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**GOVERNANÇA AMBIENTAL E QUESTÕES CLIMÁTICAS NO
ESTADO DE IMO, SUDESTE DA NIGÉRIA**

ANÁPOLIS - GOIÁS

2025

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**GOVERNANÇA AMBIENTAL E QUESTÕES CLIMÁTICAS NO
ESTADO DE IMO, SUDESTE DA NIGÉRIA**

Tese apresentada ao Programa de Pós-graduação *Stricto Sensu* em Sociedade, Tecnologia e Meio Ambiente da Universidade Evangélica de Goiás (UniEVANGÉLICA), como exigência parcial para obtenção de título de Doutor em Ciências Ambientais.

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“A luta contra o erro tipográfico tem algo de homérico. Durante a revisão os erros se escondem, fazem-se positivamente invisíveis. Mas assim que o livro sai, torna-se visibilíssimo.”

Monteiro Lobato

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LIST OF ABBREVIATIONS

ANN	Using Artificial Neural Network
CEC	Cation exchange capacity
CFCs	Chlorofluorocarbon
CO ₂	Carbon Dioxide
COP	Conference of the Parties
CRU	Climate Research Unit of the University of East Anglia.
DCC	Department of Climate Change Unit
DF	Degree of freedom
ENTRACO	Environmental Transformation Commission
FEPA	The Federal Environmental Protection Agency
GCLME	The Guinea Current Large Marine Ecosystem
GHG	Greenhouse gas
GIS	Geographic Information Systems
IPCC	INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
IWMA	Imo Waste Management Agency
LT-LEDS	Low-Emission Development Strategies
MDGs	Millennium Development Goals
NASA	National Aeronautics and Space Administration
NASS	National Academy of Social Sciences
NBSAP	The primary aim of the National Biodiversity Strategy and Action Plan
NDCs	Nationally Determined Contributions
NESREA	National Environmental Standards and Regulations Enforcement Agency
NFAP	National Forest Policy
NHP	National Health Policy
NIMET	Nigerian Meteorological Department
NNPC	Nigeria National Petroleum Corporation
NSS	Nigerian National Security Strategy
PA	Paris Agreement
PCBs	Bifenilas policloradas
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SMAPs	Investigated the presence of small macroplastics
SO ₂	Sulphur dioxide

TPHs Total Petroleum Hydrocarbons

UNCED United Nations Conference on Environment and Development

UNCOD United Nations Conference on Desertification

UNFCCC United Nations Framework Convention on Climate Change

USG United States Government

VES They utilized vertical electrical sounding

ABSTRACT

Climate issues in Nigeria presents complex socio-economic, and environmental challenges, with severe consequences such as biodiversity loss, declining agricultural yields, food insecurity, flooding, drought, and heightened public health risks. This study, focusing on Imo State, provides evidence of climate variability through irregular rainfall and temperature patterns, which significantly impact agriculture, infrastructure, and livelihoods. Findings reveal high public awareness of climate change, with flooding identified as a major threat, alongside perceptions of individuals, industrial and governmental negligence. While environmental laws exist, weak enforcement undermines their effectiveness. The study concludes that there is a strong relationship between climate issues and environmental governance in Imo State. It recommends strengthening institutional capacity, promoting climate-resilient agriculture, improving flood management, conserving ecosystems, expanding renewable energy, and integrating indigenous approaches into climate adaptation policies to enhance resilience and sustainable development.

Keywords: Climate Change. Nigeria. Biodiversity. Agricultural Productivity

RESUMO

As questões climáticas na Nigéria apresentam desafios socioeconômicos e ambientais complexos, com consequências graves, como perda de biodiversidade, declínio da produtividade agrícola, insegurança alimentar, inundações, secas e aumento dos riscos à saúde pública. Este estudo, com foco no Estado de Imo, fornece evidências da variabilidade climática por meio de padrões irregulares de precipitação e temperatura, que impactam significativamente a agricultura, a infraestrutura e os meios de subsistência. As descobertas revelam alta conscientização pública sobre as mudanças climáticas, com as inundações identificadas como uma grande ameaça, juntamente com as percepções de negligência individual, industrial e governamental. Embora existam leis ambientais, a fraca aplicação prejudica sua eficácia. O estudo conclui que há uma forte relação entre as questões climáticas e a governança ambiental no Estado de Imo. Ele recomenda o fortalecimento da capacidade institucional, a promoção de uma agricultura resiliente ao clima, a melhoria da gestão de inundações, a conservação dos ecossistemas, a expansão das energias renováveis e a integração de abordagens indígenas às políticas de adaptação climática para aumentar a resiliência e o desenvolvimento sustentável.

Palavras-chave: Mudanças climáticas. Nigéria. Biodiversidade. Produtividade Agrícola

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1. INTRODUÇÃO

Meu nome é Kelechi Christopher Nwanegwo. Nasci, cresci e concluí o Ensino Fundamental, Médio e Superior em Owerri, no estado de Imo, Nigéria. Após concluir o Ensino Fundamental em Governo e Administração Pública pela Universidade Estadual de Imo, obtive o título de Mestre em Relações Internacionais pela Universidade de Porthacourt, no estado de Rivers, Nigéria.

Minha jornada até este prestigioso instituto começou quando integrei a ilustre delegação do Embaixador da Nigéria no Brasil para discutir a possível colaboração entre esta instituição e universidades nigerianas na área de pesquisa acadêmica e intercâmbio estudantil; foi então que o destino me conduziu aos ilustres corredores desta conceituada universidade brasileira.

Enquanto nossa delegação percorria a sagrada universidade, envolvendo-se em discussões profundas com a direção e os chefes de departamento, uma centelha se acendeu dentro de mim — uma curiosidade insaciável, um anseio por exploração intelectual. Não foi apenas a eminência acadêmica que cativou meus sentidos, mas sim a essência da própria instituição — um bastião de valores cristãos perfeitamente entrelaçados com seu ethos interdisciplinar. Essa fusão única ressoou profundamente em meu espírito, despertando uma admiração fervorosa e uma ressonância pessoal. Com formação fundamental em Ciência Política e Relações Internacionais, me senti atraído pelo nexos entre sociedade, tecnologia e meio ambiente — um reino onde as possibilidades abundam. Foi aqui, em meio aos solos férteis desta respeitada instituição, que imaginei uma odisséia acadêmica — uma jornada alimentada por uma paixão ardente por desvendar as intrincadas complexidades das mudanças climáticas e da segurança ambiental.

Mergulhando no ethos da investigação interdisciplinar, encontro-me no limiar de um profundo esforço intelectual. Com o estado de Imo, no sudeste da Nigéria, como meu ponto focal, sou movido por um desejo ardente de investigar, questionar e iluminar. Por meio de pesquisas rigorosas e dedicação inabalável, aspiro não apenas aprofundar nossa compreensão da intrincada interação entre

a dinâmica climática e as estruturas sociais, mas também abrir caminho para soluções viáveis e futuros sustentáveis.

As mudanças climáticas representam uma ameaça significativa ao nosso planeta, impactando ecossistemas, economias e meios de subsistência humanos. Em regiões como o estado de Imo, localizado no sudeste da Nigéria, os efeitos das mudanças climáticas são particularmente pronunciados, exacerbando as vulnerabilidades existentes e colocando em risco a segurança ambiental.

A intersecção entre questões climáticas e governança ambiental constitui a pedra angular desta pesquisa de doutorado. Fundamental para este tema é o reconhecimento da interconexão entre a dinâmica climática, as estruturas sociais e a vulnerabilidade ambiental. Conforme destacado por Adger et al. (2007:77-86), os impactos das mudanças climáticas não são distribuídos uniformemente e, frequentemente, afetam desproporcionalmente as comunidades marginalizadas, exacerbando as desigualdades sociais existentes e amplificando as injustiças ambientais. Da mesma

forma, o conceito de segurança ambiental, conforme articulado por Barnett (2001), destaca as ligações intrínsecas entre degradação ambiental, escassez de recursos e conflitos, destacando a necessidade urgente de medidas proativas para enfrentar esses desafios interconectados.

Além disso, estudos empíricos recentes têm ressaltado a urgência de abordar os impactos das mudanças climáticas no contexto da paisagem socioeconômica e ambiental única da Nigéria. Por exemplo, Odekunle et al. (2021:107-119) realizaram uma avaliação abrangente da vulnerabilidade às mudanças climáticas na Nigéria, destacando a suscetibilidade de regiões do sudeste, como o estado de Imo, a impactos climáticos adversos, como aumento de inundações, interrupções na agricultura e degradação de ecossistemas. Da mesma forma, Okwuashi et al. (2023:114-126) examinaram as implicações socioeconômicas das mudanças climáticas na Nigéria, enfatizando a necessidade de estratégias integradas de adaptação e mitigação para construir resiliência e promover o desenvolvimento sustentável.

É importante destacar que este trabalho gira em torno do desenvolvimento e da territorialidade, visando avaliar as ações e intervenções do Estado na preservação ambiental em áreas urbanas e rurais do Estado de Imo e os efeitos da degradação ambiental na saúde humana. Em essência, este trabalho de doutorado representa um chamado à ação — um compromisso com o avanço do conhecimento, a promoção do desenvolvimento sustentável e a proteção do meio ambiente do Estado de Imo e de outras áreas.



Figure 1: Area of Study. Map of Imo State (Source: Open Africa google satellite developed by Giovanni Borgioni, Lahac, UniEVANGELICA,2024)

Nas paisagens e comunidades agitadas do estado de Imo, encontra-se um microcosmo da intrincada interação entre a atividade humana e o ambiente natural. Situado no vibrante coração da região sudeste da Nigéria, o estado de Imo é um dos 36 estados da Nigéria. Possui três zonas senatoriais: Owerri, Orlu e Okigwe. Faz fronteira ao norte com o estado de Anambra, o estado de Rivers

a oeste e sul e o estado de Abia a leste. Tem uma população de cerca de 5,6 milhões de pessoas, de acordo com o censo de 2022. O estado de Imo é predominantemente habitado pelo povo igbo, que compartilha uma língua, cultura e história comuns. O povo igbo é majoritariamente cristão, com alguns adeptos de religiões tradicionais africanas e do islamismo. O estado de Imo tem um clima tropical, com duas estações distintas: a estação chuvosa (março a outubro) e a estação seca (novembro a fevereiro). A temperatura média anual é de 26,6 °C, com pouca variação ao longo do ano. A precipitação média anual é de 2.500 mm, com a maior parte ocorrendo durante a estação chuvosa. A umidade média anual é de 75%, com níveis mais elevados durante a estação chuvosa. O estado de Imo é um dos principais produtores de petróleo da Nigéria, com depósitos de petróleo bruto e gás natural em algumas áreas de governo local, como Ohaji/Egbema, Oguta, Oru Leste, Oru Oeste, Obowo, Ngor Okpala e Iho em Ikeduru (Chuma, 2023).

1.1 Statement Of The Problem

Imo State faces growing challenges of environmental governance and climate-related issues as global warming intensifies. Rapid urbanization, agricultural expansion, and unsustainable exploitation of natural resources have contributed to forest degradation, and widespread environmental insecurity. The state is increasingly vulnerable to climate-induced hazards such as rising temperatures, irregular rainfall patterns, flooding, land degradation, and extreme weather events, all of which threaten environmental sustainability, food security, and public health.

Severe flood events highlight the scale of the crisis: in September 2018, heavy rainfall caused more than 26 deaths and displaced over 2,500 families across seven Local Government Areas, while in 2022, 33 communities in Ohaji-Egbema Local Government Area were submerged. Despite the existence of environmental laws, weak enforcement, institutional bottlenecks, and low public engagement undermine effective response. This persistent governance gap

exacerbates the impacts of climate change and underscores the urgent need for robust mitigation and adaptation strategies to safeguard the ecological integrity and socio-economic well-being of Imo State.

2. GENERAL OBJECTIVE

The research aims to analyse environmental governance and climate issues in Imo State, Nigeria, while offering insights for policy and decision-making processes to mitigate risks and build resilience.

2.1 Specific Objectives

In this research, the following objective will be realized:

1. To assess the climate impact in urban and rural areas in Imo State.
2. To analyse factors that contributes to environmental insecurity in Imo State.
3. To evaluate the environmental governance and climate related issues in Imo State.

2.2 Research questions

1. What are the impacts of climate change on urban and rural areas in Imo State?
2. What factors contribute to environmental insecurity in Imo State?
3. How effective is environmental governance in addressing climate-related issues in Imo State?

2.3 Hypothesis

This study is guided by the following hypothesis

1. H1 Variability in rainfall in Imo State is associated with climate change.
H0 Variability in rainfall in Imo State is not associated with climate change.

2. H2 There is a significant relationship between climate related issues and environmental governance.

H0 There is no significant relationship between climate related issues and environmental governance

3. JUSTIFICATION OF STUDY

This research seeks not only to contribute to the academic discourse on climate change and environmental security in Imo State but also to provide actionable insights that can inform policy formulation and sustainable development practices at the Local, State and national levels. It is pertinent to mention that limited research has been done on this topic in Imo State.

3.1 Theoretical Framework

Theoretical frameworks serve as guiding compasses for research, providing lenses through which phenomena can be explained and understood. This study adopts the Anthropocene concept as its framework to analyze the challenges of climate change and environmental governance in Imo State, Nigeria.

The Anthropocene theory, popularized by Eugene Storer and Paul Crutzen in 2000, posits that human activity has become the dominant driver of geological, biological, and ecological changes in the Earth system (Eckart et al., 2006:16). According to this theory, anthropogenic activities such as urbanization, destruction of rainforests, unsustainable exploitation of natural resources, indiscriminate waste disposal, burning of fossil fuels, and release of greenhouse gases have fundamentally altered the planet's climate and ecosystems.

Debates exist regarding the starting point of the Anthropocene. Some scholars trace its origins to the Industrial Revolution of the 1800s, when human activity significantly increased carbon and methane emissions. Others argue it began in 1945 with the detonation of atomic bombs, whose radioactive particles

became globally detectable. The Anthropocene Working Group (2016), however, proposed 1950 as the definitive beginning, marking the “Great Acceleration” of population growth, industrialization, and large-scale human impacts on the environment (National Geographic, 2016).

Patrick W. Keys et al. (2019:2) further argue that human activities have modified weather patterns, land surfaces, oceans, and even evolutionary processes, thereby fundamentally altering life’s interactions with the environment. These processes are associated with rising global temperatures and irregular weather patterns.

This theoretical lens is particularly relevant to Imo State, where human-driven activities such as improper waste disposal, oil and gas exploration, deforestation, and urban expansion contribute to air and soil pollution, release of greenhouse gases, environmental degradation, and climate related issues. By situating the study within the Anthropocene framework, the research underscores the central role of human activities in driving environmental hazards and highlights the urgent need for effective governance and sustainable adaptation strategies.

4. METHODOLOGY

In an attempt to achieve the objectives of this research study, a descriptive research was implored; it provided an opportunity to systematically describe a population, situation or phenomenon. Since there are typologies of descriptive research, namely the survey, observation and case study methods. The survey method is based on the examination of current issues, conditions and processes. The study therefore combined qualitative and quantitative research methodologies. The typology of data used in this research entails both primary and secondary categories. Data was sourced from questionnaires, journals, newspapers, books and personal interviews with individuals and groups.

Due to the nature of the work, the questionnaire method was found for this study. The questions were designed to include both open ended and close ended characteristics. They were designed in a way that even an ordinary citizen could be able to respond to it.

4.1 Population of the study/methods of data collection

The population of the study in this work are the residents of Owerri, Orlu and Okigwe, the three Senatorial District of Imo State. This study made use of questionnaire and interview. The questionnaire consists of open and closed ended questions that require the respondents to basically indicate by chosen the option they reckon appropriate in the space provided respectively. In the course of drawing up the questionnaire, the researcher examined problems based questions related to the causes and impact of climate related issues and environmental governance in Imo State.

The interviews, on the other hand, were also carried out to source for information. In this study, interviews were conducted with the Chairman Imo House committee on Environment, Permanent secretary of Imo State Ministry of Environment, Director Climate change, Deputy Director Forestry, principal staff of Imo State waste management agency and some residents in the state. The secondary source of data basically denotes content analysis and it centers on the use of existing literature on the topic of discussion; the study made use of relevant textbooks, journals, newspapers, magazines, and internet for information gathering.

4.2 Method of data analysis

Frequency distribution table using simple percentages were used as a statistical tool in analysing data obtained. Chi-square statistical test tool was used to test the hypotheses drawn in this study. The formula for Chi-square analysis is as follows:

$$X^2 = \frac{\sum(O - E)^2}{E}$$

Where;

X^2 = Chi-square.

