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Drought Characteristics in Two Agro-Climatic Zones in Sub-Saharan Africa

Ayansina Ayanlade[1,2], Maren Radeny[2], John F. Morton[3], and Tabitha Muchaba[2]

[1]*Department of Geography, Obafemi Awolowo University, Ile-Ife, Nigeria*

[2]*CGIAR Research Programmed on Climate Change, Agriculture and Food Security (CCAFS), International Livestock Research Institute, Nairobi, Kenya*

[3]*Natural Resources Institute, University of Greenwich, Kent, United Kingdom*

1. Introduction

The relationship between drought and loss of crops and livestock has long been known as an environmental challenge confronting agricultural production in many parts of Africa. Despite the great advancement of climate science in understanding and dealing with climate change and its impacts on the agricultural sector at the international and regional levels, awareness and the concern for the problem at local levels, especially among the rural farmers in Africa remains crucial. Most of the crops farming in Africa is rain-fed (Lobell *et al.* 2011; Ayanlade *et al.* 2017). Changing rainfall patterns will greatly affect both crop and livestock farming. In Nigeria for example, drought is not only main cause of crop loss but also leads to death of livestock in many parts of the country (Abaje *et al.* 2014; Tambo and Abdoulaye 2013). Thus, this study aims at examining the drought characteristics in two agro-climatic zones: Rainforest and Guinea savannah of Nigeria and assess the level of awareness and sensitivities of local farmers' to climate variability and change. The paper focuses on assessing the frequency and probability of prolonged dry spells over the period between 1984 and 2014, and the major coping strategies of smallholder farmers in both Rainforest and Guinea savannah agro-climatic zones of Nigeria. The study further identifies factors determining farmers' preference for selected adaptation strategies.

2. Methodology

The study area was divided into two agro-climatic zones: Rainforest and Guinea savannah agro-climatic zones of Nigeria. The Guinea savannah experiences precipitation of about 900-1200 mm per annum and the wet season lasts for 6 - 8 months, but much more in rainforest zone (Fig. 1). The climatic data were sourced from the archives of the Nigerian Meteorological Agency, Oshodi, Lagos over the period of 1984 to 2014. Qual-Quant research methods were used in this study. The data used were from four selected weather observatories stations; Iseyin, Shaki, Ibadan, and Osogbo. From this dataset, annual average rainfall and number of the rainy days were computed using RAINBOW software, which is designed to carry out hydro-meteorological frequency analyses and to test the homogeneity of climatic data. Questionnaires and focused group discussions were used to collect data on rural farmers' perception about the impacts of drought and their adaptation strategies used to cope during and after the extreme weather events. The study sites for household survey comprises of selected farming communities in southwestern Nigeria. The first segment of the household survey was conducted in the months of October and November of 2015, while the second segment was conducted in the months of May

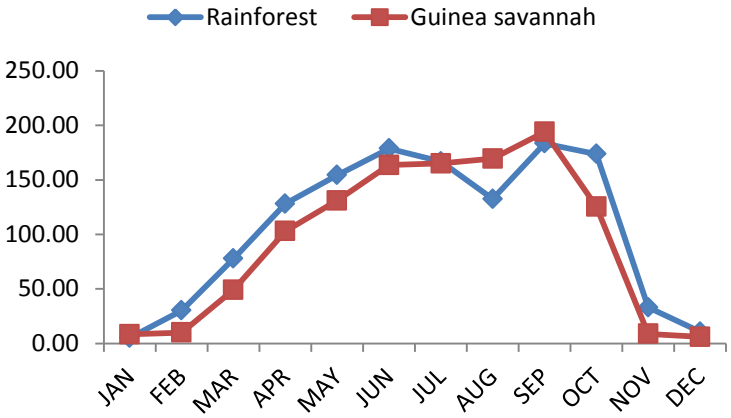

Fig. 1 Rainfall patterns in the study area.

Correspondence to: Ayansina.Ayanlade, Department of Geography, Obafemi Awolowo University, Ile-Ife, Nigeria;
E-mail: aayanlade@oauife.edu.ng

and June 2016. A total of 350 farmers belonged to the age group of 35-75 years were selected, using a multistage sampling method.

