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Analysis of variations and trends of temperature over Niger central hydrological area, Nigeria, 1911–2015

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ABSTRACT

Adequate information about the variations and trends of climatic variables is indispensable for the better management of the water resources and agricultural sectors. In this study, the variability and trends of the monthly, seasonal and annual temperatures ((TMIN, TMAX and TMEAN) time series were studied over Niger Central Hydrological Area, Nigeria (NCHA) during 1911–2015 using the Climate Research Unit (CRU) data. Different statistical operations analysis comprising descriptive statistics, linear regression model, Mann–Kendall test, Pettitt's test and standard normal homogeneity test (SNHT) were employed for the analysis. The tests were used to examine the temperature variability, presence of monotonic trends and change points of the time series. The monthly TMEAN variability over the entire area was between 2.10% and 3.61%. Periods 1914–1925 and 1974–1980 showed cooling trends, while 1930–1935, 1981–1988 and 2001–2015 exhibited warming trends. The annual TMIN and TMEAN showed positive trends across the 33 sub-basins of NCHA, while the TMAX showed mixed trends. The increasing trend was most significant on the monthly, seasonal and annual timescales of the TMIN, followed by TMEAN. In contrast, the mixed trends in TMAX were not significant. The global rate of change trends of TMIN, TMAX and TMEAN are 0.091, −0.007 and 0.043 °C/decade respectively. The overall warming of TMEAN also had a significant upward shift change of 0.43 °C since 1980 and the change spatially is characterized by a SW-NE orientation. There is a need to embrace green settlement and a green economy to reduce the impact of the ever-increasing warming trend over the region.

1. Introduction

The variability of climatic and hydrological variables and **its** consequential effects on the planet earth in recent times suffice as evidence for the change in the climate. Currently, the entire globe is experiencing the impacts of climate change, and the effects of the change are evident on the continent of Africa (Oguntunde et al., 2018). The increase in greenhouse gas emissions which arises from anthropogenic activities has brought about a shift in the temperature of the globe. Hence, a relatively new and severe threat of abrupt climate change has been witnessed (Zarenistanak et al., 2014). Tabari et al. (2012) asserted that though, different estimates of the global increase in temperature had been reported, the best present estimates suggest an increase in the range of 1.4–5.8 °C for the twenty-first century. However, due to the uneven distribution of climate, varied types of land surfaces with different surface albedo, evapotranspiration and carbon cycle, such ranges may not give a true reflection of the extent of change in different regions (Oguntunde et al., 2012).

Change in climate manifests either through a rise in temperature or an increase or decrease in rainfall. Temperature is an important climatic variable which plays a significant role in evaporation and transpiration. A temperature rise could attract several adverse effects that range from a reduction in water resources, rising crop evapotranspiration, and a decline in agricultural and food production; all of which will ultimately have an impact on humans and ecosystems (Araghi et al., 2016; Chattopadhyay and Edwards 2016). Because of the consequences mentioned above, the assessment of the behaviour and impact of temperature on the related hydrological processes has become a prerequisite in water resource planning and management (Chattopadhyay and Edwards 2016). Trend analysis and change point detection have been considered vital methods in detecting variations in available meteorological data such as temperature. Hence several studies have used the technique for

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