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ORIGINAL ARTICLE

THE NEED FOR ACCURATE AND TIMELY WEATHER AND CLIMATE SERVICES IN A DEVELOPING ECONOMY: NIGERIA IN PERSPECTIVE

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ABSTRACT: Accurate and timely weather and climate information is an ingredient for socio-economic development of a country. African countries, including Nigeria, are the most vulnerable to climate variability and change. This vulnerability is aggravated by existing developmental challenges such as endemic poverty, limited access to capital and markets, poor infrastructure and technology; ecosystem degradation; and political conflicts. These challenges have reduced the capacity of developing countries to provide the required infrastructure for effective climate services. This paper underscores the need for accurate and timely climate information and demonstrates that the management of current climate-related risks and long-term adaptation requires customation of climate information so that it would be relevant to end-users. The paper pre-supposes that climate information is an important pre-requisite for informed decision-making in risk management and adaptation that would help prevent climate extremes from becoming disasters and threats to livelihoods. The need for reliable weather and climate information as a crucial step for socio-economic development is brought to focus in this paper.

Keywords: weather, climate, adaptation, climate change, socio-economic development, Nigeria.

INTRODUCTION

The global community is currently occupied with concerns about climate changes. This paper examines the need for the provision of timely and accurate weather and climate information in the context of climate variability and change. Extreme and unusual weather conditions are being experienced on a global scale, bringing on their toll, loss of lives and property, including disruption of socio-economic activities. The increasing frequency and intensity of these events constitute a major challenge to socio-economic development, particularly in developing countries such as Nigeria. According to Srinivasan *et al* (2011), current climate variability viewed along with future climate change scenarios, highlights the need for delivering weather and climate information in a manner that is timely and accurate. In the light of the above, accurate and timely weather and climate information is a vital tool for planning in the key sectors of the economy that are sensitive to weather and climate. These sectors include, but not limited to, aviation, agriculture, health, hydro-electric power, road and marine transport, wind power and water resources management. The negative impacts of extreme and unusual weather on key sectors of the economy are many and varied.

Poor communities dependent on economic activities affected by weather and climate are exposed to risks caused by climate variability and change at local scales. Many communities in Nigeria are vulnerable since they are exposed to several hydro-meteorological hazards due to factors associated with climate variability and change. Effective use of weather and climate information to manage climate-related risks and prepare adaptive and mitigating measures to face future challenges is imperative.
Many studies have provided insight into the direction and significance of temporal and spatial variations in climatic parameters (e.g, Turke *et al.,* 2008; Brunetti *et al.,* 2001; Obot *et al.,* 2010; Simsek and Cakmak, 2010; Ewona and Udo, 2008; Enete and Ebenebe, 2009). Such studies have revealed that the climatic variability in the 20th century was characterized by apparent variability in climatic variables at different temporal and spatial scales.

The United Nations had identified climate change as a major threat to socio-economic development programmes worldwide, including the Millennium Development Goals (MDGs). Many

countries in the world, including Nigeria, are responding to the call by the World Meteorological Organisation (WMO) to provide efficient climate services for mitigation of, and adaptation to the impacts of climate change. The Nigeria's response to these calls was the establishment of the Nigerian Meteorological Agency (NIMET) in 2003. NIMET is purportedly placed on the path of steady growth and progress in actualizing its mandate of providing accurate and timely weather and climate services for national socio-economic development and safety, while also fulfilling its international obligations. Indeed, some critical components of the Nigeria's comprehensive national economic transformation programme, known as VISION 20:2020, are sensitive to weather and climate variability. Therefore, provision of accurate climate information services is critical to the implementation of the national and global socio-economic development agenda.

