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## The Changing Annual Rainfall and Temperature Averages in the Humid Tropical City Of Uyo, Southern Nigeria.

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**Abstract:** The realization of the real and potential threats to man due to the steady but slow "downsliding" on the quality of the physical earth have suddenly taken the central stage on many international conferences and discourse. The global climate change is the foremost; others included desertification, biodiversity and fertility losses, HIV/AIDS, Ozone depletion etc. Climate change knows no bounds as its impact can be felt from the local through the international or global levels. The present study is therefore aimed at assessing the issue of climate change for Uyo, Akwa Ibom State, Nigeria baring characteristic data problems of the developing world. The rainfall and temperature averages for 27 years (1971-2004) were extracted from the archives of the Nigerian Meteorological Agency, Barracks Road, Uyo and the Geography and Regional Planning Department, University of Uyo, Nigeria less than 2km apart.. The baseline climatology assessment vis-à-vis annual rainfall and temperature averages, range, extremities, standard deviation and variance and critical value assessments, etc have been defined for the study area. Trend, which is the major issue in the study, showed that from 1981-2001 (20 years at a stretch) the annual rainfall averages was just the thirty year average figure at 2384.4mm. The annual temperature averages on the other hand was either stagnant at 26.9°C or a positive (rising) trend. The observed should be placed in its correct perspective for growths in urbanization, transportation activity, industrialization, population density and farming activities within and around the town is synonymous with global warming and concomitant decline in precipitation amount, duration and intensity (Trenberth, et al. 2003; Mearns et al. 1997; Karl & Knight 1998; Berz 1999; Hulme et al 1999). Testing the series significance was positive as the null hypothesis was rejected at 95% confidence ( $t_c > t_t = 7.79 > 3.069$ ,  $n-1 = 29$  degree of freedom) it was however, not significant for annual temperature averages. In summary, while the annual rainfall averages is seemingly slowly varying and declining in direct response to the anthropogenic forces, temperature, on the other hand is steady with very strong reasons to belief it is most likely to rise if not actually rising. The time is now for serious considerations of adaptation and mitigation strategies to stem the consequences of the emerging scenario to mankind and the environment.

### Introduction

Human economic activities have, in the last 100 years, contributed to an increase in the concentration of greenhouse gases in the atmosphere leading to the 'enhanced' greenhouse effect (IPCC, 1996; 1998) which in turn is expected to result in climate change, arguably the most important and dangerous, and certainly most complex, global environmental issue to date (Holdren, 1992; Kandlikar and Saga, 1999; Hamilton, 1999). It is estimated that extraction and burning of fossil fuels is the cause of about 70-90% of anthropogenic carbon dioxide emissions (Strong, 1992; Edge and Tovey, 1996, UNFCCC, 1998), the most important greenhouse gas. A

natural mix of certain greenhouse gases reside in the atmosphere, allowing short-wave radiation from the sun to penetrate the atmosphere, but absorb the lower wavelength which is reradiated from the Earth's surface (Clayton, 1996; Hongton, 1998). Enhanced greenhouse effect is not natural, it refers to changes in the earth's radiation balance due to the anthropogenic accumulation in the atmosphere of radiatively active greenhouse gases. In addition to carbon dioxide, other greenhouse gases include methane, nitrous oxide, tropospheric ozone and chlorofluorocarbons. Their effect is to accelerate the warming effect beyond acceptable levels. Models project that if current trends in anthropogenic greenhouse gases (GHS) emissions continue through year 2030, the earth will experience an average rise in temperature ranging from 34.7 to 40.1°F (1.5° to 4.5°C) (Porter and Brown, 1991; WMO 1992). Even higher warming is considered possible because of the feed-back process (Lashof, 1989). The projected impact of this on environmental stability and life on earth is better imagined if not already manifesting. They include changes in the global climate and the consequent disruption in the temporal and spatial distribution of temperature, precipitation, clouds, evapotranspiration as well as shifts in the vegetational belts; melting of polar ice-caps, rise in sea level, most or all of which have occurred. Some or all of the above have implications for fresh water resources, agriculture and food supply, natural ecosystem and human health among others (Ayres and Walter, 1991; IPCC, 1996, UNFCCC, 2000).