O = Observed frequency

E = Expected frequency

\sum = Summation

The observed data are the data derived in the field. To obtain expected scores, the following formula was used:

$$\text{Expected score} = \frac{\text{Row Total} \times \text{Column Total}}{\text{Grand Total}}$$

The Chi-square was computed at 5% (0.05) level of significance. In the test of hypothesis using Chi-square (X^2) technique, there are two upshots (outcomes) at the end of the day which were used to reach a decision. One of the values is computed value and the other is critical value/table value. The former is arrived at through computation, while the latter is obtained from Chi-square (X^2) statistical table using a chosen level of significance at

(α) against a computed degree of freedom (df) which is obtained using the formula:

$$Df = (c-1) (r-1)$$

Where “c” stands for number of columns

“r” stands for number of rows

Having completed the computation, a decision rule adopted.

The decision rules are as follows:

- (a) Accept the null hypothesis if the computed value of Chi-square (X^2) does not exceed the table value of Chi-square (i.e. accept H_0 if $X^2_{cal} \leq X^2_{tab}$) at the appropriate degree of freedom and chosen level of significance; and vice versa.

4.3 Scope and limitations of the study

The scope of this research work is within Imo State, with a particular focus on climate issues and environmental governance.

On the other hand, this research work was constrained by financial constraint, organizational constraint this was in form of release of vital information that has fundamental bearing on the study. The research will equally be constrained by time factor as well as the difficulty of getting the designated respondents to fill the questionnaires.

4.4 Operational work

This research work was done and presented in different chapters in line with the objectives of the study. The aim is critically reviewing existing literature on environmental studies, particularly focusing on Imo State, identify gaps, limitations and areas for further research within the field of environmental science, with specific emphasis on climate issues. It explore the intersectionality between various environmental factors such as pollution and climate issues in Imo State. It assess the climate impact in urban and rural areas in Imo State; analyses factors that contributes to environmental insecurity in Imo State and also evaluate the environmental governance and climate related issues in Imo State. It provided answers on the question of how effective is environmental governance in addressing climate-related issues in Imo State.

In chapter two, the "Dynamics of Climate Change and Environmental Security in Nigeria" tackles a crucial aspect of Nigeria's sustainability and security. It also assess the climate impact in urban and rural areas in Nigeria; analyses factors that contributes to environmental insecurity in Nigeria and also evaluates the environmental governance and climate related issues in Nigeria. The paper was published by *Fronteira: Journal of Social, Technological and Environment*, a Grade A journal, underscores the scholarly rigor and relevance of the research. It provided policymakers with evidence-based strategies to mitigate these environmental risks and enhance environmental security.

Similarly, in chapter three "Climate Change in Nigeria: From Flooding, Temperature Variations and Drought Perspectives" provides a comprehensive overview of the climate change impacts specific to Nigeria, focusing on floods, temperature variations, and droughts. The literature review serves as a vital resource for understanding the country's vulnerability to climate change. While chapter four discusses Climate variability and its Evidence in Imo State. It explores climate variability in Imo State, Nigeria, highlighting empirical studies and data trends that point to increasing climatic irregularities. The researcher used mean monthly rainfall and monthly air temperatures (minimum and

maximum) and converted it to annual mean sourced from the Nigerian Meteorological Department (NIMET) for the periods of 1990 and 2023. The findings indicates the evidence of climate variability in Imo State. It is recommended that policymakers in Imo state and national should consider these trends in future development strategies, incorporating climate resilience crops, GHG emission reduction, smart agriculture, tree planting, health preparedness, environmental education, and promotion of green energy in other to adapt and mitigate the impact of the climate change. This chapter also contain the data analysis of questionnaire, answers to the research questions and test of hypothesis as well as the final conclusion.

CHAPTER 1

LITERATURE REVIEW: UNRAVELING THE NEXUS: CLIMATE ISSUES AND ENVIRONMENTAL SECURITY IN IMO STATE.

INTRODUCTION

This literature review embarks on a journey to unravel the complex relationship between climate issues and environmental security in Imo State, offering a comprehensive synthesis of existing research, scholarly insights and empirical evidence. It aims at assessing the climate impact in urban and rural areas in Imo State. To analyse factors that contributes to environmental insecurity in Imo State and to evaluate the environmental governance and climate related issues in Imo State. Moreover, it endeavors to unravel the intricate social, economic, and political dynamics shaping the state's capacity to respond to climate-induced disruptions and safeguard the well-being of its citizens.

The insights gleaned from this literature review hold profound implications for policymakers, practitioners, and scholars alike. By fostering a deeper understanding of the challenges at hand and identifying pathways toward resilience and sustainability, we endeavor to forge a brighter, more secure future for Imo State and its inhabitants in the face of a changing climate.

A study conducted by Eze et al. (2023) investigated the concentration and sources of polychlorinated biphenyls (PCBs) in the surface water and sediment of River Otamiri in Imo State, Nigeria. It employed statistical methods such as correlation analysis, principal component analysis and analysis of variance to evaluate PCB levels and determine their major sources. The findings suggest a strong correlation among sampling points and attribute PCB contamination to geogenic factors such as soil leaching from waste dumpsites and auto-mechanic workshops in the vicinity of River Otamiri. However, it is found that the study does not explicitly address the potential impacts of climate change on PCB distribution and transport in River Otamiri. Climate change can influence precipitation

patterns, river flow and sediment dynamics, which may affect the dispersion and accumulation of pollutants like PCBs. Also, while the study highlights the anthropogenic sources of PCB pollution, it does not delve into broader environmental security concerns in Imo State. Understanding the linkages between PCB contamination and broader environmental security issues such as water scarcity, land degradation and ecosystem degradation is essential for holistic risk assessment and management. Furthermore, although the study calls for the development of environmental policies to protect water and sediment quality, it lacked specific recommendations addressing climate change adaptation strategies and measures to enhance environmental security. Integrating climate resilience and environmental security considerations into policy frameworks is crucial for sustainable management of pollutants like PCBs amidst changing environmental conditions.

The study by Enyoha et al. (2022) investigated the presence of small macroplastics (SMaPs) and adsorbed heavy metals in roadside soils in Owerri, Imo State, Nigeria. While the study addresses the pressing issue of plastic pollution and its environmental implications, particularly in urban areas, there are notable gaps in the study regarding the impact of climate change and environmental security in Imo State. The study focused primarily on plastic pollution and heavy metal contamination, but it lacked explicit discussion on how climate change may exacerbate these issues or how environmental security measures are affected. Given the increasing frequency of extreme weather events and their potential to exacerbate environmental degradation, it is believed that future research should explore the intersection of plastic pollution, heavy metal contamination, climate change, and environmental security in Imo State to provide a comprehensive understanding of the challenges and potential solutions.

Agomuo and Amadi (2017) conducted a study assessing the accumulation and toxicological risk of heavy metals in top soils from markets in Owerri, Imo State, Nigeria. The study evaluated soil samples from eight markets and analyzed the concentration of various heavy metals. The findings suggested severe pollution in some markets, particularly with metals like Ag, Cu, and As. However,

certain heavy metals were found to be below baseline levels. The study recommended regular assessments of these markets and strategies to mitigate further environmental degradation. Also, while the study focused on health risks associated with heavy metal contamination, it did not delve into broader environmental security concerns in Imo State. Issues such as inadequate waste management, poor infrastructure and urban pollution, as mentioned in the study, contribute to environmental insecurity. However, the study could have explored how these factors interact with climate change to exacerbate environmental risks and threaten human well-being. The study provided a snapshot of heavy metal contamination in the markets at a specific point in time. However, it did not discuss long-term trends or consider future projections, including how climate change might alter these trends. Understanding temporal changes in heavy metal contamination is crucial for devising sustainable environmental management strategies. Furthermore, while the study recommended regular assessments of the markets and strategies to halt further degradation, it did not propose specific adaptation and mitigation strategies tailored to the local context of Imo State. Addressing climate change and environmental security requires proactive measures to enhance resilience and minimize vulnerability, which could include sustainable land use practices, green infrastructure development, and community engagement initiatives.

Agomuo and Amadi (2019) conducted a study on the quality risk assessment of swimming pools regarding heavy metal deposition and intake through oral and dermal exposure. The research focused on six swimming pools in Owerri, Imo State, Nigeria, assessing physicochemical properties, heavy metal contents, and associated risks. Results indicated elevated levels of certain heavy metals, including iron, cadmium, mercury, arsenic, nickel, and lead, exceeding safety values set by regulatory bodies. The study highlighted potential health risks posed by heavy metal contamination in swimming pools, emphasizing the need for regulatory guidelines to ensure safety. However, the study did not address the potential impact of climate change on swimming pool water quality or heavy metal deposition. Climate change can influence precipitation patterns, temperature regimes, and water availability, which may affect the transport and fate of heavy

metals in swimming pool environments. Additionally, extreme weather events associated with climate change could increase the risk of pool water contamination. Also, while the study focused on health risks associated with heavy metal contamination in swimming pools, it did not discuss broader environmental security concerns in Imo State, such as inadequate waste management or urban pollution. Considering the link between environmental degradation and public health, an examination of broader environmental security issues could provide context for understanding swimming pool contamination within the larger environmental landscape of the region.

The study by Abuta, Agumagu, and Adesope (2021) investigates the use of social media by arable crop farmers in Imo State, Nigeria, for communicating climate change adaptation strategies. It employs a multistage sampling method and collects data through structured questionnaires from 285 randomly selected farmers. Results indicate that farmers utilize social media primarily for seeking knowledge about climate change, disseminating information and sharing adaptation strategies within farmer groups. However, the study fails to delve deeply into the specific challenges posed by climate change and environmental security in Imo State. While it highlights the importance of social media in agricultural information dissemination, it lacks a comprehensive analysis of how climate change impacts farming practices, livelihoods, and environmental sustainability in the region. Moreover, the study overlooks the potential role of social media in raising awareness about climate change mitigation efforts and promoting sustainable agricultural practices. Further research should aim to address these gaps to provide a more holistic understanding of the intersection between social media, climate change and environmental security in Imo State, Nigeria.

The article by Eze, Enyoh, and Ndife (2021) examines the structural stability and fertility status of soils from active dumpsites in Nigeria, including Nekede dumpsite in Imo State. The study employs standard sampling procedures and analysis by energy dispersive x-ray fluorescence spectrometer to quantify soil cations. Results indicate high potassium and calcium concentrations in the soils, with pH and soil organic matter (SOM) within specific ranges. Correlation

analysis reveals strong relationships between cations and soil organic matter, as well as with cation exchange capacity (CEC). However, the study lacks an in-depth analysis of the impact of climate change and environmental security on soil quality in the study area. While the study acknowledges the degradation of soils due to poor management practices such as open dumping, it does not explicitly address the potential exacerbation of these issues by climate change. Climate change can intensify soil degradation through increased erosion, changes in precipitation patterns leading to leaching of nutrients, and extreme weather events. Moreover, the article does not discuss the implications of soil degradation on environmental security, particularly in the context of Imo State, Nigeria. Soil degradation can compromise food security, water quality and ecosystem resilience, thereby affecting the overall environmental security of the region. Additionally, the study focuses primarily on the physicochemical properties of soil, neglecting other important aspects such as microbial diversity, heavy metal contamination, and soil structure dynamics in relation to climate change. Understanding these factors is crucial for developing effective strategies to mitigate the adverse effects of soil degradation and enhance environmental security in Imo State, Nigeria. Therefore, future research should aim to incorporate interdisciplinary approaches that encompass climate change adaptation, sustainable land management practices and environmental policy interventions to address the gaps highlighted in this study.

Obasi et al. (2020) conducted a study on rainfall-river discharge modeling using Artificial Neural Network (ANN) for flood forecasting. They developed an ANN model and evaluated its performance for forecasting river discharge in the Imo River watershed in Nigeria. The study employed hydro-meteorological data collected from the Anambra-Imo River Basin Development Authority. The results showed high coefficients of determination for training, validation, and testing periods, indicating the effectiveness of the ANN model for short-term flood forecasting. The authors emphasized the applicability of ANN in areas with limited data sets. The study mentions climate change as one of the factors impacting the hydrologic cycle, leading to increased flood occurrences globally. However, it lacks specific analysis or discussion on how climate change is affecting Imo

State, Nigeria, and its implications for flood risk in the region. Including such analysis would enhance the understanding of the local climate change scenario and its implications for flood forecasting. While the study addresses flood forecasting, it does not explicitly discuss the broader implications of flooding on environmental security in Imo State. Flooding can lead to various environmental challenges such as soil erosion, loss of biodiversity, and contamination of water sources. Integrating a discussion on these environmental security aspects would provide a more comprehensive understanding of the impact of flood events on the region.

The study by Nkwoada et al. (2023) investigates the quality and health impact of bottled water in Uratta, Imo State, Nigeria. The retrospective analysis examines physicochemical parameters of four bottled water brands collected in the area. It assesses compliance with WHO and SON standards, highlighting concerns about nitrate levels and potential health consequences, particularly for newborns. The study emphasizes the importance of improving water quality and regulatory oversight. Obviously, there is apparent lack of consideration for the impact of climate change on water quality: The study focuses primarily on physicochemical parameters and health impacts without discussing how climate change may affect these factors in Imo State. There is also absence of analysis on the environmental security implications of water contamination: The study addresses health impacts but does not explore broader environmental security concerns associated with polluted water sources, such as implications for agriculture, ecosystems, or community resilience in the face of climate-related challenges.

In the article "Potential dam sites selection is using integrated techniques of remote sensing and GIS in Imo State, Southeastern, Nigeria" by Ajibade et al. (2020), the authors utilized remote sensing and GIS techniques to identify potential dam sites in Imo State. They considered various factors such as rainfall, runoff, stream order, soil type, geology, and land use to determine suitable locations for dam construction. While the study provides valuable insights into water resource management, it overlooks the potential impacts of climate change on water availability and the environmental security of Imo State. Given the

increasing global concern over climate change and its effects on water resources, future research should incorporate climate change projections and assess their implications for dam site selection and sustainable water management in the region. Additionally, the study does not address the potential social and ecological consequences of dam construction, such as displacement of communities, alteration of ecosystems and loss of biodiversity. Incorporating an interdisciplinary approach that considers environmental, social, and economic factors would provide a more comprehensive understanding of the challenges and opportunities associated with dam development in Imo State, Nigeria.

The study by Isiuku and Enyoh (2020) provides valuable insights into the heavy metal contamination levels in vegetables from markets in Imo State, Nigeria. The research method, involving wet-digestion of samples and atomic absorption spectrophotometry analysis, is robust. However, the study primarily focuses on the assessment of heavy metals in vegetables and associated health risks, overlooking the broader context of climate change and environmental security in Imo State.

Eze and Onwukeme (2021) conducted a study on the identification of heavy metal sources within active dumpsites in southeastern Nigeria. The researchers utilized statistical tools to analyze soil samples collected from four dumpsites and identified significant correlations between heavy metal concentrations and soil parameters. Their findings suggest potential sources of contamination in the studied areas. While the study provides valuable insights into heavy metal contamination in dumpsite soils in southeastern Nigeria, there are notable gaps concerning climate change and environmental security in Imo State, Nigeria. The study does not address the potential impact of climate change on waste management practices or heavy metal distribution in dumpsite soils. Given the increasing frequency of extreme weather events associated with climate change, such as flooding and erosion, there is a need to assess how these phenomena could exacerbate soil contamination in Imo State. The study primarily focuses on the identification of heavy metal sources without discussing broader environmental security concerns in Imo State. Issues such as the adequacy of waste management infrastructure, regulatory enforcement, and

community health impacts are crucial for understanding the broader implications of dumpsite contamination on environmental security.

The study conducted by Oyekale and Oyekale (2017) examined healthcare waste management practices and safety indicators in Nigeria using data collected from 2480 healthcare facilities. They found low compliance with standard healthcare waste management practices and recommended the promotion of environmental safety through possession of management guidelines, staff training and provision of requisite equipment. The study does not explicitly address the impact of healthcare waste management practices on climate change or environmental security. It lacks analysis specific to Imo State, Nigeria, regarding healthcare waste management practices and their implications for climate change and environmental security. Also, the study does not discuss potential measures or policies to mitigate the environmental impact of healthcare waste management in Imo State specifically.

Anosike et al. (2019) conducted a study on groundwater repositories in Njaba LGA of Imo State, eastern Nigeria, utilizing geoelectric survey and physicochemical analysis. The study by Anosike et al. (2019) investigates groundwater repositories in Njaba LGA of Imo State, eastern Nigeria, employing geoelectric survey integrated with physicochemical analysis. The research reveals the presence of four to six geoelectric layers with varying resistivity values, depths, and thicknesses. Additionally, hydraulic parameters such as longitudinal conductance, transverse resistance, hydraulic conductivity, and transmissivity were estimated. The findings suggest low groundwater potential in the study area, potentially prone to surface contamination. Water quality analysis indicates compliance with WHO standards for drinking water, with emphasis on suitability for agriculture based on sodium percentage and sodium absorption ratio. However, the study primarily focuses on groundwater quality and hydrogeological characteristics without addressing the impact of climate change on groundwater resources. Climate change can alter precipitation patterns, leading to changes in groundwater recharge rates and availability. While the study acknowledges the potential for surface contamination, it does not discuss broader environmental security concerns, including the vulnerability of

groundwater to pollution from anthropogenic activities and the implications for ecosystem health and human well-being.