EXPLANATION OF THE KEY CONCEPTS

Weather is the present condition of the meteorological elements such as air temperature, humidity, wind, atmospheric pressure, rainfall etc and their variations over shorter periods of time. ***Climate*** encompasses the statistics of temperature, humidity, atmospheric pressure, wind, rainfall, atmospheric particle count and other meteorological elements in a given region over a long period of time. The Intergovernmental Panel on Climate Change (IPCC, 2007) defined climate thus: " *Climate in a narrow sense is usually defined as the average weather, or more vigorously as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands and millions of years*." The classical period is 30years, as defined by the World Meteorological Organization (WMO). These quantities are usually surface variables such as temperature, precipitation and wind etc. Climate in a wider sense is the state, including a statistical description of the climate system. Although we maintain the distinction between weather and climate prediction and the different methodologies for generating them, it is observed that the institutional system used for generating and delivering weather and climate information are the same. For most practical purposes, users see managing both weather and climate risks as pair of the same strategy. ***Climate risk*** is the possibility of bad event such as damage to life and property or financial loss as a result of extreme or severe weather events, unusual variations such as heat waves or droughts, or long-term changes in climate or climate variability. ***Climate risk management*** is a skill of dealing with climate sensitive activities that aims to minimize the negative and maximize the positive influence of weather and climate variability and change. ***Climate change*** is the variation in global and regional climates over time. It is a reflection of changes in the variability or average state of the atmosphere over time scales ranging from decades to millions of years. These changes can be caused by processes internal to the earth, or external forces (e.g variations in the sunlight intensity) or more recently, human activities (Ledley *et al,* 1999). In recent usage, especially in the context of environmental policy, climate change often refers only to changes in modern climate, including the rise in average surface temperature known as global warming. In some cases, the term is also used with a presumption of human causation, as in the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC uses climate variability for non-athropogenic caused variations (IPCC, 2001). ***Adaptation*** in this context is" *characteristics that help living things survive under a given set of environmental conditions* "(Miller, 2005). The IPCC (2007) defined adaptation as the "*adjustment in natural or human systems to a new or changing environment".* ***Developing Economy*** lacks singleness of definition. The development of a country is measured with statistical indices such as income per capita, life expectancy, the rate of literacy etc. Although there are no universal, agreed upon criteria for categorizing an economy as developing or developed, there are general reference points such as nation's Gross Domestic Product (GDP) per capita compared to other nations. The United Nations had developed the Human Development Index (HDI), a compound indicator of the above statistics to gauge the level of human development for countries where data is available. According to Arthur and Sheffrin (2003), a developing economy is an economy characterized by low standard of living, underdeveloped industrial base, and low Human Development Index (HDI) relative to other countries. In general, developing economies are those that have not achieved significant degree of industrialization relative to their populations, and have, in most cases, a medium to low standard of living.

KEY DRIVERS OF CLIMATE CHANGE

The climate of a place is affected by its latitude, terrain, altitude, nearby water bodies and their currents, proportion of land to water, and proximity to oceans and mountains. These change only over periods of millions of years due to processes such as plate tectonics (Schwartz, 1995). Other climate determinants are more dynamic: e.g the thermohaline circulation of the ocean leads to a 5°C (9°F) warming of the North Atlantic Ocean compared to other ocean basins (Rahmstorf, 2008). Other ocean currents re-distribute heat between land and water on a more regional scale. The density and type of vegetation coverage affects solar heat absorption (de Werk and Mulder, 2008), water retention and rainfall on a regional scale. Alterations in the quantity of atmospheric greenhouse gases determine the amount of solar energy retained by the planet, leading to global warming or global cooling. Other natural drivers of change include *El Nino* and *La Nina* oscillations, volcanic eruptions, sunspot activity and changes in sun-earth distance between January and July.

The variables which determine climate are numerous and the interactions are complex, making the climate to be in chaos. However, there is a general agreement that the broad outlines are understood, at least in-so-far as the determinants of historical climate change are concerned (Ledley, *et al,* 1999). Documental long-term climate changes include changes in precipitation patterns and amounts, ocean salinity, rise in average surface temperature, wind patterns and wind speeds, extreme weather events, including drought, flooding, heat waves and intensity of tropical cyclones (European Academy of Sciences and Arts, 2007).

APPRAISAL OF IMPACTS OF WEATHER AND CLIMATE-DRIVEN PHENOMENA ON NATIONAL ECONOMY.

AVIATION SECTOR

In the aviation sector, severe weather conditions lead to the flight delays and outright cancellation, resulting in disruption of socio-economic activities. Severe weather-related air disasters are even more worrisome.

INFORMATION AND TELECOMMUNICATION

In Nigeria, the onset and offset phases of rainy seasons are characterized by thunderstorms, strong winds, line squalls and turbulence. These extreme weather events impact negatively on information and telecommunication facilities such as telecommunication cables and communication satellites.

AGRICULTURE

Agriculture in Nigeria is rain-fed. Significant change in the pattern of rainfall would lead to tremendous crop failure. Flooding of farmlands during high rainfall intensities will leave on its trail severe loss of agricultural produce. Food security is crucially dependent on the timely availability of adequate amount of water and a conducive climate. Weather and climate services are required for judging the agricultural production potential and sustainability of agricultural production system.

ELECTRIC POWER GENERATION

Dam managers are faced with the challenge of ensuring optimum performance of hydro-power stations whenever there is water shortage due to drought, or whenever there is surplus water occasioned by too much rain. In this way, hydro-power becomes adversely affected. On the other hand, accurate estimates of long-term linear trends of wind speed provide a useful indicator for circulation changes in the atmosphere and are invaluable for the planning and financing of wind energy. Furthermore, as the world gradually moves away from carbon economy to green economy, undertaking of research on the climatic potential of utilization of global solar radiation for the electric power purposes is a credible alternative to the exploitation of natural resources.