The nations of the developing world, particularly those of the West African sub-region seem to be acting as though they are removed from the issue which certainly has gone far beyond mere hypothesizing. The fact that Nigeria and other countries in the sub-region for instance are at the very bottom of countries at the root causes of this problem does not mean we are in anyway encapsulated. The direct effect may be generalized as a mere rise in the global mean temperature which leads indirectly to steady changes in the intensity, frequency, duration, and amounts of precipitation as well as global warming (AMS, 1999; Trenberth et al, 2000). The Kyoto 1997 cliché – "Think Globally, Acting Locally" has come to stay so long as solutions to environmental problems are concerned.

## Conceptual Basis and Problem

The anthropogenic concept of climate change is the basis on which this study is hinged. The fact is that the annual averages for rainfall and temperature are not just fluctuating (being primary characteristic of natural systems) but steadily and slowly changing due to human inadvertent incursions into nature by way of socio-economic development initiatives, population growth, agricultural activities as well as growth in science and technology. The gaseous and material injections that the above activities have on the earth atmosphere, the continuous clearings of the green vegetal cover for other land use purposes practically inhibits transpiration and evaporation from the land and vegetal surfaces. The stage is thus set for a change in the mean temperature and rainfall of such vicinity after decades or centuries of such human interventions (Gribbin and Kelly, 1996; Glantz, 1991; Goudie, 1980).

For our study area, expected changes in the annual temperature and rainfall averages are strongly believed to be more the result of intensive socio-economic development initiatives of both the government and the private sectors as well as the agricultural activities within Uyo and environs than natural. Carbon dioxide (CO<sub>2</sub>) and carbon monoxide (CO) (from urbanization and automobile fumes) and methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O) (from the intensive farming activities) constitute major greenhouse gases.

The frequent food crises in sub-Saharan Africa caused by drought and famine etc may be considered a climate change problem due to its permanency. In the humid tropics on the other hand, the process may not have climaxed yet but certainly the process is on. This requires therefore close monitoring through empirical researches, education of the citizenry and sector based adaptation strategies.

## Data collection and analysis

Twenty-seven (27) years data (1977-2004) on average annual temperature and rainfall were obtained from archives of the meteorological observatory, Department of Geography and Regional Planning, University of Uyo, AKS – Nigeria. This grade B weather station is read twice daily at 09.00hrs and 15hrs GMT. The Synoptic Station barely a kilometer away, managed by the Nigeria Meteorological Services Agency was established only in 1987, with a relatively shorter data duration. The annual average temperature refers to the maximum free atmosphere temperature measured with the maximum mercury- in- glass thermometer usually placed in the Stevenson screen.

The annual rainfall averages for same number of years were simultaneously obtained. A rain-day was taken as any rainfall from 3mm and above (WMO).

Data was analysed using descriptive statistics such as the mean, standard deviation, variance as well as some filtering technique used particularly on the annual rainfall ogive to show the trend more clearly (Udofia 2004). Percentage probability using the Z-score and time-series analysis for quantitative hypothesis testing were carried out also on the series.

To determine the trends of the distributions for generalization on their characteristic pattern over time with particular attention to average rainfall and temperature, the above data were subjected to the simple line and divergent graphical methods. Finally, the test for statistical significance was carried out on the Time Series with Least Square Technique on the annual rainfall averages. It was not however considered necessary to model the annual temperature patterns for reasons of H not being significant.

## Results

Table 1 gives the rainfall and temperature data for the study area. The total rainfall amount for the 27 years study period is 63,286.5mm while the average yearly is 2384.43mm. The extremities are 3825.4mm for 1979 and 1599.4mm, for 1983 respectively for the upper and lower quartiles. The range of the distribution is 2226.0mm

The total number of rainfall days for the 27 year period is 3414 days, while the average rainfall day is 126. The extremes and the range of the distribution are 155, 113 and 42 days respectively. The mean temperature is 26.9°C, with extremes 28.1 and 25.0°C, and a series range of 3.1°C, a somewhat high range for the zone.

The annual rainfall averages for Uyo Urban is shown in figure 1 using the divergent line graph technique with the 27- year average as zero while deviations from the average figure are plotted North (+ve) or South (-ve) of the zero point. For 21 out of the 27-year trend, the annual rainfall averages has been below the average figure of 2384.43mm (238.443cm).

The temporal pattern for annual temperature averages is shown in figure 2 using divergent line graph or the filtering technique.