Ejiogu et al. (2019) conducted a study on aquifer geo-hydraulic characteristics in Imo State, Nigeria, using electrical conductivity data. They utilized vertical electrical sounding (VES) data to evaluate the geo-hydraulic potentials and aquifer vulnerability of the area. The findings suggested varying groundwater potentials across different formations within the state, with certain areas being highly vulnerable to contamination. The study lacks explicit consideration of climate change impacts on aquifer vulnerability. With climate change affecting precipitation patterns and intensities, there could be significant implications for groundwater recharge rates and aquifer vulnerability to contamination. Also, while the study mentions the potential vulnerability of aquifers to contamination from anthropogenic sources, it doesn't delve into the broader environmental security implications. Understanding the interplay between groundwater vulnerability and environmental security is crucial for sustainable resource management, especially in the face of increasing anthropogenic pressures and climate change effects.

The study by Ibe et al. (2018) investigates the trace metal concentrations in street dusts around electronic repair workshops in Owerri, Nigeria. It assesses the risks posed by heavy metals like nickel, chromium, lead, copper, cadmium, and zinc, commonly found in electronic waste. The study reveals elevated levels of zinc and copper but below intervention values. Risk assessment suggests potential health risks, especially for children, in areas with electronic repair activities. However, the hazard index indicates no immediate health risk from heavy metals in the environment. The study emphasizes the importance of proper disposal of electronic waste to mitigate environmental contamination. There is apparent lack of consideration for the impact of climate change on heavy metal distribution and mobility: Climate change can influence rainfall patterns, leading to increased flooding and soil erosion, potentially affecting the dispersion of heavy metals in the environment. There is also absence of discussion on the vulnerability of electronic repair workshops to climate-related hazards: Extreme

weather events like flooding can damage electronic repair workshops, leading to the release of hazardous materials into the environment.

The study by Okoroh et al. (2019) investigates the strategies employed by farmers in Imo State, Nigeria, to mitigate and adapt to climate change effects on agricultural practices. It reveals the awareness of farmers regarding climate change and identifies various mitigation and adaptation strategies employed, such as reducing generator use and practicing crop rotation. The study emphasizes the importance of government intervention, particularly in enforcing afforestation policies, to mitigate climate change impacts. Observed gaps in their study is that there is lack of discussion on the specific climate change challenges faced by Imo State: The study mentions increased flooding as an indication of climate change but does not delve into other potential impacts such as changes in rainfall patterns, temperature extremes, or drought occurrences specific to the region. Also, there is limited exploration of the link between climate change and agricultural productivity: While the study identifies adaptation strategies used by farmers, it does not assess the effectiveness of these strategies in maintaining or enhancing agricultural productivity in the face of climate change. There is also, absence of recommendations for building resilience to climate change: The study recommends afforestation as a mitigation measure but does not offer suggestions for building resilience among farmers to cope with future climate change impacts, such as improving irrigation infrastructure or promoting drought-resistant crop varieties.

Duru (2019) conducted a study on the heavy metal pollution of soil within reclaimed auto repair workshops in Orji, Imo State Nigeria. The study utilized energy dispersive X-ray fluorescence and atomic absorption spectrophotometry to determine the presence and concentrations of toxic heavy metals. Multivariate and geostatistical models such as contamination factor, degree of contamination, pollution load index and index of geo-accumulation were employed for data analysis. The preliminary soil analysis revealed the relative abundance of heavy metals, with cadmium and arsenic showing high contamination levels. However, the study lacks a comprehensive analysis of the potential impact of climate change on heavy metal pollution in the area. Furthermore, it does not address

the implications of environmental degradation on the broader environmental security of Imo State, Nigeria. Future research should consider integrating climate change projections and assessing the socio-economic consequences of heavy metal pollution for a more holistic understanding of environmental security in the region.

The study by Wirnkor et al. (2021) examines the risk associated with consuming fish species from Oguta Lake in Imo State, Nigeria, due to petroleum hydrocarbons and heavy metals contamination. The researchers analyzed fish samples from the lake for heavy metal concentrations and total petroleum hydrocarbons using advanced analytical techniques. The article does not discuss the potential impacts of climate change on Oguta Lake or the surrounding environment. Climate change can exacerbate environmental degradation, affecting water quality, fish habitats, and ecosystem health.

Ibe, Opara, Ibe, and Amaobi (2019) conducted a study on the pollution and health risk from effluent discharge into the Inyishi River in Imo State, Nigeria. They employed various assessment models to analyze the environmental impacts, revealing significant contamination and potential health risks associated with wastewater effluent discharge. The study focuses on pollution and health risks from industrial effluent discharge but does not directly address the potential impact of climate change on the Inyishi River ecosystem. While the study identifies the negative impact of wastewater effluent discharge, it does not discuss potential strategies or policies to mitigate these impacts in the context of climate change adaptation or environmental security. The research lacks a comprehensive analysis of long-term trends or projections regarding climate change effects on water resources in Imo State, which could provide valuable insights for sustainable management practices. There is a need for further investigation into the vulnerability of the Inyishi River basin to climate change-related hazards such as increased flooding or drought events, which could exacerbate pollution and health risks in the future.

The study by Opia and Chizoruo (2024) investigates the anthropogenic sources and risk assessment of total petroleum hydrocarbons (TPHs) in groundwater within Orji auto repair workshops in Imo State, Nigeria. The authors

utilized liquid-liquid extraction and gas chromatography techniques to determine TPH concentrations in groundwater samples from five locations. Their findings suggest significant levels of TPH contamination, with implications for human health, particularly in terms of cancer risk. However, the study lacks comprehensive analysis and discussion on the impact of climate change and environmental security in Imo State, Nigeria, which are crucial factors influencing hydrocarbon contamination and its consequences on ecosystems and public health. Further research should address these gaps to provide a more holistic understanding of the environmental challenges faced by the region.

The article by Amakom et al. (2022) provides valuable insights into the carbon footprint resulting from electricity generation at the Federal University of Technology, Owerri, in Imo State, Nigeria. It highlights the significant emissions of carbon dioxide (CO₂) from both diesel and petrol generators on the campus. The study accurately quantifies the emissions, emphasizing the need for environmental sustainability and a transition to renewable energy sources to mitigate climate change impacts. However, their study fails to delve deeply into the specific impacts of these emissions on climate change and environmental security in Imo State, Nigeria. While it acknowledges the importance of reducing carbon emissions, it lacks a comprehensive analysis of the local environmental vulnerabilities exacerbated by climate change. Furthermore, there is a gap in addressing potential adaptation and mitigation strategies tailored to the region's unique challenges. Also, the article does not discuss the potential implications of climate change and environmental degradation on the socioeconomic well-being of the local communities in Imo State. Future research could benefit from integrating interdisciplinary perspectives to explore the interconnectedness between climate change, environmental security, and socioeconomic dynamics in the region.

Kanu and Onyekwere (2023) examined the perceptions of climate change-related disasters and their impact on household food security in rural farm households in Imo State, Nigeria. They found that excessive rainfall leading to flooding was the most prevalent climate change-related disaster, followed by excessive heat and irregular rainfall patterns. The study identified various

mitigation strategies adopted by households, such as changes in farming practices and irrigation methods. Government intervention priorities included improving drainage and irrigation systems, establishing community weather forecast centers, and providing fertilizer subsidies (Kanu & Onyekwere, 2023). While the study acknowledges the impact of climate change-related disasters on household food security, it primarily focuses on perceptions and mitigation strategies within rural farm households. It overlooks broader environmental security concerns beyond food security, such as biodiversity loss, ecosystem degradation, and water scarcity, which are also critical aspects of climate change adaptation in Imo State. Also, the study does not delve into a comprehensive vulnerability assessment of rural communities in Imo State to climate change impacts. Understanding the socio-economic vulnerabilities, adaptive capacities, and exposure levels of different communities is essential for developing targeted and effective adaptation strategies.

Ejiogu et al. (2017) conducted a study on the geochemical and bacteriological analysis of water resources in Imo State, Nigeria, focusing on contamination from solid waste dumpsites. They found elevated concentrations of heavy metals and bacteria in water samples collected near the dumpsites, indicating potential contamination. The study emphasizes the need for improved waste management practices to protect water resources in the area. While the study provides valuable insights into water contamination from solid waste dumpsites, it lacks explicit discussion on the implications of these findings for climate change and environmental security in Imo State, Nigeria. Climate change can exacerbate water contamination issues through extreme weather events and shifting precipitation patterns, affecting the vulnerability of communities reliant on contaminated water sources. Additionally, inadequate waste management practices contribute to environmental insecurity by compromising ecosystem health and human well-being. Therefore, addressing these gaps would involve integrating climate change adaptation strategies and enhancing environmental security measures into waste management policies and practices in Imo State, Nigeria.

The study conducted by Onwudike, Asawalam, and Ano (2015) explores the impact of burnt and unburnt agro-wastes on soil properties and cocoyam growth in Imo State, Nigeria. They investigated the effects of various agricultural wastes on soil fertility, growth, and yield of cocoyam. Through field studies conducted over two planting seasons, they observed significant improvements in soil properties and cocoyam growth with the application of cocoa pod waste. The research provides valuable insights into sustainable agricultural practices in the region. However, there is limited discussion on Environmental Impact: While the study acknowledges the environmental hazards associated with improper disposal of agricultural wastes, it primarily focuses on their agronomic benefits. There's a lack of discussion on the broader environmental implications of waste management practices, such as their contribution to climate change and soil degradation. Also, the study overlooks the importance of enhancing climate resilience in agricultural systems, particularly in the context of changing climatic conditions. Imo State, like many regions, faces climate-related challenges that could impact crop production and soil health. Incorporating climate-resilient practices into soil management strategies could strengthen agricultural sustainability.

The study by Attah et al. (2021) investigates the spatial distribution of soil physicochemical characteristics and heavy metal toxicity potential in sediments of the Nworie River micro-watershed in Imo state, southeastern Nigeria. The authors sampled sediments from three different locations along the river and analyzed various physiochemical properties and heavy metal concentrations. They found that the sediments were predominantly sandy, with acidic pH levels and low exchangeable bases. While heavy metals were present, cadmium exhibited higher concentrations compared to others. The contamination factor for chromium, copper, lead, and zinc was low, indicating minimal contamination. However, the study lacks a comprehensive analysis of the impact of anthropogenic activities on climate change and environmental security in the region. Given the rapid infrastructural development and land use changes observed in Imo state, there is a need for further research to assess the long-term implications of these factors on soil quality, water resources, and overall

environmental sustainability, particularly in the context of climate change adaptation and mitigation strategies.

Ibe et al. (2020) conducted a study analyzing atmospheric pollutant concentrations in various parts of Imo State, Nigeria, using statistical techniques. They collected air quality data multiple times a day and found that certain pollutants exceeded the US National Ambient Air Quality Standards. The study highlighted the need for regular air quality monitoring in the area. The study primarily focuses on analyzing pollutant concentrations and sources but lacks direct discussion or analysis of climate change impacts or environmental security measures in Imo State. Although the study mentions gas flaring and other anthropogenic activities as potential sources of pollution, it does not delve into their specific environmental consequences or propose mitigation strategies. There's a lack of discussion on the potential long-term effects of air pollution, such as its contribution to climate change and its implications for environmental security and public health in Imo State. Also, the study does not address the broader context of climate change adaptation or resilience-building efforts in Imo State, which are crucial for addressing the region's vulnerability to environmental hazards.

Environmental laws in Imo State

Environmental laws are policies meant for the protection of the environment. It must be enacted. In Imo State, Nigeria, there has been series of laws meant to preserve or sustain the environment since 1980. The law of 1980 section 25 stipulates that:

(1) Any person who dumps refuse in a place other than an appointed refuse dump or incinerator is guilty of an offence and shall be liable on conviction to a fine not exceeding one hundred naira or to imprisonment for a period not exceeding six months; or to both such fine and imprisonment.

26. (1) Where a child under the age of sixteen contravenes section 25, the parent or guardian or master or mistress of the Child shall be charged with committing the offence).

Sanitation law has been in place for years in Imo State but was it effective to ensure environmental security in the State. The following can be identified as the weakness of the law which resulted in 2008 law. The 1980 law focused mainly on sanitation and refuse disposal, it did not include other environmental concerns like, Pollution (air, water, noise), Deforestation and Biodiversity conservation and also the punishment for violating environmental provisions were often minimal and not enough to deter offenders. It is assumed that some of these limitations likely led to the enactment of new laws in 2008 (ENTRACO Law).

In 2008, the Imo State Government enacted a law No.3, for the establishment of Imo state Environmental Transformation Commission (ENTRACO). This statutory body was mandated to manage the environment, sanitation and other related environmental activities in the state. This law prohibits Dumping or depositing of refuse or waste of any description on any road, street, open space, gutter, walkway, drain or drainage system or tenement whether occupied or not.

The law also stated that every owner or occupier of a building or land shall plant ornament trees in front of his building or empty land. It also stipulated punishment for offenders. According to the law, any person who violates the law commits an offence and will be arrested by the agents mandated to enforce it, he shall be liable on conviction to a fine of ten thousand naira (₦ 10, 000.00)

In 2019, Emeka Ihedioha administration reinforced the ENTRACO law to include the ban of polythene disposal and the enforcement of door to door waste collection. The purpose of the reinforcement was to strengthen the already existing law.

In 2020, Imo State Government under the leadership of Chief Hope Uzodinma established a law for the Imo Waste management Agency to oversee the waste administration and other related activities in a bid to protect the environment. The agency was mandated to maintain under section 14 to

a. Clean streets, remove, collect and dispose of domestic , commercial and any other form of solid, including medical, marine waste, garden waste and building waste in accordance with regulations made by the Board for that purpose;

b. Maintain a clean and healthy environment in the state;

c. Provide refuse collection points and centers for removal and final disposal of such refuse;

d. Direct and control the dumping of refuse in the State;

e. Ensure the clearing of refuse from collection points and centers;

f. Devise and employ approved methods and measures for Improved refuse disposal,

g. Ensure the opening and clearing of public drains to allow for free flow of waste;

h. Remove nuisance from the highway, public open spaces open spaces and public parks;

i. Remove and dispose of abandoned and scrapped vehicles;

j. Remove and dispose of animal carcass from places;

k. Prepare and update the master plan for Waste collection and disposal in the cities, towns, and villages in the state and control resultant waste system within the State

- l. Approve and monitor all waste disposal system in the State;
- m. Make provision for waste management services to be rendered to State agencies, Local Governments, industries, business entities and private persons within the State by collecting refuse/waste by the Agency pursuant to relevant agreements between the Agency and such other parties;
- n. Issue, renew and revoke licenses of private waste collectors:
- o. Maintain a central data base information system for collation of data;
- p. Set guidelines and targets for waste avoidance and volume reduction through source reduction and waste minimization, measures, including compositing, recycling, re-use, recovery and green charcoal processes;
- q. Encourage proper segregation and containerization of waste through policy formulation and public awareness;
- r. Ensure proper collection, transportation, treatment and disposal of waste by adopting best environmental practices,
- s. Promote research and development programs: for improved waste management and resource conservation techniques, effective institutional arrangement for waste reduction, reuse, collection treatment, Separation and recovery, and
- t. Do all such acts as are necessary or incidental to the proper discharge of its duties under the Law.

Assessing the success of environmental management in imo state, nigeria.

Environmental laws are important frameworks for sustainable development and ecological preservation. In Imo State, Nigeria, the evolution of environmental legislation and waste management policy from 1980 through 2020

shows growing awareness and political will to address environmental degradation and ensure security. Below is a critical assessment of the successes and failures of these laws, with a focus on the ENTRACO Law of 2008, its reinforcement in 2019, and the establishment of the Imo Waste Management Agency (IWMA) Law in 2020.

The 1980, 2008, and 2020 laws institutionalized environmental sanitation/management, introduced enforcement agents, and criminalized indiscriminate dumping of refuse. It creates some level of public awareness on environmental sanitation. In 2008 law, tree planting which was not part of 1980 and 2020 law helped to promote urban greening. Penalties which was increased to ten thousand naira helped as fine helped to an extent the enforcement of the law. The 2019 reinforcement and Ban on Polythene to an extent helped reduce plastic litter, particularly during the early stages of enforcement, and addressed a key pollutant affecting water bodies and drainage systems.

The creation of Imo Waste Management Agency in 2020 under Governor Hope expanded the legal and operational scope of waste management in the state. It Mandated data collection, research, licensing of private collectors, and public awareness as a hallmarks of modern environmental governance. It also encouraged recycling, reuse, and composting strategies aligned with global best practices.

