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Comparing smallholder farmers' perception of climate change with meteorological data: A case study from southwestern Nigeria

Ayansina Ayanlade[a,b,*], Maren Radeny[b], John F. Morton[c]

[a] Department of Geography, Obafemi Awolowo University, Ile-Ife, Nigeria
[b] CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS), International Livestock Research Institute, Nairobi, Kenya
[c] Natural Resources Institute, University of Greenwich, Kent, United Kingdom

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ABSTRACT

This paper examines smallholder farmers' perceptions of climate change, climate variability and their impacts, and adaptation strategies adopted over the past three decades. We use ethnographic analysis, combined with Cumulative Departure Index (CDI), Rainfall Anomaly Index (RAI) analysis, and correlation analysis to compare farmers' perceptions in Southwestern Nigeria with historical meteorological data, in order to assess the way farmers' observations mirror the climatic trends. The results show that about 67% of farmers who participated had observed recent changes in climate. Perceptions of rural farmers on climate change and variability are consistent with the climatic trend analysis. RAI and CDI results illustrate that not less than 11 out of 30 years in each study site experienced lower-than-normal rainfall. Climatic trends show fluctuations in both early growing season (EGS) and late growing season (LGS) rainfall and the 5-year moving average suggests a reduction in rainfall over the 30 years. Climatic trends confirmed farmers' perceptions that EGS and LGS precipitations are oscillating, that rainfall onset is becoming later, and EGS rainfall is reducing. Overall impacts of climate change on both crops and livestock appear to be highly negative, much more on maize (62.8%), yam (52.2%), poultry (67%) and cattle (63.2%). Years of farming experiences and level of income of farmers appear to have a significant relationship with farmers' choice of adaptation strategies, with $r \geq 0.60$ @ $p < 0.05$ and $r \geq 0.520$ @ $p < 0.05$ respectively. The study concluded that farmers' perceptions of climate change mirror meteorological analysis, though their perceptions were based on local climate parameters. Smallholder farmers are particularly vulnerable to climate change since the majority of them do not have enough resources to cope.

1. Introduction

The scientific evidence has shown that climate change is a global challenge facing humans and their socio-economic activities, health, livelihood, and food security (Romieu et al., 2010; Amjath-Babu et al., 2016; Mitchell and Van Aalst, 2008; Clarke et al., 2012). Changes in climate affect developed and underdeveloped nations and poor and rich people are also affected by its impacts. Underdeveloped nations and the poor are, however, more vulnerable (Adger et al., 2003). Rural farmers in Sub-Saharan Africa are likely to be more vulnerable to climate change, particularly because of compounding challenges of poverty, low infrastructural and technological development, and high dependence on rain-fed agriculture (Lipper et al., 2014; Ericksen et al., 2011; Nelson et al., 2014; Adimassu and Kessler, 2016). More than 95% of agricultural production in sub-Saharan African is rain-fed (see Simelton et al. (2013), Adebisi-Adelani and Oyesola (2014) and Zake and Hauser (2014)).

Climate projections show that Africa is likely to experience significant climatic changes, as extreme drying and warming will occur in most subtropical regions with slight increments in precipitation in the tropics (Adebisi-Adelani and Oyesola, 2014; Christensen et al., 2007; Abegaz and Wims, 2015). The climate change models also estimate that the impacts of climate change would be greater in regions across Africa (Christensen et al., 2007; Sylla et al., 2016). The major challenge of these climate change models and scenarios for Africa, however, is that they are somehow complicated by uncertainty regarding changes in precipitation that may occur as climate is changing. Nearly all models show a drying Southern Africa, as well as uncertainty between projections in some regions, particularly West Africa while reports by the IPCC (IPCC, 2014, 2013) and other studies (Yamana et al., 2016; Valdivia and Antle, 2015; Hulme et al., 2001; Dosio and Panitz, 2016) revealed uncertainty about future rainfall patterns in southern Sahara, the Guinea Coast and the Sahel. At the same time, there has been an increase in the number of publications on the implications of climate

* Corresponding author at: Department of Geography, Obafemi Awolowo University, Ile-Ife, Nigeria.
E-mail addresses: aayanlade@oauife.edu.ng, sinaayanlade@yahoo.co.uk (A. Ayanlade).

