

The Impact of Climate Change on Hydrological Cycle and Crop Production in Oyo State, Nigeria: The Perspective of Smallholder Farmers

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Abstract

This study assessed the impact of climate change on hydrological cycle and crop production among smallholder farmers in Oyo State. 320 smallholder farmers were interviewed on their socio-demographic characteristics and their perceptions on drivers of climate change, practical manifestation and impact of water scarcity on crop production. Demographic data were analyzed with the aid of descriptive statistics (frequency and percentage) while the other parts which deal with the perceptions of the respondents were analyzed with inferential statistics (chi-square). The results of the study revealed that the practicing farmers agreed that human-induced activities such as fossil fuel, deforestation urban industrial expansion among others are the drivers of climate change. Also, most agricultural practitioners agreed with the listed options about the practical manifestation of climate change as observed in their farming system. The postulated hypothesis was tested with chi-square and the result revealed that water insecurity had significant impact on crop production with cal value of $\chi^2 107$ and critical value 21.03 at 0.05 alpha level of significance. The study recommends that practicing farmers should be encouraged to adopt best practice that will reduce ozone layer depletion and global warming and encourage afforestation & agroforestry. Then, public awareness campaign should be intensified on impact of climate change on water insecurity and crop production.

Keywords: Climate Change, Hydrological cycle, Crop Production, Smallholder Farmers.

Introduction and Statement of the Problem

Water is one of the world most valuable resources and it is a necessity of life for both plants and animals (UN-Water, 2016). Despite this, however, more than two billion people across the world lack adequate access to water an essential element of life (Roy et al., 2026). Global water stress directly undermines water security by creating a situation where the demand for safe, usable water exceeds the available supply and often leading to a state described by UN researchers as water bankruptcy (Roy et al., 2026; Oluwasanya, 2023 & Adesogan & Sasanya, 2022).

The impact of climate change has been experienced globally, especially in the tropics (Williams et al., 2018). The sixth intergovernmental reports on climate change (IPCC) 2022 confirmed with certainty that human activities and consequent anthropogenic greenhouse gas emission are the dominant factors that pose major threat to the global environment.

According to the intergovernmental panel on climate change (IPCC) reports tropical regions may face more precipitation extremes and changes in monsoons over the course of climate change which would put additional burdens on water management systems hence increasing vulnerability in such communities that depend on them (Ndehedehe et al., 2021).

Consideration for rainfall variability is very important for proactive planning and the building of resilience amidst climate-related risks especially in economies related to agriculture, water resources and urban infrastructure (Gilmont et al., 2016).

Rising temperature due to climate change are intensifying water stress in already affected regions and increasing the number of water-stress areas, higher temperatures are also altering global rainfall patterns making water availability less reliable and predictable (Oluwasanya, 2023, Wasko et al., 2020). For instance, sub-tropical areas such as the Mediterranean and Africa are expected to continue warning and experience more frequent and longer drought, when rainfall does occur, it is projected to be more intense, raising the rise of flooding and severe storms (Roy et al., 2026). Climate change has caused a shift in the seasons and increase in the seasonal changes of the water bodies (Gheewala et al., 2018, Ricart et al., 2020).

Nigeria already is classified as one of the ten most vulnerable countries in the world to the impact of climate change and natural hazards (World Bank, 2021). Climate change in Nigeria is disrupting the hydrological cycle through increased temperature and volatile rainfall, high evapotranspiration and declining ground water level leading to reduced water

availability (USAID, 2021; Elisha et al., 2017). The World Bank climate risk profile for Nigeria (2021) indicates that increased level of Co2 will lead to up to 17% nutrient declines in rice with increased rainfall variability and higher temperature likely to further reduce the country's rice yield. Given projected trends in climate change, Nigeria and the surrounding West African region is projected to be a hotspot of water and food insecurity (World Bank, 2021). This is because 70% of water withdrawals are used for farming (FAO 2018, United Nations 2019).

Oyo state faces climate related challenges; including variability in rainfall patterns, increasing temperature and extreme weather-events (OYSIPA, 2023) periods of drought and water scarcity reduced water availability which adversely affected Agricultural productivity, water supply and the overall viability of water-dependent projects (OYSIPA, 2023). Also Oyo State is prone to occasional extreme weather events such as storms and flash floods which often disrupt project timelines and damage infrastructure. The region is characterized by wet and dry seasons with increasing unpredictability in rainfall pattern.