However, despite some of the successes of these laws, the challenges of environmental security in the State persist. Illegal dumping persists, especially in gutters, roadsides, and undeveloped plots, undermining the purpose of the laws. Deforestation continues because of rapid urbanization and encroachment into forest reserve areas. The persistence of these atmospheric insecurity could be as a result of weak enforcement of these laws by the relevant authorities; funds, corruption, inadequate personnel to carryout the function in all the LGAs. It could be inferred that even when citizens are willing to comply, the system cannot absorb and manage waste efficiently, leading to overflowing refuse collection points and polluted environments.

Finally, none of the laws adequately addresses the impacts of climate issues such as increase in temperatures, or intensified rainfall on waste management and public health.

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CHAPTER 2

THE DYNAMICS OF CLIMATE CHANGE AND ENVIRONMENTAL SECURITY IN NIGERIA

ABSTRACT

Climate change and environmental security are ongoing challenges in Nigeria. This literature review explores the dynamics of climate change and environmental security alongside proposed solutions. The study employs qualitative research, primarily drawing on reports from international NGOs that address climate change and ecological security in Nigeria. It also utilizes content analysis based on literature, additional bibliographies, and published academic works. The results indicate that climate change in Nigeria has generated adverse effects with various socio-environmental impacts. Furthermore, the findings also emphasize that Nigeria has made significant domestic adaptations to international agreements and treaties to mitigate the effects of climate change. However, research indicates that these efforts have not effectively addressed the consequences of climate change, resulting in more significant environmental degradation. The article highlights the shortcomings in the ways government agencies and other institutions have addressed climate change in Nigeria, including legal and institutional limitations, corruption, and governance deficiencies

Keywords: Climate Change, Environmental Security, Human Security, Nigeria.

INTRODUCTION

In contemporary discourse, climate change has become a central focus of study among scholars, governments, and non-government institutions (Kniess et. al 2022, Domenech 2017, Teso Alonso & Fernández-Reyes 2020, Faustino, Mantovaneli Junior & Barbosa 2024). Dominant literature suggests that there have been varied considerations concerning the causes of climate change. According to Fakana (2020), many factors, both anthropogenic and natural activities, are drivers of climate change; it is deeply rooted in factors such as changes in the sun's activity, significant volcanic eruptions, and changes in the Earth's orbit; others contend that it primarily results from human activities. Scholars such as Mitchell et al. (2020) posit that human activities predominantly cause climate change. Hesmati (2020), in another direction, offers a similar perspective, positing that humans and their activities have significantly transformed natural systems, leading to a net accumulation of carbon dioxide in the atmosphere.

The viewpoint mentioned earlier corroborates NASA's stance, which attributes the increase in global warming trend to human activities that have released substantial amounts of greenhouse gases into the atmosphere (NASA, 2002). National Academy of Social Sciences (NASS) reveals that the Earth's temperature was approximately 2 degrees Fahrenheit (or about 1.11 degrees Celsius) higher than the late 19th-century average, representing global climate change. This significant shift in climate is already impacting every inhabited region worldwide, contributing to various observed changes in weather patterns and climate extremes (IPCC, 2021).

Considering the foregoing, it is observed that Nigeria, as a country, has not been immune to the severe consequences of life-threatening climate conditions and shifts in weather patterns. These changes in weather patterns are noticeable in apparent variations in heavy rainfall, extreme heat, and cold temperatures, resulting in floods, landslides, droughts, rising sea levels, and air pollution. Perhaps this is why Ogbo et al. (2013) reasoned that the increasing

incidence of disasters in Nigeria, including floods, landslides, droughts, rising sea levels, and air pollution, poses significant challenges to Nigeria's national sustainability. In a seeming corroborative stance, Amobi et al. (2015) postulate that some of these natural and human-induced disasters have detrimental impacts on Nigerian society, affecting areas such as health, food production, the economy, and human security.

On the other strand of contemplation, environmental security focuses on freedom from military threats and political coercion to encompass non-military concerns, according to Romm (1993). The implication of the stand is well explicated within the bounds of scholars such as Buzan (1991), Egwu (2001), and Paleri (2008) postulations that traditional security is rooted in the belief that National Defense considerations dominate national security ethos. It is interesting to note that the belief, as mentioned earlier, aligns with the viewpoint of Walt (1991), which asserts that security revolves around the examination of threats, the utilization of military force, and control. It is, however, imperative to note that these prevailing approaches to the traditional perception of security, as highlighted above, draw inspiration from Lipmann's perspective that security involves a state possessing sufficient military capabilities to deter the risk of having to compromise core values to prevent war and, if challenged, to secure victory in such a conflict (Lipmann 1943). Thus, one can infer that Lipmann's contemplation raises a fundamental question concerning the crucial state requirement of sufficient military capability to avert threats to its "core values."

Miller (2008) took a different approach, attempting to classify, clarify, and explain this ambiguity. He insightfully identified two distinct approaches to studying security: the traditional concept of security and security in the post-Cold War era. According to Miller, in the conventional idea of security, the primary threats are neighboring nations or great power rivals, with military capability at the forefront. In contrast, in the post-Cold War concept of security, the threats are non-state, encompassing domestic and trans-border issues. These include economic, domestic, political, and transnational or global challenges such as

immigration, drugs, diseases and environmental concerns, proliferation of weapons, crime, and terrorism.

Considering the foregoing, this paper is grounded in the contrasting view presented by Miller (2008), which posits that the most profound threats are non-state in nature, encompassing both domestic and trans-border issues such as economic, domestic, political, and transnational or global challenges such as immigration, drugs, diseases, and environmental concerns. Furthermore, through a literature review approach, the paper aims to shed light on the evolving nature of climate change and its relationship with ecological security within the Nigerian State. The vulnerability of Nigeria to climate change poses significant threats across various sectors, including food security, poverty reduction, energy, infrastructure, and overall economic development. Eze (2010:8) highlights the alarming risk in the Sudan-Sahel region, where up to 133,994 square kilometers of arable land may be jeopardized, with an estimated capital value at risk of about US\$6.4 billion. The Niger Delta region, already suffering from the detrimental effects of oil and gas exploration, faces further environmental degradation as oil spills and chemical pollution continue to disrupt local biodiversity and the livelihoods of the inhabitants. The compounding effects of climate change in this region underscore the country's broader human security challenges, potentially exacerbating the already precarious conditions for millions of Nigerians. This grave outcome of insecurity and its detrimental impact on national development underscores the urgent need for a comprehensive and adaptable security strategy. It is observable in this direction that the National Security Strategy (NSS) of Nigeria outlines the core national interests, which include the security and welfare of its people, the defense of territorial integrity, and the promotion of peace, democracy, economic growth, and social justice (Centre for Security Studies, 2018). Thus, in the context of this paper, the traditional security paradigm, which has primarily focused on military and territorial defense, is no longer sufficient.

Considering the foregoing, this paper beams a searchlight on Climate change as it presents a particularly pressing and complex challenge to Nigeria's security landscape. In Nigeria, where the effects of climate change are already being felt, integrating environmental considerations into security planning is not just a matter of policy—it is necessary to ensure the country's future stability and prosperity. We argue that climate change is a serious concern for Nigeria's environmental security, considering its impact on Nigeria's security, economic, social, infrastructure, and well-being. It has brought a growing burden to existing environmental concerns, including deforestation and land degradation, which have unfavorably affected Nigeria's agricultural output. It is also argued that Climate change will worsen if various international protocols to combat its effects are not adhered to or correctly enforced and if the anthropogenic nature of man's activities is not curtailed through sustainable practices. However, this research reviewed relevant literature based on qualitative data, with the primary sources being reports from international non-governmental organizations that have produced reports and other studies on climate change and environmental security in Nigeria.

Climate change and environmental security in imo state: anthropogenic and natural drivers discourse

Some scholars have traditionally viewed environmental security in international relations through the lens of geopolitical power. David Haglund (1992:15) argued that the proponents of this concept emphasized the "man-milieu relationship," suggesting that the environment, understood as a multifaceted framework influencing states and leaders, played a pivotal role in international relations. This perspective refined long-standing practices linking geography, a quintessential environmental factor, with power distribution and influence on the global stage.

However, Haglund (1992:16) took another direction. He pointed out that what is noteworthy in contemporary discussions on security is the emphasis on environmental degradation as both a consequence and a catalyst of interstate

conflicts. In a similar vein, Porter (1995:218) observed that environmental security introduces a significant departure from traditional notions of national security. It addresses two distinct issues: the environmental factors that can potentially lead to violent conflicts and the impact of global environmental degradation on the well-being of societies and economies. The idea that environmental degradation can be considered a security issue when it serves as a cause of violent conflict aligns with the conventional definition of national security.

The points mentioned earlier emphasize that environmental security is a pressing reality and a global threat to the entire system. The increasing pressures on the Earth's ecological support systems will likely have profound consequences for human well-being and health, potentially as severe as traditional military threats. Recognizing the shifts in ecology and climate patterns and the resulting implications, nations have developed strategies to mitigate and adapt to the adverse effects of climate change.

As Mathew (1989:362-340) aptly noted, environmental challenges that transcend national boundaries are already eroding the conventional concept of national sovereignty to the extent that they should be regarded as our era's most critical security issues. She further highlighted that the proponents of ecological security attribute the depletion of the ozone layer, which shields humanity from harmful ultraviolet radiation to destructive environmental practices such as the indiscriminate destruction of tropical forests and the release of hazardous gases like Chlorofluorocarbon (CFCs) and halons by industries. According to her, it is to prevent national and global catastrophes resulting from environmental-related crises and the disruption of the planet's natural heritage that advocates for ecological security and calls for new forms of diplomacy, institutions, and regulatory frameworks to address the world's increasing environmental interdependence.

Climate change is one of the most significant challenges of the 21st century, particularly for developing countries like Nigeria. Nigeria is not exempt

from its adverse impacts, which threaten environmental security, human livelihoods, and sustainable development. This research paper deploys vulnerability theory as a guiding theoretical framework to provide a lens through which to understand the nexus between climate change and environmental security in Nigeria.

In this direction, the Vulnerability Theory serves as a cornerstone for understanding the susceptibility of Imo State to climate change. Vulnerability is the degree to which a system is susceptible to and unable to cope with the adverse effects of climate change, including climate variability and extremes (IPCC, 2014). This theory posits that vulnerability is a function of exposure, sensitivity, and adaptive capacity. In the context of Imo State, the theory can be applied to examine how different communities within the state are exposed to climate-related hazards such as flooding, erosion, and extreme weather events and how their socio-economic conditions influence their sensitivity and adaptive capacity.

The influence of human activities on climate change is profound and well-documented. The European Commission on Climate Action (2010) underscored that industrial activities such as burning fossil fuels, deforestation, and intensive livestock farming are principal contributors to global climate alterations. These activities emit significant quantities of greenhouse gases, particularly Methane and Carbon Dioxide (CO₂), which are instrumental in trapping heat within the Earth's atmosphere, thereby exacerbating global warming. As IPCC (2021) highlighted, these greenhouse gases are the primary agents of climate change, creating an imbalance in the Earth's natural systems by enhancing the greenhouse effect. This disruption is further intensified by the increase in global emissions driven by heightened consumption of fossil fuels, as articulated by Perera (2018), leading to significant environmental consequences such as rising sea levels and extreme weather events.

In the light of the foregoing, evidence overwhelmingly supports the assertion that human activities are the central forces driving geological, biological and ecological changes in the Earth's system. Thus, rapid urbanization, industrial expansion, over-exploitation of natural resources, and deforestation are myriad activities altering the planet's climate. Deforestation, in particular, is critical as it reduces the number of trees that can absorb CO₂, a crucial mechanism in regulating the environment. Furthermore, the extensive use of synthetic fertilizers in agriculture releases additional greenhouse gases, compounding the problem. The anthropogenic footprint on the environment is also evident in the escalating extinction rates of various animal species, both terrestrial and aquatic, which are directly linked to habitat loss and climate change.

While human activities are significant, natural factors also influence climate variability. According to a report by the United States Government (USG, 2019), natural events such as volcanic eruptions also temporarily alter climate patterns by releasing vast quantities of Sulphur dioxide (SO₂), water vapor, dust, and ash into the atmosphere. These volcanic aerosols have a short-term cooling effect on the Earth's climate and contribute to ozone layer depletion. NASA (2010) also acknowledges that before the Industrial Revolution, Earth's climate changes were predominantly driven by natural forces such as variations in solar radiation and volcanic activities. The Nigerian Hydrological Services Agency, as referenced by Umar and Gray (2022), emphasizes that natural factors, including extreme weather patterns influenced by climate change, soil moisture levels, and topographical features, are key contributors to flooding in Nigeria. Trenberth (2011) further argues that climate change, exacerbated by these natural factors, has led to altered precipitation patterns, affecting the distribution and intensity of rainfall, thereby increasing the frequency and severity of flooding.

Nigeria, despite being less prone to certain natural disasters associated with global warming, is not immune to the impacts of climate change. Rising sea levels and coastal erosion are evident consequences, leading to devastating flooding in various parts of the country.

Furthermore, in Imo State, the effects of climate change are starkly visible through widespread gully erosion, which has ravaged the land and led to severe environmental and socio-economic consequences. It is important to note that despite challenging incidents in Nigeria, flooding appeared to be the most severe the country has encountered in the past decade.

The forgoing discourse implies the stark visibility of climate change's consequences. Worthy note is that they extend beyond immediate physical impacts to broader socio-economic challenges. Thus, the interplay between anthropogenic and natural factors continues to drive climate change in Nigeria, with far-reaching impacts on the environment and society. Addressing these challenges requires a comprehensive approach that integrates mitigation, adaptation, and resilience-building strategies to safeguard Nigeria's environmental security and ensure sustainable development.

International Environmental Laws: Evolution and Regulatory Challenges

A significant focus in the discourse on international environmental regulation can be found in the United Nations Framework Convention on Climate Change document. According to this document, the Kyoto Protocol was adopted on December 11, 1997, but did not come into force until February 16, 2005. The document outlines that the Kyoto Protocol operationalized the United Nations Framework Convention on Climate Change by obligating industrialized countries and transitioning economies to limit and reduce their greenhouse gas (GHG) emissions according to agreed-upon individual targets. The Convention requires these countries to adopt mitigation policies and measures and report on them periodically. As of 2022, the UNFCCC had 198 parties, and its highest decision-making body, the Conference of the Parties (COP), convenes annually to assess progress in addressing climate change. However, due to key signatory states not adhering to their commitments, the UNFCCC has faced criticism for its perceived failure to reduce carbon dioxide emissions since its inception.

In essence, the Kyoto Protocol is built upon the principles and provisions of the Convention and follows its annex-based structure. It exclusively binds developed countries and places greater responsibility on them under the principle of "common but differentiated responsibility and respective capabilities" because it acknowledges their significant role in the current high levels of GHG emissions in the atmosphere.

In their writings, Falola and Heaton (2008), highlights that Nigeria's origin as a nation can be traced back to the conquest of Lagos in 1851 and its subsequent annexation in 1861. Notably, Nigeria's focus on environmental regulation did not become significant until the country gained independence in 1960. This observation was primarily based on the perception that ecological problems were predominantly the concerns of Western industrialized nations. Adegoke and Adegoroye (1994) posited that this contributed to Nigeria's neglect of environmental issues. Akin (1964) suggested that the British colonial rulers were more motivated by economic interests like commerce rather than environmental concerns. Rebecca (2005) echoed a similar sentiment, asserting that the colonial powers were primarily focused on exploiting the region for their national interests.

This perspective became evident in Oluwasegun's (2017) view, which emphasized that the colonial approach was primarily concerned with public health rather than broader environmental issues. Within the context of colonial medicine ideology, colonial administrations used public health concerns to legitimize their rule and enact racial segregation. The colonial era was also marked by establishing legislation and public health laws, such as the Criminal Code Law of 1916 and the Public Health Act of 1917, which aimed to address public health violations.

However, it is worth noting that starting in 1960, the discovery and exploitation of oil in Nigeria became a major source of environmental issues, particularly related to gas flaring and oil spillage, with significant impacts on oil-producing communities. Ogbodo (2010) argued that the drilling, exploitation, and

processing of oil in Nigeria gave rise to a range of environmental challenges even in Imo State, Southeast Nigeria such that necessitated the development of environmental regulations and laws.

However, Nigeria appears to lack clear national policy objectives for the country's environment. Nevertheless, Nigeria has enacted various policies to align with multiple international conventions and protocols on the environment. Interestingly, Section 20 of the 1999 Nigerian Constitution articulates the underlying principles of environmental protection and management. This section states, "the state shall protect and improve the environment and safeguard the water, air, land, forest, and wildlife of Nigeria." Unfortunately, this constitutional provision is non-justiciable, meaning that the Nigerian government cannot be compelled to enforce these provisions to safeguard the environment. Numerous legislative statutes have been enacted to address this constitutional limitation, and several international treaties have been ratified to protect and preserve Nigeria's environment. It is important to note that Nigeria's statutes encompass acts, laws, decrees, edicts, and ordinances. An act passed by the Federal Legislature is called an "Act," while a statute passed by a state's House of Assembly is called a "law." Decrees are enactments by the central military government, while edicts are those of the state military government. Ordinances are laws passed by the Nigerian Central Legislative Assembly before October 1, 1954, when Nigeria adopted a Federal Constitution.

