ISSN 2229-5518

# Investigation of the Relative Humidity Profile Variations in Calabar, Nigeria.

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**ABSTRACT: T**his paper focusee on the Investigation of the Relative Humidity Profile Variations in Calabar, Nigeria. Base on available data, simple descriptive analysis was employed. The results among others show that, Relative Humidity Profile Variations is one of the Climatic factor that can indicate Climate change. Using the relationship of the expression In equation (1) $\{\mathbf{R.H} = \frac{w}{ws}\ \mathbf{X\ 100}\}$, the values of Relative humidity for January to December in Calabar (2003 - 2012) was derived by NIMET Calabar using Dry & Wet Bulb Thermometer. The results of relative humidity during the period of study shows a variations over the years and exceeded 65%, except for January 2007. Studies show that, Stations within the tropical rainforest always have high relative humidity throughout the year. Calabar happens to be one of this stations, its item exceed 70% in all months. The Relative Humidity per year also varies inconsistently over the years. The hihgest total Relative Humidity was observed in July and August 2011, while the lowest is 61 in January (2007) with these impacts, the research work therefore recommends further studies in the area which enhance predictability as well as help in studies on global heating and climate change.

**Key Words:** Temperature, Humidity, climate , Variations and Calabar.



## INTRODUCTION

Calabar is the capital of Cross River State. It is located at the Southern part of Cross River State. Calabar is located between longitudes $8^0 17$ E and $8^0\ 2^0$E latitudes $4^0\ 5^0$N and $5^0 1^0$N. Calabar metropolis comprises of Calabar Municipality and Calabar South Local Government Areas and covers an area of about 1,480 Sq km. Calabar is sandwiched between the Great Kwa River to the East and the Calabar River to the West. The presence of urban area is on the eastern bank of the Calabar River; its growth to the south is hindered by the mangrove swamps. Calabar falls within tropical equatorial climate with high temperature, high relative humidity and abundant annual rainfall. Two major air masses affect the climate of Calabar as well as other contiguous locations in the West African region. The Tropical Maritime (mT) and the tropical continental (cT) air masses affect the climate in two distinct seasons. mT air prevails and influences its moisture characteristic while the cT air influences the dry season condition due to is desert source across the two air masses at the upper troposphere from east to west, Oladipo, (1995), Osang et al (2013), Dougas et. al. (1985), Ojar et. al. (2014).

The aim of this research work is to present some simple but quantifiable ideas concerning the way in which the atmosphere's population of unsaturated air emerges from the interplay of transport and condensation. The various incarnations of this idea that will be discussed in this research work account for the prevalence of dry air, offer some insight as to how the relative humidity distribution may change in response to a changing climate, and yield some diagnostic techniques that can be used as a basis for comparing moisture-determining processes in models and the real world.

**Relative Humidity**

Relative humidity is the ratio of the partial pressure of water vapor in an air-water mixture to the saturated vapor pressure of water at a prescribed temperature, Oladipo, (1995), IPCC, (2007), Kalnay et.al. (1196). The relative humidity of air depends on temperature and the pressure of the system of interest. Relative humidity is an important index in climate change considerations. Climate change is now a common feature even in ordinary village discussions, Osang et al., (2013b) Pierrehumbert et al., (2007), Gohil et al (2013); Tompkins et al (2000). Water vapour content of air is termed humidity. The capacity of air to hold water vapour is primarily a function of temperature, and pressure of both the water vapour and air are the same, Soden & Bretherton (1993) NOAA (2008). Warmer air has a greater capacity for holding water vapour than cooler air, Shine & Sinha (1991). Relative humidity is the ratio (expressed as a percentage) of the amount of water vapour actually in the air to the maximum water vapour the air can hold at a given temperature, Danh et. al. (1999), Dougas et.al. (1985). If air is relatively dry compared to its capacity, the relative humidity percentage is low, if it is relatively moist, the percentage is high, Knutti et.al. (2003). Relative humidity varies because of evaporation, condensation and temperature charges, Pierrehumbert et al., (2007), NOAA (2008), Osang et al., (2014), Ettah et al., (2012), Obi et. al. (2013), Shank, (2006).

$$R.H = \frac{W}{WS} \; X \; 100 \qquad 1$$

Where:-
RH is the relative humidity With respect to water (expressed as a persentage)
W is the ratio of the mixing ratio
$W_S$ is the saturated mixing ratio with respect to water at the same temprature and pressure.