WATER RESOURCES

Study of rainfall variability is significant for promoting water resources management and planning, including managing environmental hazards such as flooding, erosion and drought. Disaster managers are confronted with disaster risk occasioned by increasing risk of flooding, soil erosion and drought in various parts of the country.

PUBLIC HEALTH

The outbreak and spread of some diseases such as cerebro-spinal meningitis, malaria and respiratory

tract infections could result from the phenomenon of climate variability and change. Furthermore, studies have found that dwindling wind speed leads to higher concentrations in pollution plumes (e.g Jacob and Winner, 2009; Holzer and Boer, 2001). According to Ramanathan and Feng (2009), air pollution is transported across continents and ocean basins as a result of fast long-range transport, giving rise to trans-oceanic and trans-continental plumes of atmospheric brown clouds (ABCs). Reduced wind speeds imply poor ventilation of pollutants with the attendant consequences of exacerbating lung and heart diseases especially for asthmatic patients. According to Jacob and Winner (2009), the two air pollutants of most concern for public health are surface ozone and particulate matters, which are subject to long-range transport by the winds. In addition, wind speed and direction data are useful in air dispersion modeling and identifying emission-pollutant sources (Droppo and Napier, 2008).

AVAILABILITY OF INFORMATION FOR END-USERS

The current goal of applied climate science is to improve knowledge at regional and local levels. The smaller the scale at which information are to be provided, the greater the relevance to users for most applications. It is pertinent to point out that societies have been rendered more vulnerable to climate risks owing to several non-climatic factors such as patterns of settlement, high population density and poverty. According to Ezber *et al,* (2007), urbanization makes significant changes in the surface parameters which have the potential to alter the local climate in cities. In the light of these, adaptation does not only entail making adjustments in natural and anthropogenic systems to deal with a changing climate; it equally entails addressing long-standing development issues that make people vulnerable to the negative impacts of climate variability and change. Climate information coupled with climate risk management and adaptation strategies can minimize the loss of lives and damage of properties, infrastructure and crop production from natural climate variability and extreme weather events.

Weather and climate information ought to contain the temporal scale (e.g century, decades, years, seasons, months, weeks, days etc); such information should specify the spatial scale (e.g global, continental, regional, national, community). To be relevant or useful for decision-making, the information needs to contain the change scenarios, predictions, guidance, threat assessments, forecasts, warnings and alerts.

NIMET AND THE CHALLENGE OF PROVIDING WEATHER AND CLIMATE SERVICES IN NIGERIA.

The Nigerian government is reportedly investing in infrastructural and man-power resources development to strengthen the capacity of NIMET (Njeze 2011). This is to enable NIMET to predict weather and climate more accurately and provide timely advisories to farmers, water resources managers, policy makers, stake holders in health, energy and transport sectors, and of course, the general public. NIMET has embarked on key infrastructural development projects. Some of these projects that have either been completed or at various stages of completion include (Njeze, 2011):

I. *"Establishment of National Weather Forecasting and Climate Research Centre (NWFCRC);*
II. *Installation of six Doppler Weather Radars (DWR) at Abuja, Kano, Lagos, Maiduguri, Port-Harcourt and Yola;*
III. *Installation of low-level wind shear alert system (LLWAS) at three airports, namely, Lagos, Port-Harcourt and Kano airports;*
IV. *Reactivation and expansion of network of Upper Air Stations;*
V. *Establishment of five weather stations along Nigerian coasts;*
VI. *Installation of Meteosat Second Generation (MSG) ground receiver at the four international airports;*
VII. *Installation of thunderstorm detectors at airports across the country;*
VIII. *Development of an electronic data transfer system (e-Met) to ease data transfer from remote station to collection centre;*
IX. *Intensive and extensive capacity building."*

These projects are perceived as NIMET's response to the implementation of the Federal Government's policy of safety, security and zero-tolerance for accident in the Nigerian airspace. Perhaps, it is in furtherance of this policy that President Goodluck Jonathan in 2011 commissioned the Total Radar Coverage of Nigeria (TRACON) project of the Federal Ministry of Aviation. NWFCRC is central to the development of a National Framework for climate services (NFCS) for Nigeria, patterned after the Global

Framework for Climate Services (GFCS). Under the arrangement, the centre is expected to: (I) engage in co-ordinated operational and research activities in the areas of applied meteorology, weather forecasting, climate modeling and climate information services (II) provide platform for closer collaborations between NIMET and science communities in Nigerian universities, polytechnics and institutes. The expectation is that such collaborations will foster research activities aimed at understanding the scientific basis of the observed changes in our weather and climate patterns, and proffer solutions to reduce the negative impacts of climate change in Nigeria.