The Federal Environmental Protection Agency (FEPA) Act was enacted in 1988 in response to the Koko toxic waste dump incident, during which approximately 3,000 tons of toxic waste were illegally dumped in Koko port by Italian businessmen. The establishment of FEPA can be seen as the initial step in Nigeria's environmental governance. However, following substantial criticism, FEPA was abolished in 1999, and its responsibilities were transferred to the Ministry of Environment. Subsequently, the Act was revised to pave the way for enacting the National Environmental Standards and Regulations Enforcement Agency (NESREA) Act in 2007. The mandate for active participation in the

evolving global environmental protection process was conferred upon Nigeria, along with many other countries, at the Stockholm Conference in 1972. Besides the Stockholm Conference, numerous other international treaties, protocols, and conventions hold significance in environmental governance in Nigeria. Some notable examples include the Universal Declaration of Human Rights in 1948, the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter in 1972, the International Convention for the Prevention of Pollution of the Sea by Oil in 1954 (amended in 1962 and 1969), the Convention on the High Seas in 1958, the United Nations Conference on Desertification (UNCOD) in 1977, the International Conference on the Establishment of an International Fund for Compensation for Oil Pollution Damages in 1978, the African Charter on Human and Peoples' Rights in 1983, the Convention for Cooperation in the Petroleum and Development of the Marine and Coast Environments of West and Central Africa in 1984, the United Nations Conference on Environment and Development (UNCED) in 1992, the United Nations Convention to Combat Desertification in 1994, the Vienna Convention for the Protection of the Ozone Layer, the Rio Declaration on Environment and Development, and several others.

To implement the Environmental Policy, Nigeria has formulated specific policies and action plans that, if effectively executed, could support the country's national climate change adaptation responses, particularly in areas such as drought and desertification, erosion and flood control, coastal zone management, national sanitation, forestry, and biodiversity protection. For instance, the National Policy on Drought and Desertification acknowledges the potential intensification of drought and desertification in the country's northern regions due to climate change. Consequently, the policy outlines strategies to mitigate the adverse impacts of climate change on drought and desertification. To address climate change-related challenges, the policy emphasizes the need to equip relevant agencies, institutions, and citizens with the necessary tools to collect, analyze, and utilize climate data effectively for drought and desertification mitigation. Moreover, the policy promotes land-use practices that enhance carbon dioxide sequestration, such as afforestation and agro-forestry, with the

added benefits of reducing soil erosion and increasing crop productivity, thus supporting climate change adaptation and economic development. Additional long-term integrated strategies are detailed in the National Action Programme (NAP) to Combat Desertification and Mitigate the Effects of Drought, which was developed in 2000 and remains the primary implementation framework for drought and desertification policies.

The National Forest Policy has been finalized, and Nigeria has established the National Forestry Action Program (NFAP). NFAP is designed to prioritize sustainable forest management, encourage participatory development processes, facilitate private sector engagement in forestry development, and adopt an integrated approach. This comprehensive program comprises three subprograms: forest management, social forestry, and forest industries. Effective implementation of these initiatives can significantly expand Nigeria's forest cover, contributing to climate change mitigation and adaptation efforts and positioning the country to benefit from the global REDD+ program. The primary aim of the National Biodiversity Strategy and Action Plan (NBSAP) is to create a suitable framework and program tools for the preservation of Nigeria's biological diversity. This includes promoting its sustainable use to enrich the country's biodiversity and leverage its positive impact on climate change adaptation and mitigation strategies. NBSAP seeks to encourage the integration of biodiversity considerations into national planning, policies, and development plans (NBSAP, 2015).

On the other hand, the National Erosion and Flood Control Policy and its Action Plan aim to ensure a systematic and coordinated approach to managing and controlling erosion and flood hazards. The goal is to minimize their adverse impacts on the population and the environment.

Additionally, Nigeria introduced a new agricultural policy in 2001, aiming to achieve self-sufficiency in essential food supplies, boost agricultural raw material production for industries, enhance the production and processing of export crops using advanced technologies, and create job opportunities (AfDB

2005, FMARD 2001, Manyong et al 2003). This policy also seeks to reduce risks and uncertainties in agriculture, including those related to natural hazards like climate change, which can impact agricultural production and investment security. The policy framework covers various areas vulnerable to climate change impacts, including crops, livestock, fisheries, agro-forestry production, pest control, water resources, and irrigation.

Nigeria has an extensive coastline that stretches over 800 kilometers, featuring diverse geomorphological characteristics that are highly vulnerable to the impacts of climate change. Although a specific policy for coastal zone management has yet to be developed, the country is actively participating in the UNDP/UNEP/UNIDO/GEF project aimed at addressing coastal area degradation and the depletion of living resources within the Guinea Current Large Marine Ecosystem (GCLME) through regional initiatives. A significant result of this project is establishing a Strategic Action Programme to promote sustainable environmental management across the sub-region. Several measures within this initiative present promising opportunities for proactive adaptation responses to climate-induced changes in Nigeria's coastal environment.

In energy policy and planning, Nigeria's National Energy Policy outlines guidelines to protect the environment during fossil fuel exploitation. It highlights the importance of exploring renewable and alternative energy sources, particularly solar, wind, and biomass. Nigeria envisions a future in which renewable energy plays a crucial role, aiming for sustainable and affordable renewable sources to supply half of the nation's total energy demand by mid-century. This strategy will significantly help reduce greenhouse gas emissions and decrease the country's reliance on fossil fuels.

The health policy of Nigeria is closely linked to climate change adaptation, given the expected increase in climate-related health issues. The National Health Policy (NHP) 's primary aim is to improve Nigerians' health status and achieve health-related Millennium Development Goals (MDGs). Supporting the NHP's implementation are policies such as the National Adolescence Health Policy, the

National Reproductive Health Policy, and the forthcoming Nigerian Health Promotion Policy. These policies collectively seek to lower disease morbidity and mortality rates, tackle communicable diseases, and enhance Nigerians' overall quality of life and life expectancy in light of the challenges posed by climate change (National Climate Change Policy for Nigeria, 2021).

Moreover, Nigeria's transport sector faces vulnerability issues heightened by adverse weather conditions. The transport sector struggles with challenges such as a collapsed rail system, a weak civil aviation framework, and a poorly maintained road transportation network. Nigeria's comprehensive transport policy aims to tackle issues related to the economic regulation of urban transport, funding, land use and transportation planning, safety enforcement, institutional framework, and public-private partnerships within the transportation sector. Effectively implementing this policy is crucial for improving Nigeria's readiness to handle more severe weather conditions due to climate change. (National Climate Change Policy for Nigeria, 2021).

Department of Climate Change Unit (DCC): Nigeria has established a Department of Climate Change Unit (DCC) within the Federal Ministry of Environment in Abuja. The primary role of the DCC is to implement activities related to the Convention and protocols on climate change. It also serves as the coordinating body for the Inter-ministerial Committee on Climate Change, which includes representatives from various ministries such as Finance, Agriculture, Water Resources, the Energy Commission, the Nigeria National Petroleum Corporation (NNPC), Foreign Affairs, the Nigerian Meteorological Agency (NIMET), industry, NGOs like the Nigerian Environmental Study/Action Team, and academia. (National Policy on Climate Change, 2020).

Regarding afforestation initiatives, it is essential to recognize that afforestation serves as a significant response to mitigate the effects of climate change, with the Nigerian government actively participating in various afforestation programs. Nigeria is involved in the African Union Commission's "Green Wall Initiative," which aims to create a "green wall" of trees across the

country's arid regions. This initiative seeks to combat deforestation while promoting agriculture and sustaining livelihoods in the Sudano-Sahelian zone, addressing climate change in alignment with the United Nations Millennium Development Goals. Additionally, the Presidential Initiative on the Afforestation Program for Environmental Sustainability has established ambitious targets to plant approximately 40 million trees annually. The government acknowledges the urgent need to address climate change challenges and has prioritized them on the national development agenda. Efforts are being intensified to integrate climate risk considerations into national development projects and strategies, including NEEDS/SEEDs and the Economic Blueprint known as Vision 20:2020 (Casimir, Omeh, Ike 2014, Igbuzor 2009).

Related to Long-Term, Low-Emission Development Strategies (LT-LEDS), Nigeria, as a signatory to the Paris Agreement (PA), recognizes the crucial role of transitioning to low-emission development to achieve sustainable economic growth and reduce greenhouse gas (GHG) emissions while also yielding broader social, economic, and environmental benefits. In addition to its Nationally Determined Contributions (NDCs) outlining climate actions until 2030, the Paris Agreement, under Article 4.19, encourages all Parties to strive to develop and communicate LT-LEDS. This process considers common but differentiated responsibilities and respective capabilities, taking into account varying national circumstances. To fulfill this commitment, the Federal Government of Nigeria has initiated the development of its LT-LEDS, starting with an initial focus on a Long-Term Vision extending to 2050 for the nation. This vision provides a clear sense of direction for all stakeholders, guiding them in effectively managing the transition to a low-carbon economy. This transition aims to stimulate the growth of existing and emerging sectors, creating new jobs and economic opportunities for the country.

Challenges and Strategies for Enforcing Environmental Laws in Nigeria

The enforcement of environmental laws in Nigeria encounters significant challenges that undermine efforts to tackle environmental degradation and foster

sustainable development. It has been identified that poverty, selfishness, insecurity, militancy, low levels of environmental awareness, and corruption are key factors contributing to the limited implementation of environmental regulations in the country. These challenges are intensified by weak institutional capacity, a lack of political will, insufficient funding, and the absence of regulations. Consequently, the lack of awareness about environmental laws complicates enforcement efforts, leading to widespread environmental non-compliance.

A critical aspect of improving environmental law enforcement in Nigeria is enhancing the welfare of enforcement officers. Undeniably, better compensation, capacity-building incentives, and providing necessities such as food, clothing, and shelter for enforcement officers could contribute to achieving sustainable development goals. The rationale behind this approach is that well-compensated and motivated officers are more likely to perform their duties, thereby improving enforcement outcomes diligently.

However, addressing endemic corruption within enforcement agencies is crucial. It is important to note that tackling corrupt practices among enforcement officers requires stringent penalties, including dismissal, to deter others and uphold the integrity of environmental law enforcement. Failing to address corruption severely undermines environmental security and worsens climate change issues in Nigeria, as it allows for the continued violation of ecological laws without consequences. Furthermore, modern technology can be transformative in monitoring and enforcing environmental regulations. Technologies such as satellite imagery, Geographic Information Systems (GIS), and drones can provide real-time data and evidence of environmental violations, thereby improving the ability of enforcement agencies to detect and address infractions. However, despite the availability of such technologies, their use has been limited due to institutional and financial challenges.

A notable challenge in enforcing environmental laws in Nigeria is the gap between international multilateral ecological treaties and their domestic

incorporation. Although Nigeria is a signatory to numerous international environmental agreements, many of these treaties have not been fully integrated into domestic law, which undermines the country's legal framework for environmental governance. This gap hinders enforcement agencies' ability to hold violators accountable under international standards and limits the legal remedies available within the domestic legal system.

Institutional efficiency is also worth mentioning. It is a critical determinant of effective environmental law enforcement in Nigeria. The National Environmental Standards and Regulations Enforcement Agency (NESREA) is the primary institutional agency responsible for environmental governance in the country. NESREA's mandate includes formulating ecological research and technology policies, conserving biodiversity, promoting the sustainable development of natural resources, and providing advisory support to the Federal Government on environmental issues (Njoku and Enebeli, 2023: 144).

Despite NESREA's broad mandate, the agency has encountered significant challenges in enforcing environmental laws. The difficulty in apprehending and prosecuting violators has resulted in ongoing environmental degradation. Moreover, NESREA's limited success in enforcing environmental regulations underscores the more significant issue of institutional inefficiency within Nigeria's environmental governance framework. This inefficiency stems partly from inadequate funding, bureaucratic delays, and poor inter-agency coordination, which undermines the agency's ability to fulfill its mandate effectively. Therefore, while NESREA plays a critical role in environmental governance in Nigeria, the enforcement challenges need urgent attention. Improved enforcement mechanisms, stricter adherence to environmental regulations, and institutional reforms are essential for addressing the persistent environmental issues faced by Nigeria. Strengthening the enforcement of environmental laws is crucial for protecting the environment, promoting sustainable development, and mitigating the impacts of climate change in Nigeria.

Final Remarks

Given the preceding discussion, a wealth of literature exists that presents various studies and opposing viewpoints on the effects of climate change on environmental security and whether climate-induced environmental stress serves as a catalyst for interstate conflicts. Notably, there seems to be considerable consensus among security policy experts and multiple non-governmental organizations that view climate change as a threat multiplier in conflict scenarios.

It is undeniable that climate change represents a tangible and undeniable phenomenon that the global community is grappling with. The repercussions of climate change and its role as a threat multiplier are observable in both the northern and southern hemispheres, albeit with varying degrees of impact influenced by each continent's unique characteristics and the effectiveness of their adaptive and mitigating measures. The effects of climate change and its potential catalysts have led to severe consequences for Nigeria's environment.

These consequences include dwindling fish stocks, loss of biodiversity and ecosystem services, exacerbated poverty, diminished freshwater resources, heightened disease burdens, infrastructure damage, resource scarcity, crop failures, and reduced agricultural yields, which result in food insecurity. Furthermore, climate change exacerbates gender inequalities, as women often bear the brunt of providing for their families under increasingly challenging circumstances.

Furthermore, climate change's adverse impact includes the depletion of forest reserves and wetland destruction, which results in the loss of essential ecosystem services, such as food, medicine, and carbon sequestration. From a perspective aimed at addressing climate change threats, the Nigerian National Security Strategy (NSS), launched in 2019, recognizes forests as critical national assets and forest conservation as a strategic imperative.

Effectively addressing climate change adaptation requires the collective response of both state and non-state actors. It is widely acknowledged that state actors alone cannot adequately confront the challenges posed by climate change. In response, the Nigerian government has established various institutional frameworks and formulated numerous policies to mitigate climate change and its effects on human security. Despite achieving significant milestones, environmental agencies in Nigeria have struggled to apprehend and prosecute offenders, leading to further environmental degradation.

The overarching inability of responsible agencies to protect the environment through the effective implementation and enforcement of relevant regulations and laws arises from several factors. These factors include deficiencies in the legal framework, institutional bottlenecks, corruption, inadequate funding, governance issues, intimidation, and a lack of awareness. Despite the numerous environmental protection laws, enforcing the right to a clean and healthy environment remains a work in progress in Nigeria. Consequently, addressing climate change challenges also involves addressing security threats. States must tackle the underlying causes of climate change to mitigate these security risks effectively.

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CHAPTER 3

CLIMATE CHANGE IN NIGERIA: FROM FLOODING, TEMPERATURE VARIATIONS, AND DROUGHT PERSPECTIVES

ABSTRACT

This paper assesses the impact of Climate change in Nigeria through the lens of existing literature. Drawing upon a widespread review of academic literature, government reports, and scholarly articles, this paper summarizes existing knowledge and identifies research gaps which include lack of integrated research that addresses the combined and interconnected effects of different climate-related hazards in Nigeria, as well as the role of indigenous knowledge in climate adaptation. The research findings indicate that Nigeria faces significant and diverse impacts from Climate Change, including increased flooding, temperature variations and drought. These challenges threaten ecosystems, agricultural productivity, infrastructure, public health, and overall human livelihood. It recommends that future research endeavors are essential for enhancing our understanding of climate change impacts and informing the development of effective adaptation strategies that are inclusive, sustainable, and tailored to the needs of diverse communities in Nigeria and its regions.

Keywords: Climate change; Floods; Temperature variations; Drought; Adaptive strategies

INTRODUCTION

Global climate change stands as one of the most formidable challenges of our time, affecting natural systems and human societies with increasing severity. Increasing global temperatures, changing precipitation, and more frequent extreme weather events have greatly disrupted ecosystems and socio-economic systems. These climatic shifts impact environmental processes globally and increase specific risks such as rising CO₂ concentrations, flooding, temperature extremes, rising sea levels, and prolonged droughts, among others. The consequences of these phenomena extend far beyond environmental degradation, impacting water resources, agricultural productivity, infrastructure, and public health.

Globally, rising anthropogenic activities and waste contribute to environmental stress while climate change continues to drive ecological disruption. While natural processes such as the weathering of rocks and volcanic activities contribute to baseline heavy metal levels in soils, human activities, on the other hand, including industrial operations, mining, waste disposal, and urbanization, have dramatically increased pollutant loads in the environment [3]. In this context, Nigeria is particularly vulnerable. With its vast geographical diversity, ranging from the arid regions of the north to the humid tropics of the south, Nigeria faces a wide range of climatic challenges that are becoming increasingly pronounced due to global warming.