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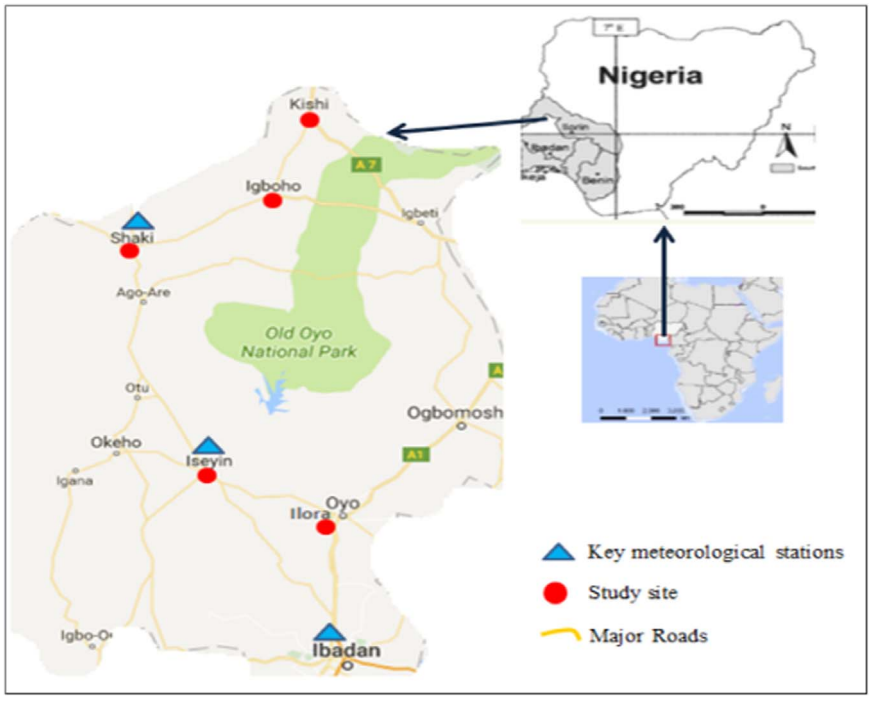

Fig. 1. Study site in southwestern Nigeria and key meteorological stations (modified from Google Earth accessed: 23/08/2016).

change and consequential weather extreme events such as erosion processes, drought, marine flooding, storm surges among others. Over the years, studies on climate change principally assessed impacts and adaptation, based on climate change scenarios, using only quantitative climatic data and models. However, a successful understanding of climate change will not necessarily be limited to values of climate parameters; it will also encompass variability and associated extreme weather events, and the understanding of these by local farmers who are being affected. Therefore, there is a need for an in-depth study, to examine farmers' understanding of extreme weather events, their significant impacts on crop and livestock production, and their strategies for adaptation. Communicating scientific findings to farmers, and incorporating their understandings will be very useful in implementing and monitoring strategies which would improve the crop yield not only in Africa but in the other part of tropical regions. This understanding will enable rural farmers to prepare a local response to the anticipated impacts of climate change (Zake and Hauser, 2014; Nyasimi et al., 2013; Savo et al., 2016; Adimassu and Kessler, 2016).

There are diverse opinions in the literature to the effect that rural farmers' knowledge of climate change and their adaptive capacity is insufficient for reliable adaptation. Some scientists also perceive that rural farmers' knowledge is insufficient for rigorous evaluation of planned adaptation. The recent IPCC report (IPCC, 2014) reveals, however, that local awareness and vulnerabilities are increasingly being incorporated in interdisciplinary, multi-stakeholder assessments. The report of the IPCC and previous studies in Africa have shown the need for assessments of the potential impacts of climate variability/change and for the integration of rural people's awareness of these changes alongside other weather stresses (Heltberg et al., 2009; Mubiru et al., 2015; Nyasimi et al., 2013; Van Griensven et al., 2016; Tschakert et al., 2014).

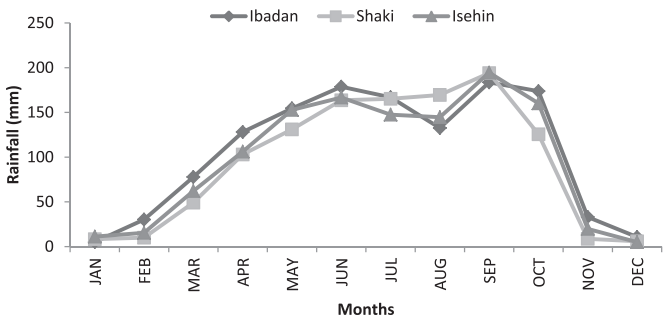

Fig. 2. Average monthly rainfall for the key meteorological stations around the study sites (1970–2014).

A review of the climate change literature shows that more attention has been paid to climate change system modeling, climate change impacts, adaptation and risk assessment, but relatively little attention has been devoted to the perceptions and options for adaptation of those experiencing climate change. In the case of climate change impacts on smallholder agriculture, what is apparent is the gap between scientists' analysis of global climate change and rural farmers' awareness. Despite the great advancement of climate science in understanding and dealing with the problem of climate change and its impacts on the agricultural sector at the international level, awareness and the concern for the problem at local levels, especially among the rural farmers in Africa, remains crucial. Studies in other part of the world have shown that farmers cope with climate change based on their perceptions of changing climate (Li et al., 2013; Abid et al., 2015).

In Nigeria, studies have shown that most crop farming is rain-fed, thus rainfall in the most important element of climate (Odekunle et al., 2007; Adejuwon, 2006), a change which could greatly affect both crop and livestock farming in the country. These studies reveal that crops and livestock farmers are likely to be more severely affected because of their lack of adaptive capacity to climate change/variability (Mertz et al., 2009).

Though good agricultural management practices have the potential to be the basis for effective climate change adaptation methods, local knowledge should be used in conjunction with scientific knowledge systems for impact reduction (Morton, 2017). When crop yields are low, due to losses as a result of climate change as evidenced in changing times for the start and stop of rainy (growing) and dry seasons, farmers pay dearly for their ignorance or unpreparedness. In the present study, rural farmers' awareness of climate change, its impacts, and their specific adaptation measures, are valid starting points for science-driven assessments, for appraising the climate trend. This was based on