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RESEARCH ARTICLE
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# Government Strategies in Managing Climate Change in Nigeria: An Empirical Assessment

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## Abstract

Climate change poses serious environmental and socio-economic challenges in Nigeria, requiring effective government intervention to promote sustainable development. This study examined government strategies for managing climate change in Nigeria using annual data from 1990 to 2024. Data were obtained from the World Development Indicators and Climate Watch Database and analyzed using time-series econometric techniques. EViews 10 was employed because of its suitability for estimating and testing time-series models and conducting the required dynamic analyses. The findings indicate a stable long-run relationship among the variables. In the short run, government climate footprint strategy, renewable energy strategy, and GDP per capita significantly influence climate change. In the long run, GDP per capita, trade openness, and urbanization significantly mitigate climate change, while government climate footprint worsens climate conditions. The study concludes that effective climate management requires stronger environmental regulation, increased renewable energy investment, and climate-responsive development planning.

**Keywords:** Climate Change; Government Strategies; Renewable Energy; Climate Governance; Nigeria.

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## INTRODUCTION

Climate change has become one of the most significant environmental and developmental challenges facing the world today. Rising global temperatures, changing precipitation patterns, sea-level rise, and the increasing occurrence of extreme weather events have generated serious consequences for ecosystems, economies, and human livelihoods (Intergovernmental Panel on Climate Change [IPCC], 2021). Although climate change is a global phenomenon, developing countries are particularly vulnerable because of their limited adaptive capacity, weak institutional structures, and heavy dependence on climate-sensitive sectors such as agriculture, forestry, and water resources (Nwankwoala, 2015).

Nigeria is among the countries most exposed to the adverse effects of climate change. The impacts are evident across the country's diverse ecological zones. Northern Nigeria has experienced increasing temperatures, desertification, and prolonged droughts, which have reduced agricultural productivity and intensified food insecurity. At the same time, southern and coastal regions face recurrent flooding, coastal erosion, and sea-level rise, resulting in the destruction of lives, property, and critical infrastructure (National Emergency Management Agency [NEMA], 2022). The devastating floods recorded in recent years have highlighted the growing vulnerability of communities and the need for effective climate management strategies. Beyond environmental concerns, climate change has contributed to poverty, migration, health challenges, and conflicts over scarce natural resources, thereby posing a significant threat to sustainable development in Nigeria (World Bank, 2010).

Recognizing these challenges, the Nigerian government has introduced several policies and institutional frameworks aimed at mitigating climate change and enhancing adaptation. These include the National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN), the National Climate Change Policy, Nigeria's Nationally Determined Contributions (NDCs) under the Paris Agreement, and the Climate Change Act of 2021. These initiatives demonstrate the government's commitment to addressing climate-related risks and promoting environmental sustainability.

Above all, the effectiveness of government strategies in managing climate change remains a subject of concern. Existing studies suggest that climate policy implementation in Nigeria is constrained by inadequate funding, weak institutional coordination, limited technical capacity, and insufficient political commitment. In many cases, climate-related programmes have failed to achieve their intended objectives due to poor monitoring mechanisms, policy inconsistencies, and weak stakeholder participation. Consequently, a significant gap persists between policy formulation and practical outcomes.

Despite the growing body of climate-change research in Nigeria, empirical evidence assessing the effectiveness of government interventions remains limited, particularly regarding policy implementation, institutional capacity, and sub-national climate action (Okereke et al., 2025). This study seeks to fill this gap by empirically examining government strategies for climate change management in Nigeria. Specifically, the study evaluates the effectiveness of public sector climate initiatives, assesses the integration of adaptation and mitigation measures into government policies, and identifies the institutional challenges affecting climate governance. The findings are expected to provide valuable insights for policymakers and contribute to strengthening climate change management and sustainable development efforts in Nigeria.

ISSN 2689-5129 • Volume 9, Issue 5, 2026 • pp. 1–25

## LITERATURE/THEORETICAL UNDERPINNING

### Conceptual Framework

A conceptual framework serves as the foundation for understanding the relationships between key variables in a study. For this study, the framework is designed to examine how government activities and capacities influence the management of climate change in Nigeria. It identifies the independent, dependent, and intervening variables that structure the study.

### Definition of Concepts

### Climate Change

Climate change refers to long-term alterations in temperature, precipitation, wind patterns, and other elements of the Earth's climate system. It is largely driven by human activities such as burning fossil fuels, deforestation, and industrial processes that increase greenhouse gas (GHG) emissions in the atmosphere (IPCC, 2021).

### Government Strategies on Managing Climate Change

Government strategies on managing climate change encompass the deliberate actions, policies, and interventions undertaken by public authorities to address climate change through mitigation and adaptation measures. These strategies are designed to reduce greenhouse gas emissions, promote low-carbon development, enhance resilience to climate-related shocks, and ensure environmental sustainability and long-term economic growth (IPCC, 2021).

### Diagram of the Conceptual Framework

**Independent Variables**

Government Strategy on Climate Footprint
Government Strategy on Renewable Energy
Gross Domestic Product (GDP) per Capita

↓

**Dependent Variable (Climate Change)**
(Proxied by Annual Mean Temperature)

↑

**Moderating Variables**

Industrial Share of GDP
Trade Openness
Urbanization Rate

**Figure 1*: Conceptual Diagramme***
*Source: Researcher's Conceptualization (2026).*

The conceptual framework for this study illustrates the relationship between government climate change strategies, selected macroeconomic variables, and climate change in Nigeria. The framework identifies Government Strategy on Climate Footprint (GSCFP), Government Strategy on Renewable Energy (GSRE), and GDP per Capita (GDPCP) as the independent variables because they represent the principal government interventions and economic conditions expected to influence climate change outcomes. Government strategy on climate

ISSN 2689-5129 • Volume 9, Issue 5, 2026 • pp. 1–25

footprint reflects efforts aimed at reducing greenhouse gas emissions, while government strategy on renewable energy captures initiatives to promote cleaner and sustainable energy sources. GDP per Capita is included to account for the role of economic development in environmental management and climate resilience.

The framework further incorporates Industrial Share of GDP (INDGDP), Trade Openness (TOP), and Urbanization Rate (UBR) as moderating (control) variables. These variables are expected to influence the relationship between government climate strategies and climate change by affecting the level of industrial activities, international trade, urban expansion, and environmental quality. Their inclusion helps to isolate the effects of the main explanatory variables and improve the robustness of the empirical analysis.

The dependent variable is Climate Change (CLC), proxied by annual mean temperature. This variable represents the outcome of interest and captures changes in climatic conditions resulting from the interaction of government climate policies, economic activities, and other macroeconomic factors. Overall, the framework demonstrates that effective government climate strategies, supported by favourable economic conditions and appropriate control variables, are expected to contribute to improved climate outcomes in Nigeria.

**Theoretical Review**

To establish the economic relationship on the subject matter, the relevant economic theories that best explain this topic were examined. They include but are not limited to the following:

**Public Goods Theory**

Public goods are characterized by non-excludability (no one can be excluded from use) and non-rivalry (one person's use doesn't reduce availability for others). Clean air, climate stability, and disaster risk reduction are all public goods. Because of the free-rider problem, individuals and private firms lack the incentive to provide or protect such goods voluntarily (Samuelson, 1954). In Nigeria, climate-resilient infrastructure, flood control systems, early warning systems, and reforestation programmes are public goods. The private sector typically does not invest in these because they cannot easily extract direct profit. Therefore, it is the responsibility of the government to fund and manage these goods. Agencies like the National Emergency Management Agency (NEMA) and the Nigerian Meteorological Agency (NiMet) play roles in providing public environmental goods, but their reach is limited without adequate political and financial backing. Public sector involvement is vital to ensure equitable access to climate protection measures, especially for vulnerable communities.

**Externalities Theory**

An externality is a cost or benefit from an economic activity that affects a third party who did not choose to incur that cost or benefit. Climate change is the result of negative externalities**,** primarily from carbon emissions, industrial pollution, and deforestation. Since these costs are not reflected in market prices, polluting activities are overproduced (Pigou, 1920). In Nigeria, industries often emit pollutants, burn fossil fuels, or exploit natural resources without paying the full environmental cost. For instance, gas flaring in the Niger Delta is a significant source of emissions, with direct impacts on health and agriculture in local communities. The public sector has the responsibility to correct these market failures through carbon taxes or emissions charges, subsidies for renewable energy, enforcement of environmental regulations, and polluter-pay principles. Without these interventions, the economy continues to suffer long-term environmental degradation and public health crises.