Flooding, for instance, is emerging as a recurrent disaster in several Nigerian urban centres. Cities like Lagos and Makurdi have seen catastrophic floods, with events such as the 2012 floods displacing millions of people and causing extensive damage to infrastructure and agriculture across thirty states in the country. These floods are often not solely a result of intense rainfall but are compounded by poor urban planning, deforestation, and inadequate drainage systems. Moreover, the disruption caused by floods extends beyond immediate physical damage to include long-term socio-economic consequences, such as

loss of livelihoods and increased vulnerability to waterborne diseases (Echendu, 2020).

Increase in temperature, drought, flooding are another critical evidence of climate change that has a profound impact on Nigeria (Ayeni et al, 2022). It could cause global warming. This warming not only worsens the intensity of heatwaves, increasing the risk of heat-related illnesses among urban populations, but also affects agricultural productivity by accelerating the desiccation of arable land and reducing crop yields. The combined effects of higher temperatures and altered rainfall patterns further contribute to the occurrence of droughts, particularly in the northern Sahelian regions. Prolonged drought conditions reduce water availability, jeopardize food security, and intensify socio-economic challenges, often leading to resource conflicts and forced migration.

Urbanisation and rapid population growth in Nigeria add yet another layer of complexity (Adedeji,2023). Many Nigerian cities are expanding without adequate infrastructure development, leading to unplanned settlements that are highly susceptible to climate-induced disasters. Informal settlements, often located near water bodies or on low-lying land, face an increased risk of flooding and water contamination due to inadequate drainage and waste management practices. Furthermore, these urban centres experience the urban heat island effect, where the concentration of buildings, roads, and other impervious surfaces increases local temperatures even further.

Despite the recognised threats posed by climate change, a notable gap persists in the comprehensive assessment of its multifaceted impacts on Nigeria. While studies have individually examined phenomena such as flooding, drought, rainfall disparities, and temperature variations, few reviews have integrated these elements into a cohesive analysis that addresses the regional and socio-economic nuances of Nigeria's diverse climate. Moreover, there is limited attention given to the intersection of scientific data with indigenous knowledge and local adaptation strategies, factors that are critical in developing effective and sustainable responses to climate change challenges. Thus, this review sought to

review the existing literature on climate change impacts in Nigeria, focusing on flooding, temperature variations, and drought to specifically elucidate the underlying drivers of climate-related hazards and their subsequent effects on infrastructure, agriculture, and public health.

Theoretical framework for an assessment of climate change impact in nigeria

Climate change is a global phenomenon characterized by shifts in weather patterns and temperature variations, presenting a significant threat to environmental stability and human livelihoods, particularly in developing countries such as Nigeria (Okon et al, 2021). Thus, this paper examines the impact of climate change on floods, temperature variations, and drought in Nigeria. The theoretical framework guiding this research paper draws upon the Vulnerability Framework. The vulnerability framework is believed to provide understanding of how societies are vulnerable to the impact of climate change in Africa and demands adaptive capacities(Diaz-Sarachaga et al, 2020).

The Vulnerability Framework as Adger (2006:268-281) emphasize the susceptibility of social and ecological systems to climate change impacts. In the context of Nigeria, this framework is particularly relevant as it addresses the country's inherent vulnerabilities due to socioeconomic factors such as poverty, population density, and dependence on climate-sensitive sectors such as Agriculture. The framework posits that the degree of vulnerability is influenced by exposure to climate risks (e.g., floods, temperature extremes, droughts), sensitivity (e.g., the extent to which people and ecosystems are affected) and adaptive capacity (the ability to adjust to potential damage, take advantage of opportunities or respond to consequences).

This framework is supported by studies highlighting the disproportionate impact of climate change on marginalized communities in Nigeria. For instance, Adamaagashi et al (2023) argued that the rural populations in Nigeria are more vulnerable due to their limited access to resources and information necessary for

effective adaptation strategies. This perspective is crucial in understanding the uneven distribution of climate change impacts across different regions and communities in Nigeria

Overview of climate change in Nigeria

Nigeria has experienced notable shifts in its climatic regime over recent decades, reflecting both global warming trends and regional factors that uniquely shape the country's weather patterns. Historical climate records indicate that average temperatures have risen gradually, mirroring the global trend attributed to increased greenhouse gas emissions from anthropogenic activities. According to Haider (2019) the significant evidence in Nigeria's climate change has been an increase in temperature, a rise in sea level, variable rainfall, drought and flooding. This warming trend is accompanied by erratic precipitation patterns that have led to both intense rainfall and prolonged dry spells. The World Bank in Hoornweg [20] emphasises that such alterations in Nigeria's climate are not merely a local phenomenon; they are part of a broader global pattern observed since the advent of the industrial revolution. These climatic changes have significant implications for the nation's hydrology, agricultural productivity, and overall environmental stability. Future projections based on regional climate models predict that if current emission trends persist, Nigeria could witness further temperature increases, exacerbating the extremes of both flooding and drought. Moreover, the frequency of intense rain events is expected to rise, raising concerns about urban flooding, infrastructure damage, and the spread of waterborne diseases.

In parallel with global warming, Nigeria's climate is characterised by its remarkable regional diversity, which plays a critical role in mediating the impacts of climate change. The country spans several climatic zones, from the arid Sahel in the north to the tropical rainforests in the south, with transitional savannah and semi-arid regions interposed between. Figure 2 (A) illustrates potential climate variability across various Nigerian regions, while Figure 2 (B) depicts the detection of floods along the basins of Nigeria's two major rivers: the Niger and Benue. These geographical variations mean that while northern areas are

increasingly vulnerable to drought and desertification, the southern regions face different challenges, primarily heavy rainfall and flooding. This inherent climatic heterogeneity further complicates both the assessment of impacts and the formulation of effective adaptation strategies. For instance, studies such as those conducted by Gana, Sadiq have illustrated that decreased and erratic rainfall in northern Nigeria has reduced soil moisture and agricultural productivity, intensifying water scarcity and food insecurity. In contrast, urban centres such as Lagos, which is located in the southern geopolitical zone, are grappling with the dual challenges of rising sea levels and extreme precipitation events, which lead to recurrent flooding and disruptions in urban drainage systems. Such divergent patterns necessitate region-specific adaptation policies that are sensitive not only to the magnitude of climatic shifts but also to local socioeconomic conditions and the existing state of infrastructure.

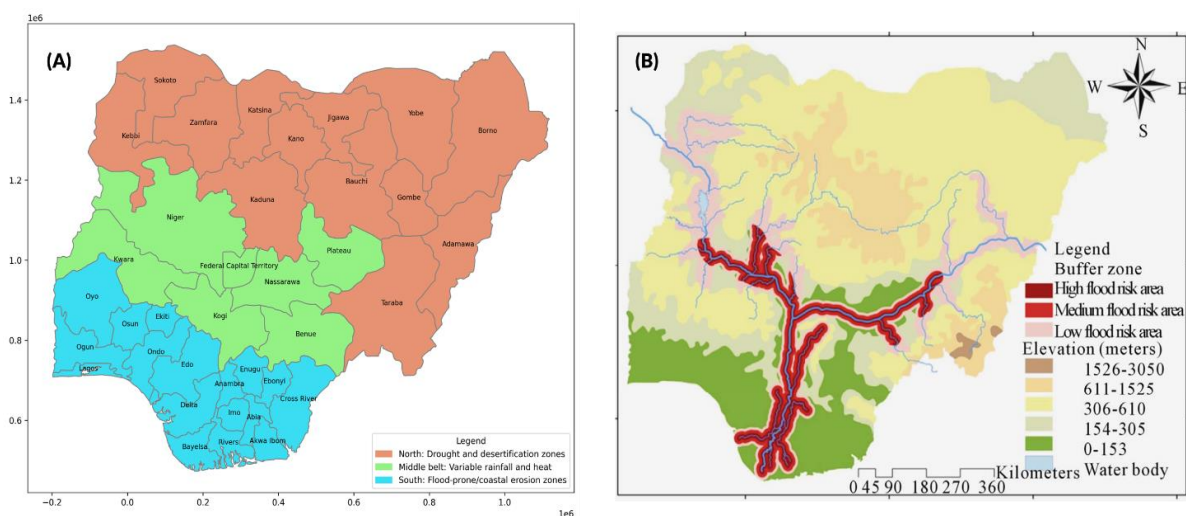


Figure 2: Map of Nigeria showing possible climate variability (A), and the flood risk detection of Nigeria along the Niger-Benue basin sourced from Nkeki, Henah (B)

The contrasting climatic regions of Nigeria underscore the complex interplay between natural climate variability and anthropogenic influences. The long-term climate records suggest that natural cycles, such as those driven by ocean-atmosphere interactions (e.g., the El Niño/Southern Oscillation), further

modulate Nigeria's climate (Salau et al., 2016). These phenomena add a layer of complexity to the already unpredictable weather patterns, sometimes intensifying dry conditions in the Sahel or increasing the frequency of heavy rainfall events in coastal areas. According to Balogun & Onokerhoraye(2020) the Niger Delta Region of Nigeria is particularly vulnerable to climate change given its extensive coastline, crude oil drilling and refining activities, and the high population of people dependent on agriculture. It could be equally inferred that vulnerability to climate change in Nigeria is not uniform; it could varies depending on local topography, land use patterns, and population density. For example, urban areas with dense populations and poor drainage infrastructures experience intensified urban heat island effects and flash flooding compared to rural areas where natural vegetation may offer some buffering capacity.

Moreover, the socio-economic dimensions of climate change in Nigeria further complicate the picture. The rapid pace of urbanisation, deforestation, and industrial expansion has altered environmental landscape and lifestyle, climate and ecosystem (Oladunmoye, 2024) These human-induced changes, combined with natural geographical diversity, have led to scenarios where the same climatic event can trigger quite different outcomes depending on where it occurs. In poorly planned urban settlements, heavy rainfall may overwhelm inadequate drainage systems (Bibi et al, 2023) while in agricultural areas, similar rainfall could improve soil moisture if managed effectively (Afolabi et al 2009). Such dichotomies highlight the importance of developing regionally tailored adaptation measures that address both environmental and socio-economic challenges.

Impacts of climate change on nigeria's environment and society

Climate change in Nigeria manifests in various interconnected ways, impacting hydrological systems, temperature regimes, water resources, ecosystems, and socio-economic stability. Its effects on infrastructure, agriculture, public health, and overall community welfare are both immediate and distant, depending on the specific drivers involved. Therefore, it is essential to

discuss significant climate crises in relation to factors affecting societal well-being.

Impacts on hydrological systems and flooding

Nigeria has experienced an escalating frequency of extreme rainfall events in recent years that, when combined with inadequate urban drainage, have led to recurrent flooding. Metropolitan centres, like Lagos, have been especially impacted as flooding not only damages critical infrastructure, including homes, markets, and public utilities, but also disrupts transportation networks. Table 1 presents some impacts of flooding crises in Nigeria between 2011 and 2020, as reported by Beitelmal, Nwokolo. The documented impacts reveal that such events contribute to large-scale displacement of communities and foster conditions for waterborne disease outbreaks, as contaminated floodwaters increase exposure to pathogens (Ahmed, Yan, & Ahmed, 2018). Consequently, the economic repercussions are considerable, with recurring floods imposing long-term burdens on municipal budgets through escalating repair costs of infrastructure and facilities.

Table 1. The effects of flooding in Nigeria on people and the economy during the period from 2011 to 2020

Year	Effects		
	No. of People	Death Recorded	Economic damages (\$)
2011	30,915	174	4,500
2012	7,000,867	363	500,000
2013	81,506	19	n.a
2014	10,000	15	n.a
2015	100,420	53	25,000
2016	12,000	18	n.a
2017	10,500	20	n.a
2018	1,938,204	300	275,000

2019	123,640	36	n.a
2020	193,725	189	100,000
Total	9,501,777	1,187	904,500

Adapted from Beitelmal, Nwokolo. n.a: not available

Climate change further exacerbates these flooding incidents in Nigeria by altering precipitation patterns and raising global temperatures (Haider, Huma, 2019).

From Table 1, 2012 was heavily hit by floods, more than ever recorded in the past 4 decades, affecting over 7 million people in 34 states of the country, out of which more than 300 were confirmed dead, coupled with several thousand economic damages. In 2022, Nigeria experienced severe flooding that impacted most states, leading to extensive damage and displacement of many residents. These incidents were attributed to two events: prolonged heavy rainfall lasting days, and the release of the Lagdo Dam in northern Cameroon. While dam releases played a role in flooding in Nigeria, other contributing factors include tidal movements causing river and ocean surges, poor urban planning, and high population density.

The destructive effects of flooding on infrastructure, agriculture, and human settlements are well documented. Flood events disrupt transportation networks, damage critical infrastructure, and reduce crop yields, thereby affecting the overall economic stability and food security of the country. In an investigation of Lake Iyieke in Southeastern Nigeria, Nwonumara and Okogwu (2013) examined the effects of flooding on water quality and the composition of zooplankton communities. Their canonical correspondence analysis revealed the significant roles played by environmental variables, such as temperature, pH, transparency, conductivity, and total dissolved solids, in shaping zooplankton dynamics. Although this study provides valuable short-term insights, it leaves gaps in understanding the long-term ecological implications of recurrent flooding and the adaptability of zooplankton populations over extended periods.

Similarly, Okogwu and Ugwumba (2012) examined phytoplankton responses to water level fluctuations in Cross River floodplain lakes in West Africa. Their research showed significant differences in environmental parameters between low-water and high-water periods, underscoring the influence of hydrological changes on phytoplankton communities. However, despite their detailed environmental analysis, the study did not sufficiently address the impact of anthropogenic activities, like pollution and habitat destruction, on these ecosystems. This omission suggests that while natural hydrological factors are critical, human-induced alterations could further complicate ecosystem dynamics and require more integrated analysis in future research.

In addition to the environmental and ecological dimensions, flooding has pronounced social impacts, displacing communities and jeopardising livelihoods, especially in informal settlements and slum areas that lack adequate infrastructure (Asongu & Nnanna, 2019). Flood vulnerability in Nigeria is driven by a confluence of factors, including inadequate infrastructure, poor urban planning, weak institutional frameworks, rapid urbanisation, deforestation, and the resulting loss of natural absorptive capacity (Ahmed, Yan, & Ahmed, 2018). While studies such as those by Igwe, Zarei, and Stahr (2022) provide nuanced insights into soil mineral distributions on the River Niger floodplain.

Collectively, these studies illustrate that flooding in Nigeria is driven by a complex interplay of climatic and anthropogenic factors. Addressing these challenges requires robust and integrated policy responses that not only improve urban planning and drainage infrastructure but also enhance ecosystem management and community preparedness. As climate change continues to alter hydrological cycles and intensify rainfall events, further research is essential to develop long-term, sustainable adaptation strategies that mitigate the adverse effects on infrastructure, agriculture, and public health across Nigeria.

Impacts on temperature and heatwaves

Rising ambient temperatures in Nigeria, particularly across the northern and arid regions, are having profound implications on agriculture (Ahmed, Alhaji, & Pindiga, 2020). In regions where agriculture constitutes a primary livelihood, these modest temperature rises intensify irrigation demands and accelerate desertification processes. The overall effect is a decline in the economic viability of farming practices and a threat to national food supplies, thereby underscoring the urgency of developing adaptive agricultural practices and policies.

Recent empirical studies demonstrate that Nigeria has experienced a discernible upward trend in mean annual temperatures over the past few decades. Abatan et al. (2015) a significant increase in the average temperature, attributing this pattern to global climate change. Such rising temperatures are anticipated to further stress agricultural systems, particularly by altering the length of the growing season and affecting soil moisture levels. This trend calls for more robust research to project future temperature scenarios and to develop region-specific adaptation strategies for farmers facing changing climatic conditions.

Urban areas in Nigeria exacerbate the challenges posed by rising temperatures through the urban heat island effect. Dense concrete structures, extensive asphalt surfaces, and minimal vegetation cover combine to raise local temperatures significantly above those in surrounding rural areas. This intensification of heat not only promotes more frequent and severe heatwaves but also increases the incidence of heat-related illnesses such as heatstroke, dehydration, and cardiovascular events among urban residents (Namaita Yadav et al.,). The heightened urban temperatures also drive-up energy consumption for cooling purposes, further straining power grids and escalating household energy costs (Santamouris, 2020). These factors add an extra layer of stress to urban public health systems, which already face the challenges of rapid population growth.

Beyond the direct agricultural impacts, rising temperatures influence broader aspects of water resource management. Laraib et al (2024) report that increased temperatures contribute to a disrupted hydrological cycle by accelerating evaporation, thereby reducing water availability. This dual impact on both crop productivity and water resources means that communities must cope with not only diminished yields but also the challenges of securing adequate water supplies, a problem that could compound food insecurity in vulnerable regions.