Drought characteristics were assessed using seasonal rainfall fluctuations and coefficient of variance (CV). The coefficient of variance statistics was calculated for rainfall amount (RA) and a number of rainy days (RD) with their T-test statistics were carried out to assess the significance of variation. Besides, the probability and the frequency of dry-spell occurrence, during the growing seasons, were estimated by considering the number of rainy days in the growing months. Any day with rainfall less than 0.3 mm was counted as a dry day.

The CV is measured as the relative variability of the rainfall amount and number of rainy days per month. It was calculated as the ratio of the standard deviation to the mean (average) for both RA and RD as in Equation 1,

$$CV = \frac{\delta_{RA/RD}}{\mu_{RA/RD}} * 100\% \quad (1)$$

where CV is the ratio of the standard deviation δ_(RA/RD) to the mean μ_(RA/RD) for both rainfall amount and number of rainy days. The probability and the frequency of dry spells, during the growing seasons were estimated. The probability that consecutive dry days would occur were established by considering the number of the days in the month and the total possible number of days in the growing seasons. Information about the coping strategies adopted by farmers and farmers' perception of drought was gathered through questionnaires and focus group discussions in the farming communities.

3. Results

The probabilities that dry spells exceed 3, 5, 10, and 15 consecutive days are much higher in the Guinea Savanna than in Rainforest zone (Fig. 2). Generally, the probabilities values of dry spells exceed the selected consecutive days are generally lower in rainforest agro-climatic zone compared to Guinea savanna agro-climatic zone. The results show a high probability that dry spells exceed 3 and 5 consecutive days during both growing seasons. In all stations, the probability that dry spells exceed 25 consecutive days is very low in all

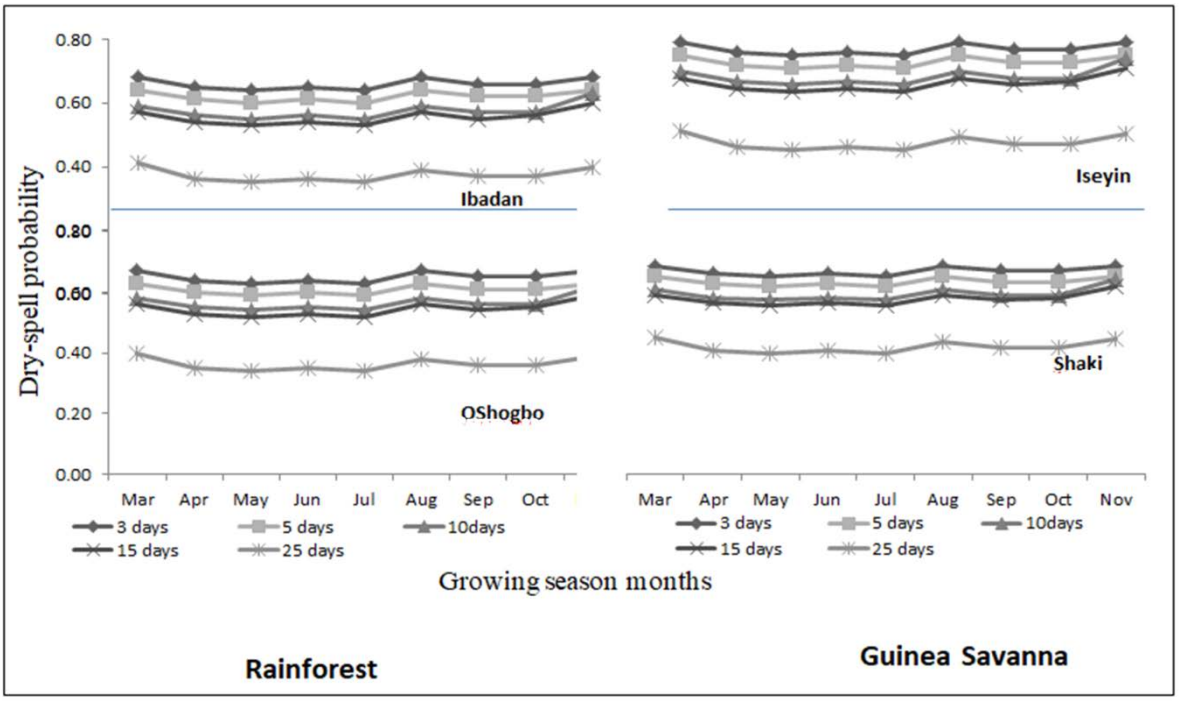

Fig. 2 Probability of dry-spell exceeding 3, 5, 20, 15 and 25 consecutive days in growing seasons.