### Market Failure Theory

A market failure occurs when the free market fails to allocate resources efficiently. In environmental economics, this happens when markets ignore environmental costs generated by economic production and consumption activities, such as pollution or climate impacts, leading to overuse of natural resources and underinvestment in sustainability (Bator, 1958). Climate change in Nigeria, manifested through rising temperatures, flooding, desertification, and biodiversity loss, underscores the need for strong public sector interventions. To mitigate these impacts and enhance climate resilience, the government implements targeted actions such as carbon sequestration programmes, biodiversity and ecosystem management, Environmental Impact Assessments (EIAs), green fiscal reforms, regulation of extractive industries, and the development of national climate change frameworks. These interventions are designed to correct environmental externalities, promote sustainable resource use, and guide the economy toward climate-resilient and inclusive growth. By prioritising measurable mitigation and adaptation strategies, the public sector directly contributes to stabilizing climate outcomes and reducing the vulnerability of communities and ecosystems.

### Theoretical Synthesis

This study is anchored on Public Goods Theory, Externalities Theory, and Market Failure Theory, which collectively explain the necessity of government intervention in climate change management. Public Goods Theory (Samuelson, 1954) posits that environmental quality, climate stability, and disaster prevention are public goods that are often underprovided by the private sector due to the free-rider problem. Externalities Theory (Pigou, 1920) argues that climate change results from negative externalities arising from activities such as pollution, deforestation, and greenhouse gas emissions, whose environmental costs are not reflected in market prices. Market Failure Theory (Bator, 1958) integrates these perspectives by explaining that markets alone cannot efficiently allocate environmental resources or address climate-related challenges. Consequently, government intervention through environmental regulations, climate policies, public investments, and adaptation programmes becomes essential. While the three theories are complementary, Market Failure Theory serves as the anchor theory of the study because it provides a broader framework for understanding how government strategies can correct environmental distortions, promote sustainable development, and enhance climate resilience in Nigeria.

### Empirical Review

Empirical evidence on climate change in Nigeria can broadly be grouped into studies of climate vulnerability, mitigation and adaptation, and the interaction between environmental pressures and economic activity. An important pattern in the literature is that climate change affects Nigeria through interconnected environmental and socio-economic channels, while the effectiveness of responses depends considerably on institutional capacity and policy implementation. Grossman and Krueger (1995) provided an influential empirical examination of the relationship between economic growth and environmental degradation, showing that environmental pressure may change as income levels rise. Obayagbona (2023) also examined the relationship between carbon footprint and economic growth in Nigeria and Ghana, highlighting the importance of considering environmental consequences alongside economic expansion.

Studies on vulnerability have consistently established that climate change presents differentiated risks across Nigeria. Akande and Olorunfemi (2009) linked climate-related changes to human-security concerns, while Olaniyi et al. (2014) documented the implications of climate variability for agriculture, food security, health, and livelihoods. Nwankwoala (2015) similarly highlighted the consequences of environmental change for water resources and vulnerable communities. More recent evidence continues to support this vulnerability perspective.

A second strand of evidence examines mitigation through renewable energy and changes in energy use. Muse (2021) found that economic growth and carbon emissions are important determinants of renewable-energy demand in Nigeria, suggesting that environmental pressures can encourage a transition towards cleaner energy sources. Somoye et al. (2022), using a nonlinear ARDL approach, also found that renewable-energy consumption has a significant relationship with economic growth in Nigeria, reinforcing the importance of renewable energy within the country's development strategy. More recent evidence reports that renewable energy and energy efficiency can reduce environmental pollution, strengthening the case for policies that support cleaner energy adoption.

The literature also demonstrates that economic and structural changes have important environmental implications. Oyebanji and Kleynhans (2021) found long- and short-run relationships among renewable energy, international trade, carbon dioxide emissions, and economic growth in Nigeria. Their evidence of causality running from economic growth to carbon emissions indicates that the pattern and composition of economic expansion matter for environmental outcomes. This finding is particularly relevant to Nigeria, where industrialisation, energy demand, and urban expansion continue to interact with environmental pressures.

Another emerging strand focuses on the effectiveness of climate governance rather than climate impacts alone. Letta et al. (2024) showed that households repeatedly exposed to climate shocks and possessing fewer assets may face constraints in adapting through migration, highlighting the importance of economic capacity in determining climate resilience. The study points to the need for policies that address underlying socioeconomic inequalities rather than relying solely on physical adaptation measures. More directly related to government action, recent evidence from Nigeria shows substantial weaknesses in sub-national climate governance. A nationwide assessment found low climate knowledge among officials, limited state-level climate policies, inadequate climate-related budgetary commitments, and weak inter-agency coordination, indicating a considerable gap between national climate commitments and implementation at the sub-national level (Okereke et al., 2025).

Taken together, the empirical literature provides strong evidence that climate change in Nigeria is closely associated with economic activity, energy use, environmental degradation, and institutional capacity. However, three limitations remain evident. First, much of the literature concentrates on sectoral vulnerability, particularly agriculture and livelihoods, rather than directly measuring the effectiveness of government climate strategies. Second, studies of renewable energy and emissions generally examine energy or environmental outcomes without integrating government climate strategies into a broader national framework. Third, governance studies increasingly identify institutional weaknesses, but relatively few provide a quantitative time-series assessment linking government-related climate strategies to observed climate outcomes. This study contributes to the literature by bringing these dimensions together and empirically examining the relationship between government climate strategies, economic conditions, structural factors, and climate change in Nigeria over 1990-2024.

**Empirical Synthesis**

The empirical literature broadly establishes that climate change constitutes a major environmental and socio-economic challenge in Nigeria, but the emphasis of existing studies varies considerably. Earlier studies largely concentrated on climate vulnerability, documenting the effects of changing climatic conditions on human security, agriculture, water resources, food security, and livelihoods (Akande and Olorunfemi, 2009; Olaniyi et al., 2014; Nwankwoala, 2015). More recent studies have extended this literature to renewable energy, climate adaptation, household resilience, and climate governance (Letta et al., 2024; Nwosu et al., 2024; Omokaro, 2025; Okereke et al., 2025). Despite differences in focus and methodology, these studies generally agree that climate-related pressures are becoming increasingly important for Nigeria’s development.

However, the literature presents a less consistent picture regarding the interaction between economic activity, energy use, and environmental outcomes. Studies on renewable energy and economic growth indicate that energy use, economic expansion, and trade are closely associated with environmental performance, although the direction and magnitude of the relationships vary across studies (Muse, 2021; Oyebanji and Kleynhans, 2021; Somoye et al., 2022). This variation suggests that the environmental consequences of economic development may depend on the structure of production, energy composition, and the extent to which cleaner technologies are adopted.

The literature also reveals a significant shift from examining climate impacts towards understanding adaptation and governance responses. Household- and community-level studies demonstrate that socioeconomic conditions influence the capacity to respond to climate shocks, while recent evidence on climate governance points to weaknesses in policy implementation, financing, institutional coordination, and technical capacity (Letta et al., 2024; Okereke et al., 2025). Nevertheless, much of the existing evidence remains either sector-specific or descriptive, with relatively limited quantitative assessment of government climate strategies at the national level.

Consequently, an important empirical gap remains. Existing studies have provided valuable evidence on climate vulnerability, renewable energy, economic growth, and institutional challenges, but few have jointly examined government climate strategies alongside major economic and structural factors using a national time-series framework. This study contributes to the literature by empirically examining how government strategies on climate footprint and renewable energy interact with GDP per capita, industrial activity, and urbanisation in shaping climate outcomes in Nigeria over 1990-2024. It therefore provides a broader empirical basis for evaluating the effectiveness of government climate interventions and for designing policies that reconcile environmental protection with economic development.

ISSN 2689-5129 • Volume 9, Issue 5, 2026 • pp. 1–25

## METHODOLOGY

This section describes the research design, data sources, variable measurement, model specification, and analytical techniques employed to examine the effectiveness of government strategies in managing climate change in Nigeria. It also outlines the procedures used to ensure reliable estimation and robust empirical findings.

### Study Design

This study adopts an ex pos facto research design in examining government strategies in managing climate change in Nigeria from 1990 - 2024.