Global ambition to ensure water security include international water and sanitation efforts largely coordinated by Un-Water which works to accelerate progress towards fulfilling Goal 6 of the Sustainable Development Goals (SDGs) a sweeping fifteen-year development agenda adopted by UN member states in 2015. Goal 6 aims to ensure availability and sustainable management of water and sanitation for all.

Water has also become more prominent in international climate discussions. Also at the 2023 UN-Water Conference, countries adopted the water action agenda a set of voluntary commitment to increase investment in water infrastructures and strengthen water-related governance to meet global water goals and water was a major tropical Cop 3, the United Nations annual climate field in November 2025 (Roy et al., 2026). However, unlike efforts to combat climate change or preserve biodiversity, there is no comprehensive global framework focused on tackling water stress and insufficient international co-ordination on water security has slowed the search for solutions (Roy et al., 2026).

Apart from the signed Paris agreement, Nigeria enacted Climate Change Act 2021 as part of nationally determined commitment to ensure Net zero emission in 2030. Oyo state is implementing several measures to align with Sustainable Development Goals (SDGs), particularly in water management and climate resilience (Oyo State Rural Water supply and Sanitation Agency (RUWSSA) is prioritizing infrastructure to enhance access to safe water and improve sanitation addressing SDG6, also proactive measures including dredging and water ways to manage flash floods particularly through Urban Flood Management Agency (UFMA). Effective water management is vital to achieving many of the other SDGs including eliminating hunger and ensuring good health and well-being.

Aim and Objectives

The aim of this study is to assess the impact of climate change on hydrological cycle and crop production in Oyo State Nigeria focusing on the perspective of smallholder farmers. In order to achieve this aim, the objectives are to:

- examine the socio-demographic characteristics of the smallholder farmers;
- identify the farmers' perceived drivers of climate change;
- examine their observations about practical manifestation of climate change;
- identify their perceptions on impact of water insecurity on crop production;
- proffer suggestions to the individual and policy makers about solutions to water stress and improvement in sustainable development in Oyo state in particular and Nigeria in general.

Hypothesis Formulated

H0: Water insecurity has no significant impact on crop production

Significance of the Study

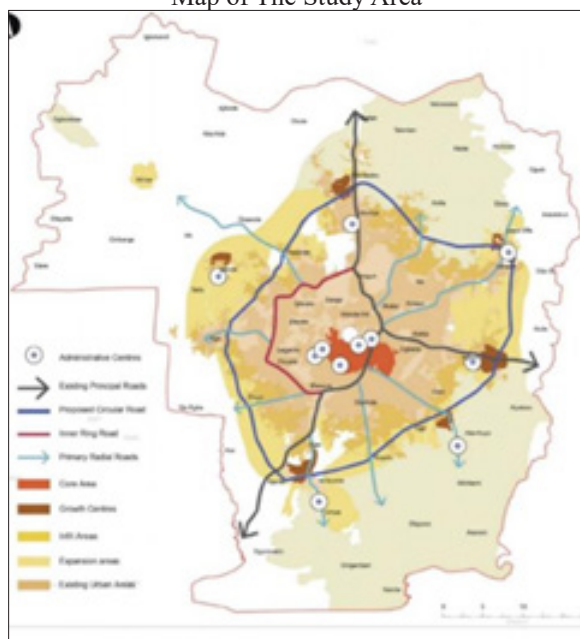
Water is one of the world most valuable resources and it is a necessity of life for both plants and animals (UN-Water, 2016). Despite this, however, more than two billion people across the world lack adequate access to water an essential element of life (Roy et al., 2026).

In this study, the focus is asserted on assessing the impact of climate change on hydrological cycle and crop production in Oyo state which deviates from existing studies targeting other aspects. The significance and motivation for this choice is based on the importance of water to both plants and animal particularly agriculture which is responsible for 70% of water withdrawals for farming (United Nations, 2019), account for around 25.18% of GDP and over 70.8 million hectares of farmland is severely affected by drought, flooding and soil degradation leading to lower yields of such crops, like maize, cassava millet & rice (Redige Per De Tresor, 2024). Therefore, assessing the perceptions of smallholder farmers on how climate change affect water availability for agricultural practice will provoke an overview of relevant practical knowledge based on experience on adaptation and mitigation strategies to complement the fact of the literature.

