AFRICA REGIONAL CLIMATE MULTI-DATA ANALYSIS AND MANAGEMENT

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Abstract

Background: *One of the major problems of accurate forecasting and interpretation of tropical, savanna and sahelian climate in Africa is the inability of climatologists and meteorologists to handle multiple climate data. The dearth of accuracy in terms of validity and reliability of multiple data on regional climate in Africa leads to so many fallacies and misinterpretations. This paper seeks to address the issue of climate multi-data analysis and management that are caused by malfunctioned and outdated meteorological equipment and services in Africa. The paper suggests "triangulation" (combination of methods) and steps in multiple climate data analysis that could be used in the management of climate change in Africa. The paper argues that no single method can often provide sufficient information on regional climate dynamics in Africa.*

Methodology: *Descriptive study was used based on multiple climate data distribution, surveillance and ecological correlation analyses in Nigeria, Niger Republic and Chad.*

Results: *Regional climate data analysis and management in Nigeria, Niger Republic and Chad hardly undergo tests of validity. Information on validity is key to influencing the choice of climate study methods and subsequent interpretation of the climate data findings. Invalidity and unreliability of the instruments used in forecasting climate information are common in Africa.*

Conclusion: *Correct interpretation(s) of multiple climate data must be given to findings. There is the demand for technical competence of the climate experts. Incorrect information and spurious associations cause serious climate change implications.*

Keywords: *Regional climate; Multiple climate data; Analysis; Management; Validity; Reliability; Nigeria; Niger Republic; Chad.*

1. INTRODUCTION

One of the major problems of accurate forecasting and interpretation of tropical, savanna and sahelian climate in Africa is the inability of climatologists and meteorologists to handle multiple climate data. However, PRECIS regional climate modelling system has been used to generate a five member ensemble of climate projections for Africa over the 50 km resolution Coordinated Regional Climate Downscaling Experiment (CORDEX) in the Africa domain (Carlo et al, 2014). The major challenge of Africa's PRECIS Regional Climate Modelling (RCM) and downscaling, is its inability to capture the spread in outcomes from the projections of other models. The PRECIS simulations that were run from December 1949 to December 2100 could only capture the annual cycle of temperatures for Africa as a whole and the sub-regions. Though it exaggerates the precipitation over Africa, but it is more reliable, because it improves the patterns and magnitude of precipitation simulation compared to the Global Climate Model (GCM) which is particularly noticeable in the Sahel for both the magnitude and timing of the wet season.

2. MERITS AND DEMERITS OF RCM-CORDEX ON CLIMATE DATA INTERPRETATION IN AFRICA

The fact that highly skilled and innovative climate simulation models have been developed to collate and interpret data, seasonal variability over the Sahel, and the Tropical regions of Africa, there exists an underlying disagreement on climate change projections. This disagreement has the potential to make long term model projections and comparison nearly impossible for the region until further advancement is made in the underlying scientific understanding (Ben et al, 2010: 4). As Dave et al (2010) asserted, "Through an analysis of the most intense droughts of the 20th century three focus areas were identified. For west-most Sahel most models agree on a significant decline in annual precipitation. For eastern Ethiopia the signal is less clear but most of the models expect an increase in annual precipitation.

For the area around Lake Chad, at the moment we do not have enough information to evaluate with confidence whether precipitation is more likely to increase or decrease in the future.

However, Dave's interpretation was confined to the Sahelian region such as the Niger Republic. It was silent on the tropical climate multi-data analysis and management, especially in Nigeria. There is already a dearth of accuracy in terms of validity and reliability of multiple data on Nigeria's climate in Africa, which leads to so many fallacies and misinterpretations (Jibo, 2014: 1).

For instance, The Tropical wet and dry climate in Nigeria may be difficult to analyze, determine and interpret its data accurately, because of the use of malfunctioned and outdated meteorological equipment and services (Jibo et al, 2014). This would have been a very good case study for regional climate downscaling experiment, because it is extensive in area and covers most of Western Nigeria to central Nigeria beginning from the Tropical rainforest climate boundary in the south to the central part of the country where it exerts enormous influence on the region.

Using the precise PRECIS's Regional Climate Model, this tropical savanna climate would have exhibited a well marked rainy season and a dry season with a single peak due to its distance from the equator. The Sahelian climate in Northern Nigeria is, however, similar to that of Niger Republic where annual rainfall totals are lower compared to the southern and central part of the country.

Rainy season in the northern part of Nigeria lasts for only three to four months (June–September). The rest of the year is hot and dry with temperatures climbing as high as 40 °C (104.0 °F).