### Model Specification

The study is anchored on Market Failure Theory because climate change represents a classic case of market failure arising from negative externalities and the under-provision of environmental public goods. The theory provides a comprehensive explanation for the necessity of government intervention through climate mitigation and adaptation policies aimed at promoting environmental sustainability and climate resilience in Nigeria. The model is specified in functional notation as follows:

$$CLC = f(GSRE, GSCFP, IND\text{-}GDP, GDP\text{-}CP, UBR) \qquad (1)$$

This can be transformed into econometric form in equation 2 as follows:

$$CLC_t = \beta_0 + \beta_1 GSRE + \beta_2 GSCFP + \beta_3 IND\ GDP + \beta_4 GDP\ CP + \beta_5 UBR + \mu_t \qquad (2)$$

Where:

| | | |
|---|---|---|
| CLC | = | Climate Change (proxied as annual mean temperatures [°C]) |
| GSRE | = | Government strategy on renewable energy (proxied as share of renewable energy in total energy supply.) |
| GSCFP | = | Government Strategy on Climate Change (proxied as Total Climate Footprint Index, using total Greenhouse Gas Emissions, [GHG] emissions in tons $CO_2$ equivalent [Million $tCO_2e$]) |
| IND-GDP | = | Industrial Share of Gross Domestic Product |
| GDP-CP | = | Gross Domestic Product per Capita |
| UBR | = | Urbanization Rate |
| Bi | = | parameters to be estimated |
| t | = | time series of the estimated variables |
| μ | = | error term |

ISSN 2689-5129 • Volume 9, Issue 5, 2026 • pp. 1–25

**Sources of Data**

The data used in this work are secondary data. They are annual time series from the period of 1900 to 2024, were sourced from the Central Bank of Nigeria Statistical Bulletin, National Bureau of Statistics of Nigeria, United Nations, United Nations Conference on Trade and Development (UNCTAD), International Monetary Fund (IMF), and World Bank.

**Unit Root Test**

The unit root was conducted to ascertain the order of integration (or stationarity) of a given series. In testing for the stationarity of the series, the Augmented Dicke-Fuller (ADF) and Phillip-Perron unit root tests were utilized. The test was conducted under intercept, constant and trend, and none assumption on the level and first difference of the series. The models are presented below:

$$\Delta X_t = \propto_0 + \propto_1 X_{t-1} + \sum_{i=1}^{m} \propto_2 \Delta X_{t-1} + \varepsilon_t \tag{3}$$

And that

$$\Delta X_t = \propto_0 + \delta t + \propto_1 X_{t-1} + \sum_{i=1}^{m} \propto_2 \Delta X_{t-1} + \varepsilon_t \tag{4}$$

Where $X_t$ is a time series, t is a linear time trend, $\Delta$ is the first difference operator, $\beta_0$ is a constant, $i$ is the optimum number of lags in the independent variables, and $\varepsilon_t$ is random error term.

**Estimation Technique**

The study employed EViews 10 for data processing and econometric estimation because the software provides suitable procedures for analysing annual time-series data and estimating dynamic multivariate models. In particular, EViews 10 supports the Augmented Dickey-Fuller and Phillips-Perron unit root tests, Johansen cointegration analysis, Vector Error Correction Models (VECM), impulse response functions, forecast error variance decomposition, and Granger causality tests, which are required for the empirical objectives of this study. Version 10 was specifically used because it was the econometric package available to the researcher and provided all the estimation and diagnostic procedures required for the analysis in an integrated environment.

**Assessment of Effectiveness Using t-Tests**

The effectiveness of government strategies in managing climate change was assessed from the statistical significance, direction, and magnitude of the estimated coefficients of the government strategy variables. The t-test associated with each estimated coefficient was used to determine whether the effect of the variable on climate change was statistically different from zero. At the 5% level of significance, a coefficient was considered statistically significant when the absolute value of its t-statistic exceeded the critical value of approximately 1.96, or when its probability value was less than 0.05. A statistically significant coefficient with a direction consistent with the expected climate-mitigation effect was interpreted as evidence that the corresponding government strategy was effective in influencing climate change. Where the coefficient was statistically insignificant, the strategy was considered to have no statistically established effect over the period examined.

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ISSN 2689-5129 • Volume 9, Issue 5, 2026 • pp. 1–25

$$\mathrm{CLC}_t = a_0 + \sum_{p=0}^{q} b_{11}\mathrm{CLC}_{t-i} + \sum_{p-1}^{q} b_{12}\mathrm{GSRE}_{t-i} + \sum_{p-1}^{q} b_{13}\mathrm{GSCFP}_{t-i} + \sum_{p-1}^{q} b_{14}\mathrm{IND\ GDP}_{t-i} + \sum_{p-1}^{q} b_{15}\mathrm{GDP\ CP}_{t-i} + \sum_{p=1}^{q} b_{16}\mathrm{UBR}_{t-i} + \mu_{it} \quad (5)$$

$$\mathrm{GSRE}_t = a_0 + \sum_{p=0}^{q} b_{21}\mathrm{GSRE}_{t-i} + \sum_{p-1}^{q} b_{22}\mathrm{CLC}_{t-i} + \sum_{p-1}^{q} b_{23}\mathrm{GSCFP}_{t-i} + \sum_{p-1}^{q} b_{24}\mathrm{IND\ GDP}_{t-i} + \sum_{p-1}^{q} b_{25}\mathrm{GDP\ CP}_{t-i} + \sum_{p=1}^{q} b_{26}\mathrm{UBR}_{t-i} + \mu_{it} \quad (6)$$

$$\mathrm{GSCFP}_t = a_0 + \sum_{p=0}^{q} b_{31}\mathrm{GSCFP}_{t-i} + \sum_{p-1}^{q} b_{32}\mathrm{CLC}_{t-i} + \sum_{p-1}^{q} b_{33}\mathrm{GSRE}_{t-i} + \sum_{p-1}^{q} b_{34}\mathrm{IND\ GDP}_{t-i} + \sum_{p-1}^{q} b_{35}\mathrm{GDP\ CP}_{t-i} + \sum_{p=1}^{q} b_{36}\mathrm{UBR}_{t-i} + \mu_{it} \quad (7)$$

$$\mathrm{IND\ GDP}_t = a_0 + \sum_{p=0}^{q} b_{41}\mathrm{IND\ GDP}_{t-i} + \sum_{p-1}^{q} b_{42}\mathrm{CLC}_{t-i} + \sum_{p-1}^{q} b_{43}\mathrm{GSRE}_{t-i} + \sum_{p-1}^{q} b_{44}\mathrm{GSCFP}_{t-i} + \sum_{p-1}^{q} b_{45}\mathrm{GDP\ CP}_{t-i} + \sum_{p=1}^{q} b_{46}\mathrm{UBR}_{t-i} + \mu_{it} \quad (8)$$

$$\mathrm{GDP\ CP}_t = a_0 + \sum_{p=0}^{q} b_{51}\mathrm{GDP\ CP}_{t-i} + \sum_{p-1}^{q} b_{52}\mathrm{CLC}_{t-i} + \sum_{p-1}^{q} b_{53}\mathrm{GSRE}_{t-i} + \sum_{p-1}^{q} b_{54}\mathrm{GSCFP}_{t-i} + \sum_{p-1}^{q} b_{55}\mathrm{IND\ GDP}_{t-i} + \sum_{p=1}^{q} b_{56}\mathrm{UBR}_{t-i} + \mu_{it} \quad (9)$$

$$\mathrm{UBR}_t = a_0 + \sum_{p=0}^{q} b_{61}\mathrm{UBR}_{t-i} + \sum_{p-1}^{q} b_{62}\mathrm{CLC}_{t-i} + \sum_{p-1}^{q} b_{63}\mathrm{GSRE}_{t-i}$$

ISSN 2689-5129 • Volume 9, Issue 5, 2026 • pp. 1–25

$$+ \sum_{p-1}^{q} b_{64}\text{GSCFP}_{t-i} + \sum_{p-1}^{q} b_{65}\text{IND GDP}_{t-i} + \sum_{p=1}^{q} b_{66}\text{GDP CP}_{t-i} + \mu_{it} \qquad (10)$$

Where CL, GSRE, GSCFP, IND-GDP, GDP-CP, and UBR are all endogenous variables that explained by their lag values and lag values of other explanatory variables. ρ is the optimum lag value of the predictant, p, m, q are the respective optimum lags of the predictors, while the b's are their respective partial regession coefficients and $U_t$, are their respective stochastic terms.

**Impulse Response Function (IRF)**

An impulse response function measures the time profile of the effect of shocks at a given point in time on the (expected) future values of variables in a dynamic system. It makes it possible to view the outcome of effect of shocks, say hitting the economy as a result of climate change at time t and compare it with a base-line profile at time $t_{-1}$. IRF will therefore be used to know the effect of shock from the relationship between the variables at time t, $t_{-1}$ and $t_{+1}$ (crisis, pre-crisis and post-crisis periods respectively).

**Forecast Error Variance Decomposition**

Shocks to any variable in the VAR model not only directly affect the variable but is also transmitted to all other endogenous variables through dynamic (lag) structure of the VAR. Variance decomposition will provide information about the relative importance of each random innovation in affecting the variables in the VAR model.