Study Area

The study was carried out in Oyo State which consists of 33 local government areas. The entire Oyo State is homogenous and comprises of the Oyos, the Ibarapas and the Ibadans all belonging to Yoruba family and speaking the same Yoruba language.

Map of The Study Area



Source: <http://www.google.com/src?map-of Ibadan.html> map of the study area 2022.

Materials and Methods

Organized smallholder cooperative farmers (societies) operating across the various local government areas in Oyo State were interviewed for their perceptions on their socio-demographic characteristics, perceived drivers of climate change, perceived practical manifestation of climate change and impact of water scarcity on crop production. The ministry of Trade Industry and Cooperative was approached to identify the registered farmers' cooperative societies in Oyo State. These cooperative societies include Oyo Ifelodun Cassava Processing Cooperative Investment Ltd in Oyo, Agbeloba Cooperative Society, Agbeparapo Multiple Purpose Society, Oyo State, Ejawa Multi-Purpose Cooperative Society based in Ibadan among others. The study population comprises of all registered farmers' cooperative societies in Oyo State. A sample of three hundred and fifty was drawn with the purposive random sampling technique. A researcher's structured interview that had been thoroughly validated by experts from Ministries of Agriculture and Environment in Oyo State was used for the study. A reliability coefficient correlation of .82 was obtained

through the use of split half method of reliability. However, only three hundred and twenty (320) structured interviews were retrieved for final analysis.

Data Analysis

The data relating to the socio-demographic attributes of the respondents were analyzed with descriptive statistics (frequency & percentage) while the perceptions of the respondents on drivers practical manifestations of climate change and impact of water scarcity on crop production were analyzed with inferential statistics (chi-square).

Results and Discussion

Variable	Frequency	%
Gender		
Male	272	85
Female	48	15
Age		
18 – 24 years	32	10
25 – 31 years	48	15
32 – 38 years	50	25
39 years and above	160	50
Educational Qualification		
No formal education	42	13.12
Primary school	45	14.06
Secondary school	163	50.9
Tertiary education	70	21.8

Table 1: Distribution of the Respondents by Gender, Age and Education

Source: Field Survey 2026

As indicated in table 1 above, most of the respondents were male (85%), the female constituted (15%). In addition, most of the respondents were 39 years and above (50%) followed by those in the age 32 – 38 years (25%) and 25 – 31 years (15%). Lastly, the category of farmers in 18 – 21 years (10%). Also, most of the respondents had secondary school education (50.9%) followed by those in tertiary education (21.8%) primary education (14.06%) and lastly no formal education (13.12%).

Table 2: Perceived Climate Change Drivers

Category of Items	SA	A	D	SD	Row Total	Cal χ^2	DF	Crit. value	Rem
Anthropogenic greenhouse gas mainly through fossil fuel and deforestation	115	155	27	23	320	70.8	12	21.03	-
The increasing use of nitrogen-based fertilizer in farming	135	165	10	7	320				
Waste burning and air pollution	145	142	22	11	320				
Overgrazing and fodder harvest	160	145	7	8	320				
Urban and industrial expansion	130	185	3	2	320				
Column Total	685	795	69	51	1600				

Source: Field Survey 2026

Table 2 presents the descriptive statistics of the respondents on perceived drivers of climate change. In the first category of the items, majority of the respondents strongly agreed (36%) and agreed (48.4%) respectively that anthropogenic greenhouse gas through fossil fuel and deforestation activities of human beings are mainly drivers of climate change. The second row (item) on the table 42% strongly agreed and 53% agreed respectively that the increase use of nitrogen-based fertilizer in

farming practice is a major driver of climate change. The third row revealed that 45.3% strongly agreed and 44.0% agreed that waste burning and air pollution are the major drivers of climate change. In the fourth row 50% strongly agreed and 45% agreed that overgrazing and fodder harvest are the major drivers of climate change. Item five, the last category revealed that 40% strongly agreed and 58% agreed that urban industrial expansion in a major driver of climate change.