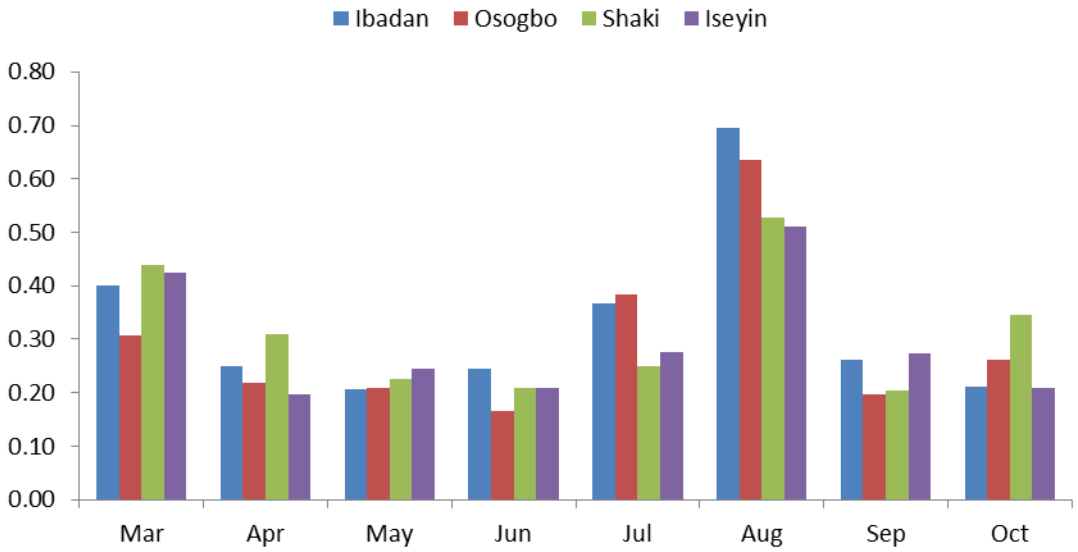

Fig. 3 Coefficient of variation in rainy days (CV-RD) during growing seasons.

the stations with $0.37 \leq p \leq 0.52$ (Fig. 2). These results denote that rainfall is much more reliable from the months of May till July in early growing season (EGS) but September in late growing season (LGS) for cropping.

Rainfall is much more reliable from the month of May until July with the coefficient of variance for rainy days less than 0.30, but less reliable in the months of March, August and October with CV-RD > 0.30, though CV-RD appears higher in the month of August for all the stations (Fig. 3). It is apparent that farmers' perceptions of drought fundamentally mirror climatic patterns from historical weather data. The results of the household survey show that farmers' perception of drought and extreme climate events mirror meteorological analysis. The majority of the farmers perceived that "rainfall onset, duration, and cessation have not been normal in the recent years" and they claim that "prolonged dry spell during growing seasons are now frequent in recent years". These sensitivities by farmers therefore, confirm the results from meteorological trend presented in the sections above. Though, the length of farming experiences has a significant relationship with farmers' perceptions of climate change adaptation strategies. Besides, many herders observed that "cattle health is now poor and the milk obtained from their cattle has reduced greatly, compared to several earlier centuries". In general, the "Fulani" pastoralists complained mostly about "the reduction of grazing grass and water for their cattle, though they move their cattle around for pasture".

4. Summary and conclusions

This study examined drought characteristics during growing seasons in two agro-climatic zones of Nigeria and farmers perceptions of impacts and adaptation strategies. Most farmers had observed some prolonged dry spells within the months of March, April, and August, which affect their planting dates. This condition is worsened by marginally available financial resources and know-how for designing and implementing effective adaptation measures. In all the study sites, the farmers stated that "the planting dates were re-scheduled to the most suitable and favorable times for the crops to be planted". For instance, some crops are planted at the onset of rainfall, but in situations when rainfall is delayed, the planting date of the crop would be shifted to the time when the rain starts. It is apparent that farmers' perceptions of drought fundamentally mirror climatic patterns from historical weather data. However, farmers have adopted different strategies to cope with recurrent drought events in the study area. These strategies only partially compensated for the fact that agriculture would almost certainly have been better if the climate had kept constant. The facilities and equipment for adaptation should be provided at a subsidized price by the government, and that efforts should be made to develop crop varieties that can cope with the current conditions of climate change in Nigeria.

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