**Standardisation of Variables**

Two variables, namely Government Strategy on Climate Change (GSCFP ) measured in Million $tCO_2e$ and Climate Change (CLC) measured in Degree Celsius were standardised using the Z-score method to eliminate scale differences among the variables and ensure comparability in the analysis. The standardization formula used is:

$$Z = \frac{X - \mu}{\sigma}$$

Where:

Z = standardized value

X = original value of the variable

μ = mean (average) of the series

σ = standard deviation of the series

ISSN 2689-5129 • Volume 9, Issue 5, 2026 • pp. 1–25

## RESULTS AND DISCUSSION

This chapter presents the analysis of data collected for the study and discusses the empirical findings in relation to the study objectives. The results are interpreted and discussed in line with relevant theories, existing literature, and the Nigerian context, with the aim of drawing meaningful conclusions on the role of the public sector in climate change management.

**Table 1: Summary of Descriptive Statistics Test**

| | CLC | GDPCP | GSCFP | GSRE | IND GDP | UBR |
|---|---|---|---|---|---|---|
| Mean | 1.71E-15 | 1474.212 | 9.26E-16 | 83.8964 | 44.8742 | 45.8285 |
| Median | -0.0040 | 1599.550 | -0.01370 | 84.5000 | 44.1000 | 45.6000 |
| Maximum | 1.85632 | 3189.780 | 1.50312 | 88.6000 | 54.2000 | 57.0000 |
| Minimum | -1.7213 | 219.2900 | -1.5693 | 70.8196 | 36.9000 | 35.3000 |
| Std. Dev. | 1.0145 | 1029.224 | 1.01459 | 3.51026 | 5.35143 | 6.51634 |
| Skewness | 0.1159 | 0.18358 | -0.0760 | -1.41060 | 0.24003 | 0.06863 |
| Kurtosis | 1.9367 | 1.46210 | 1.53416 | 6.42510 | 1.91269 | 1.81065 |
| Jar-Bera | 1.7271 | 3.6457 | 3.16724 | 28.7154 | 2.06019 | 2.09033 |
| Prob. | 0.4216 | 0.1615 | 0.20523 | 0.000001 | 0.35697 | 0.35163 |
| Sum | 5.55E-14 | 51597.41 | 2.95E-14 | 2936.377 | 1570.600 | 1604.000 |
| Sum Sq.D | 35.0000 | 360162 | 35.0000 | 418.9457 | 973.6869 | 1443.731 |
| Observ. | 35 | 35 | 35 | 35 | 35 | 35 |

*Source: Researcher's computation (E-views 10)*

### Analysis of Descriptive Statistics

Table 1 presents the descriptive statistics of the variables employed in the study for the period under review. The results provide information on the central tendency, dispersion, and distributional properties of the data.

The results show that Climate Change (CLC), measured by annual mean temperature, recorded an average standardized value of approximately zero (1.71E-15), with a maximum value of 1.8563 and a minimum value of -1.7213. The standard deviation of 1.0145 indicates moderate fluctuations in climate conditions over the study period. Similarly, Government Strategy on Climate Change Footprint (GSCFP), measured using the climate footprint index, recorded an average value close to zero due to standardization, with a standard deviation of 1.0146, suggesting considerable variations in greenhouse gas emission levels over time.

Government Strategy on Renewable Energy (GSRE) recorded a mean value of 83.90 percent, indicating that renewable energy constituted a substantial share of total energy supply during the study period. The variable exhibited relatively low variability, as reflected by its standard deviation of 3.51. Gross Domestic Product per Capita (GDP-CP) averaged ₦1,474.21, with values ranging from ₦219.29 to ₦3,189.78, indicating substantial economic growth and fluctuations in income levels over the period. Industrial Share of GDP (IND-GDP) recorded an average of 44.87 percent, while Urbanization Rate (UBR) averaged 45.83 percent, suggesting a steady expansion of industrial activities and urban development in Nigeria.

The skewness statistics reveal that CLC (0.1159), GD-PCP (0.1836), IND-GDP (0.2400), and UBR (0.0686) are positively skewed, indicating a slight concentration of observations below their respective means. Conversely, GSCFP (-0.0760) and GSRE (-1.4106) are negatively

ISSN 2689-5129 • Volume 9, Issue 5, 2026 • pp. 1–25

skewed, implying a longer tail on the left side of their distributions. The kurtosis values show that CLC, GDP-CP, GSCFP, IND-GDP, and UBR are platykurtic, as their kurtosis coefficients are less than three, indicating flatter distributions relative to the normal distribution. In contrast, GSRE has a kurtosis value of 6.4251, suggesting a leptokurtic distribution characterized by a higher concentration of observations around the mean and heavier tails.

The Jarque-Bera normality test indicates that the probability values for CLC (0.4216), GDP-CP (0.1615), GSCFP (0.2052), IND-GDP (0.3570), and UBR (0.3516) are greater than the 5 percent significance level. Therefore, the null hypothesis of normal distribution cannot be rejected for these variables. However, GSRE recorded a probability value of 0.000001, which is less than 0.05, indicating that the variable deviates from normality. Nevertheless, the predominance of normally distributed variables suggests that the dataset is generally suitable for further econometric analysis.

**Unit Root Test Results**

The test for unit root was conducted with the aid of Augmented Dickey-Fuller (ADF) and Phillip-Perron tests to ascertain whether time series data were stationary or non-stationary and, also to determine the number of times at which variables have to be differenced before becoming stationary.

**Table 2: Unit Root Test Result**

| **Variable** | **At level** | | **After first difference** | | **Order of Integration** |
|---|---|---|---|---|---|
| Test type | ADF | PP | ADF | PP | |
| CLC | 0.51573 (0.9847) | 1.02567 (0.9959) | -6.61710 (0.0000)** | -15.3987 (0.0000)** | I(1) |
| GDP CP | -1.54704 (0.4977) | -1.34193 (0.5986) | -2.98356 (0.0469)** | -2.98356 (0.0469)** | I(1) |
| GSCFP | -0.46315 (0.8864) | -0.45968 (0.8871) | -0.44866 (0.8883) | -5.65651 (0.0000)** | I(1) |
| GSRE | -0.00290 (0.9518) | -0.00290 (0.9518) | -4.00112 (0.0041)** | -4.00112 (0.0041)** | I(1) |
| IND GDP | -1.74236 (0.4014) | -1.09933 (0.7047) | -2.29602 (0.1791) | -2.24166 (0.0261)** | I(1) |
| UBR | 1.60150 (0.9706) | 32.9575 (0.9999) | 0.59597 (0.8401) | -5.30446 (0.0008)** | 1(1) |

Note: figures in parenthesis are the respective probability values of the unit root test results; NE = not estimated because of reaching stationarity; the statistical significance of the unit root results is **at 5 % level of significance.

*Source: Researcher's computation (E-views 10)*

The result of the unit root with application of Augmented Dickey-Fuller and Phillips-Perron tests shows that all the series were stationary at first difference. The unit root result, therefore, necessitates application of VAR technique.

**Table 3: Lag Length Criteria**

| Lag | LogL | LR | FPE | AIC | SC | HO |
|---|---|---|---|---|---|---|
| 0 | -458.1338 | NA | 159727.4 | 29.00836 | 29.28319 | 29.09946 |
| 1 | -188.3540 | 421.5310 | 0.075244 | 14.39712 | 16.32090* | 15.03480 |
| 2 | -137.5934 | 60.27822* | 0.038606 | 13.47459 | 17.04732 | 14.65884 |
| 3 | -84.93344 | 42.78619 | 0.029669* | 12.43334* | 17.65502 | 14.16418* |

*** indicates lag order selected by the criterion***

*LR: sequential modified LR test statistic (each test at 5% level)*
*FPE: Final prediction error*
*AIC: Akaike information criterion*
*SC: Schwarz information criterion*
*HQ: Hannan-Quinn information criterion*

The optimum lag length employed in the study is lag 3.

