AGRICULTURAL AUTOMATION, CLIMATE CHANGE-ACTION AND FOOD SECURITY: GLOBAL ISSUES & LOCAL PERSPECTIVES

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Preface

This book adopts an exegetical approach as well as a pedagogic model, making it attractive agriculture and environmental economics teachers, professional practitioners and scholars. It is eschews pedantry and

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lays bars the issues in such clarity that conduces to learning. The book elaborates on contemporaneous Agricultural Automation, Climate Change-Action and Food Security issues of global significance and at the same time, is mindful of local or national perspectives making it appealing both to international and national interests. The book explores the ways in which Agricultural Automation, Climate Change-Action and Food Security issues are and should be presented to increase the public's stock of knowledge, increase awareness about burning issues and empower the scholars and public to engage in the participatory dialogue Agricultural Automation, Climate Change-Action and Food Security necessary in policy making process that will stimulate increase in food production and environmental sustainability. Agricultural Automation, Climate Change-Action and Food Security**:** *Global Issues & Local Perspectives* is organized in three parts. Part One deals with The Concept of Agricultural Automation, Part Two is concerned with The Concept of Climate Change-Action and Part Three deals with the Concept of Food Security

Eteyen Nyong; October 2026

IMPACT OF CLIMATE CHANGE ON GROWTH IN NIGERIA.

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By

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Introduction

A shift in the long-term weather patterns that could have detrimental effects on the world is referred to as climate change. Rooney et al. (2020) define climate change as a change in climate patterns primarily brought on by greenhouse gas emissions from human activity and natural systems. Many academics believe that the 18th-century industrial revolution, which resulted in a shift in energy sources, was the catalyst for global climate change. Field et al. (2014) claim that climate change has already had an effect on our world, while Renner et al. (2014) said that mountain glaciers have retreated and Artic sea ice has decreased due to rising temperatures. Sea levels have increased as a result of warmer air temperatures raising ocean temperatures (Abraham et al., 2013) (Kuh Brodt & Gregory, 2012). Global warming has increased by roughly 1.00C from pre-industrial times due to anthropogenic activity, and if current emission rates continue, it is expected to reach 1.50C between 2030 and 2052 (Roonet et al., 2020).Once more, according to the Intergovernmental Panel on Climate Change (IPCC, 2007), referenced in Odugo (2010), climate change is defined as a change in the state of the climate that is detectable (for example, through statistical tests) by variations in the mean or variability of its properties and that lasts for a long time, usually decades or more. The degree of deviation from the norm and its effects on the environment are more significant than how long it takes for the changes to become apparent.According to Ayoade (2003), a change in climate typically occurs over a long period of time, at least 150 years, with obvious and permanent effects on the ecosystem. However, secular variations in climate change that occur over a period of 100 to 150 years may not qualify as a climate change if conditions

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quickly reverse later. The IPCC (2007b) reports that the overall annual emissions of greenhouse gasses are increasing. GHG emissions have risen by an average of 1.6% annually over the last three decades, with carbon dioxide (CO2) emissions from the burning of fossil fuels rising at a pace of 1.9% annually.By the end of the twenty-first century, CO2 concentrations might range from 490 to 1260 parts per million (75–350% above the pre-industrial concentration), according to the IPCC Special Report on Emission Scenarios. CO2 levels were approximately 280 parts per million by volume before the Industrial Revolution began, and they are currently at 370 parts per million by volume. Cox, Betts, Jones, Spall, and Totterdell (2000) state that substantial climate changes are anticipated as a result of the ongoing rise in CO2 concentrations in the atmosphere brought on by human emissions. The seas and land ecosystems absorb around half of the present emissions, but this absorption is sensitive to both atmospheric CO2 concentrations and climate, resulting in a feedback loop. According to India Council of Agricultural Research (ICAR), some scanty information of extreme events of cold waves, heat waves, and excess rainfall have been noticed. In Agra, wheat yields were lowered due to cold waves in 2002 to 2003 as compared to previous years. In Bihar, loss of seed setting in maize and loss of productivity in rice was recorded in response to extreme coldness. Higher air temperatures can increase cases of salmonella and other bacteria-related food poisoning because bacteria grow more rapidly in warm environments. These diseases can cause gastrointestinal distress and, in sever

