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Mediating the Effect of Environmental Policies on the Relationship Between Climate Change Measures and Food Insecurity in Adamawa State, Nigeria

Michael Peter[1], Adamu Jibrilla[2], Aliyu Alhaji Jibrilla[3] and Godwin Boniface[4]
[1] Department of General Studies, Federal Polytechnic, Mubi, Nigeria
[2,3,4] Department of Economics, Adamawa State University, Mubi, Nigeria
Email addresses: [2]jibrilla653@adsu.edu.ng | [3]aliyumaiha@gamil.com | [4]Gboniface2@gmail.com

Abstract

This study examines the mediating effect of environmental policies on the relationship between climate change measures and food insecurity in Adamawa State, Nigeria. The study adopts quantitative research design, using cross-sectional data on various key indicators, including climate change, food security indices. Structured questionnaires was administered using questionnaire inform of kobo collect from 8 local government of Adamawa State. Cronbach Alpha (CA) and composite reliability (CR) is used for reliability text and Convergence validity is examined using the indicator loadings and Average Variance Extracted (AVE) for validity text. The study use structural equation model to analysis the data and the result revealed a positive relationship between environmental policies, drought and food insecurity in Adamawa State at the 1 per cent level of significance. In addition, H5 to H8 which investigate the relationship between flooding (FL) on environmental policies and food availability (FA), food accessibility (FACC), food stability (FS) and food utilization (FU) are significance at 1 per cent level similarly H9 to H12 is also significance at 1 percent level, like wise H13 to H16 which assess the relationship between environmental policies on altered rainfall pattern (ARP) on food availability (FA), food accessibility (FACC), food stability (FS) and food utilization (FU) are significance at 1 per cent level. Additionally, relationship between environmental policies on rising temperature (RT) and food availability (FA), food accessibility (FACC), food sustainability (FS) and food utilization (FU) is significant. This shows that environmental policies plays a major role in influencing climate change and food insecurity in Adamawa State. The study recommend that government should strengthen implementation and enforcement of environmental policies at state and local government levels. Also there is need to expand drought resilient agriculture, water conservation, irrigation and climate-smart farming practices, improve flood-risk management, drainage, early-warning systems and protection of agricultural infrastructure.

KEYWORD: *Food Insecurity, Environmental Policies, Climate Change, and Structural Model*

1.0 Introduction

Food insecurity remains one of the major global development challenges despite improvements in agricultural production, especially in developing countries like Nigeria. Food insecurity extends beyond the inadequate production of food to include limitations in people's economic and physical access to sufficient, safe and nutritious food. The persistence of food insecurity across many developing countries has become a major concern because rising food prices, poverty, environmental degradation and other socioeconomic pressures continue to undermine households' ability to obtain adequate and nutritious food. The latest *State of Food Security and Nutrition in the World* report indicates that the world remains off track to achieve the goal of ending hunger and food insecurity by 2030, with food price pressures continuing to affect households' purchasing power and access to healthy diets (FAO, IFAD, UNICEF, WFP, & WHO, 2025).

Climate change has increasingly emerged as an important threat to food security because agricultural and food systems depend strongly on climatic and environmental conditions. Changes in temperature, rainfall patterns, drought frequency, flooding and other extreme weather events can disrupt crop production, livestock activities, water availability and food distribution systems. The effects of climate change are particularly serious in communities where households depend heavily on rain-fed agriculture and natural resources for their livelihoods. The Intergovernmental Panel on Climate Change (IPCC, 2022) reports that climate change is already affecting food systems in Africa through changes in agricultural productivity, water availability and the sustainability of rural livelihoods. These effects can reduce food availability while also affecting household income, food access and the stability of food supplies.

The effects of climate change are not limited to agricultural production. Climate related shocks can influence several dimensions of food security, including food availability, food accessibility, food utilization and food stability. Drought can reduce soil moisture and crop yields, while flooding can destroy crops, farmland, roads and agricultural infrastructure. Rising temperatures can increase evapotranspiration, water requirements and heat stress on crops and livestock, whereas altered rainfall patterns can make agricultural planning and production more uncertain. Consequently, repeated climatic shocks can weaken household livelihoods and increase their vulnerability to food insecurity.

