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Observed Trend of Changes in Relative Humidity Across North-East Nigeria (1981-2010)

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Abstract
Monthly relative humidity (RH) data for 6 stations in North-east Nigeria were provided by the Nigeria Meteorological Agencies. Mean RH variabilities, and trends calculated by the Mann-Kendal method are analyzed. The annual regional mean of RH ranged between 47.5±20.6%, with a clear maximum (62.5%) in Taraba and minimum (36.9%) in Borno. Extensive analyses of trends in mean monthly and annual relative humidity were examined for north-east Nigeria, for the period 1981 to 2010. Regression and analysis of variance were used to illustrate trends and calculate mean and annual rate of change. Results showed an inconsistent pattern of trend and a statistically significant stable increase in RH across locations.
Keywords: Trend, Changes, Relative humidity, North-east Nigeria

1. Introduction

Relative humidity RH is a measure of water vapour held in the atmosphere. Water vapour is intimately involved in the greenhouse because its concentration is linked with those of other gases brought about by greenhouse gases. Increase evaporation allows the atmosphere to hold more water vapour which in turn enhances the warming (Nwaogazie and Ologhadien, 2014). Hess et al., (1999) observed that the mean monthly saturation vapour pressure follows the seasonal trend in temperature. A constant global mean RH does not necessarily correspond to a static distribution of RH, however, and even small changes can be consequential for other aspects of the climate (Sherwood et al., 2010). Relative humidity is an important factor in determining the distribution and occurrence of clouds (Wright et al., 2010). Changes and variations in RH in the lower levels of the atmosphere are critical to understanding changes in the hydrological cycle, including moisture content and precipitation. Thus, understanding patterns and trends in RH will reduce uncertainties in the estimation of future climatic changes and be helpful in constraining cloud feedbacks, which currently represent the largest source of intermodel spread in climate sensitivity (Frimpong, 2014; Van Wijngaarden and Vincent, 2005; Vicente-Serrano et al., 2014; Xie et al.,2011; Randall et al., 2007). In recent decades, significant progress has been made in the analysis of RH through multiple data sets. Using the analysis of the European Centre for Medium-Range Weather Forecasts Re-Analyses (ERA-40 and ERA-Interim), a widespread reduction in RH has occurred over land, which may be due to limited moisture supply from the oceans [Simmons et al., 2010]. On regional scales, comprehensive analyses have improved understanding, modeling, and prediction of RH [Isaac and Van Wijngaarden, 2012; Simmons et al., 2010]. The levels of ambient air temperature and humidity are fundamental in assessing environmental heat stress on the health of a given population, especially in the tropics of developing countries where there are larger numbers of outdoor occupations (Byass et al., 2010). In the changing climate, the combined effect of heat and humidity is becoming more stressful to outdoor workers (Sherwood & Huber, 2010), This makes it imperative to assess recent trends of relative humidity in this area in order to develop an appropriate community response to increase/decrease in humidity. The issue is further compounded by the fact that this region is in excessively humid and temperate environment.

2.0 Materials and Methods

2.1 The study area

The study site cover an area of aproximately 157,000 sq km located between latitude 10^0 03′ 00′′ – $13^0$50′ 00′′E and longitude 7^0 43′ 00′′ – 12^0 45′ 00′′ N.