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Cases like death. Flooding and heavy rainfall can cause overflows from sewage treatment plants into fresh water sources. Overflows could contaminate certain food crops with pathogen-containing faces. Mosquitoes favor warm, wet climates and can spread diseases such as West Nile virus. The geographic range of ticks that carry Lyme disease is limited by temperature. As air temperatures rise, the range of these ticks is likely to continue to expand northward. Typical symptoms of Lyme disease include fever, headache, fatigue, and a characteristic skin rash. In 2002, a new strain of West Nile virus, which can cause serious, life-altering disease, emerged in the United States. Higher temperatures are favorable to the survival of this new strain.

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Statement of Problem

Combustion from fossil fuels such as oils and coal emits harmful substances like carbon dioxide, nitrogen oxide, Sulphur oxide, hydrogen ,nitrogen and particles into the atmosphere. Increase in household energy demand, urbanization, industrialization and transportation continue to exert pressure on the atmosphere, causing severe damage and increased global warming. Climate change Continue to change earth's atmosphere at an unprecedented rate. Extreme heat, degraded air quality and spread of infectious diseases among others are evidence of a degrading environment. According to Baker (2020) climate change causes severe and accelerating economic damage projected to cost the world economy roughly US$38 trillion annually by 2050.These losses are reflected in supply chain via reduced exports, lower tax revenues and disrupted international trade. In Nigeria, losses from climate change costs billions in Gross Domestic Product (GDP) the country ranked 154th out of 181 in the ND-GAIN 2021 index which assesses vulnerability and resilience to climate change .Climate change effect affects agriculture through flood and drought. According to Nigerian hydrological Services Agency (NIHSA) floods destroyed more than 440,000 hectares of farmland, affecting thousands of residents and an estimated loss of USD6.68billion Against this backdrop, this study examined climate change impact and strategies to mitigate climate change and global warming in Nigeria

Objectives of the Study

i. examine the impact of climate change on economic development of Nigeria

ii. identify the trend of climate change in Nigeria

Research Hypothesis

i. Climate change has no significant impact on socio-economic development of Nigeria

ii. Climate change has significant impact on economic development in Nigeria

LITEWRATURE REVIEW

Conceptual Clarification

Climate Change

Climate change represents the changes in the variability or average state of the atmosphere over time (decades to millions of years) and over a region (local to global scale), or in other words all forms of climatic inconsistency. For example, climate change includes changes in temperature, wind patterns and precipitation. According to the definitions of the 1992 UN Framework Convention on Climate Change (1992), ‘‘climate change’’ means a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. As per the definition of the American Meteorological Society (n.d.) glossary, climate change is: any systematic change in the long-term statistics of climate elements (such as temperature, pressure, or winds) sustained over several decades or longer. Climate change may be due to natural external force, such as changes in solar emission or slow changes in the earth’s orbital elements; natural internal processes of the climate system; or anthropogenic forcing.

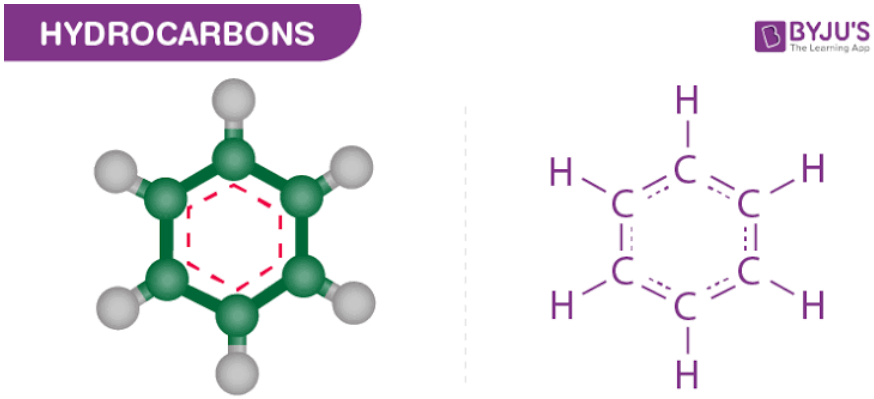
Global Warming :