**Mixing Ratio (w)**

This is the mass of water vapor per unit mass of dry air. It is measured in grams/Kg. Which is represented in equation 2

$$W = \frac{Mv}{Md} \qquad 2$$

Where:-
W is the ratio of the mixing ratio
$W_V$ is the mass of water vapor
$M_d$ is the mass of dry air

Climate control refers to the control of temperature and relative humidity for human comfort, health, and safety; for the technical requirements of machines and processes; and in buildings, vehicles, and other enclosed spaces, Pierrehumbert et al., (1998), (2007), Chantasut et. al (2011). Humans are sensitive to humid air because, the human body uses evaporative cooling, enabled by perspiration, as the primary mechanism to rid itself of waste heat, Ewona, & Udo (2008). The rate at which perspiration evaporates on the skin under humid conditions is lower than under arid conditions. Because humans perceive a low rate of heat transfer from the body, the same as a higher air temperature, the body experiences greater distress of waste heat burden at a lower temperature with high humidity than at a higher temperature at lower humidity, Ewona, et. al. (2013). Humans can be comfortable within a wide range of humilities depending on the temperature — from thirty to seventy percent. But ideally between 50% and 60% .The relative humidity of an air-water mixture is defined as the ratio of the partial pressure of water vapor ($H_2O$) in the mixture to the saturated vapor pressure of water at a given temperature, Gohil et al., (2014), Osang et al., (2013a).

Water is a nearly a miraculous molecule that enters into the operation of climate system in a remarkable variety of ways, Raymond et al (2007); Pierrehumbert et al., (2007). Man's survival has been dependent on his innate curiosity to examine by trial and error all aspects of his environment, and as such, every society tries to make meaning out of its surrounding environment, Gohil et al., (2014), Agbor et. al. (2014), Chayanis et. al. (2003) .

The relation between man and climate is reciprocal in the sense that man responds to variations in climate or verious ways such as insulating buildings, heating and air-conditioning, Spencer & Braswell (1997). Man's aim is to be comfortable despite the climate, and this gives rise to the notion of thermal comfort Ettah et al (2012). Thermal comfort has been studied since the start of 20th century, and improvements in building techniques, as well as discoveries in central heating and air conditioning systems have led to improved comfort in indoors, even in the hottest and coldest climates, IPCC, (2007). Several indices of comfort and mathematical models to predict thermal comfort and discomfort have also been developed, Pierrehumbert et al 2007; Osang et al., 2013., Ettah et al., 2012.



For most indoor conditions, the efficiency of a person or group of people has been described 'as being bound up in the climatic conditions in which they work and live' argued that buildings are designed to suit the climate within which they are located and the functions for which they are intended, (Ettah et al., 2012), Osang et al., (2013d). This, however, is probably untrue for most developing countries, especially in areas with planning problems. Several investigators have also shown that variation in the heat indices, especially temperature, have significant relations with human mortality and prevalence of certain diseases, IPCC, (2007), Ettah et al., 2012; Gohil et al., 2014.

The young children, elderly and pregnant women are often considered to be particularly vulnerable to temperature extremes that can cause cardio-respiratory and skin diseases, Gohil & Mathur, (2013). With global increase in temperature, especially from the 1960s and the tendency for further warming, as well as the concern for the increased urbanization in developing countries, concerns for thermal comfort have become important in the programme of the World Meteorological Organization (WMO) Gohil *et al.,* (2014), Ewona & Udo, (2008).