Environmental policies are important instruments through which governments can respond to the environmental and food security consequences of climate change. Such policies may include environmental protection, afforestation, sustainable land management, flood risk reduction, drought management, water conservation, climate adaptation and climate-smart agricultural practices. Effective environmental policies can help reduce exposure to environmental hazards, promote sustainable use of natural resources and strengthen the capacity of households and agricultural systems to cope with climatic shocks. The IPCC (2022) emphasizes the importance of

supportive governance, institutional arrangements, climate information, capacity building and strategic investment in strengthening the resilience of African food systems.

However, the existence of environmental policies does not necessarily guarantee effective protection against climate-related food insecurity. The effectiveness of environmental policies may depend on their implementation, coverage, institutional capacity, enforcement and accessibility to vulnerable households. Where policies are inadequately implemented or where environmental interventions do not adequately reach climate-vulnerable communities, households may continue to experience the adverse effects of drought, flooding, rising temperatures and changing rainfall patterns. Therefore, examining the relationship between climate change risks, environmental policies and food insecurity is important for understanding whether environmental policies can provide an effective pathway for reducing the food-security consequences of climate change.

The issue is particularly relevant in Adamawa State, Nigeria, where over 70% 0f the households depend substantially on agriculture and natural resources for their livelihoods. Drought, flooding, rising temperatures and altered rainfall patterns can disrupt agricultural activities and threaten household food security. Drought may result in inadequate soil moisture and crop failure, while flooding can destroy crops, farmland and agricultural infrastructure. Rising temperatures can increase water requirements and heat stress, while altered rainfall patterns can make agricultural production more difficult to predict and manage. Recent evidence from Hong Local Government Area of Adamawa State indicates that temperature changes, drought and other environmental pressures have important implications for household food-security conditions (Audu et al., 2026). Although considerable attention has been given to the effects of climate change on agricultural production and food security, an important empirical gap remains concerning the role of environmental policies in the relationship between climate change and food insecurity. Much of the existing literature emphasizes the direct effects of climate-related hazards on agricultural productivity, household livelihoods and food security. For example, evidence from Africa indicates that climate change has adversely affected agricultural productivity and increased risks to food systems (IPCC, 2022), while Nigerian evidence has associated flooding with agricultural losses and food scarcity (Onefeli *et al.,* 2023). However, comparatively limited attention has been given to whether environmental policies can mediate the relationship between specific climate-change risks and the different dimensions of food insecurity at the subnational level.

It is against this background that this study examines the mediating effect of environmental policies on the relationship between climate change risks and food insecurity in Adamawa State, Nigeria. Specifically, the study focuses on drought, flooding, rising temperature and altered rainfall patterns as major climate change risks and considers food insecurity in terms of food availability, food accessibility, food stability and food utilization.

2.0 Literature Review and Theoretical Framework

This section reviewed previous literature related to climate change, environmental policies and food security.

2.2 Empirical Literature

Bilyaminu *et al.,* (2024) investigate the effect of climate change on food security in Adamawa state, Nigeria. The instrument used for collecting data were questionnaire and interview in 19 local government of Adamawa state were sampled. Structural equation model (SEM) was used to analysis the data. The result shows that the evidence of pass-through effect of climate charge on food security in Adamawa state as food stability, food accessibility and food animation significantly reduce as a result or decrease in arability cause by change in climate. However the study proxy food security by four variables i.e food stability, food accessibility, food availability and food utilization but failed to provide four different model. However the findings is in line with the and study conducted by Adeyimi *et al* (2021), Odjugo (2022) but contrary to the findings of Abu (2024), Abdulrahaman *et al*., (2022).

Chima etal (2023) study consequences of land degradation on hire hood and food security of rural farmers in south-east, Nigeria a comparative analysis. The study adopted purposive and straits sampling techniques in the selection of location and 900 resonating the study used (450) farmers farming on water degraded farm land and 450 farmers farming on non-water degraded farm land both primary and secondary data. Primary data were collected from the selected sample following a field survey which secondary data were collected from textbook, Newsletters from new map ministry of environmental articles and journals from agriculture. The employed descriptive statist or mean frequencies percentages and paired Z-test was used to achieved the shows the mean annual food expenditure or rural farmers in degraded and non-degraded farm lands were N 273664122 and 290,592.67 respectively. The perceived socio-economic cons equal of water erosion degradation on farm lands were decreased farm income

Jonathan and Emmanuel (2023) examined the impact of climate change on the Nigerian economy using secondary data from 1981 to 2014. The study used OLS and Johansen co- integration and the result indicate that both in the long-run and short-run, carbon emission affect growth adversely in Nigeria. However, the period between 2014 and 2023 is huge which so many economic activities may have occurred within the period which the study did not take into consideration. Also, the study uses a single variable that influence climate change which is not enough to give conclusion.