Research by Adelekan et al. (2012:45) emphasizes the critical role of urban planning measures, such as the development of green spaces, the incorporation of reflective building materials, and the implementation of early warning systems for heatwaves to mitigate the urban heat island effect. Complementing these strategies, studies utilizing geospatial technologies, as demonstrated by Mahmoud Ibrahim Mahmoud et al. (2016), reveal that rapid urban growth in cities like Abuja is eroding natural cooling mechanisms. This underscores the necessity for integrated urban development policies that balance expansion with environmental sustainability to protect public health while maintaining agricultural productivity.

Impacts on drought and water resources

Drought conditions in Nigeria, particularly in the Savanna regions (see Figure 3A), represent one of climate change's most severe and persistent challenges. According to reports, these regions have experienced drought almost annually since 1981. The risk levels affecting the exposed populations are depicted in Figure 3B. Prolonged drought reduces soil moisture and hampers plant growth, directly leading to significant agricultural yield declines. Rural communities that depend on rain-fed agriculture suffer acute water shortages, which force a greater reliance on poorly developed irrigation systems. This water deficit not only undermines crop production but also destabilises local food security, contributing to rural poverty and diminishing overall community resilience (Nadal et al., 2015;). Moreover, the recurring nature of drought

incidents in semi-arid regions of Nigeria aggravates these challenges, leaving farmers with little buffer to absorb shocks and forcing many smallholder farmers to face the dual burden of low productivity and increased production costs.

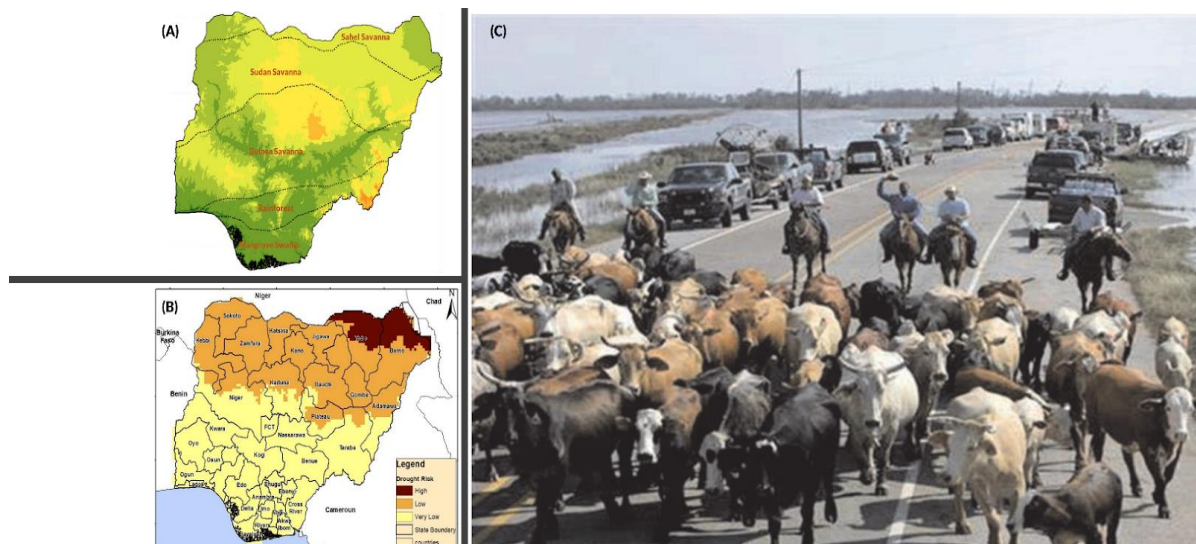


Figure 3: Drought risk in Nigeria and its implications. (A) Topography and eco-climatic zones of Nigeria; (B) Drought risk map of Nigeria; and (C) Fulani herdsmen migrating southwards with their cattle, obstructing transportation.

Beyond its immediate impact on crop yields, drought has wide-ranging socio-economic repercussions across Nigeria. The scarcity of water intensifies competition among agricultural, industrial, and domestic sectors, often resulting in conflicts over access to limited water resources. This competition drives up the costs of water and irrigation, placing a heavy financial burden on already vulnerable rural populations. Reduced water availability exacerbates food insecurity as rising costs and declining yields combine to lower overall food production, which in turn drives up market prices and further strains local economies. Such economic pressures can lead to broader social instability, as communities experience heightened stress over dwindling resources and diminished livelihoods. The interplay between these factors means that drought not only disrupts agricultural production but also has cascading effects on regional development and socio-political stability.

In addition to these economic challenges, drought conditions also play a critical role in driving migration and igniting socio-ecological conflicts in Nigeria. The drought-migration nexus is well documented in studies such as those by Ajaero, Mozie, which show that prolonged water scarcity in the Sahelian region forces rural inhabitants, including farming communities and pastoralists, to relocate in search of more favourable environmental conditions. Figure 3C illustrates the southward migration of cattle and their rearers. This migration often leads to conflicts over land and water resources when migrant populations settle in areas already under stress. Such conflicts can exacerbate existing social tensions and undermine efforts to develop effective adaptation strategies. Although Ajaero, Mozie provided a comprehensive analysis of these interconnections, their work also highlights the gap in policy responses that could better mediate such conflicts and build resilience among the most affected communities. There is a pressing need for more targeted research into the socio-cultural dynamics of these migration patterns and conflict drivers to develop more robust, community-based adaptation policies.

The environmental consequences of drought extend well beyond agriculture and migration. Reduced water availability disrupts ecosystem processes by impairing plant and microbial functions essential for maintaining soil fertility, carbon sequestration, and overall ecosystem productivity. When precipitation declines, soil organic matter decreases, and the natural regeneration of vegetation is stifled. These conditions further exacerbate land degradation and contribute to desertification, particularly in the northern parts of Nigeria. These environmental shifts create a feedback loop where degraded soils and reduced vegetation cover further diminish the region's ability to retain water, intensifying the drought conditions. Consequently, biodiversity loss and habitat degradation become increasingly severe, undermining ecosystem services vital for both natural environments and human communities. The decline in ecosystem health resulting from prolonged drought underscores the urgency for more integrated research approaches that combine ecological monitoring with socio-economic analyses to capture the full spectrum of drought impacts.

Despite the growing body of literature on drought and its various impacts, significant research gaps remain that hinder the development of effective adaptation strategies and policy interventions. Future research must employ advanced modeling techniques to better understand the spatiotemporal patterns of drought occurrence across Nigeria and predict future trends under various climate scenarios. This information is critical for designing region-specific adaptation strategies that address the unique vulnerabilities of different communities. Additionally, there is a need to explore in depth the socio-economic and cultural dimensions of drought impacts, particularly how water scarcity and declining agricultural productivity influence migration patterns and conflict dynamics among rural populations. Studies that integrate indigenous knowledge with modern scientific approaches can offer valuable insights into locally appropriate adaptation measures. Policymakers require this comprehensive understanding to implement innovative interventions, like improved irrigation infrastructure, sustainable water management practices, and targeted financial support, to enhance the resilience of agriculture and rural livelihoods. Addressing these research gaps through interdisciplinary collaboration will be essential for developing robust, evidence-based policies that mitigate the adverse effects of drought and safeguard Nigeria's socio-economic future.

Impacts on ecosystems and biodiversity

Climate change is causing widespread alterations in Nigeria's ecosystems, manifesting through shifts in species distribution, changes in reproductive cycles, and increased rates of local extinction. Extreme weather events, including both flooding and drought, disrupt ecological processes and reduce the stability of natural habitats. For instance, coastal wetlands and forests that serve as critical carbon sinks and biodiversity reservoirs are under threat from sea-level rise and intensified drought conditions. Loss of biodiversity not only diminishes the resilience of ecosystems but also undermines the natural services, such as soil conservation and water regulation, that communities depend on for survival (Salau et al., 2016).

The impacts of climate change are not uniform across Nigeria; regional variability plays a significant role. Southern regions face more frequent flooding and coastal erosion, whereas northern areas struggle with persistent drought and desertification. This diversity in climate impacts necessitates region-specific strategies to bolster ecosystem resilience. Although some ecosystems exhibit adaptive capacities and recovery mechanisms, continuous anthropogenic pressures, such as deforestation and urban expansion, limit these natural processes and accelerate ecosystem degradation.

Impacts of climate change on socio-economic and public health

Climate change in Nigeria has inflicted severe economic shocks on both national productivity and local livelihoods. Recurrent flooding damages critical infrastructure, leading to costly repairs and renovations. At the same time, prolonged droughts, particularly in the semi-arid Sahelian zone, diminish agricultural yields and erode water resources. These dual stressors lower household incomes in rural communities, drive food prices upward, and ultimately hinder overall economic growth. As a result, the nation faces not only immediate economic losses but also long-term challenges in sustaining development, indicating an urgent need for resilient infrastructure and climate-adaptive economic policies (Nadal et al., 2015).

In rural regions, drought conditions are especially crippling for agriculture, a sector on which a large segment of Nigeria's population depends. Reduced soil moisture and declining water availability force farmers to rely more heavily on underdeveloped irrigation systems, which leads to increased operational costs and reduced productivity. The resulting scarcity not only diminishes crop output but also intensifies food insecurity, deepening rural poverty and compelling many to migrate in search of more viable livelihoods.).

The public health implications of climate-induced phenomena such as floods and droughts are equally grave. Floods often lead to the contamination of water supplies, sparking outbreaks of waterborne diseases, direct water borne

diseases like typhoid, cholera, pneumonia, diarrhoea and malaria (Eke& Onafalujo, 2023) In contrast, drought conditions exacerbate malnutrition with implications for morbidity and mortality (Stanke, et al 2013).

Beyond these health impacts, the socio-economic destabilization brought about by climate change contributes indirectly to widespread public health challenges. The erosion of agricultural productivity and subsequent food insecurity often force communities to reallocate limited resources, reducing expenditure on healthcare and weakening the capacity of families to cope with emergent health crises. Economic hardship tends to reduce access to essential services, including clean water, sanitation, and medical care, which exacerbates the spread of infectious diseases and impairs the resilience of local health infrastructures (Nadal et al., 2015).

Further complicating the picture, climate-induced drought has become a significant driver of migration and socio-ecological conflict in Nigeria. Studies indicate that the drought-migration nexus has led to intensified competition for scarce resources, particularly between pastoralists and settled farming communities, thereby fueling conflict, and undermining regional stability (Ajaero et al., 2015). The displacement of people due to drought not only disrupts social structures but also deepens existing vulnerabilities, as displaced populations face challenges in accessing healthcare, education, and income-generating opportunities. This mass migration underscores the urgent need for integrated adaptation strategies that address both socio-economic stability and public health resilience.

Considering these challenges, future policies must incorporate comprehensive adaptation strategies to mitigate the socio-economic and public health impacts of climate change. Effective policy responses should include the development of sustainable water management systems, investment in resilient agricultural technologies, and the establishment of robust social safety nets to protect the most vulnerable populations. Strengthening public health systems is equally critical; governments must prioritize improving disease surveillance,

emergency response, and mental health services to counter the multifaceted health impacts of climate stressors. Such integrated approaches will be essential in building a resilient Nigeria capable of confronting the growing challenges posed by climate change (Ajaero et al., 2015;).

Integration of impacts: vulnerability, adaptive capacity, and policy implications

To better visualise the interconnected effects of climate change in Nigeria, we propose a conceptual framework (see Figure 4) that maps how environmental drivers (e.g., flooding, drought, heatwaves) cascade into sectoral disruptions, ultimately shaping vulnerability and adaptive capacity. Climate change disproportionately impacts the most vulnerable segments of Nigerian society. Rural communities, informal urban settlements, and low-income households often lack the financial resources and infrastructural support needed to adapt to extreme weather conditions.

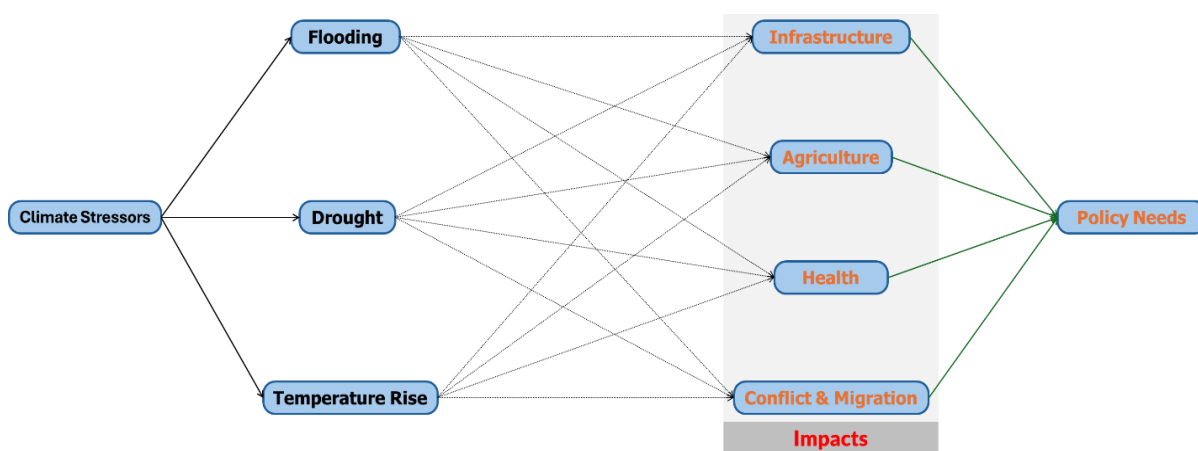


Figure 4. Conceptual framework showing how climate stressor affects infrastructure, health, agriculture, and migration, leading to policy needs

The complex and multifaceted impacts of climate change demand a coordinated policy response that integrates environmental management with socio-economic development. Effective adaptation strategies must encompass improved urban planning, robust early warning systems, sustainable water

management, and climate-smart agricultural practices. Policy frameworks should also enhance public health systems to better manage and mitigate the consequences of extreme weather events. Government interventions, alongside international cooperation and public education initiatives are critical for developing resilient infrastructure and adaptive capacity, (Ajala, 2019). Integrated policy measures will be essential to addressing the myriad effects of climate change and ensuring a sustainable future for Nigeria.

Current adaptation strategies and policy responses

Climate change in Nigeria has necessitated the development of varied adaptation and mitigation measures to safeguard vulnerable populations, protect critical infrastructure, and maintain sustainable economic and environmental systems. In response to the adverse effects of flooding, drought, and temperature extremes, a range of strategies have been proposed and, in some cases, implemented by both government agencies and local communities.

Adaptation measures for extreme weather events

Adaptation responses in Nigeria are multifaceted and vary according to the specific climate hazard. In urban areas, where rapid, unplanned development often exacerbates the impacts of heavy rains and floods, improving infrastructure has become a central priority. Researchers such as Onuoha et al. (2024) emphasise the critical role of Urban planning and design which are among the most effective tools in dealing with climate change, because of the fact they address both mitigation and adaptation. She further emphasise that spatial plans directly control the physical development of the city by giving permission for various infrastructures like transportation, industries, housing and resource allocations. However, sustainable urban planning includes, the construction of robust drainage systems, flood zoning regulations, and flood-resistant building codes. These measures are intended not only to reduce physical damage to infrastructure but also to minimise displacement and health risks associated with flooding. In rural and agricultural regions, adaptation strategies are equally

imperative. For instance, water scarcity caused by prolonged droughts has prompted the adoption of climate-smart agriculture practices, such as the introduction of drought-resistant crop varieties, improved irrigation systems, and the diversification of crops. Ajibade and McBean (2018) document the need for these adaptive measures to protect food security and livelihoods, noting that even modest changes in temperature and precipitation patterns can significantly affect crop yields and water resource availability.

Additionally, communities have initiated localised early warning systems and disaster preparedness programs. Ahmed, Yan, and Ahmed (2018) underscore the importance of community-based approaches that combine conventional meteorological monitoring with indigenous knowledge to forecast extreme events. Such systems facilitate timely evacuations and bolster the resilience of vulnerable groups, although research points to persistent gaps in the breadth and effectiveness of these initiatives across Nigeria's diverse socio-economic landscapes.

Mitigation strategies for reducing greenhouse gas emissions

In parallel with adaptation measures, mitigation strategies targeting the root causes of climate change have been increasingly prioritised in Nigeria. A key focus is the transition from fossil fuel dependency to renewable energy sources. National initiatives are underway to promote clean energy options such as solar, wind, and bioenergy, which directly contribute to reducing greenhouse gas emissions. Efforts under global frameworks, such as the Paris Agreement, have reinforced this national focus by setting emission-reduction targets that incentivise investments in low-carbon technologies (IPCC, 2022;)Beyond the energy sector, mitigation strategies include reforestation, afforestation, and the sustainable management of natural ecosystems to enhance carbon sequestration. These ecological approaches not only offset emissions but also improve biodiversity and reinforce ecosystem services. Studies by Awewomom et al. (2024) have demonstrated that aligning national policies with international environmental goals can lead to robust mitigation frameworks; however, the

effective implementation of these strategies remains contingent on overcoming technical, financial, and institutional barriers.