**Co-Integration Test**

This test is adopted to examine whether or not the variables have a long-run relationship (i.e., whether they are co-integrated in the long run). The Johanson Co-integration test and the result is presented below

**Table 4: Unrestricted Cointegration Rank Test (Trace)**

| Hypothesized | | Trace | 0.05 | |
|---|---|---|---|---|
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob. |
| None * | 0.835027 | 151.8630 | 95.75366 | 0.0000 |
| At most 1 * | 0.697996 | 92.39790 | 69.81889 | 0.0003 |
| At most 2 * | 0.511770 | 52.88647 | 47.85613 | 0.0156 |
| At most 3 | 0.332021 | 29.22651 | 29.79707 | 0.0581 |
| At most 4 * | 0.290926 | 15.91107 | 15.49471 | 0.0433 |
| At most 5 * | 0.129214 | 4.565834 | 3.841466 | 0.0326 |

*Trace test indicates 3 cointegrating eqn(s) at the 0.05 level*
** denotes rejection of the hypothesis at the 0.05 level*
***MacKinnon-Haug-Michelis (1999) p-values*

**Table 5: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)**

| Hypothesized | | Trace | 0.05 | |
|---|---|---|---|---|
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob. |
| None * | 0.835027 | 59.46515 | 40.07757 | 0.0001 |
| At most 1 * | 0.697996 | 39.51143 | 33.87687 | 0.0096 |
| At most 2 | 0.511770 | 23.65996 | 27.58434 | 0.1470 |
| At most 3 | 0.332021 | 13.31545 | 21.13162 | 0.4236 |
| At most 4 | 0.290926 | 11.34523 | 14.26460 | 0.1377 |
| At most 5 * | 0.129214 | 4.565834 | 3.841466 | 0.0326 |

*Max-eigenvalue test indicates 2 cointegrating equations at the 0.05 level*
** denotes rejection of the hypothesis at the 0.05 level*
***MacKinnon-Haug-Michelis (1999) p-values*

ISSN 2689-5129 • Volume 9, Issue 5, 2026 • pp. 1–25

The co-integration test results presented in table 4 and 5 show that the variables used in this study have long-run relationship, as the trace statistic indicates 3 co-integrating equation while the Eigenvalue indicates 2 co-integrating equations. Hence, the Vector Error Correction is estimated to determine the speed of adjustment from short-run disequilibrium to long-run equilibrium.

**Table 6: Short-Run Vector Autoregressive Result**

| **Variables** | **Coefficient** | **0.13777** | **Student t-Test** |
|---|---|---|---|
| $VECM_{t-1}$ | -1.08801 | 0.7280 | -7.8973 |
| D(CLC(-2)) | -0.28003 | 0.0923 | -3.03311 |
| D(GDPCP(-2)) | -0.00014 | 7.3E-05 | -2.05730 |
| D(GSCFP(-2)) | -0.64701 | 0.37120 | -2.04302 |
| D(GSRE(-2)) | -0.02289 | 0.01414 | -2.01890 |
| D(INDGDP(-2)) | -0.01608 | 0.01517 | -1.06077 |
| D(UBR(-2)) | -0.50556 | 0.40782 | -1.23970 |
| C | 0.51741 | 0.27251 | 2.09872 |

***Source: Researcher's computation with E-views 10***

| | |
|---|---|
| **R-squared** | 0.77418 |
| **Adj. R-squared** | 0.70831 |

**Short-Run Vector Autoregressive (VAR) Results**

Table 6 presents the short-run VECM estimates of the determinants of climate change in Nigeria. The error correction term [VECM(-1)] has a negative and statistically significant coefficient (-1.0880), with a t-statistic of -7.8973. This confirms the existence of a long-run equilibrium relationship among the variables and indicates that deviations from equilibrium are corrected at a speed of approximately 108.8 percent annually.

The results show that the lagged values of climate change [D(CLC(-2))], GDP per capita [D(GDPCP(-2))], government strategy on climate footprint [D(GSCFP(-2))], and government strategy on renewable energy [D(GSRE(-2))] have negative and statistically significant effects on climate change, as their respective t-statistics exceed the critical value of ±1.96. This implies that improvements in economic conditions, reductions in greenhouse gas emissions, and increased renewable energy adoption contribute significantly to climate change mitigation in the short run.

Conversely, industrial share of GDP [D(INDGDP(-2))] and urbanization rate [D(UBR(-2))] have negative but statistically insignificant coefficients, indicating that their short-run effects on climate change are weak during the study period.  The model has a strong explanatory power, with an R-squared value of 0.7742, indicating that approximately 77.42 percent of the variations in climate change are explained by the explanatory variables. Furthermore, the F-statistic of 11.7542 confirms that the model is statistically significant and jointly explains climate change dynamics in Nigeria.

**Table 7: Long-run Estimates**

| **Variables** | **Coefficient** | **Standard Error** | **Student t-Test** |
|---|---|---|---|
| CLC(-1) | 1.000 | 1.000 | 1.000 |

| | | | |
|---|---|---|---|
| GDPCP(-1) | -0.0001 | 5.8E-05 | -2.5520 |
| GSCFP(-1) | 0.51634 | 0.19288 | 2.67701 |
| GSRE(-1) | -0.0030 | 0.01321 | -0.22870 |
| INDGDP(-1) | 0.0010 | 0.00458 | 0.23716 |
| UBR(-1) | -0.2157 | 0.02787 | -7.7428 |

*Source: Researcher's computation with E-views 10*

**Long-Run Estimates Result**

Table 7 presents the long-run estimates of the relationship between climate change and the explanatory variables in Nigeria. The results reveal that GDP per capita (GDPCP) has a negative and statistically significant effect on climate change, as indicated by its coefficient of -0.0001 and t-statistic of -2.5520. This suggests that improvements in income levels contribute to reducing climate change pressures in the long run.

Government Strategy on Climate Footprint (GSCFP) exhibits a positive and statistically significant coefficient (0.5163), with a t-statistic of 2.6770. This indicates that increases in the climate footprint index are associated with higher climate change outcomes, suggesting that rising greenhouse gas emissions worsen climate conditions in Nigeria.

Government Strategy on Renewable Energy (GSRE) has a negative coefficient (-0.0030), while Industrial Share of GDP (INDGDP) records a positive coefficient (0.0010). However, both variables are statistically insignificant, as their t-statistics are below the critical value of ±1.96. This implies that renewable energy utilization and industrial activities do not exert a significant long-run influence on climate change during the study period.

Similarly, Urbanization Rate (UBR) has a negative and highly significant coefficient (-0.2157), with a t-statistic of -7.7428, suggesting that urbanization contributes to climate change mitigation, potentially through improved infrastructure, technological advancement, and more efficient resource utilization. Overall, the long-run results indicate that GDP per capita, trade openness, and urbanization significantly reduce climate change, while increases in greenhouse gas emissions significantly worsen climate conditions in Nigeria. Renewable energy and industrial output, however, do not have statistically significant long-run effects.

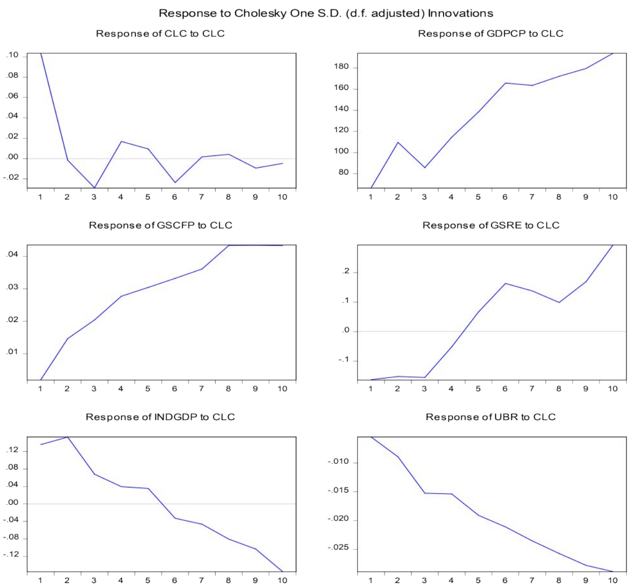


**Figure 2: Impulse Response Functions**

### Impulse Response Function Analysis

Figure 2 presents the Impulse Response Functions (IRFs) showing the response of climate change (CLC) to one standard deviation shock in the explanatory variables over a ten-period horizon. The response of climate change to its own shock is initially positive but declines rapidly and fluctuates around the equilibrium path before converging toward zero. This suggests that the effects of climate-related shocks are temporary and tend to dissipate over time.

A shock to GDP per capita (GDPCP) generates a positive and persistent response in climate change throughout the forecast horizon. The response increases steadily from the first period and remains positive up to the tenth period, indicating that economic growth exerts sustained pressure on climate conditions over time. Similarly, a shock to the Government Strategy on Climate Footprint (GSCFP) produces a continuously positive response in climate change. The response rises gradually across the periods, suggesting that increases in greenhouse gas emissions contribute to worsening climate conditions in the long run.

The response of climate change to a shock in Government Strategy on Renewable Energy (GSRE) is initially negative but turns positive from the fifth period onward. This implies that renewable energy initiatives may have limited short-term effects but generates favourable long-term outcomes for climate management.