3. CHOICE OF MULTIPLE DATA COLLECTION METHODS AND ANALYSIS

Besides, PRECIS's RCM, there are usually alternative methods such as the thermal indices methods used to determine the degree and nature of climate thermal stress. These methods are also not 100% reliable, because their application and choice mostly complicate choice (Prucnal-Ogunsote, 2007: 6). Nonetheless, Spearman's correlation analyses could be used to pick up the best. The thermal indices that were used in interpreting Nigeria's climate multi-data analysis and management were the Mahoney scale; the Evans scale; the Bioclimatic chart; and the effective temperature (Evans, 1980; Olu et al, 2007).

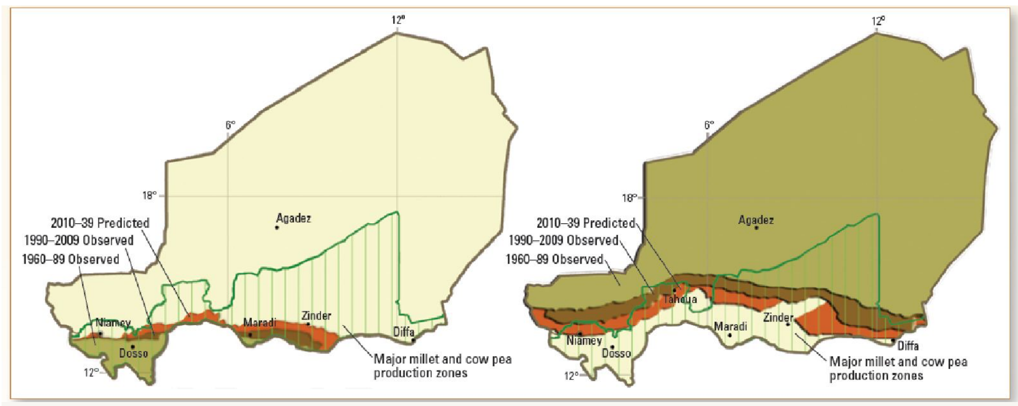
Below is a summary of the techniques used in Nigeria's climate multi-data analysis, which could be extended to determine the annual climate and temperature variability for Niger Republic's Sahelian climate and the Chad.

Method	**Thermal Index**		
	Best	**2nd Best**	**3rd Best**
Distribution of error of prediction	Bio Chart	ET 22-27	ET 20-25
Mean of error of prediction	Evans	ET 22-27	Bio Chart
Skewness of error of prediction	ET 20-25	Mahoney	Bio Chart
Cumulative frequency of error of prediction	Bio Chart	ET 22-27	ET 20-25
Ability to predict overheating, comfort and under-heating	Mahoney	ET 20-25	Evans
Gamma test of statistical significance	Evans	Mahoney	Bio Chart
Kendall's rank-order correlation coefficient (tau)	Evans	Mahoney	ET 20-25
Spearman's rank-order correlation coefficient (rho)	Evans	Mahoney	ET 20-25
Pearson correlation Coefficient (r)	Evans	Mahoney	ET 20-25
Eta correlation ratio (PTS dependent)	Evans	Mahoney	ET 20-25
Summary	Evans	Mahoney	ET 20-25

Adopted from Olu Ogunsote and Prucnal Ogunsote, 2007.

From the above summary, Evans scale emerged as the best technique for climate thermal stress predictions, because it is the most accurate. New comfort limit (20-25 degrees) was also recommended for the Effective Temperature index analysis (Prucnal-Ogunsote, 2007).

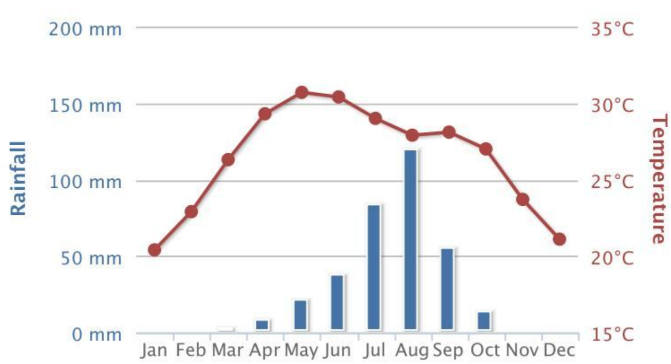
For Niger Republic, however, it is a landlocked country with an area coverage of 1, 267, 000 square kilometers. Rainfall declined between 1950-the mid 1980s, which partially recovered in 1990 and the year 2000. The country's Sahel climate is one of the most unbearable conditions in the Sahelian regions.



Source: United States Geological Survey and Department of Interior (2012).