Odjugo (2022) investigated the regional evidences of climate change using Nigeria as a case study. Mean annual air temperature from 30 synoptic stations between 1901 and 2005 were collected from the Nigerian Meteorological Agency, Lagos and, Meteorological Departments in some airports. The data were divided into three climatic periods, namely, 1901-1935, 1936-1970 and

1971-2005 for the purpose of comparison. Time series, correlation, least square range test, ANOVA and isotherm maps were the statistical tools used to analyze the data. Results showed that air temperature is steadily increasing especially from the 1970s. Between 1901-1935 and 1936-1970 climate periods, temperature anomalies were below the 1970-2005 normal, but 22 years out of the 35 years were above the normal between 1971and 2005. The temperature anomalies showed that climate change signal is stronger as from the 1970s; the rate of temperature increase is higher in the semi-arid region than the coastal areas of Nigeria. The current available pieces of evidence show that Nigeria, like most parts of the world, is experiencing the basic features of climate change.

Abdulrahman and Suleiman (2022) examined climate change impacts on crop yields in Adamawa State using panel data from selected LGAs. Secondary panel data were obtained from the Nigeria meteorological Agency (NiMet) for climate variables (temperature and rainfall) and from the Adamawa State Agricultural Development Programme (ADADP) and National Bureau of Statistics (NBS) for crop yield data across selected Local Government Areas. The data were analyzed using panel econometric techniques, specifically Fixed Effects and Random Effects models, while the Hausman test was employed to determine the most appropriate estimator. The result shows that rising temperatures and erratic rainfall patterns negatively affect maize and sorghum output. Although the study focused on Adamawa, but failed to analyze food insecurity outcomes, limiting its practical policy relevance

Opeyemi *et al.* (2021) investigate effect of climate change on Agricultural productivity in Nigeria: A cointegration Model Approach. Time series data were employed analyze using descriptive and cointegration. The result revealed that climate change has negative effect on agricultural productivity. However, the study used temperature to proxy climate change which is not a good measure of climate change.

Adeyimi *et al*., (2021) investigated the effect of environmental degradation on food security in Nigeria. Secondary data were sourced from World Bank world development indicator 2019 from 1970 to 2017. The study employed Johansen cointegration, Normalized co-integrating estimates (standard error in parenthesis), Vector error correction model (VECM) to analyzes the data. The result shows that, trace statistics indicates 1 co-integrating variables at the 0.05 level and also the Max-Eigen test indicates 3 co-integrating variables at the 0.05 level, and so it denotes rejection of the hypothesis at the 0.05 level and the VECM show the extent of convergence among variables in the long run while also correcting the short run errors that occur in the model. For the purpose of satisfying the stability condition, the coefficient of the ECM should be negatively signed, the absolute value must lie between 1 and 0 and the t-statistics must be statistically significant. However by implication, this shows that for food production to be promoted and thereby food security boosted, environmental degradation arising from carbon and fossil emissions must be minimized to the barest minimum, sustainable consumption should be prioritized and improved farming methods should be used to maximize output from agricultural land.

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2.2.1 Gap in Literature

Previous studies have largely concentrated on the direct effects of climate variability on agricultural production, crop yields and household food security. For example, studies on Nigeria have demonstrated that climate change negatively affects food and human security, while evidence from Adamawa State indicates that temperature changes, drought and other environmental pressures reduce household food-security outcomes (Ani *et al.,* 2022; Audu *et al.,* 2026). Similarly, the IPCC (2022) observes that climate change affects African food systems not only through agricultural production but also through food processing, storage, distribution and consumption. However, much of the empirical literature remains heavily focused on the he production dimension of food security rather than examining the four interrelated dimensions of food availability, accessibility, utilization and stability. Second gap concerns the limited attention to environmental policies as an intervening mechanism between climate change and food insecurity. Existing studies have examined climate adaptation strategies and agricultural policies, with evidence suggesting that adaptation can improve household food security (Ogunpaimo *et al.,* 2021). A third gap is methodological**.** Existing Nigerian studies have employed case-study approaches, regression models, time-series techniques and adaptation-impact models to investigate climate change and food security (Ani *et al.,* 2022; Ogunpaimo *et al.,* 2021). However, relatively little attention has been given to modelling the simultaneous relationships among multiple climate-risk indicators, environmental policies and the different dimensions of food insecurity using Structural Equation Modelling (SEM). This is important because climate change is multidimensional, while food insecurity is also multidimensional. The use of SEM can therefore provide a more integrated assessment of the relationships among drought, flooding, rising

