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Assessment of daytime physiologic comfort, its perception and coping strategies among people in tertiary institutions in Nigeria

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ABSTRACT

Adequate understanding of the extreme thermal condition is as important as that of the averages for planners and policy makers. A significant knowledge gap exists in the physiologic comfort in many developing countries, particularly in the tropical region where thermal stress can pose significant threat to life because of inadequate infrastructure. This study examines the hourly variations in the physiologic comfort of Nigeria using the effective temperature, temperature–humidity and relative strain indices (ETI, THI and RSI, respectively). It also examines the perceptions of a selected sample of Nigerians, and their coping strategies to extreme conditions of cold and heat stress. The results showed that physiologic comfort in Nigeria exhibits variations across the different latitudinal locations; shows seasonal variations and is affected by local geography. Perception of the comfortable climate exhibits variation based on the latitudinal location of the respondents but the coping strategies vary with the wealth of individuals. The study showed that physiologic discomfort is severe in many parts of Nigeria (especially in the climate regions outside the montane climate) but the infrastructure to cope with the thermal stress is either poorly known or unaffordable for the majority of the people.

1. Introduction

1.1. Background

Physiologic climatology is the aspect of the study of climate that deals with the direct effects of climatic elements, patterns on the physiologic behaviour of man and other warm blooded animals (Lee, 1953). It has also been defined as the classification or regionalisation of climatic environments based on measurable human psychological and physiologic reactions (Terjung, 1967). Physiologic climate is usually computed by the use of individual heat related elements of climate such as air temperature, relative humidity, radiant energy and wind, and by coupling at least two of the elements of climate as indices of physiologic comfort. Eludoyin and Adelekan (2013) and Eludoyin et al. (2013) reviewed a detailed list of the popular indices of physiologic comfort, and argued that three of them; the temperature–relative humidity index (THI), effective temperature index (ETI) and relative strain index (RSI) are commonly applied to the tropical climate. The three indices can, however, provide relatively different interpretations in large areas, where climate are not known to be homogenous, when their annual and seasonal patterns were investigated (Eludoyin et al., 2013). The relative disparity in models interpretations can cause problems while making important decisions on climate-related health warning system for regions with spatially heterogeneous climate systems, especially when such decisions are informed from single model-based experiments.

Information on physiologic comfort of an area can be useful for regional planning for warning systems in areas that are vulnerable to climate-related sickness, thermal stress and for planning for migration, tourism and building (Parish and Putnam, 1977; Jauregui, 1997; McMichael and Kovats, 2000; Jonsson, 2004; McMichael et al., 2006). For example, the Harmattan period is known to be associated with dry skin, heat stress, red eyes and respiratory diseases due to prevalence of the Sahara desert-sourced dusts in Nigeria (Adefolalu, 1985). The rainy or wet season on the other hand is often associated with water-based diseases, especially in the southern Nigeria while heat-related sicknesses such as meningitis prevails in the northern and the middle belt part of Nigeria in the dry season (e.g. Sawa and Buhari, 2011). Physiologic climate has also become of global concern because of the current concerns for the effects of extreme climate and increased urbanisation in most countries, especially in the developing countries where health and welfare infrastructure is not sufficient to cope with reported cases of climate-related morbidity and mortality (Jauregui, 1993; Wolkoff and Kjaergaard, 2007; Lin et al., 2011; Le Treut et al., 2007; Boko et al., 2007; Ostro et al., 2011; White-Newsome et al., 2011).

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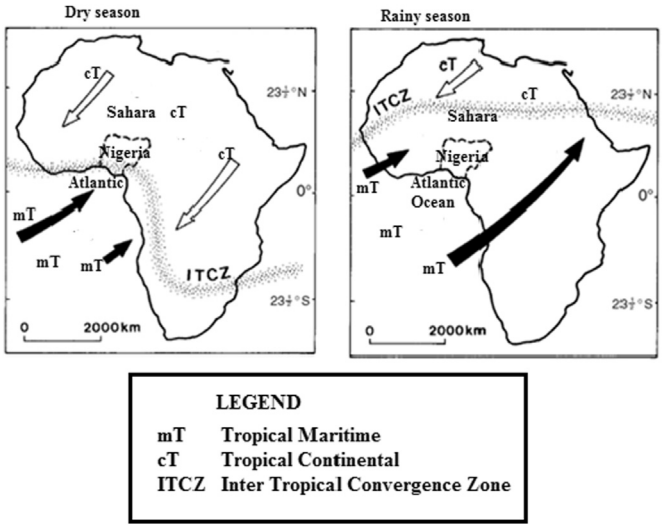

Fig. 1. Nigeria in Africa, and the seasonal direction of the air masses and the Inter-Tropical Convergence Zone that determine the season in the region.