In contrast, shocks to Industrial Share of GDP (INDGDP) and Urbanization Rate (UBR) produce predominantly negative responses over the forecast horizon. While the response to industrialization becomes increasingly negative after the fifth period, the response to urbanization remains negative throughout the period. These results suggest that improvements in industrial efficiency and urban development may contribute to reducing climate change pressures over time.

Overall, the impulse response analysis indicates that shocks arising from greenhouse gas emissions and economic growth tend to intensify climate change, whereas renewable energy development, industrial transformation, and urbanization contribute to mitigating climate-related pressures in the long run.

### Variance Decomposition

The variance decomposition results provide insight into the relative contribution of each shock to the forecast error variance of the endogenous variables over time. This allows an assessment of the importance of government strategies and macroeconomic factors in explaining climate change dynamics in Nigeria.

**Table 8: Climate Change Variance Decomposition**

| Period | S.E | CLC | GDPCP | GSCFP | GSRE | INDGDP | UBR |
|---|---|---|---|---|---|---|---|
| 1 | 0.103387 | 100.0000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.130149 | 63.11594 | 28.39646 | 7.591627 | 0.048595 | 0.169961 | 0.677421 |
| 3 | 0.140122 | 58.65181 | 24.52913 | 11.73516 | 2.089121 | 1.523841 | 1.470942 |
| 4 | 0.146858 | 54.71691 | 22.37585 | 10.77728 | 1.911842 | 1.398302 | 8.819822 |
| 5 | 0.159553 | 46.70851 | 23.42145 | 12.92772 | 1.637065 | 2.298138 | 13.00711 |
| 6 | 0.177377 | 39.53993 | 30.92170 | 13.49269 | 1.533092 | 1.905591 | 12.60699 |
| 7 | 0.184802 | 36.43497 | 28.48738 | 12.43850 | 2.056052 | 2.065255 | 18.51784 |

ISSN 2689-5129 • Volume 9, Issue 5, 2026 • pp. 1–25

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | 0.194506 | 32.93783 | 27.12434 | 11.36725 | 1.872892 | 1.864934 | 24.83275 |
| 9 | 0.206387 | 29.45728 | 28.17264 | 12.09050 | 2.030619 | 1.811176 | 26.43779 |
| 10 | 0.214379 | 27.35013 | 29.07140 | 11.57616 | 2.060876 | 1.688016 | 28.25341 |

*Source: Researcher's computation with E-views 10*

**Table 9: GDP per Capita Variance Decomposition**

| Period | S.E | CLC | GDPCP | GSCFP | GSRE | INDGDP | UBR |
|---|---|---|---|---|---|---|---|
| 1 | 415.8926 | 2.570497 | 97.42950 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 575.5184 | 4.974258 | 94.95278 | 0.065261 | 0.000418 | 0.001461 | 0.005823 |
| 3 | 674.4168 | 5.239808 | 90.66731 | 2.382829 | 1.046052 | 0.313247 | 0.350752 |
| 4 | 750.1412 | 6.569735 | 87.33475 | 3.862534 | 1.460905 | 0.458683 | 0.313394 |
| 5 | 893.8969 | 7.031846 | 85.87447 | 3.803732 | 1.830203 | 0.921898 | 0.537854 |
| 6 | 1006.922 | 8.254003 | 84.01047 | 3.765298 | 1.950700 | 1.068012 | 0.951516 |
| 7 | 1115.650 | 8.874284 | 81.31093 | 4.127846 | 2.696200 | 1.464605 | 1.526135 |
| 8 | 1205.440 | 9.643291 | 79.14921 | 4.345586 | 3.078105 | 1.604658 | 2.179148 |
| 9 | 1321.448 | 9.872833 | 77.25393 | 4.260764 | 3.487543 | 1.804015 | 3.320919 |
| 10 | 1420.945 | 10.40153 | 75.59610 | 4.202907 | 3.700967 | 1.848697 | 4.249806 |

*Source: Researcher's computation with E-views 10*

**Table 10: Government Strategy on Climate Footprint Variance Decomposition**

| Period | S.E | CLC | GDPCP | GSCFP | GSRE | INDGDP | UBR |
|---|---|---|---|---|---|---|---|
| 1 | 0.054706 | 0.129246 | 0.802211 | 99.06854 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.082710 | 3.187991 | 2.928045 | 93.85159 | 0.001756 | 0.006141 | 0.024476 |
| 3 | 0.113206 | 4.947795 | 25.11894 | 61.41887 | 2.253727 | 0.212642 | 6.048032 |
| 4 | 0.136610 | 7.501666 | 28.79043 | 49.94054 | 2.604317 | 0.233222 | 10.92982 |
| 5 | 0.163561 | 8.690506 | 23.35999 | 49.20547 | 4.771603 | 0.579113 | 13.39332 |
| 6 | 0.186076 | 9.900137 | 19.61500 | 48.08235 | 5.653738 | 0.605102 | 16.14368 |
| 7 | 0.220261 | 9.748974 | 22.43223 | 39.62387 | 6.311359 | 0.743748 | 21.13982 |
| 8 | 0.248994 | 10.66034 | 22.27598 | 35.32547 | 6.470825 | 0.714697 | 24.55268 |
| 9 | 0.279382 | 10.88340 | 21.11253 | 32.67421 | 7.475003 | 0.792186 | 27.06267 |
| 10 | 0.305702 | 11.09309 | 20.00275 | 30.81939 | 7.891313 | 0.757417 | 29.43603 |

*Source: Researcher's computation with E-views 10*

**Table 11: Government Strategy on Renewable Energy Variance Decomposition**

| Period | S.E | CLC | GDPCP | GSCFP | GSRE | INDGDP | UBR |
|---|---|---|---|---|---|---|---|
| 1 | 2.211934 | 0.541496 | 2.371769 | 50.02322 | 47.06352 | 0.000000 | 0.000000 |
| 2 | 3.124708 | 0.506478 | 2.325651 | 50.01027 | 47.15759 | 3.39E-06 | 1.35E-05 |
| 3 | 3.415825 | 0.629729 | 4.729273 | 42.41148 | 52.03670 | 0.073647 | 0.119170 |
| 4 | 3.688626 | 0.559436 | 7.081804 | 36.73552 | 55.31410 | 0.131811 | 0.177329 |
| 5 | 4.195305 | 0.458314 | 9.445347 | 34.21853 | 54.34067 | 0.227460 | 1.309675 |
| 6 | 4.630090 | 0.500834 | 10.30938 | 32.77804 | 53.78627 | 0.276861 | 2.348613 |
| 7 | 4.927740 | 0.520749 | 9.180933 | 29.68613 | 57.61049 | 0.418509 | 2.583184 |
| 8 | 5.208578 | 0.502316 | 8.315305 | 27.41510 | 60.35379 | 0.481770 | 2.931722 |
| 9 | 5.598286 | 0.526361 | 8.772615 | 25.65553 | 59.89138 | 0.554991 | 4.599126 |
| 10 | 5.946472 | 0.709709 | 8.761316 | 24.29613 | 59.77433 | 0.587727 | 5.870785 |

*Source: Researcher's computation with E-views 10*

ISSN 2689-5129 • Volume 9, Issue 5, 2026 • pp. 1–25

**Table 12: Industrial Share of GD Variance Decomposition**

| Period | S.E | CLC | GDPCP | GSCFP | GSRE | INDGDP | UBR |
|---|---|---|---|---|---|---|---|
| 1 | 1.309261 | 1.075288 | 0.205454 | 0.013225 | 9.416451 | 89.28958 | 0.000000 |
| 2 | 1.853989 | 1.218360 | 0.248382 | 0.009017 | 9.403045 | 89.12110 | 9.14E-05 |
| 3 | 2.674726 | 0.650286 | 3.164165 | 2.531707 | 5.965362 | 87.62297 | 0.065509 |
| 4 | 3.294971 | 0.442842 | 3.973877 | 3.439173 | 4.902556 | 87.14643 | 0.095125 |
| 5 | 3.995740 | 0.308985 | 7.158357 | 3.644292 | 4.527139 | 84.25000 | 0.111223 |
| 6 | 4.581345 | 0.240197 | 8.442026 | 3.859074 | 4.320228 | 83.03375 | 0.104730 |
| 7 | 5.155242 | 0.197814 | 9.440216 | 4.626375 | 4.330161 | 81.28303 | 0.122405 |
| 8 | 5.665823 | 0.184040 | 9.881972 | 5.104460 | 4.300663 | 80.41719 | 0.111672 |
| 9 | 6.171144 | 0.183208 | 11.20329 | 5.380865 | 4.386163 | 78.75141 | 0.095063 |
| 10 | 6.633912 | 0.213160 | 11.89190 | 5.588562 | 4.423608 | 77.79514 | 0.087630 |