THE MISSING LINKS

I. In Nigeria, the expected collaborations between the government agency (NIMET) and the science communities in Nigerian universities have not been strengthened. The idea of connecting providers and end-users in an end-to-end system of climate information generation and application has been advocated by a lot of experts and policy makers. This idea seems straight forward but the implementation is not simple.

II. There exists a mismatch between the temporal and spatial scales required for decision making. As a consequence, climate information is not tailored to user requirements. For instance, oftentimes, only information on seasonal rainfall totals is available but for most farming activities, the rainfall distribution within a season, as well as probabilities of a dry or wet spell within a season is more critical.

III. Meteorologists forecast what they know rather than provide information that meet the needs and requirements of the end-users.

IV. Forecasters are not trained in communicating probabilistic scientific information for sectoral use with user agencies and communities.

V. There exist weak forecast provider-user communication channels.

VI. Users do not have the mechanism for processing information once it is received.

In many situations, a combination of these factors result in inaction and mismanagement, leading to losses of lives and property. Lack of awareness of the consequences of delayed action, and lack of confidence in the information provided could spell doom and gloom. The need for evolving a system that will translate information into recommended actions (e.g warnings, alerts, evacuation order) and finally deliver the information is imperative. The United States National Research Council panel study (NRC 2009) observed that "decisions depend not on the quality and availability of information, but on the ways people (working individually or in groups) process information and evaluate options." Lugon (2010) observed that "many policies fail because experts believe that better science will automatically lead to better decisions without fully understanding the specific situation and the institutional context which the climate information is to be used." Providing accurate climate information is constrained by the limitations of the present global modeling systems to provide location – specific forecasts. Model development and global climate analysis requires input from many scientific disciplines.

THE WAY FORWARD

Recognizing the fact that climate model development and analysis requires input from many scientific disciplines, NIMET should through the NWFCRC, provide and sustain platform for closer collaborations with science communities in Nigerian universities and other research-based institutions. Such collaborations will promote scientific research and information technology which are the outcomes of university-driven activities as the melting pot of intellectual activities. The concept of "***knowledge-based"*** economy entails the use of knowledge to enhance economic activities for socio-economic transformation and innovative modernization of national economies (Ewa 2014).

The involvement of government agencies (NIMET in this case), research institutions and end-users of knowledge-based economy is indispensable. Strengthening the link among the trio would ensure a successful interacting mode of the "***Triple Helix Model"*** that has been mooted and elucidated by some authors (e.g Ewa 2014) as a sovereign remedy for socio-economic stalemate and stagnation. The ***Triple Helix Model of Innovation*** ensures that government agencies, research institutions and user sectors assume some of the capabilities of the others without prejudice to each entity's primary role and distinct identity. A successful interacting mode of the ***Triple Helix Model*** would engender

collaborations, sustained activity and innovation. The apparent nonexistent and weak linkages among the three entities are responsible for lack of positive feedbacks. Encouraging partnership among the trio in the context of the ***Triple Helix Model*** is critical and is recommended for leveraging a knowledge-based economy for Nigeria's socio-economic development.

CONCLUSION

Accurate and timely weather and climate information is an essential ingredient for socio-economic development of any nation. The key elements of the Nigerian VISION 20:2020 economic transformation programme are sensitive to weather and climate, and require efficient climate services for successful implementation. The Nigerian Meteorological Agency (NIMET), patterned after the World Meteorological Organization (WMO) and National Hydrological and Meteorological Services (NMHS), was established as a child of necessity and charged with the mandate of providing accurate and timely weather and climate services for national socio-economic development.

The meteorological services are founded and evolved on the bedrock of observations and science, a focus that needs to be maintained to bring much – needed progress in climate science and technology. It is vital, nay imperative, to develop mechanisms for delivering climate services at community levels so that the process remains user-driven. Within the institutional system for delivering climate information generation, delivery and services, there is a need for mechanism that can identify appropriate research findings and demonstrate their potential use in sectors and communities in the context of the ***Triple Helix Model*** and ***knowledge-based*** economy. The NIMET should partner effectively with Universities, Polytechnics, Institutes and other stakeholders in climate research. This will evolve programme/methodology for establishing climate information generation and applications systems. These could include: assessment of user information needs and existing capacities of national meteorological institutions to meet these needs; assessment of relevance of latest scientific information to meet these needs; developing partnerships and enhancing capacities of national institutions to generate climate information, institutional development to communicate information to end-users; applying information to enable proactive decision-making; and monitoring and evaluation of outcomes.

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