Table 3: Perceived Practical Manifestation of Climate Change

Category of Items	SA	A	D	SD	Row Total	Cal χ^2	DF	Crit. value	Rem
Erratic rainfall and delay planting, delay onset of rain which lead to stunted growth of staple such as maize and others leads to poor yield	152	140	20	8	320	64.1	12	21.03	-
Increase drought and water shortage during dry season which need to drying of streams and brooks	135	155	18	12	320				
Flooding of farmland in low lying areas leading to water logging crop mortality and disruption of vegetable farms	140	150	18	4	320				
Reduction of crop yield and its quality caused by high temperature and fluctuating humidity which increase pest and disease outbreaks for crop like cassava, maize and vegetable	105	170	30	15	320				
Increase farming costs and input use to combat declining soil fertility caused by flooding and erosion	185	130	2	3	320				
Column Total	725	745	88	42	1600				

Source: Field Survey 2026

Table 3 above presents the perceptions of the respondents on practical manifestation of climate change in Oyo State. Item one in the first row revealed that 45% strongly agreed and 44% agreed respectively that practical observation of erratic rainfall and delay planting, delay onset of rain which lead to stunted growth of staple such as maize and others leads to poor yield of crops show the advent of climate change. The second item revealed that 42% strongly agreed and 48% agreed respectively that increase drought and water shortage in streams and books indicates the presence of climate change. The third row of the category of items revealed that 46% strongly agreed and 47% agreed respectively that flooding of farmland in low lying areas leading to water logging crop mortality and disruption of vegetable farms indicates the presence of climate change. The fourth category revealed that 33% strongly agreed and 53% agreed respectively that reduction of crop yield and quality and increased pests are the major manifestation of the presence of climate change among the farmers. The last category of item revealed that 57.8% strongly agreed and 40.6% agreed respectively that increasing farming cost and input use which caused a reduction on overall income to farmers are the major manifestation of climate change effect.

Table 4: Perceived Impact of Water Insecurity on Crop Production

Category of Items	SA	A	D	SD	Row Total	Cal χ^2	DF	Crit. value	Rem
There is reduction in ground water through decrease in precipitation and high temperature which affect crops growth	145	132	30	13	320	107	12	21.03	H0 rejected
Changes in rainfall pattern leads to unpredictable low water level in rivers and stream which reduces overall water availability for crops	146	152	10	12	320				
Reduction in water availability for crops leads to food insecurity for residents	165	95	40	20	320				
It increases drought especially in arid and semi-arid regions and severely affect agricultural practice	105	114	45	56	320				
It increases temperature and extreme weather which affect crop production	115	135	43	27	320				
Column Total	676	628	68	128	1600				

Source: Field Survey 2026

The findings from the analyses in table 4 above shows the calculated chi-square (χ^2) value of 107 against the table value of 21.03 at 0.05 alpha level of significance with degree of freedom (df) 12. Since the calculated χ^2 value of 107 was greater than the table value of 12.03, thus the null hypothesis was rejected which means that water insecurity had significant impact on crop production among smallholder farmers in Oyo State.

Discussion of Findings

Table 1 revealed that majority of the respondents is male and adults with adequate education and experience in farming. Table 2 shows that the majority of the farmers are familiar with the fact that climate change results from the anthropogenic activities of man (human-induced). This is in line with (IPCC 2021; Lasalle et al., 2009; WMO, 2013). Table 3 shows that farmers observed the presence of climate change among them through rainfall pattern, decay on-set of rain, drought and flooding in low lying areas which lead to water insecurity and low crop yield among others are some of the factors. This is in tandem with the studies by Olusanya (2023), Ndehedehe et al. (2021) and Abdulkadir et al. (2017). Table 4 shows that water insecurity significantly affect crop production in Oyo State. This is in line with the study by Olusanya (2023), UN-Water (2016) and Kinda et al. (2019) who observed that water plays a significant role in agricultural practice.

Recommendations

Based on these findings the researchers recommend as follows:

1. Farmers and residents are advised to avoid burning of fossil fuel and deforestation instead Agroforestry and tree planting should be encouraged
2. Indiscriminate burning of refuse should be discouraged
3. Government should organize public awareness about the impact of climate change on sustainable development particularly agricultural productivity
4. Farmers are encouraged to adopt best practices that will reduce ozone layer depletion and global warming.
5. Government should use laws and regulations to reduce pollution

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