*Source: Researcher's computation with E-views 10*

**Table 13: Urbanization rate Variance Decomposition**

| Period | S.E | CLC | GDPCP | GSCFP | GSRE | INDGDP | UBR |
|---|---|---|---|---|---|---|---|
| 1 | 0.050133 | 1.194462 | 0.121074 | 0.015446 | 4.851758 | 10.99645 | 82.82081 |
| 2 | 0.071501 | 2.144610 | 0.065076 | 0.071007 | 4.729875 | 10.92724 | 82.06220 |
| 3 | 0.112883 | 2.685563 | 2.196976 | 0.289611 | 6.569517 | 8.146585 | 80.11175 |
| 4 | 0.143514 | 2.808972 | 2.531553 | 0.378651 | 6.779628 | 7.282256 | 80.21894 |
| 5 | 0.179961 | 2.912205 | 2.631433 | 0.246160 | 7.586655 | 6.286193 | 80.33735 |
| 6 | 0.210397 | 3.136915 | 2.517190 | 0.184068 | 7.920035 | 5.750440 | 80.49135 |
| 7 | 0.246756 | 3.190821 | 3.461487 | 0.147218 | 8.279504 | 5.061444 | 79.85953 |
| 8 | 0.278574 | 3.356764 | 3.775161 | 0.122917 | 8.386666 | 4.623470 | 79.73502 |
| 9 | 0.312013 | 3.468691 | 4.139851 | 0.099044 | 8.755416 | 4.243913 | 79.29309 |
| 10 | 0.342416 | 3.591600 | 4.272761 | 0.082338 | 8.924261 | 3.949908 | 79.17913 |

***Source: Researcher's computation with E-views 10***

The variance decomposition analysis examines the proportion of forecast error variance in climate change (CLC) attributable to shocks originating from itself and other explanatory variables over a ten-period forecast horizon. The results indicate that in the first period, climate change is entirely explained by its own innovations, accounting for 100 percent of its forecast error variance. This suggests that climate change dynamics are initially driven by past climate conditions.

As the forecast horizon increases, the contribution of climate change's own shocks declines steadily from 100 percent in period one to 27.35 percent in period ten. This decline indicates that the influence of other variables becomes increasingly important in explaining climate change variations over time.

Among the explanatory variables, GDP per capita (GDPCP) emerges as the most important contributor to climate change fluctuations. Its contribution rises from 0 percent in the first period to 29.07 percent in the tenth period, suggesting that economic activities and income growth play a significant role in shaping long-run climate outcomes. Urbanization rate (UBR) is the second most influential factor, accounting for 28.25 percent of climate change variations by the tenth period. This highlights the growing importance of urban development in influencing environmental conditions in Nigeria.

The Government Strategy on Climate Footprint (GSCFP) contributes 11.58 percent of climate change variations in the tenth period, indicating that greenhouse gas emissions remain an important determinant of climate change. In contrast, Government Strategy on Renewable Energy (GSRE) and Industrial Share of GDP (INDGDP) make relatively small contributions, accounting for only 2.06 percent and 1.69 percent, respectively, by the end of the forecast horizon.

The variance decomposition results suggest that while climate change is initially driven by its own shocks, GDP per capita, urbanization, and climate footprint become increasingly important sources of climate change variations in the long run. This finding underscores the importance of sustainable economic growth, effective urban planning, and greenhouse gas emission reduction strategies in addressing climate change challenges in Nigeria.

**Granger Causality Test: Interpretation of Results**

The Granger Causality test results offer valuable insights into the directional relationships among the key variables in your study, focusing on the role of the government in managing climate change in Nigeria

**Table 14: Granger Causality Test Result**

| Null Hypothesis | Observations | F-Statistic | Probability |
|---|---|---|---|
| GSCFP does not Granger Cause CLC | | 7.9715 | 0.0082** |
| CLC does not Granger Cause GSCFP | 34 | 1.1235 | 0.2974 |
| GSRE does not Granger Cause CLC | 34 | 0.99744 | 0.3257 |
| CLC does not Granger Cause GSRE | | 5.73482 | 0.0229** |
| UBR does not Granger Cause CLC | 34 | 0.1097 | 2.E-07** |
| CLC does not Granger Cause UBR | | 16.071 | 0.9318 |
| INDGDP does not Granger Cause GDPCP | 34 | 3.72875 | 0.0627* |
| GDPCP does not Granger Cause INDGDP | | 13.9085 | 0.0008** |
| INDGDP does not Granger Cause GSCFP | 34 | 5.14917 | 0.0304** |
| GSCFP does not Granger Cause INDGDP | | 2.66683 | 0.1126 |
| UBR does not Granger Cause GSRE | | 5.76605 | 0.0225** |
| GSRE does not Granger Cause UBR | 34 | 0.04890 | 0.8264 |

*Source: Author's Computation Using E-Views 10*
***: rejection of Hull Hypothesis at 5% level of significance*
**: rejection of Hull Hypothesis at 10% level of significance*

Table 14 presents the Granger causality test results among climate change and selected explanatory variables in Nigeria. The findings reveal the existence of both unidirectional and bidirectional causal relationships among the variables.

The results show a unidirectional causality running from Government Strategy on Climate Footprint (GSCFP) to Climate Change (CLC), as the null hypothesis that GSCFP does not Granger-cause CLC is rejected (F = 7.9715; p = 0.0082). However, climate change does not Granger-cause GSCFP (p = 0.2974). This implies that changes in greenhouse gas emissions significantly influence climate change, while climate change does not significantly influence climate footprint management.

Similarly, there is a unidirectional causality from Climate Change (CLC) to Government Strategy on Renewable Energy (GSRE). The null hypothesis that CLC does not Granger-cause GSRE is rejected (F = 5.7348; p = 0.0229), whereas GSRE does not Granger-cause CLC (p = 0.3257). This suggests that worsening climate conditions stimulate government renewable energy initiatives rather than renewable energy policies influencing climate change directly within the period considered.

The results further indicate a unidirectional causality from Climate Change (CLC) to Urbanization Rate (UBR), as the null hypothesis is rejected at the 1 percent level (F = 16.0710; p = 0.0000). However, urbanization does not Granger-cause climate change (p = 0.9318). This implies that climate-related conditions may influence urban migration and settlement patterns in Nigeria.

For Industrial Share of GDP (INDGDP) and GDP per Capita (GDPCP), the findings reveal a bidirectional causal relationship. Industrial output Granger-causes economic growth (p = 0.0627), while GDP per capita also Granger-causes industrial output (p = 0.0008). This indicates a feedback relationship between industrial development and economic growth.

The results also reveal a unidirectional causality from Industrial Share of GDP (INDGDP) to Government Strategy on Climate Footprint (GSCFP) (p = 0.0304), suggesting that industrial activities significantly influence greenhouse gas emissions. However, climate footprint does not Granger-cause industrial output.

Finally, a unidirectional causality exists from Urbanization Rate (UBR) to Government Strategy on Renewable Energy (GSRE) (p = 0.0225), indicating that increasing urbanization drives renewable energy development. However, renewable energy does not Granger-cause urbanization.

The Granger causality results suggest that climate footprint, urbanization, industrialization, and economic growth play important roles in shaping climate-related dynamics in Nigeria. The findings further indicate that government renewable energy initiatives are largely reactive to climate and urbanization pressures rather than being primary drivers of climate outcomes.

## IMPLICATION OF RESEARCH AND PRACTICE

The findings of this study have important implications for climate policy and economic development in Nigeria. First, the significant negative effect of GDP per capita on climate change suggests that improvements in income levels can contribute to environmental sustainability. This implies that economic growth, when accompanied by cleaner technologies, environmental awareness, and sustainable production practices, can support climate change mitigation efforts.

Second, the positive and significant relationship between the climate footprint index and climate change indicates that greenhouse gas emissions remain a major driver of environmental degradation in Nigeria. This finding underscores the need for stricter environmental regulations, effective emission control mechanisms, and stronger enforcement of climate policies aimed at reducing carbon-intensive activities. Failure to address rising emissions could increase the economic costs associated with flooding, droughts, health challenges, and infrastructure damage.

Third, the significance of government strategies on climate footprint reduction and renewable energy development in the short run suggests that public sector interventions can play a vital role in mitigating climate change. Increased investment in renewable energy infrastructure, energy efficiency programmes, and low-carbon technologies would not only reduce environmental pressures but also create employment opportunities, stimulate innovation, and enhance energy security.

