2001-2010)**

Meteorological Parameter	Mean Solar Radiation (Pearson Correlation Value) r	Mean Solar Radiation (Pearson Correlation Coefficient) r^2	P-Value
Mean Humidity	0.619	-0.383	0.274

From Figure 1and 2 Relative humidity is at its lowest peak in the month of March (29.4%) while solar radiation was at its highest peak of 21MJ/m^2/day. Humidity increases from the month of April due to the onset of raining season. This gradually increases as it attains its maximum peak between the month of July and September which is the raining season from the month of October solar radiation is seen to have increased and relative humidity decreased due to retreat of raining season.The level of relative humidity recorded in 2001stood at an average of 58.42% and increase to 59.17% in the ascending year (2002). However, relative humidity recorded its peak in 2007 (61.25%), the year 2006 and 2009 showed the lowest mean value of 57.83% each. The relative humidity also shows a negative relationship with a correlation coefficient value of 0.383 and P value of 0.274.

IV. CONCLUSION

The evaluation of the decadal yearly and monthly mean values of solar radiation with some meteorological parameters that is temperature, relative humidity and rainfall amount in Yola demonstrates the existence of marked trends in the parameters for the station. The yearly trends displayed in figure 1 and 2 shows that highest relative humidity was recorded in 2007. Proper knowledge of solar activities as it relate to some meteorological or climatological parameters is paramount as it helps us understand the effect of this relationships on our everyday life and the factors that might be responsible for such variations. Thus, this study is of great importance in providing us with helpful information in the prediction of natural processes that occur in the atmosphere.

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