Above is a climate change in Niger Republic. The left map shows the average location of the June- September 500 millimetre rainfall isohyets for 1960-89 (light brown); 1990-2009 (dark brown); and 2010-39 (predicted, orange). The green polygons in the foreground show the main crop production districts. The right map shows analogous changes for the June-September, 30 degrees Celsius air temperature isotherms.

For Chad Republic, it is important to evaluate how climate has varied and changed in the past in the region before asserting on how its data can be analyzed and managed. The monthly mean historical rainfall and temperature data can be mapped to show the baseline climate and seasonality by month, for specific years, and for rainfall and temperature.



The chart above shows mean historical monthly temperature and rainfall for Chad during the time period 1900-2012. The dataset was produced by the Climatic Research Unit (CRU) of University of East Anglia (UEA).

Indeed, several software programs were developed for environmental climatology in Nigeria. Programs such as *Clicomp, Clidata, Coldhot, Klimax, S4S* and *System Stress* could be used to analyze and interpret multiple climate data in different regions of the Sudan, Tropical and the Sahel regions of Africa. For instance, Clidata, is a database of annual and long-term climatic data for more than 20 years. The library contains climatic data for 36 towns and cities including most state capitals in Nigeria. It is structured with specific fields in a predetermined format for access by various software packages (Olu et al, 2007). The climatic data shows the minima and maxima and their extreme of air temperature and humidity, mean monthly rainfall, number of days with rain, hours of sunshine, mean air velocity as well as prevailing and secondary wind directions. The ***S4S is*** a computer spreadsheet template that uses climatic data and established mathematical techniques to determine the basic geometry of sun shading devices. It was written using *SuperCalc4* whereas the *Coldhot* is a FORTRAN program for multi-index thermal stress analysis for Nigerian cities. It uses basic climatic data to produce a graph of the thermal stress for every fifteen minutes of the day using any or all of several thermal indices. The climatic data used are the monthly minima and maxima of temperature and relative humidity while the thermal indices used are the Mahoney scale, the Evans scale and the Effective Temperature (ET) index with indoor air velocities of 0.1 and 1.0m/s. The degree of thermal stress is measured on a five-point scale – very hot, hot, comfortable, cold and very cold. Apart from a graph of the thermal stress, bi-monthly assessment of the degree of thermal stress in percentages and a comparative summary of the degrees of thermal stress for all the indices used are produced (Prucnal-Ogunsote, 2007; Olu, 2007).

Triangulation method is, however, a combination of methods that could be used with empirical and laboratory observations. It is a combination of quantitative and qualitative methods. This method is very useful, because often no single method can provide sufficient information to achieve desired climate data interpretation goals (Margaret, 2003).

Therefore, information on validity and reliability is the main solution for influencing the choice of regional climate study methods and interpretation of the climate data findings. The major issue with Africa regional climate multi-data analysis and management has to do with invalidity and unreliability of the instruments used in forecasting climate information (Jibo, 2014).

4. THE STEPS IN MULTIPLE CLIMATE DATA ANALYSIS AND MANAGEMENT

Certain steps are needed for the climate data analysis and management after verification of validity, reliability and cleaning. These steps could be tabulated as follows:

Questions to ask	Steps to take	Important elements of each step
What data have been collected for each research objective? Is it complete and accurate?	Prepare data for analysis	Review field experiences. Take inventory for each data objective, check quality, and sort the data.
How does the data look like?	Describe variables.	Frequency distributions, figures and means.
How can the data be summarized for easy analysis?	Cross-tabulate quantitative data. Summarize qualitative data.	Cross-tabulate in relation to objectives. Graphic displays and narratives.
For quantitative data: Does each research objective aim to describe, compare or find associations?	Determine the type of statistical analysis required.	Review statistical objectives, study type and variables.
a. How can the data be described?	Determine the type of descriptive statistical analysis required	Choose significant tests.
b. How can difference between groups be determined?	Analyze paired and unpaired observations.	T-test, paired T-test; Chi-square test; McNemar's chi-square test CI estimation technique.
c. How can the association between variables be determined?	Measure associations between variables.	Scatter diagram; regression line and correlation co-efficient; Relative risk; odds ratio etc.

Source: (Margaret, 2003 and Jibo, 2014).

5. RESULT AND CONCLUSION

Regional climate data analysis and management in Nigeria, Niger Republic and Chad hardly undergo tests of validity. Information on validity is key to influencing the choice of climate study methods and subsequent interpretation of the climate data findings. Invalidity and unreliability of the instruments used in forecasting climate information are common in Africa. Correct interpretation(s) of multiple climate data must be given to findings. There is the demand for technical competence of the climate experts. Incorrect information and spurious associations cause serious climate change implications.

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