Studies on temperature and humidity have showed the relevance of climate and weather to human health migration, retirement, tourism and energy requirements. Significant changes in Relative humidity have occurred both in pattern and seasonality, Ewona et al., 2013, Pierrehumbert et al 1998, 1999, 2007; Ettah et al., (2012). The radiative effects of atmospheric water vapor on climate, and with the kinematics of how the water vapor distribution is maintained (Raymond et al 2007; Gohil et al 2014). These effects are important because feedbacks due to changes in atmospheric water vapor amplify the climate system's response to virtually all climate forcing, including anthropogenic and natural changes in $CO_2$, changes in solar luminosity, and changes in orbital parameters, Igwe et.al. (2013), (Pierrehumbert et al., 2007; Osang et al., 2013; Obi et al., 2013).

In contrast to cloud feedbacks, which differ greatly amongst general circulation models, clear-sky water vapor feedback is quite consistent from one model to another. Essentially all general circulation models (GCMs) yield water vapor feedback consistent with that which would result from holding relative humidity approximately fixed as climate changes. This is an emergent property of the simulated climate system; fixed relative humidity is not in any way built into the model physics, and the models offer ample means by which relative humidity could change, (Gohil et al 2014; Ewona et al., 2013; Pierrehumbert et al., 1998, 2007), Osang et al., (2013c).

## MATERIALS AND METHODS

### Data Source:

The Data for Relative Humidity (%) which Cover a period of ten years (January 2003 to December 2012), were collected from the Nigerian Meteorological agency (NIMET), l Margaret Ekpo International Airport, Calabar. A simple descriptive analysis was used to show: values of Relative humidity for January to december in Calabar (2003 - 2012), Indicating multiple bar chart showing comparative values of Relative humidity for January in Calabar (2003 - 2012), Indicating trend values of Relative humidity over time for January in Calabar (2003 - 2012) for all the months years respectively.



## RESULT AND DISCUSSION

### Results

Table 1**:** values of Relative humidity for January to December in Calabar (2003 - 2012).

| Year | **Relative Humidity** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| 2003 | 81 | 82 | 82 | 84 | 86 | 86 | 87 | 92 | 90 | 85 | 86 | 82 |
| 2004 | 81 | 73 | 77 | 88 | 85 | 89 | 92 | 89 | 90 | 86 | 86 | 83 |
| 2005 | 67 | 82 | 85 | 83 | 85 | 90 | 93 | 92 | 87 | 87 | 86 | 86 |
| 2006 | 87 | 84 | 85 | 84 | 87 | 85 | 90 | 90 | 90 | 86 | 86 | 80 |
| 2007 | 61 | 83 | 81 | 87 | 86 | 88 | 89 | 91 | 89 | 86 | 86 | 84 |
| 2008 | 73 | 70 | 82 | 86 | 88 | 89 | 91 | 91 | 88 | 84 | 87 | 85 |
| 2009 | 85 | 84 | 82 | 84 | 84 | 87 | 92 | 92 | 89 | 87 | 84 | 84 |
| 2010 | 82 | 85 | 83 | 83 | 85 | 88 | 90 | 91 | 89 | 86 | 85 | 83 |
| 2011 | 76 | 85 | 83 | 83 | 84 | 90 | 93 | 93 | 90 | 88 | 84 | 80 |
| 2012 | 77 | 86 | 82 | 92 | 83 | 87 | 92 | 90 | 90 | 87 | 84 | 83 |

Derived From Dry & Wet Bulb Thermometer; from Margaret Ekpo International Airport, Calabar (NIMET-January 2003 to December 2012).