## Discussion

It may be considered safe to also generalized that taking-away the initial 4 or 5 years (i.e. 1977-1980) with well above annual average figures, the explanation of the annual rainfall pattern (y) by time in years (x),  $R^2$  is 0.311 or 31%. This rather low percentage relationship should be expected to be most likely to increase in a few decades time as urbanization, industrialization, fuel consumption, farming activities expectedly double or triple as a result of more socio-economic developments and initiatives by incoming administrations in the State. Notice that unlike the rainfall there seems to be a high likelihood for the element to rise the more with such fluctuating trends. The rising arm after 1993 may continue with increasing socio-economic and infrastructural development activities in the town i.e with more green house gaseous emissions, population den-

**Table 1: Annual rainfall and temperature averages for Uyo, Akwa Ibom State-Nigeria**

Years	Rainfall in mm	Temperature in °C.
1977	3373.8	28.1
1978	3270.7	25.4
1979	3825.4	25
1980	2867.6	27.7
1981	2422.8	26.9
1982	2372.5	27
1983	1599.4	28.1
1984	1878.7	26.6
1985	2132.6	27.4
1986	1905.1	27.1
1987	2251.4	28.2
1988	2115	26.4
1989	2588.5	25.8
1990	2032.8	27.4
1991	2246.7	27.1
1992	2256.8	27.9
1993	2229.5	26.4
1994	2668.7	25.9
1995	2281.9	27.3
1996	2332.8	27.7
1997	1921.3	27.1
1998	2033.8	26.8
1999	2868.9	26.8
2000	1840.9	28.1
2001	2317.1	27.6
2002	2331.3	27.4
2003	2220.1	28.1