Global warming refers to a gradual increase in the earth’s average temperature due to the increase in atmospheric concentration of greenhouse gases (GHGs). According to NASA’s Goddard Institute for Space Studies, average temperatures around the world have increased by 0.8°C since 1880, much of this increase being in recent decades. Over the past 100 years, the average global temperature has increased. According to Purohit &Singh (2014) Global warming means the rise in

the average temperature of Earth's atmo-sphere and oceans as well as its projected continuation. The greenhouse effect is the process by which absorption and emission of infrared radiation by gases in the atmosphere warm a planet's lower atmosphere and surface. Since the early twentieth century, Earth's mean surface temperature has increased by about 0.8°C (1.4°F), with about two-thirds of the increase occurring since 1980. The major greenhouse gases are water vapor, CO_2, CH_4, and ozone. Water vapor contributes for 36–70 percent of the greenhouse effect, whereas CO_2, CH_4 and ozone accounts for 9–26 percent, 4–9 percent, and 3–7 percent of the green house effect, respectively. Human activity, since the Industrial Revolution, has increased the amount of greenhouse gases in the atmosphere; concentrations of CO_2 and methane have increased by 36 percent and 148 percent, respectively, since 1750.

Hydro carbon

A **hydrocarbon** is any organic chemical compound made entirely of two elements: **carbon (C)** and **hydrogen (H). Types of hydrocarbon includes,1.Aliphatic hydrocarbons:open chain or ring-like structures that do not contain a benzene ring.2. Alkanes (Saturated):contain only single carbon-carbon bonds, general formula (CnH2nt$_2$) examples include methane(CH_4) and propane ((C_3H_8).3. Alkyne(Unsaturated) contain**



Precipitation

Global warming, changes in precipitation patterns, and changes in resource use by humans in response to climate change could also significantly alter the quality of surface waters. The future climate variability is likely to be different from past climate variability, particularly in terms of the rate and magnitude of changes in meteorological, hydrological and environmental sectors.

Green Gas Emission

Greenhouse gas emissions are gases—primarily carbon dioxide, methane, and nitrous oxide—that trap heat in Earth's atmosphere and drive global warming.

Main Types of Greenhouse Gases

- **Carbon Dioxide (CO_2):** Accounts for roughly 75% to 77% of total greenhouse gas emissions; released mainly by burning fossil fuels (coal, oil, and natural gas) and deforestation.
- **Methane (CH_4):** Released from livestock agriculture, fossil fuel production/ventilation, and decomposing waste in landfills. It is far more potent than CO_2 over a short timeframe.
- **Nitrous Oxide (N_2O):** Generated largely through agricultural soil management, synthetic and organic fertilizers, and fossil fuel combustion.
- **Fluorinated Gases:** Man-made synthetic gases (like HFCs and PFCs) used in refrigeration, air conditioning, and industrial processes with high warming potential.

Hydrocarbon Tax (HT) and Company Income Tax (CIT) Provision

The Act introduces the Hydrocarbon Tax under Section 260 of the Act which shall be applicable and levied upon the profits of companies engaged in the upstream petroleum operations in the onshore, shallow water, and deep offshore, payable during each accounting period. The chargeable tax for any accounting period shall be 30% of the profit from crude oil for petroleum mining leases with respect to offshore and shallow water areas and 15% of the profit from crude oil for onshore and shallow water for petroleum prospecting license. Also, the Company Income Tax (CIT) is now applicable to companies, licensees, concessionaire, lessees, contractors, or subcontractors engaged in the upstream, midstream, or downstream petroleum operations in addition to the hydrocarbon tax as provided in Section 302 of the Act, subject to the Companies and Allied Matters Act.

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Petroleum Fiscal Industry Framework

Chapter 4 of the Act introduces the Petroleum Fiscal Industry Framework (PIFF). The objectives of PIFF include establishing a progressive fiscal framework that encourages investment in the Nigerian petroleum industry, balancing rewards with risk and enhancing revenues to the Federal Government of Nigeria; provide a forward-looking fiscal framework that is based on core principles of clarity, dynamism, and fiscal rules of general application, etc. the Act provides that all money collected from the petroleum industry that is due to the government are to be transferred to a federal account and such collection of the government revenue in the petroleum industry shall be the function of the Federal Inland Revenue Service (FIRS)