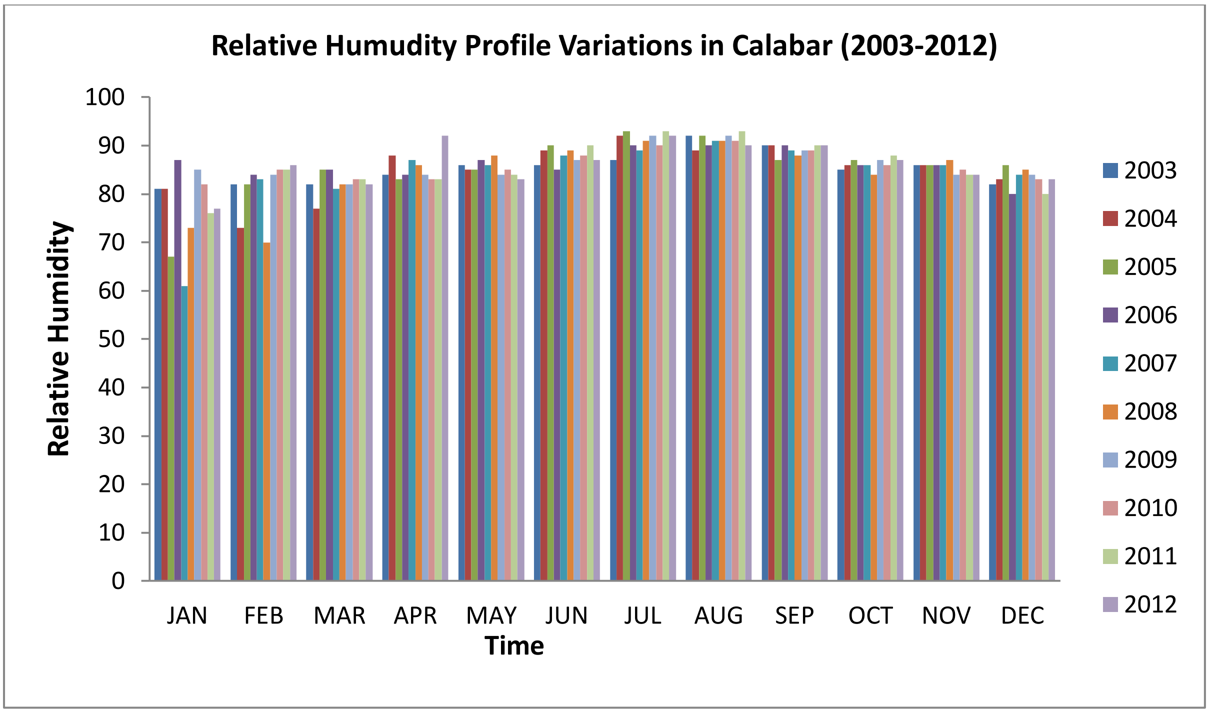


**Fig. 1:** Indicating a 2-D multiple bar chart showing comparative values of Relative humidity using vertical variations in Calabar (2003 - 2012).