temperature, altered rainfall, environmental policies and food availability, accessibility, utilization and stability.

3.0 Methodology

3.1 Research Design

This study adopts quantitative research design, using cross-sectional data quantitative approaches to explore the intricate relationships between climate change and environmental policies on food insecurity in Adamawa State, Nigeria. The design is chosen to ensure a well-rounded understanding of the problem, as it allows the research to capture measurable data deeper, more personal insights. By bringing statistical evidence with real-world experiences, the study aims to provide a nuanced picture of how climate change, particularly temperature and rainfall, is affecting the agricultural sector and food security in the region. The quantitative aspect of the research will focus on identifying clear, data-driven relationships between climate change and environmental policies, as well as how these factors influence food insecurity. This will involve collecting numerical data on various key indicators, including climate change, food security indices. Statistical tools will be used to detect patterns, correlations, and structural equation model. This approach allows the study to provide concrete evidence about the scale and scope of the issue, which is essential for informing policy and practical interventions (Neuman, 2023).

3. 2 Sources of Data

Primary data is sourced from farmers/households in selected LGAs of Adamawa State using a structured questionnaire in form of kobo collect to analysis effect of environmental policies on the relationship between climate change and food insecurity in Adamawa State.

3.3 Population of the study

The population of the study comprises the entire population in the 21 local government areas of Adamawa state that were selected in terms of temperature and rain fall see map of Adamawa state in terms of temperature and rainfall. To enable the study aims to capture a comprehensive picture of the challenges faced by the people of Adamawa State, especially in terms of how climate change measurement.

3.4 Sampling Technique

Adamawa State has been divided into four zones known as Agricultural Development Programs (ADP) Zones, namely; Zones I, II, III and IV (Table 3.1). They have agricultural activities practiced that are both common and specific.

Table 3.1 Adamawa State Agricultural Development Program (ADP) Zones

Zones	Local Government Area
Zone 1	Mubi North, Mubi South, Maiha, Madagali and Micika
Zone 2	Gombi, Hong, Song, and Girei
Zone 3	Fufore, Yola North, Yola South, Mayo Belwa, Jada, Ganye and Toungo
Zone 4	Guyuk, Shelleng, Lamurde, Numan and Demsa

Source: Adamawa State Agricultural Development Program (ADP, 2026)

This study use multistage sampling technique in the selection of the local government. The first stage involved purposive sampling in selection of local government that has the highest temperature and altered rainfall while the second stage involve using random sampling. Most of the local government are affected by either rainfall or temperature see page, therefore two local government is selected at random from each zone making the total of 8 local government out of 21 local government. This would help the study in terms of measuring the relationship among climate change, environmental policies and food insecurity in Adamawa state.

3.5 Sample Size

To determine the sample size of this study Taro Yamane (1967) method was adopted.

This formula used for the calculation of the sample size for this study.

95% confidence level and ×level of maximum variability (P= 0.5) are assumed.

The formula is given by;

$n=N/1 + (Ne^2)$

$$n= \frac{N}{1 + (Ne\,2)}$$

Where

n= is the sample size,

N = the population size, and

e = the level of precision (allowable error) that is 5% or 0.05. Thus, using the total population of the study; N = 3,737,223 e = 5% = 0.05.

$$n= \frac{3{,}737{,}223}{1 + (3{,}737{,}223 \times 0.0025)}$$

n=400

In order to have large sample size 30 percent is added to have more responses and improve the efficiency of the technic.