Theoretical Clarification

Environment and Social Theory

Environment and Social theory is widely accredited to Friedrich Ratzel. The theory conceptualize the complex interlink between the environment, social theory and nature dating from ancient and modern thinking to contemporary so cial theory linking cultural and social theory

Empirical Review

Edeh *et al.* (2024) used time series data from the Central Bank of Nigeria (CBN) statistical bulletin to investigate the relationship between climate change and economic growth in Nigeria for the years 1981–2021. Inflation, temperature, precipitation, and carbon dioxide emissions were the independent variables, while economic growth was defined as a function of capital stock. Pairwise correlation, the Bound test cointegration analysis for long-term relationships, and the Augmented Dickey-Fuller unit root test for stationarity were used to perform preliminary tests on the time series data. Since the time

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series were stationary at levels I(0) and the first difference, the study result showed that precipitation, mean temperature, and carbon dioxide emissions had negligible effects on economic growth during the study period, the Autoregressive Distributed Lagged Model (ARDL) technique was used to estimate the model's parameters.

Onyejiuwa and Ifarajimi (2022) using four endogenous variables (growth rate of per capita income, Human Development Index, Gross Fixed Capital Formation, and Savings rate) to represent economic welfare and climate change variables (carbon dioxide damage, forest depletion, natural resource depletion, and carbon dioxide emission) derived from World Development Indicators, 2019. The impact and causation of climate change on Nigeria's economic welfare were estimated using the Granger causation test and the Fully Modified OLS estimator, respectively. The study found that Nigeria's savings rate, human development index, and per capita income growth rate were all adversely affected by climate change. In particular, carbon dioxide emissions had a significant detrimental effect on Nigeria's economic well-bein

METHODOLGY

Resign Design/ Sources of Data

The study employed an ex-post-facto research design was used in the study. Secondary time series data was sourced from World Development Indicators (2025).

Model Specification:

The study adopted and modified the model by Ovbasanmi & Akhamie(2025)

$$GDPCg = \beta_0 + \beta_1 RF + \beta_2 GHG + \beta_3 CO_2 + U_t$$

RESULTS AND DISCUSSIONS

Table 1: Descriptive Statistics

	CO2	RF	GHG	GDPgr
Mean	97481.09	1182.41	277838.4	4.29
Max	123180.0	1288.90	332247.0	15.33
Min	72768.80	1063.04	233668.6	-2.04
Jarque-Bera Prob	0.58(58%)	0.41(41%)	0.26(26%)	3.39(339%)

Source: Researchers' Computation 2026

The result of table 1 revealed that the average Carbon emission from 1990 to 2023 was 97481.09 KiloTon, and average precipitation (rainfall) was 1182.41mm and average GHG was 277838.4 KiloTon and the average GDPgr was 4.29%. The maximum carbon emission was 123180.0 KiloTon and the minimum was 72768.80

KiloTon. The maximum precipitation (rainfall) was 1288.90mm and the minimum was 1063.04mm. the maximum GHG emission was 332247.0 KiloTon and minimum was 233668.6KiloTon. The maximum GDPgr was 15.33% and the minimum was -2.04%. All the variables considered in this were normally distributed because the jarque bera probability were all greater than 5%

Table 2: Unit Root Test Using ADF

Variable	P-value	Order of Integration
CO2	0.0000	I(1)
RF	0.0080	I(0)
GHG	0.0000	I(1)
GDPgr	0.0000	I(0)

Source: Researchers' Computation 2025 at 0.05 significant level

The ADF was used in the study to test the variables for the unit root problem. All of the variables were stationary at first difference (CO2 and GHG) except RF and GDPgr which were stationary at level. Since there was a mixed effects of level and first difference in the determination of the stationality, the study applied ARDL

Table 3: Cointegration Using Bounds Test

Test statistic	**value**	**Signif**	**I(0)**	**I(1)**
f-stat	2.56	5%	3.38	4.23
K	3			

Source: Researchers' Computation 2025

The result of table 3 revealed that the dependent and independent variables have no long-run correlations or there is no cointegration because the f-stat value (2.56) was lesser than the lower bound value (3.38) at 5% significant level. This indicates that all of the variables are not cointegrated, and have no long-run link, or do not move in the same direction.