**Source:** Department of Geography Meteorological Station, University of Uyo – Nigeria

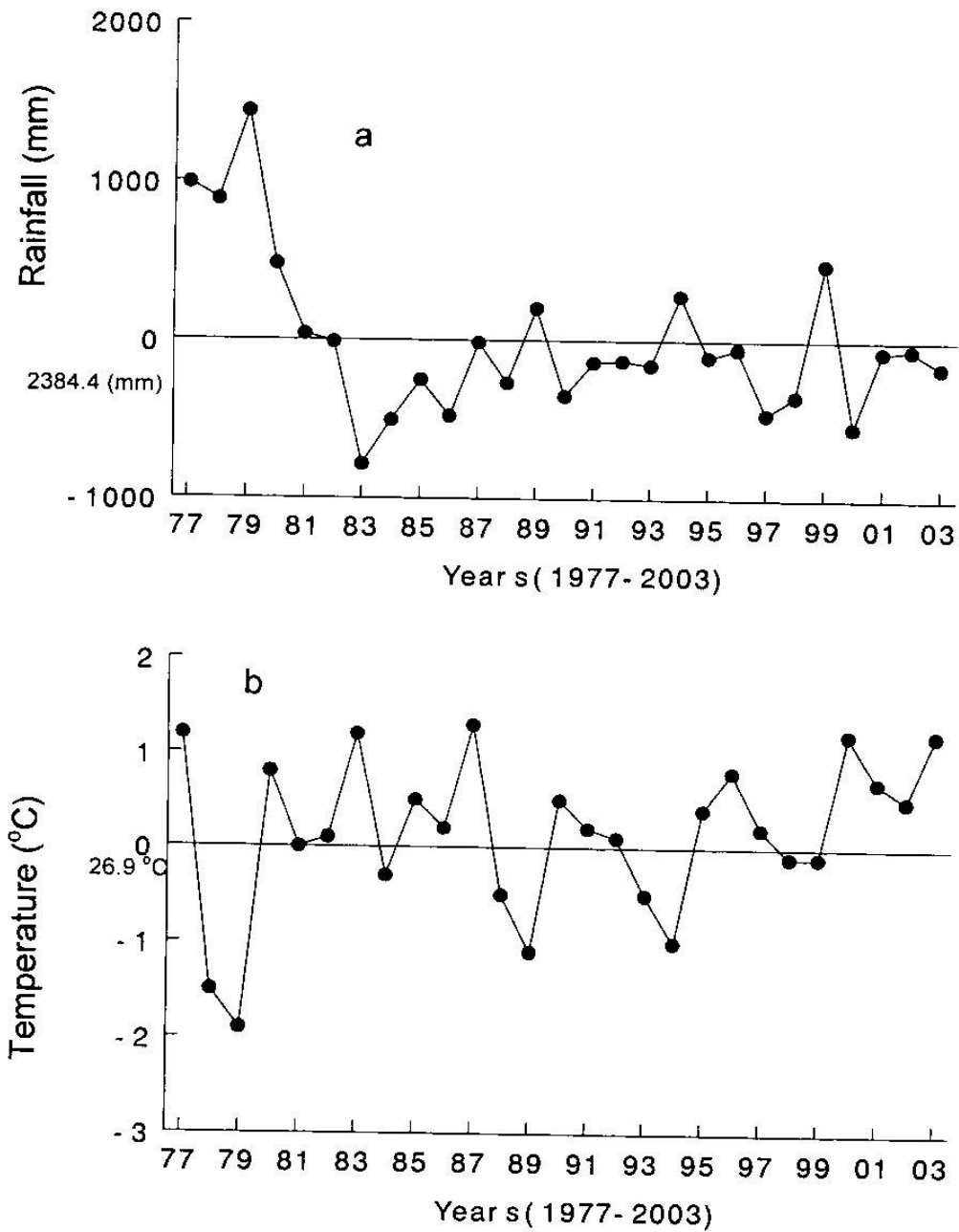


Fig. 1: Divergent line graphs of (a) annual rainfall and (b) temperature averages over time

Table 2: Health based adaptation

Adaptive measure	Heat-related illness	Vector-borne diseases	Health & extreme weather events
Administrative/ Legal	Implement weather watch/ warning system	Implement vaccination programs.	Create disaster preparedness programs.
	Plant trees in urban areas.	Enforce vaccination laws	Employ land use planning to reduce flash floods.
	Implement education campaigns	Implement education campaigns to eliminate breeding sites	Ban precarious residential placements Construct strong seawalls
Engineering	Insulate buildings	Install window screens	
	Install high albedo materials for roads	Release sterile male vectors	Fertility sanitation system
Personal behaviour	Maintain hydration.	Use topical insect repellent	
	Schedule work breaks during peak daytime temperature	Use pyrethroid impregnated bed nets.	Heed weather advisories.

Adapted from Inter Parliamentary Panel on Climate Change 2001.

Table 3: Summary of agric-base adaptation

Adaptation Strategy	Number of Measures
Change of topography of land	11
Use of artificial systems to improve water use/ availability and protection against erosion	29
Change farming practice	21
Change timing of farm operations	2
Use different crop varieties	7
Government and institutional policies and programs	16
Research into new technologies	10

Adapted from Inter Parliamentary Panel on Climate Change 2001

sity and deforestation

The possibility of an imminent disaster for the citizenry has been hinted through this research if appropriate adaptation strategies to the emerging scenarios are not considered. While the average temperature can be regarded as relatively stable with reasons to believe it will be increasing than reducing, the annual rainfall is rather cascading significantly. Put differently, while the city's temperature regime is either steady, annual rainfall, on the other hand is reducing in quantity. After all a hot environment is that lacking in moisture. Uyo and its environs, in a few decades time will be warmer than it is today, by extension most if not all Nigerian Towns. To avert this pending food and water crises as a result, adaptation measures must be sought and kept handy for 'deployment'. The Inter Parliamentary Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC) have come up with possible adaptation measures or strategies that have potentials to moderate impacts if implemented in the health and agricultural sectors of governments ( Benioff et al 1996; Smith et al 1996; Mimura 1999b, Tables 2 & 3). Such possible adaptations are based on experiences, observations and speculation about alternatives that could be created (Carter 1996); they cover a wide range of types and take numerous forms (UNEP, 1998). For example possible adaptive measures for the health risk associated with climate change are given below:

Similarly, in coastal zone studies, comprehensive lists of potential adaptation measures are presented. These adaptation include a wide array of engineering measures improvements or changes, including agricultural practices that are more flood-resistant, negotiating regional water sharing agreements, providing efficient mechanisms for disaster management, developing desalination techniques; planting mangrove belts to provide flood protection; planting salt-tolerant varieties of vegetation; improving drainage facilities, establishing setback policies for new developments; developing food insurance schemes, devising flood early warning system, and so forth. In many other sectors and regions, arbitrary lists of possible adaptations are common (Erda, 1996; Iglesias et al, 1996). In the agricultural sector alone, different adaptation measures are identified and summarized below:

## Summary and Conclusion

The global climate change issue has so far been studied from a local humid tropical environment. Baring the seeming data handicaps the result is clear-from whatever ramifications one may wish to. The annual rainfall amount is shown to be decreasing while annual temperature is steady with very strong and obvious signs of increase in the near future. Hypothesis testing of the trend indicates a low but significant relationship for annual rainfall over-time. In an environment usually thought to be absolved from this pandemic problem, the study findings may be least described as stunning but timely for both the people and government to take seriously adaptation science and education for sustenance of its citizenry and posterity.

## Reference

- Adefolalu DD (1981), *The Weather and Climate of Calabar. A Study of Coastal Micro-climatology in the Tropics*. Monograph, Senate Research Project, Unical – Nigeria.
- Afangideh AI (2001), *Global Climate Change and Variability. The Special Role of the Tropical Oceans*. Paper Presented at the NES workshop, Unical Chapter, Unical – Nigeria.
- Andre G (1980), *The Human Impact. Man's Role in Environmental Change*. Methnew, London pp271.
- layton K (1996), *The Treat of Global Warming*. In D'Riordau. T. (ed) *Environ. Sci. for Environ'tl Mgt*. English; London group. Pp 80
- Dail AKE, Trenbelth E & Karl T R (1998), in *Global variations in Droughts and Wet Spells; 1900 – 1995*. *Geophysics Res. Lett* 25: 33067-3370.
- Edge G Tovey K (1996), *Energy: Hard Choices ahead* in O'Riordan, T. (ed). Lond Group Ltd.



- Ekanem EM (1996), The Surface Energy Balance in A Humid Tropical City: A Case Study of Aba. Unpublished Ph.D Dissertation in Climatology. Geography Dept. U. I., Nigeria.
- Hamilton L (1999), Justice, the Mrkt + clim. Change. In Low N. (ed) Global Ethics & Environ. Routledge, London.
- Hennessy KJ Gregory M & Mitchell J. F. B. (1997), Changes in Daily Precipitation under enhanced greenhouse Conditions. *Climate Dyn.*, 13: 669-680.
- Hense A, Krahe P and Flohn H (1988), Recent Fluctuations of tropospheric temperature and water vapour content in the tropics. *Meteor. Atmos. Phys.* 38: 215-227.
- Huwell JW (1995), Decadal Trends in the North Atlantic Oscillation regional temperatures and precipitation *Science*, 269: 676-679. IPCC, 1996. *Climate Change (1995): Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analysis*. In R. T. Watsons, M. C. Zinyoweve, and R. H. Moss (eds). IPCC., CUP. Cambridge.
- John C & Mick K (1990), *Winds of Change. Living in the Global Greenhouse*. Headway. Holder & Stoughton, Toronto. Pp111
- Kandlikar M & Sagar A (1999) *Climate Change Research and Analysis in India: An Integrated Assessment of a South-North divide*. *Glob. Evt'l Chg.* 9(2): 119-138.
- Lashof DA (1989) The Dynamic Greenhouse: Feedback processes that may influence future Concentrations of Atmospheric trace gases and Climate Change. *Climate Change* 14: 213.
- Meteorological Office Observers Handbook (1969) Her Majesty's Stationary Office, London. Pp135
- Nicholson SE (1981). Rainfall and Atmospheric Circulation during Droughts period and Wetter Years in West Africa, American Meteorological Society. Pp186
- Nicholson SE (2000) The Nature of Rainfall Variability over Africa on time scales of decades to Millenia. *Global and Planetary Change* 26: 137-158.
- Rosenfeld D (2000). Suppression of Rain and Snow by Urban and Industrial Environment Pollution. *Science* 287: 1793-1796
- Strong MF (1992) The Energy Predicament in Perspective, In Mintzer I M (ed) *Confronting Climate Change: Risk, Implication & Response* Canadian University Press, Cambridge. Pp 286
- Todorov AV (1984). *Sahel: The Changing Rainfall Regime and the "Normals" Used for its Assessment*. Elsevier Books, Paris pp289
- Udofia EP (2003) *Fundamentals of Social Science Statistic*. IPL, New Layout Enugu. Pp201