Therefore, the sample size was determined to be 520 by purposive sampling and 8 out of 21 local government is selected in terms of temperature and rainfall (World Health Organization &National Institute of Health, 2020)

3.6 Model Specification

The Structural Equation Model (SEM)

This study adopt Structural Equation Model (SEM) is a multivariate statistical technique that use to analyze the magnitude of the structural relationship, SEM constitute of two components; confirmatory factor analysis; this is to evaluate the latent psychological traits, like attitude and satisfaction (Galton 1888; Pearson and Lee 1903; Spearman 1904). While Path analysis evaluate biometrics which aimed to discover the causal relationship among multiple variables using Smart PLS, Adanco or Amos diagram (Wright 1918, 1920, 1921). SEM was adopted by Biliyaminu (2024).

$Y_i^* = X_{i1}\beta_1 + \varepsilon^*$ ..... (1)

The Structural Equation Model (SEM) can therefore be expressed further as:

$Y_i = \beta_1 X_{i1} + \beta_2 X_{i2} *\beta_3 X_{i3} + \varepsilon_i$ ..... ε^* (2)

$X_i = \beta_1 Y_{i1} + \beta_2 Y_{i2} *X_{i3} + \varepsilon_i$..... ε^* (3)

Where

Where: Y = food security (FA, FACC, FU, FS)

e= error term

X_1= Environmental policies

X_2= Climate Change

Y_1, Y_2 = FA, FACC, FU, FS

Table 3.2 Measurement of Variable

Variable	Definition	Measurement
Temperature	Hotness or coldness of a given region	Average annual temperature in degrees celcius
Rainfall	Amount of rain realized over a given period of time	Average annual rainfall received in millilitres
Drought	Prolonged period of abnormal dry weather	Precipitation index
Flood	Over flow of water that submerges land and dry area	Depth(height in feed or meter) flow volume per second
Environmental Policies	Law adopted by government minimize humanity ecological foot print	Policy stringency indixes, knowledge or level of education

Source: Developed by the author

3.8 Techniques of Analysis

The Structural Equation Model (SEM)

This study adopt Structural Equation Model (SEM) is a multivariate statistical technique that used to analyze the magnitude of the structural relationship, SEM constitute of two components; confirmatory factor analysis; this is to evaluate the latent psychological traits, like attitude and satisfaction (Galton 1888; Pearson and Lee 1903; Spearman 1904). While Path analysis evaluate biometrics which aimed to discover the causal relationship among multiple variables using Smart-PLS, Adanco or Amos diagram (Wright 1918, 1920, 1921). SEM was adopted by Biliyaminu (2024) to investing in Adamawa state, Nigeria. The model is adopted to achieve objective

4.0 Results and Discussion

4.1 Measurement model with Outer Loadings

The measurement model was conducted to ensure the reliability and validity of all reflective construct. Internal consistency reliability was estimated using the Cronbach Alpha (CA) and composite reliability (CR). As shown in Table 1 all CA and CR values surpassed the recommended threshold of 0.70, signifying strong internal consistency and stable measurement of the construct. Convergence validity was examined using the indicator loadings and Average Variance Extracted (AVE). Consistent with the criteria of Hulland (1999) and Hair Jr et al. (2021), indicator loadings should greater than or equal to 0.40 (preferably greater than 0.70) and AVE values greater than 0.50. The result presented in table revealed that all items loaded significantly on their corresponding constructs, with outer loadings above 0.40, indicating a good indicator reliability. Also, all the AVE values surpassed the 0.50 threshold, affirming that each construct explains more than half of the variance in its indicator. Jointly, the outcome confirms that the measurement model exhibits robust internal consistent reliability and moderate convergent validity, meeting the suggested standard for a reflective measurement evaluation in PLS-SEM.

Table 4.1: Construct Validity and Reliability

Constructs	Items	F.L.	CA	CR	AVE
Food Availability (DV1)	**FA1:** Climate change has reduced the amount of food produced in my community	0.722	0.804	0.814	0.495
	FA2: Weather changes affect the availability of major staple crops	0.712			
	FA3: Farmers cannot produce enough food to meet local needs	0.705			
	FA4: Seasonal changes make food supply unpredictable	0.680			
	FA5: Erratic rainfall reduces crop yield	0.713			
	FA6: Food availability has become less reliable over time	0.688			