1.2. Problem

Previous studies on the physiologic climate of Nigeria have involved relatively long-term data (1951–2009) and the variations in 1951–1980 and 1981–2009 periods (Ayoade, 1978; Olaniran, 1982; Eludoyin et al., 2013; Eludoyin and Adelekan, 2013; Eludoyin, 2013). Climate, on the other hand, has been argued to include not only the averaged weather conditions over a period of time, but also short term extreme weather and climate conditions as well the spatial and temporal variability and change (Ologunorisa, 2011). A review of the existing studies on the physiologic climate in Nigeria showed that little or no information exists on the diurnal patterns of the physiologic climate in Nigeria (Eludoyin, 2013; Eludoyin and Adelekan, 2013). Furthermore, studies (e.g. Ayoade, 1978; Olaniran, 1982) recognised the importance of using multiple indices to interpret the physiologic comfort in large regions in the tropics because of their heterogeneous climate, and the approach has been adopted in previous studies where air temperature, relative humidity, THI, ETI and RSI have been investigated for their monthly and annual variations for a relatively long (1951–2009) term. Thermal stresses (cold and heat) are a measure of climate extremes that can also be useful in the assessment of variations or change in climate. The cold stress can be defined as an extreme climate condition that is less than the physiologically comfortable condition (e.g. when ETI, THI and RSI is less than 18.9 °C, 15 °C or 0.1, respectively) while the heat stress condition is a measure well above the physiologic comfort level (e.g. when the ETI, THI and RSI is greater than 25.6 °C, 24 °C or 0.2, respectively). Vulnerability to both heat and cold stress has been shown in the literature to be linked with significant morbidity and mortality consequences (Miller, 1952; Adefolalu, 1985; Bypass, 2009).

1.3. Study focus and objectives

This study involves an investigation of the hourly patterns of the THI, ETI and RSI in Nigeria in two different years (1971 and 2001). Studies, such as Romero et al. (1998), Tank et al. (2002), and Le Treut et al. (2007) have shown that most days in 2001 were warmer than those in 1971 as a result of increased urbanisation and general global temperature increase. When the global temperature trend for 1900–2005 (Le Treut et al., 2007) was examined, the year 1971 showed about −2 °C as mean decrease in temperature while in 2001, the mean temperature increased by about 4 °C. The study also investigates the perceptions of a sample of Nigerians on physiologic comfort and coping strategies.

Table 1
Some information about the human geography of Nigeria (Eludoyin et al. 2013).

Variables	Explanation	Rate
Landuse	Deforestation Reforestation Forested area (2008)	4000 km^2/year^{-3} 10 km^2/year 10.8%
Urban Population	Annual growth Urban population in 2004, 2010	3.8% 45%, 48.9%
Rural population	Annual growth	1.8%
Total population	Population density in 2004, 2009 Annual growth	137.6, 167.5 persons/km 2.5%
Total fossil fuels emission	1951 1980 2008	460,000 metric tons 18,586,000 metric tons 26,113,000 metric tons

2. Materials and methods

2.1. Study area

The study area, Nigeria, lies between 4–14°N and 3–15°E in the southeastern edge of the West African region with about 923,800 km^2 land area or about 14% of West Africa. Nigeria is characterized by two main seasons: dry and rainy seasons. The dry season is accompanied by a dust-laden wind from the Sahara desert, known as Harmattan, which is brought by the Tropical Continental (cT) air mass, while the rainy season is heavily influenced by the Tropical Maritime (mT) from the Atlantic Ocean (Fig. 1).

The local climate in the north central region may also be more influenced by the high elevation in the region than the south. The climate of Nigeria can be classified into (a) tropical rainforest eco-climate, (b) tropical savanna eco-climate and (c) highland climate or montane climate. The tropical rainforest eco-climate, which