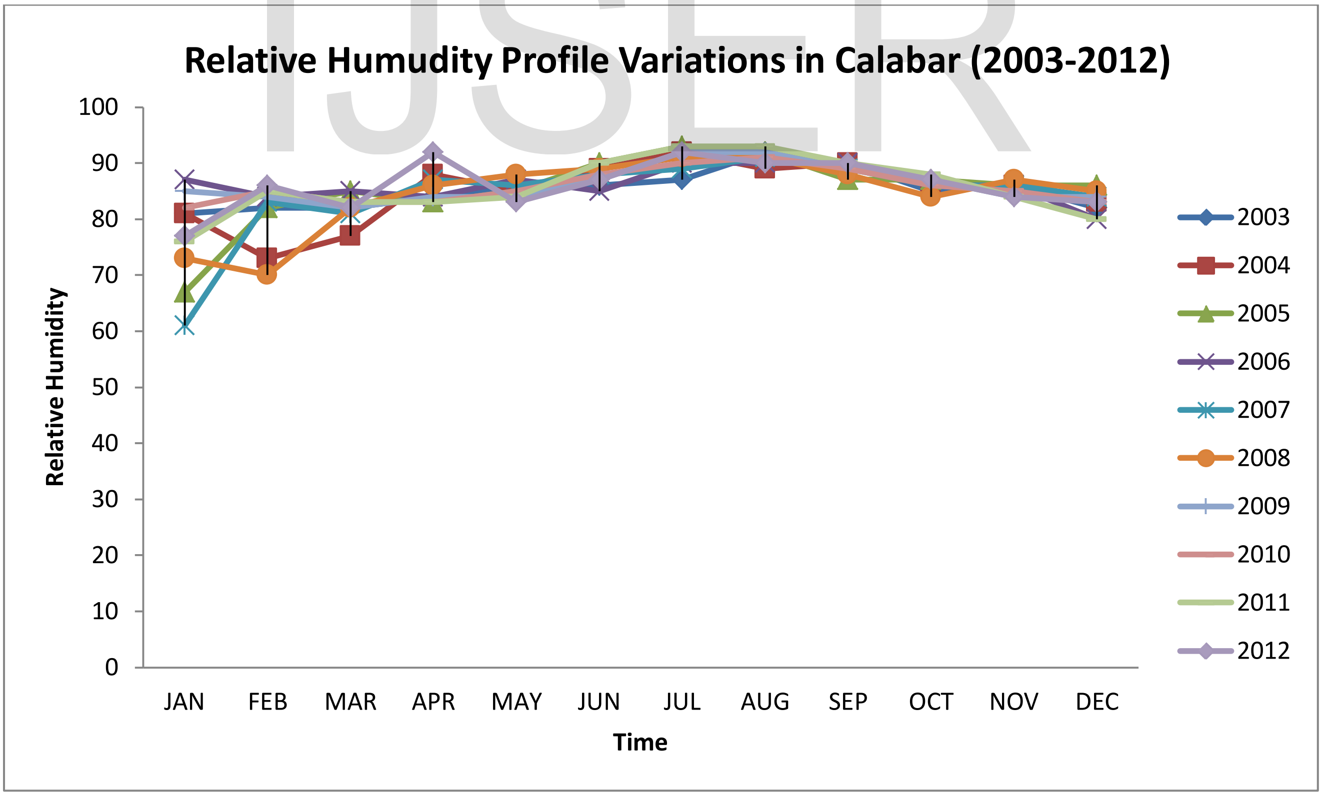


Fig 2: Indicating trend values of Relative humidity over time for January in Calabar (2003 - 2012).

## Discussion of Results

Base on the result in Table 1, fig 1 and 2, the Relative humidity in Calabar is high in all the months, especially between March and December in all the years within the study area which affects the seasonality of the monochromatic conditions. The relative humidit within the period of study recorded, exceeded 40%, and least was January 2007(61%) as and the highest value observed was (93%) table1 and fig.1 Stations within the tropical rainforest always have high relative humidity throughout the year and Calabar happen to be one, exceeding 70% in all the months , it shows that the Relative Humidity per year varies inconsistently over the years. The hihgest total Relative Humidity was recorded/observed in July and August 2011, while the lowest is 61 in January 2007 (table 1).



## CONCLUSION AND RECOMMENDATIONS

### Conclusion

Base on the result, the relative humidity profile variation in Calabar indicated the least in January 2007(61%) and the highest value observed was (93%) table 1 and fig.1&2. which shows that Calabar falls within tropical equatorial climate with high temperature, high relative humidity and abundant annual rainfall. The relative humidity profile variation was very unstable and as such indicating that humidity affects the seasonality of the microclimatic condition within the location of the study and the period under consideration. Two major air masses affect the climate of Calabar as well as other contiguous locations in the West African region due to the relative humidity profile variations. There have been a massive development and urban expansion in the area over the last 10 years, and as such this development is not without repercussions on the natural environment as lands that were formally vegetated, used for agriculture and as habitat for biodiversity are now being used for residential, commercial and industrial purposes to accommodate the growing population and businesses. The loss of once vegetated land implies a corresponding alteration of the micro-climate of the area which in turn has great impact on the long term climatic averages of the area due to the relative humidity profile variation.

### Recommendations

I strongly recommend that, this work should be studied at different locations within the country. The knowledge for the Relative Humudity Profile Variations is Essential to the Economic and social development. Moreover, it will improve the quality of life in Calabar. The result derived from this study encourages the utilization of fertile ground on the coastal area.

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