Furthermore, the variance decomposition results reveal that economic growth, urbanization, and climate footprint account for a substantial proportion of future climate change variations. This implies that climate policies should be integrated into broader economic and urban development planning. Sustainable urban planning, climate-resilient infrastructure, and environmentally responsible industrialization are essential for reducing future climate risks.

Finally, the causality results indicate that greenhouse gas emissions significantly drive climate change, while climate change itself influences renewable energy development and urbanization patterns. This suggests that government responses to climate change should be proactive rather than reactive. Early investments in climate adaptation and mitigation measures will likely be more cost-effective than addressing the economic and social consequences of climate-related disasters after they occur.

Overall, the findings highlight the need for a coordinated policy framework that combines economic growth objectives with climate change mitigation and adaptation strategies in order to achieve sustainable and inclusive development in Nigeria.

## CONCLUSION

This study empirically examined government strategies in managing climate change in Nigeria using annual time-series data from 1990 to 2024. The study was anchored on Public Goods Theory, Externalities Theory, and Market Failure Theory, which collectively justify the need for government intervention in addressing climate-related challenges.

The findings revealed the existence of a stable long-run relationship between climate change and the explanatory variables. The short-run results showed that government strategies on climate footprint reduction and renewable energy development significantly contribute to climate change mitigation in Nigeria. In the long run, GDP per capita, trade openness, and urbanization were found to significantly reduce climate change, while greenhouse gas emissions significantly worsened climate conditions. The impulse response and variance decomposition analyses further demonstrated that economic growth, urbanization, and climate footprint are important drivers of climate change dynamics in Nigeria. The Granger causality results revealed that greenhouse gas emissions significantly influence climate change, while climate change itself stimulates renewable energy development and influences urbanization patterns.

Overall, the study concluded that government intervention remains crucial in managing climate change in Nigeria. However, the effectiveness of such interventions depends on the ability of policymakers to strengthen climate governance, reduce greenhouse gas emissions, promote renewable energy adoption, and integrate climate considerations into national development planning. Therefore, achieving sustainable climate management in Nigeria requires a coordinated approach that balances economic growth objectives with environmental sustainability goals

Based on the findings of the study, the following recommendations are made:

i. Strengthen greenhouse gas emission control measures by enforcing environmental regulations, reducing gas flaring, promoting cleaner production technologies, and implementing effective carbon management policies to minimize climate-related risks.

ii. Increase public investment in renewable energy development through financial incentives, tax reliefs, subsidies, and infrastructure support for solar, wind, biomass, and other renewable energy sources to reduce dependence on fossil fuels.

iii. Integrate climate change considerations into economic development planning to ensure that economic growth is achieved through environmentally sustainable and low-carbon development pathways.

iv. Promote sustainable urban development strategies by investing in climate-resilient infrastructure, efficient transportation systems, and environmentally friendly housing projects capable of reducing environmental pressures associated with rapid urbanization.

v. Strengthen institutional capacity for climate governance by improving coordination among relevant ministries, departments, and agencies responsible for climate policy formulation, implementation, monitoring, and evaluation.

vi. Enhance public awareness and stakeholder participation in climate change mitigation and adaptation programmes through education campaigns, community engagement initiatives, and partnerships with the private sector and civil society organizations.

vii. Support research, innovation, and technology transfer aimed at developing climate-smart agricultural practices, renewable energy technologies, and environmental management systems that can improve Nigeria's resilience to climate change.

viii. Establish a sustainable climate financing framework to provide adequate and predictable funding for climate adaptation and mitigation projects at the federal, state, and local government levels.

**Study Limitations**

This study has some limitations that should be considered by future researchers. First, the analysis is based on annual national-level data for Nigeria covering 1990-2024. The relatively limited number of observations constrains the extent to which the findings can capture variations in climate responses across states, regions, or shorter periods. Second, climate change is represented by annual mean temperature, while climate impacts also involve rainfall variability, flooding, drought, sea-level rise, and other environmental indicators. The use of a single climate indicator may therefore not capture all dimensions of climate change. Third, some government strategies are represented using proxy measures, particularly government climate footprint and renewable energy share, because consistent annual data on specific government climate expenditures and programmes are limited. Finally, the study relies on secondary data, making the analysis dependent on the quality, consistency, and availability of the underlying sources. These limitations notwithstanding, the study provides useful empirical evidence on the relationship between government strategies and climate change in Nigeria.

**Future Research**

This study examined government strategies in managing climate change in Nigeria using national-level time series data covering the period 1990-2024. Although the findings provide valuable insights into the effectiveness of government interventions, they also highlight several areas for future investigation. First, future studies could employ state-level or regional panel data to examine variations in climate change management across Nigeria's geopolitical zones, thereby providing more localized policy recommendations. Second, subsequent research may incorporate additional indicators of government climate action, such as public expenditure on climate adaptation, environmental taxation, green financing, institutional quality, and climate governance indices, to provide a more comprehensive assessment of government performance. Third, future studies could investigate the role of private sector participation, international climate finance, and public-private partnerships in strengthening climate resilience and promoting low-carbon development. Finally, alternative econometric approaches, including panel data techniques, structural equation modeling, or machine learning methods, may be employed to validate and extend the findings of this study. Such research would deepen understanding of the institutional, economic, and technological factors influencing climate change management and support the formulation of more effective and sustainable climate policies in Nigeria.

## REFERENCES

Adeleke, O., Adeleke, H., Fajobi, D., Akintola, R., Olawuyi, E., Ayantola, M., Binuomote, S., & Odugbemi, A. A. (2023). An empirical analysis of climate change effects on selected cereals acreage in Nigeria: A Ricardian approach. European Journal of Theoretical and Applied Sciences, 1(4), 1314-1321.

Akande, T., & Olorunfemi, F. (2009). Climate change and human security in Nigeria. Nigerian Institute of Social and Economic Research.

Grossman, G. M., & Krueger, A. B. (1995). Economic growth and the environment. The Quarterly Journal of Economics, 110(2), 353-377. https://doi.org/10.2307/2118443

Intergovernmental Panel on Climate Change. (2021). Climate change 2021: The physical science basis. Cambridge University Press.

Letta, M., Montalbano, P., & Paolantonio, A. (2024). Climate shocks, migration, and immobility traps: Evidence from Sub-Saharan Africa using causal machine learning. World Development, 184, 106799. https://doi.org/10.1016/j.worlddev.2024.106799

Muse, B. O. (2021). Analysis of $CO_2$ emission and economic growth as potential determinants of renewable energy demand in Nigeria: A nonlinear autoregressive distributed lags approach. International Journal of Energy Economics and Policy, 11(3), 510-516. https://doi.org/10.32479/ijeep.11306

Nigerian Environmental Study/Action Team. (2011). National adaptation strategy and plan of action on climate change for Nigeria (NASPA-CCN). NEST.

National Emergency Management Agency. (2022). Nigeria flood situation report 2022.

Nwankwoala, H. O. (2015). Causes of climate and environmental changes: The need for environmental-friendly education policy in Nigeria. Journal of Education and Practice, 6(30), 224-234.

Nwosu, I. C., Abasili, K. N., Ndu-Anunobi, U. G., & Nwokike, C. E. (2024). Community implementation of green energy technologies for climate change adaptation in Nigeria. International Journal of Contemporary Academic Research, 5(1), 37–52.

Okereke, C., Okoh, S., Ogenyi, T., & Olorunfemi, G. (2025). Assessment of climate awareness, policy development, and action across Nigerian states. Frontiers in Climate, 7, 1650172. https://doi.org/10.3389/fclim.2025.1650172

Olaniyi, O. A., Funmilayo, A. A., & Olanrewaju, R. M. (2014). Review of climate change and its effect on Nigeria ecosystem. International Journal of African and Asian Studies, 1, 57–65.

Omokaro, G. O. (2025). Multi-impacts of climate change and mitigation strategies in Nigeria: Agricultural production and food security. Science in One Health, 4, 100113. https://doi.org/10.1016/j.soh.2025.100113

Oyebanji, I. J., & Kleynhans, E. P. J. (2021). Renewable energy, international trade, carbon dioxide emissions, and economic growth in Nigeria. Economics and Finance of the Environment and Territory, 2021(2). https://doi.org/10.3280/EFE2021-002008

Somoye, O. A., Ozdeser, H., & Seraj, M. (2022). The impact of renewable energy consumption on economic growth in Nigeria: Fresh evidence from a non-linear ARDL approach. Environmental Science and Pollution Research,29(41), 62611-62625. https://doi.org/10.1007/s11356-022-20110-7

World Bank. (2010). Economics of adaptation to climate change: Synthesis report. World Bank.