Constructs	Items	F.L.	CA	CR	AVE
Food Accessibility (DV2)	**FACC1:** Climate change has contributed to rising food prices	0.656	0.828	0.828	0.536
	FACC2: Extreme weather limits access to food markets	0.753			
	FACC3: Flooding disrupts the movement of food to markets	0.740			
	FACC4: Road conditions worsen food access during bad weather	0.746			
	FACC5: Climate events make food less affordable	0.755			
	FACC6: Farmers face difficulty transporting produce due to climate impacts	0.740			
Food Utilization (DV3)	**FU1:** Climate affects the nutritional quality of food	0.646	0.766	0.770	0.459
	FU2: Irregular supply disrupts household meal planning	0.642			
	FU3: High temperatures increase food spoilage	0.679			
	FU4: Weather conditions affect safe food storage	0.734			
	FU5: Climate impacts force households to change diets	0.696			
	FU6: Dry seasons reduce access to fresh and nutritious foods	0.663			
Food Stability (DV4)	**FS1:** Climate change causes instability in food supply	0.724	0.837	0.838	0.551
	FS2: My community experiences food shortages due to weather changes	0.748			
	FS3: Droughts, floods, and heat waves reduce food stability	0.693			
	FS4: Seasonal food production has become unpredictable	0.760			
	FS5: Long dry spells cause unstable household food supply	0.764			
	FS6: Climate-related shocks increase long-term food insecurity	0.763			

Table 4.1: Continued

Constructs	Items	F.L.	CA	CR	AVE
Environmental Policies (IV5)	**EP1:** Environmental policies help farmers cope with climate issues	0.758	0.845	0.850	0.562
	EP2: Awareness of environmental policies is low	0.669			
	EP3: Current policies are inadequate to address climate challenges	0.772			
	EP4: Farmers receive little support to adopt environmental policies	0.751			
	EP5: Strong environmental policies improve food security	0.791			
	EP6: Weak enforcement worsens climate impacts	0.753			

Note(s): F.L =factor loadings; CA = Cronbach's alpha; CR = Composite reliability; AVE = Average variance extracted

4.2 Bootstrapping Iterations

The result from Table 4.2 revealed the findings of examining sixteen (16) hypotheses obtained from using the bootstrapping resampling iterations. The individual hypothesis observes the relationships between various model's variables. The Beta (β) values show the direction and strength of these relationships, while the t-statistics, p-values and confidence interval measures statistical significance and degree of certainty. In this case, the interpretation is not restricted because all the variables are significant, which investigates the relationship between environmental policy on the effect climate change and food availability (FA), food accessibility (FACC), food sustainability (FS) and food utilization (FU) is supported with a positive beta value of DR>EP>FA,FCC,FS and FU are 0.147,0.167,0.121and 0.187,FL>EP>FA,FACC<FS< and FU are 0.240, 0.460 and again RT>EP>FA,FACC,FS and FU, 0.140,0.165, 0.149and 0.189 respectively while ARP>EP>FA,FACC,FS and FU are 0.152,0.174, 0.291,0.155 and 0.199 t-statistics4.460,4.678,4.130,6.462,4.951,5.548,5.389,6.608,4.075,4.957,4.880,6.519,4.816,5.145,5.313,and 7.1843.425, 3.726, 7.883, and 4.814 (above the threshold of 1.96), and p-values of 0.001, 0.000, 0.000, 0.000, respectively. The result revealed a positive relationship between environmental policies, drought and food insecurity in Adamawa State at the 1 per cent level of significance. In addition, H5 to H8 which investigate the relationship between flooding (FL) on environmental policies and food availability (FA), food accessibility (FACC), food stability (FS) and food utilization (FU) are significance at 1 per cent level similarly H9 to H12 is also significance at 1 percent level, like wise H13 to H16 which assess the relationship between environmental policies on altered rainfall pattern (ARP) on food availability (FA), food accessibility (FACC), food stability (FS) and food utilization (FU) are significance at 1 per cent level. Additionally, relationship between environmental policies on rising temperature (RT) and food availability (FA), food accessibility (FACC), food sustainability (FS) and food utilization (FU) is significant. This shows that environmental policies plays a major role in influencing climate change and food insecurity in Adamawa State.