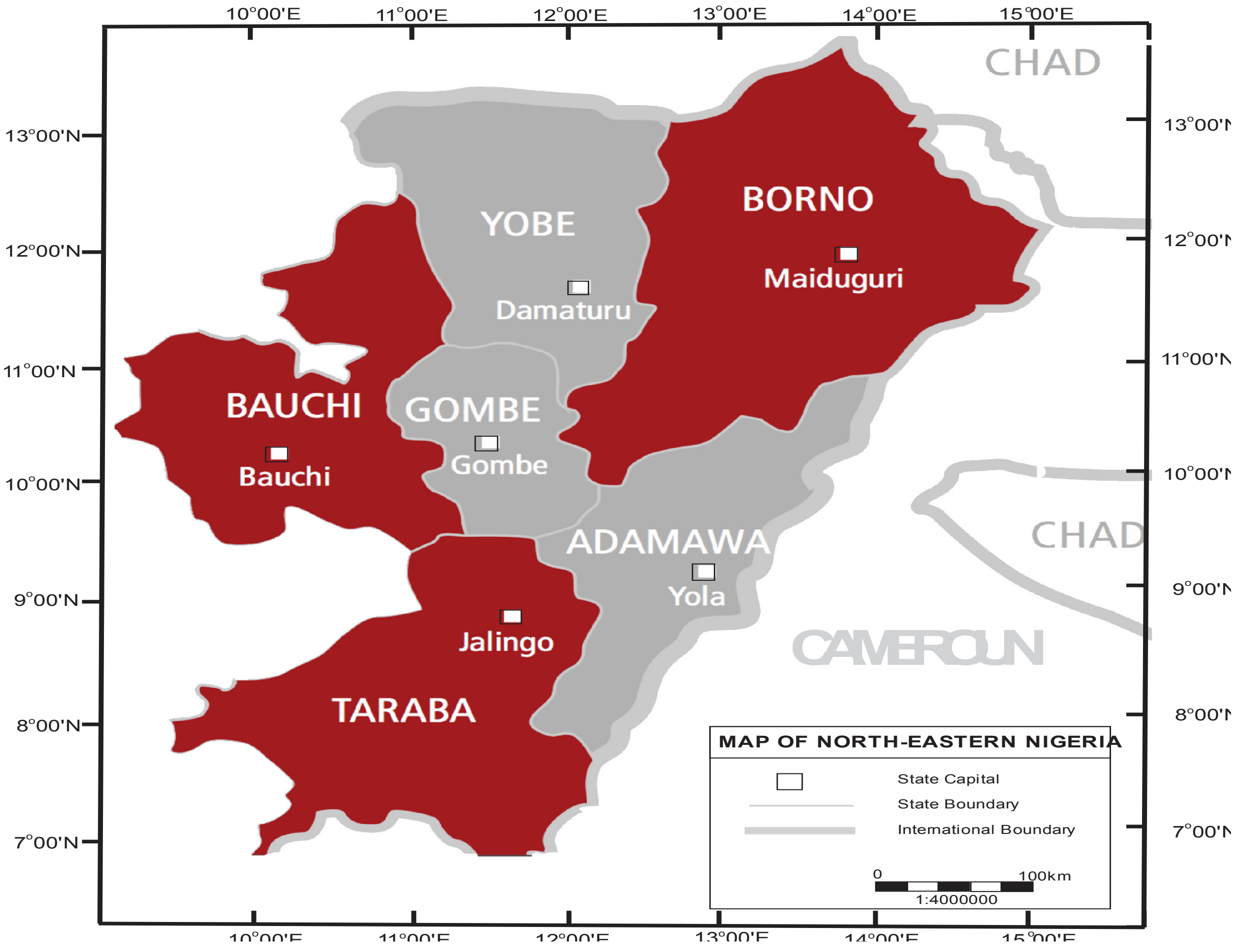


Fig. 1: Map of North Eastern Nigeria
Source: Lands and Survey Maiduguri, 2011

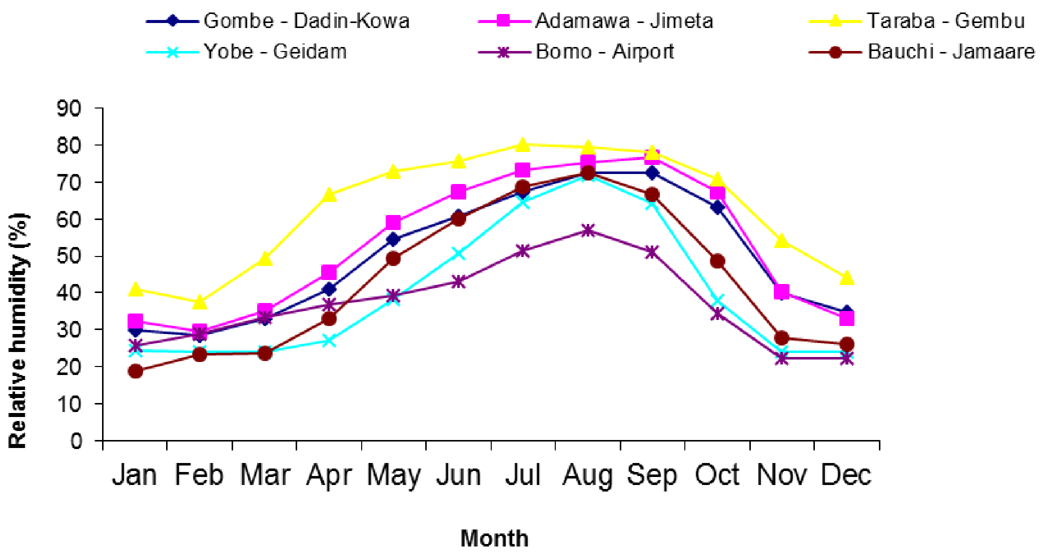
2.2 Methodology
Data were collected on relative humidity for a period of 30 years, (1981 – 2010). Existing gaps were generated using the model of Monte Carlos (1994). Analysis of variance were carried out to test whether the mean monthly relative humidity observed in the region are the same for the year 1981-2010 or vary significantly.

3.0 Results

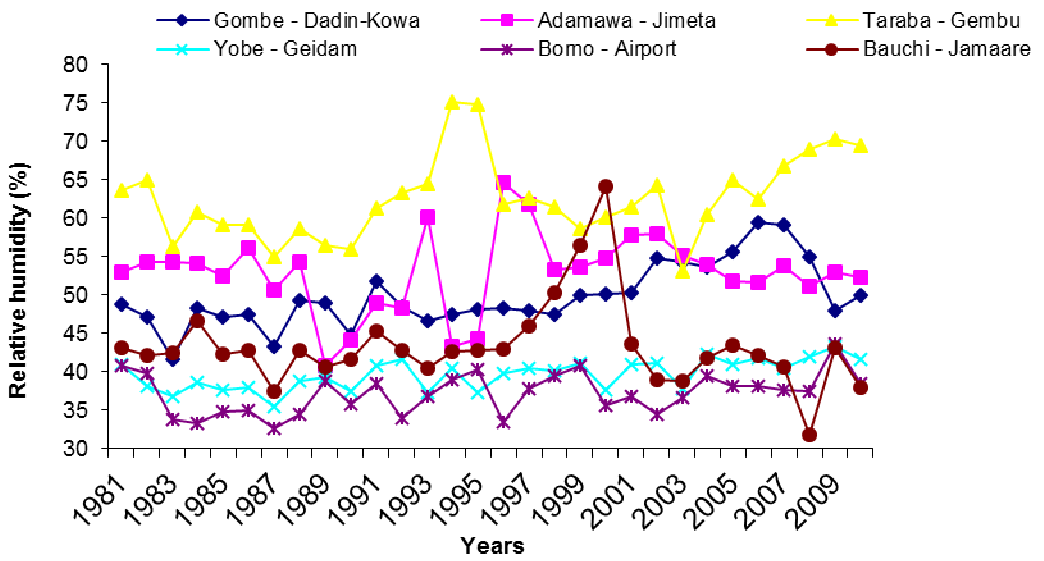
There was a highly significant ($p<0.05$) variation in relative humidity in respect of location, months and year from 36.9 to 62.5% among location and over months and years (Table 1). Taraba recorded the highest relative humidity followed by Adamawa, Bauchi, Gombe, Yobe and Borno and relative humidity in 1987, 1989 and 1990 were apparently lower than other years (Fig.a). This agrees with Hess (1999) observation of RH following the seasonal trend in temperature Relative humidity was significantly higher in August while July and September are statistically at par. The rise could be attributed to global warming as the result of atmospheric pollution, aridity and deforestation. Relative humidity for May, June and October are about the same and months April, May and October, did not differ significantly, but were higher than recorded values from January - March, and November/ December (Fig.b).