Table 4: ARDL Estimation Result

	Dependent Variable: GDPgr	**(*p-value*)**
SR		
	D(CO2)	**0.00059**(*0.0091**)
	D(RF)	**0.0069**(*0.3831*)
	D(GHG)	**-0.0003**(0.0097*)
	*CointEq(-1)**	**-0.8008**(*0.0009**)
LR		
	CO2	**0.0004**(*0.0213**)
	RF	**0.0105**(*0,6078*)
	GHG	**-0.0004**(*0.0004**)
R Squared		0.7534
Adjusted R Squared		0.6424
F stat (prob)		0.0001
DW		1.87

Source: Researchers' Computation 2025

The result of table 4 revealed that components of climate change (CO2, GHG and RF) considered in this study accounts for 75.34% variation in GDP growth rate GDPgr in Nigeria and this was endorsed by the adjusted R squared of 64.24%. Also, the result revealed that at least one of the components of climate change considered in this study significantly influence Nigerian GDP growth rate and the study is free from serial auto-correlation

because the DW stat was approximately 2 using the rule of thumb.

The ECM revealed that there is a short to long run dynamics. The result revealed that the disequilibrium in the system was 0.8008 and it was significant because the p-value was lesser than 5% which was 0.09%. The implication of this is that every year the speed of adjust from SR to LR for equilibrium to be reach would be 80.08% because that data where annual in nature.

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The result also revealed that both in the SR and LR RF has positive and non-significant impact on Nigerian GDP growth rate, while CO2 had positive and significant impact on Nigerian GDP growth rate in both SR and LR. However, in both SR and LR, GHG has negative and significant impact on Nigerian GDP growth rate in both SR and LR.

Post-Estimation

Table 5; B-G Serial Correlation LM Test

F-stat	1.1746	Prob F(2,16)	0.3342
Obs* R squared	3.9687	Prob Chi Square (2)	0.1375

Source: Authors' Computation 2026

The result revealed that the model is free from serial correlation because the Obs* R squared Prob Chi Square (2) is greater than 5% which is 13.75%, thus making the model result or output not to be illegitimate or spurious

Table 6; B-G Heteroskedasticity Test

F-stat	1.1788	Prob. F912,18)	0.3655
Obs* R squared	13.6417	Prob Chi squared (12)	0.3242
Scaled explained SS	6.7720	Prob Chi squared (12)	0.8723

Source: Authors' Computation 2026

The result revealed that the model is free from heteroskedasticity, meaning the model is homoskedasticity the Obs* R squared Prob Chi Square (2) is greater than 5% which is 32.42%, thus making the model result or output not to be illegitimate or spurious.

Table 7; B-G Heteroskedasticity Test: Arch Effect

F-stat	0.0566	Prob F(1,28)	0.8137
Obs* R squared	0.0605	Prob Chi Square (1)	0.8057

Source: Authors' Computation 2026

The result revealed that the model is free from arch Observations* R squared Probability Chi Square (1) is greater than 5% which is 80.57%, hus making the model result or output not to be illegitimate or spurious

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FINDINGS FROM RESULTS

The results from the study revealed that both in the short run(SR) and long run(LR), climate change has positive and non-significant impact on Nigerian GDP growth rate, while CO2 had positive and significant impact on Nigerian GDP growth rate in both SR and LR. However, in both SR and LR, GHG has negative and significant impact on Nigerian GDP growth rate in both SR and LR.

SUMMARY CONCLUSION AND RECOMMENDATIONS

The study on the impact of climate change on economic growth in Nigeria employed a ex-post-factor research design and sourced secondary time series data from World Development Indicators(2025) and NBS(2025). The study concludes that the use of renewable energy would be a promising strategy for promoting sustainable development, as well as for addressing climate change, by reducing environmental impacts that it comes with. This study had investigated the impact of climate change on Nigeria economic growth and found that GHG emission had negative implication for Nigeria GDP growth rate; hence adequate proactive measures must be taken to forestall these negative implications. Based on the findings of the study, the researcher recommended the following

1. Nigerian citizens and farmers be sensitized on the effects of climate change on health, environment and the economy.
2. Early warning and preventive mechanisms be put in place by the government at all levels to mitigate flood and climate change effects.
3. Ecological funds appropriated should be utilized in containing erosion in all parts of the country

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