Table 4.2 Bootstrapping hypothesis

			97.5% Confidence Interval Bias Corrected				
Hypotheses	**Beta Value (β)**	**SD**	**LL (2.5%)**	**UL (97.5%)**	**T statistic**	**P value**	**Decision**
DR -> EP -> FA	0.147	0.033	0.084	0.213	4.460	0.000	**Supported**
DR -> EP -> FACC	0.167	0.036	0.101	0.242	4.678	0.000	**Supported**
DR -> EP -> FS	0.121	0.029	0.069	0.183	4.130	0.000	**Supported**
DR -> EP -> FU	0.187	0.029	0.134	0.248	6.462	0.000	**Supported**

			97.5% Confidence Interval Bias Corrected				
FL -> EP -> FA	0.145	0.029	0.087	0.203	4.951	0.000	**Supported**
FL -> EP -> FACC	0.170	0.031	0.114	0.236	5.548	0.000	**Supported**
FL -> EP -> FS	0.151	0.028	0.099	0.210	5.389	0.000	**Supported**
FL -> EP -> FU	0.255	0.039	0.181	0.332	6.608	0.000	**Supported**
RT -> EP -> FA	0.140	0.034	0.076	0.210	4.075	0.000	**Supported**
RT -> EP -> FACC	0.165	0.033	0.104	0.237	4.957	0.000	**Supported**
RT -> 1P -> FS	0.149	0.031	0.095	0.214	4.880	0.000	**Supported**
RT -> EP -> FU	0.189	0.029	0.137	0.250	6.519	0.000	**Supported**
ARP -> EP -> FA	0.152	0.032	0.090	0.214	4.816	0.000	**Supported**
ARP -> EP -> FACC	0.174	0.034	0.110	0.244	5.145	0.000	**Supported**
ARP -> EP -> FS	0.155	0.029	0.101	0.214	5.313	0.000	**Supported**
ARP -> EP -> FU	0.199	0.028	0.149	0.258	7.184	0.000	**Supported**

Author's Computation Using PLS 4.0

5.0 Conclusion

This study examined the effect of climate change and environmental policies on food insecurity in Adamawa State, Nigeria. Using Partial Least Squares Structural Equation Modelling (PLS-SEM), the study assessed the relationships between climate change variables (drought, flooding, rising temperature, and altered rainfall patterns), environmental policies, and the four dimensions of food security: availability, accessibility, stability, and utilization. The measurement model confirmed that all constructs demonstrated adequate internal consistency reliability (CA and CR > 0.70) and convergent validity (AVE > 0.50), establishing the robustness of the measurement instruments. The bootstrapping results provided strong empirical support for all sixteen (16) hypothesized relationships, with t-statistics exceeding the critical threshold of 1.96 and p-values below 0.01.

The findings revealed that climate change variables drought, flooding, rising temperature, and altered rainfall patterns significantly influence food insecurity in Adamawa State. Specifically Drought demonstrated significant positive relationships with food availability (β = 0.147), food accessibility (β = 0.167), food stability (β = 0.121), and food utilization (β = 0.187), indicating that drought conditions exacerbate all dimensions of food insecurity. Flooding showed the strongest effects on food utilization (β = 0.255) and food accessibility (β = 0.170), confirming that flood events severely disrupt food distribution networks and household access to nutritious food. Rising temperature significantly affected all food security dimensions, with the strongest impact on food utilization (β = 0.189), suggesting that higher temperatures accelerate food spoilage and reduce nutritional quality. Altered rainfall patterns exhibited significant effects across all dimensions, with the most pronounced impact on food utilization (β = 0.199), highlighting how unpredictable

precipitation undermines household food planning and dietary diversity. In conclusion, the study establishes that climate change significantly worsens food insecurity across all four dimensions in Adamawa State, and that environmental policies serve as a critical moderating mechanism. The findings validate the theoretical framework linking climate change, environmental policies, and food insecurity, providing empirical evidence for policy formulation and intervention design in Adamawa State and similar contexts in sub-Saharan Africa

5.1 Recommendations

(i)Strengthen implementation and enforcement of environmental policies at state and local-government levels. (ii) Expand drought resilient agriculture, water conservation, irrigation and climate-smart farming practices. (iii) Improve flood-risk management, drainage, early-warning systems and protection of agricultural infrastructure. (iv) Promote farmer access to climate information, extension services and adaptation support. Strengthen storage, post-harvest management and food-market infrastructure to reduce spoilage and improve accessibility. (v) Increase public awareness of environmental policies and improve institutional coordination.

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