Table 1: Mean annual relative humidity across 6 locations in North-eastern Nigeria

Locations	Gombe	Adamawa	Taraba	Yobe	Borno	Bauchi
Mean	49.8c	52.9b	62.5a	39.6e	36.9f	43.3d



(a)



(b)

Figs. a and b: Mean monthly and annual relative humidity over 30 year in 6 locations of N/E Nigeria.

The data indicates consistent increase in relative humidity over the years and across location with a stable increase in relative humidity at all locations (Table 2). Figure c show mean annual relative humidity anomalies across the region varying in all locations with decrease in the 1981 – 1994 and increase from 1995 – 2010. This is clear evidence that decrease in RH result in decreasing rainfall as the data falling in the period of intense drought that ravaged the Sudan- Shalian zone of Nigeria (Abaje et al., 2010).

Table 2: Mean annual relative humidity for 3 decades in 6 locations in N/E Nigeria (%)

Location	Average Relative humidity (%)			
	1981 – 1990	1991 – 2000	2001 – 2010	Station
Gombe	46.69	48.64	54.03	Dadin- k
Adamawa	51.42	53.31	53.79	Jimetta
Taraba	59.00	64.37	64.61	Gembu
Yobe	38.06	39.64	41.23	Geidam
Borno	35.64	37.33	37.89	Airport
Bauchi	42.18	46.74	47.30	Jamaare
Range	35.64 – 59.00	37.33 – 64.37	37.89 – 64.21	

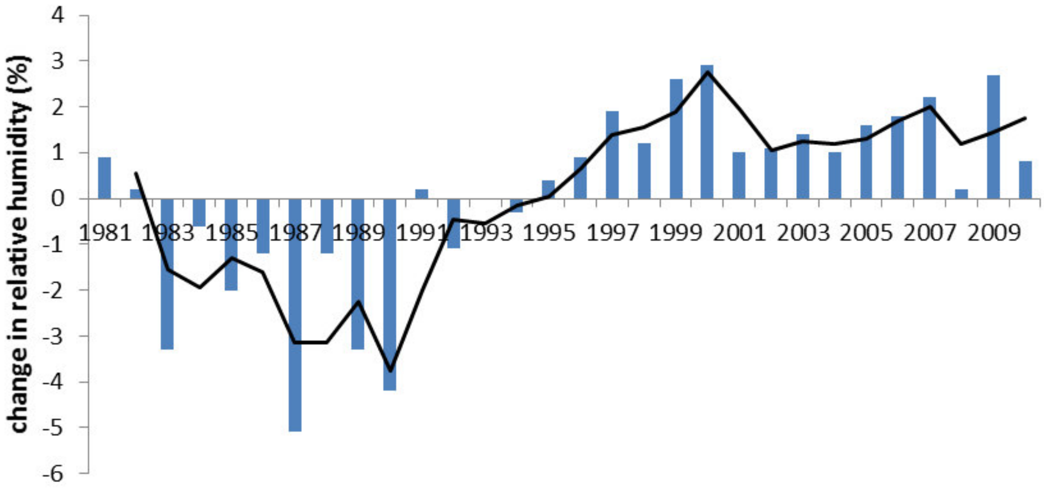


Fig c: Annual relative humidity anomalies for 30 year across 6 locations in N/E Nigeria

4.0 Conclusion

Results expressed high variability in relative humidity. Mean relative humidity across the region, varied from 37.1 - 62.5%, respectively. Relative humidity was observed to highest in Taraba and lowest in Borno. The changes of relative humidity observered across the region could have positive or negative effects thus, causing increase or reduction of water in the river in the study area.

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