Technological innovations in adaptation and mitigation

Technological advancements play a critical role in supporting both adaptation and mitigation efforts. Nigeria has witnessed the gradual integration of advanced forecasting models, remote sensing techniques, and digital monitoring systems that improve the precision of extreme weather predictions. (Pienaaah et al, 2023), posit that early warning systems enhances climate preparedness. Moreover, climate-smart agricultural technologies, such as precision irrigation, soil moisture sensors, and mobile weather applications, facilitate adaptive farming practices that are vital for coping with drought and temperature variability

In the energy sector, significant investments in clean technology have led to advances in carbon capture and storage (CCS) systems, as well as improvements in grid management to accommodate intermittent renewable energy sources. Such technological innovations are essential for lowering the carbon footprint of Nigeria's energy sector and for supporting wider sustainable development goals. While promising, the transfer and localization of these technologies still face challenges related to cost, technical expertise, and the need for tailored solutions that reflect Nigeria's diverse environmental conditions.

Policy frameworks and institutional responses

Institutional and policy responses are fundamental to both adaptation and mitigation strategies. Nigeria's national climate change policies, which align with international agreements like the Paris Agreement, provide a legislative framework for reducing emissions and enhancing adaptive capacity. These policies focus on promoting renewable energy, improving urban planning, and strengthening disaster management systems. However, the successful execution

of these policies requires coordinated efforts across multiple government agencies and the active involvement of local communities.

Studies have highlighted the importance of integrated climate governance that bridges the gap between national policies and local realities. For example, Oladokun (2016) opined that effective flood risk management requires a high level of coordination and integration among the various agencies of the Nigerian government. Furthermore, the adoption of public-private partnerships has emerged as a key strategy for mobilising resources and expertise. Despite these efforts, challenges persist, such as inconsistent policy enforcement, limited funding, and inadequate data collection mechanisms, which can hinder the realisation of policy objectives.

Barriers to implementation and gaps

While numerous adaptation and mitigation strategies have been proposed, their practical implementation in Nigeria faces several barriers. Funding constraints, technical limitations, and institutional inefficiencies often limit the scalability of adaptation projects, especially in rural and marginalised communities. Socio-economic disparities further exacerbate the vulnerability of certain groups, and inadequate public awareness impedes community engagement in climate initiatives. Regulatory fragmentation across federal, state, and local levels can also result in uneven policy application and hinder coordinated responses. Moreover, the integration of indigenous knowledge with scientific research remains inconsistent, highlighting the need for more inclusive participatory approaches in policy formation. These shortcomings underscore the need for enhanced research and coordinated policy efforts that address not only the technical challenges but also the socio-economic dimensions of climate change.

Recommendations for strengthening adaptation and policy responses

To bridge the identified gaps, future policy responses should focus on:

- a) **Enhancing Coordination and Funding:** Establishing dedicated climate funds and improving inter-agency coordination can ensure that adaptation and mitigation projects are adequately resourced and effectively implemented.
- b) **Promoting Technological Transfer:** Facilitating the adoption of advanced technologies through incentives and capacity-building initiatives can improve the accuracy of early warning systems and support renewable energy integration.
- c) **Integrating Indigenous and Local Knowledge:** Policies should incorporate local experiences and traditional practices into national climate adaptation frameworks, ensuring that strategies are context-specific and socially inclusive.
- d) **Strengthening Legal and Institutional Frameworks:** Enacting clear legislation with enforceable standards and robust monitoring mechanisms will help create a stable and predictable environment for climate-responsive investments.
- e) **Fostering Public Engagement:** Increasing public awareness through education and outreach programs will empower communities to participate actively in climate adaptation and mitigation efforts.

CONCLUSION

Climate change in Nigeria poses a multifaceted threat that disrupts socio-economic stability and public health by intensifying extreme weather events such as flooding and drought. Recurrent floods cause widespread damage to infrastructure and agricultural land, reducing household incomes and triggering food insecurity through increased production costs and soaring food prices. Droughts exacerbate water scarcity and impair agricultural productivity, further

straining rural livelihoods and contributing to escalating poverty. These climatic disruptions also have severe public health implications, with contaminated water supplies from floods leading to outbreaks of waterborne diseases and prolonged droughts limiting access to safe drinking water and increasing malnutrition, while the persistent stress of climate-induced hazards fuels rising levels of anxiety, depression, and post-traumatic stress among affected communities. Although various adaptation strategies, including improvements in urban planning, early warning systems, and climate-resilient agricultural practices, have been introduced, critical research gaps remain, particularly regarding comprehensive regional analyses, the integration of indigenous perspectives, and holistic assessments of adaptation measures. Addressing these challenges necessitates a coordinated, multidisciplinary approach that leverages technological innovation, inclusive policy frameworks, and community-driven initiatives to build resilience, adapt effectively, and promote sustainable development across Nigeria's diverse regions.

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CHAPTER 4

CLIMATE VARIABILITY AND ITS EVIDENCE IN IMO STATE, NIGERIA.

ABSTRACT

Climate variability refers to fluctuations in weather and climate patterns, particularly changes in rainfall and temperature, driven by diverse atmospheric, oceanic, and geographic dynamics. This paper investigates climate variability in Imo State, Nigeria, with an emphasis on empirical trends, anomalies, and evidential data from over three decades. The study employed mean monthly rainfall and air temperature datasets (maximum and minimum) converted to annual mean were sourced from the Nigerian Meteorological Agency (NIMET), specifically from the Owerri synoptic station, covering the period between 1990 and 2023. Findings confirm notable variability in both rainfall and temperature patterns in the region, consistent with national and global climate trends. The paper recommends integrated climate adaptation and mitigation strategies in Imo State's developmental agenda. These include the adoption of climate-resilient crops, reduction of greenhouse gas emissions, promotion of smart agriculture, environmental education, afforestation, climate-responsive health policies, and the use of renewable energy. These approaches will build a more resilient and sustainable response to the growing threats of climate change.

KEYWORDS: Climate Variability, Change, Rainfall, Temperature, Imo state

INTRODUCTION

Climate variability and change are no longer speculative but have become globally acknowledged phenomena with direct and indirect consequences on ecosystems, economies and human livelihoods. In the context of Nigeria and particularly within Imo State; these phenomena are manifesting in observable shifts in weather patterns, temperature regimes and precipitation cycles. While climate change refers to long-term alterations in global or regional climate patterns, climate variability describes the short- to medium-term deviations from average climate statistics, including fluctuations in rainfall and temperature on seasonal, annual, or decadal scales (IPCC, 2021).

The drivers of climate variability are multifaceted. Natural factors such as solar radiation changes, ocean-atmosphere interactions (e.g., ENSO events) and volcanic activities interact with anthropogenic influences such as deforestation, urbanization and the emission of greenhouse gases (GHGs). According to the United Nations (2022), human activities, especially since the Industrial Revolution; have become the dominant force propelling recent climate disruptions. Mitchell et al. (2020) assert that the pattern of recent climate anomalies can be directly linked to human-induced processes through comparative modeling and empirical fingerprinting techniques. Hesmati (2020) further reinforces that the large-scale transformation of natural systems has culminated in increased atmospheric carbon concentrations, significantly altering climatic baselines.

Nigeria, a country of over 200 million people, is experiencing acute manifestations of climate variability. Extreme weather events—including flooding, prolonged dry seasons, erratic rainfall, and rising temperatures—have become recurrent, with socio-economic and ecological consequences. Ogbo et al. (2013) warn that the growing trend of climate-induced disasters poses a threat to sustainable development in Nigeria. Similarly, Amobi et al. (2015) highlight how climate extremes have exacerbated public health issues, food insecurity, migration pressures, and inter-ethnic conflicts.

Imo State, situated in the rainforest belt of southeastern Nigeria, has witnessed increasingly irregular climatic events over recent decades. Reports of displaced populations in flood-prone zones (e.g., Orlu LGA) and abandonment of structures due to prolonged inundation (Okorie et al., 2012) underscore the region's vulnerability. Ifenkwe et al. (2015) attribute the environmental hazards in the state to an intricate blend of climate variability, land-use mismanagement, and inadequate policy response. This paper, therefore, investigates the evidence of climate variability in Imo State using long-term meteorological data, while also reviewing the existing body of knowledge to position the study within a broader academic discourse.

Climate variability in imo state: literature review, evidence and identified gaps

Climate variability in Imo State has been studied by several scholars employing diverse datasets and analytical models. Their findings reinforce the argument that both rainfall and temperature patterns in the region have undergone significant and often unpredictable shifts.

Okorie et al. (2012) explored 30 years of meteorological data (1980–2009) from the Nigerian Meteorological Agency (NIMET) and discovered clear fluctuations in both rainfall and temperature, with indications of delayed onset and early cessation of rains. This has serious implications for agriculture, food security and water resource management. However, their study did not examine the implications of these fluctuations on specific agro-ecological zones within Imo State, leaving a spatial knowledge gap on micro-regional vulnerabilities.

In another direction, Okekeke and Okorie (2011) distinguished between climate variability and long-term change by focusing on the common range of climatic extremes typical of southeastern Nigeria. Their findings show that while short-term fluctuations can be natural, the amplitude and frequency of these events have recently exceeded historical norms. However, their work lacks a disaggregation of temperature variability across urban versus rural contexts,

which may mask localized heat island effects or variations in microclimatic responses.

Also, Alexander and Ndakara (2021) conducted a comprehensive spatial analysis of climate patterns in Nigeria using archival data from 1901–2017 obtained from the Climate Research Unit (CRU) of the University of East Anglia. Their high-resolution spatial modeling revealed significant intra-regional variations in rainfall and temperature trends, with the southeastern region, particularly Imo State; exhibiting intensifying thermal stress and seasonal rainfall volatility. Despite their robust spatial framework, the study does not address the socio-economic impacts of such spatial variations on vulnerable populations, particularly farmers, women, and the urban poor in Imo.

Ajiere et al. (2021) confirmed the intensifying climate variability in Imo State through a 30-year study using rainfall and temperature data from NIMET. Their analysis pointed to increasing temperature anomalies and irregular rainfall patterns that do not conform to the region's historical agro-ecological calendar. However, this study did not incorporate climate perception data from local communities, thereby missing a critical opportunity to validate instrumental data with indigenous knowledge systems. Similarly, Okorie (2015) analyzed rainfall variability over Imo State across a 30-year period and concluded that the observed shifts in precipitation suggest the onset of climate transition. Such anomalies have caused significant disruptions to agricultural calendars, with ripple effects across economic and food systems. Nevertheless, there remains a lack of exploration into how these transitions have influenced crop choices, yield patterns, and adaptive strategies among smallholder farmers in Imo State.

Arthur et al. (2022) shifted focus to sectoral impacts by assessing the implications of climate variability on transportation infrastructure in Imo State. Their study, which used data from 1999–2019, showed that erratic rainfall and rising temperatures had adverse effects on road durability and urban mobility. A limitation in their study is the absence of integration between climatic data and actual engineering failure case studies, which could offer a more grounded

understanding of infrastructure vulnerability.

In another approach, Akamuga et al. (2022) employed remotely sensed daily rainfall data (1981–2020) from the CHIRPS archive. Their trend analysis confirmed the existence of decadal and annual rainfall variability, with striking wet-dry alternations that challenge the predictability of climate-dependent planning.

However, the study lacks calibration with ground-truth station data in Imo State, raising concerns about the precision and reliability of satellite-only datasets for hyperlocal planning.

Oguike et al. (2021) assessed climate variability in the Owerri area using NIMET data from 1987–2016. Their findings show a significant decline in annual rainfall totals and a steady warming trend, thereby corroborating the hypothesis that climate variability in the region is not just seasonal, but progressively structural. Despite this, their research does not engage with possible drivers of these trends such as urbanization, land cover change, or industrial activity, which limits the ability to recommend precise mitigation measures.

From the foregoing, it is found that while the existing literature confirms the presence of climate variability in Imo State, several critical gaps remain:

1. Insufficient socio-spatial analysis of variability patterns across LGAs and rural-urban gradients.
2. Lack of integration between scientific data and local/community-based climate perceptions, which would enhance the cultural relevance of interventions.
3. Limited sectoral impact assessments, particularly in agriculture, water resources, and health, where localized studies could inform practical adaptation framework
4. Minimal investigation into adaptive capacities or resilience strategies

currently employed by residents of Imo State.

These gaps collectively demonstrate the need for a more integrated, participatory, and data-grounded approach to understanding and responding to climate variability in Imo State.

METHODOLOGY

This researcher used mean monthly rainfall and monthly air temperatures (minimum and maximum) data converted to annual mean, sourced from the Nigerian Meteorological Department (NIMET) from Owerri synoptic station for the periods of 1990 and 2023.

The temperature and rainfall data that are used in this study indicates that these parameters are significant climate variables. The research covers a climatic period of 33 years which however provides a better avenue to investigate and evaluate the climate variability and changes in the study area. The total rainfall, mean annual rainfall and temperature (minimum and maximum) data of each year was computed and used to create charts(Figs, 1 & 2) which were used to examine the temperature and rainfall variability in the state within the period under study.

RESULTS AND DISCUSSION

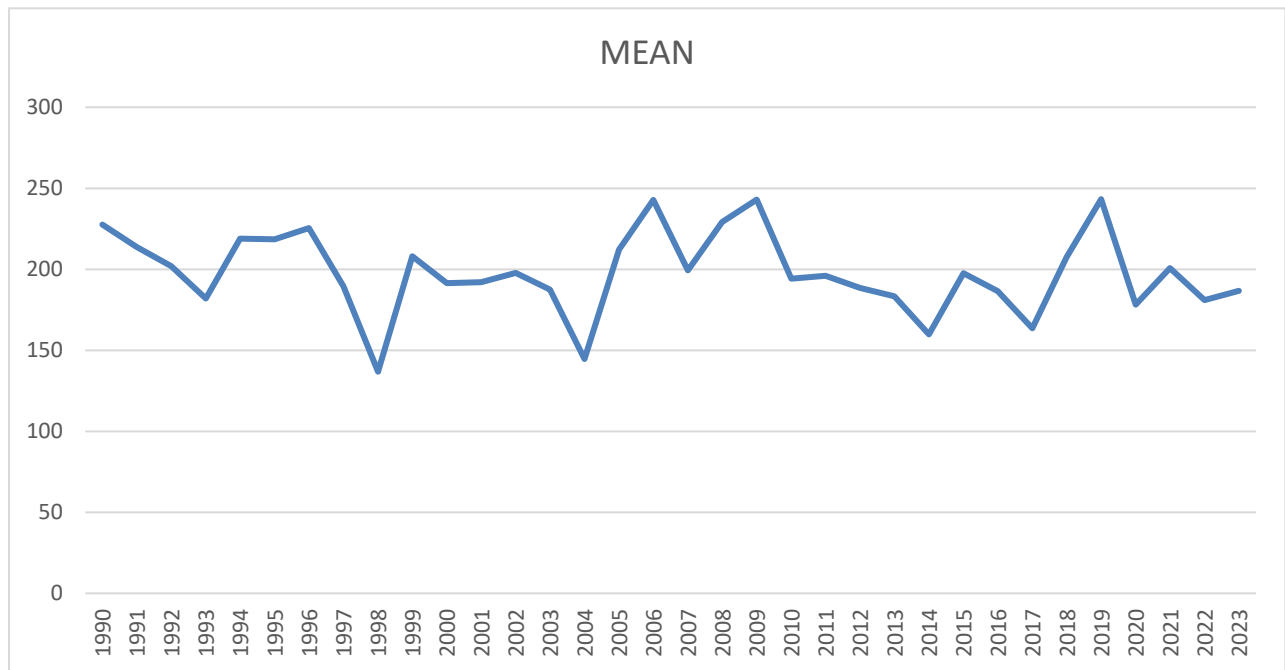


Figure 5. Line Graph for Mean Annual Rainfall Distribution in Imo State, Nigeria from 1990-2023(source: NIMET)

The analysis of rainfall data over the study period clearly indicates variability in the climate system of Imo State, Nigeria. As illustrated in Figure 5 and referenced in Table 2, the average mean of annual rainfall in 1990 was 227.658mm. A noticeable decrease occurred between 1991 and 2005, with the most severe drop recorded in 1998, when rainfall declined to a low of 136.79mm, the lowest of the entire period under review.

However, rainfall began to increase afterward, reaching significant peaks in the year, 2009 and 2019. These years recorded average annual rainfall values of 243.0583mm and 243.2583mm respectively; making the highest rainfall levels during this climatic period. It is noted that despite these increases, rainfall amounts again declined in subsequent years of 2020, 2021 and 2023, thus suggesting continued fluctuations and irregularities in precipitation trends.

The findings highlight a general pattern of variability, with alternating periods of increase and decrease in annual rainfall. The presence of such fluctuations points to climatic instability and underscores the evidence of climate variability in Imo State.

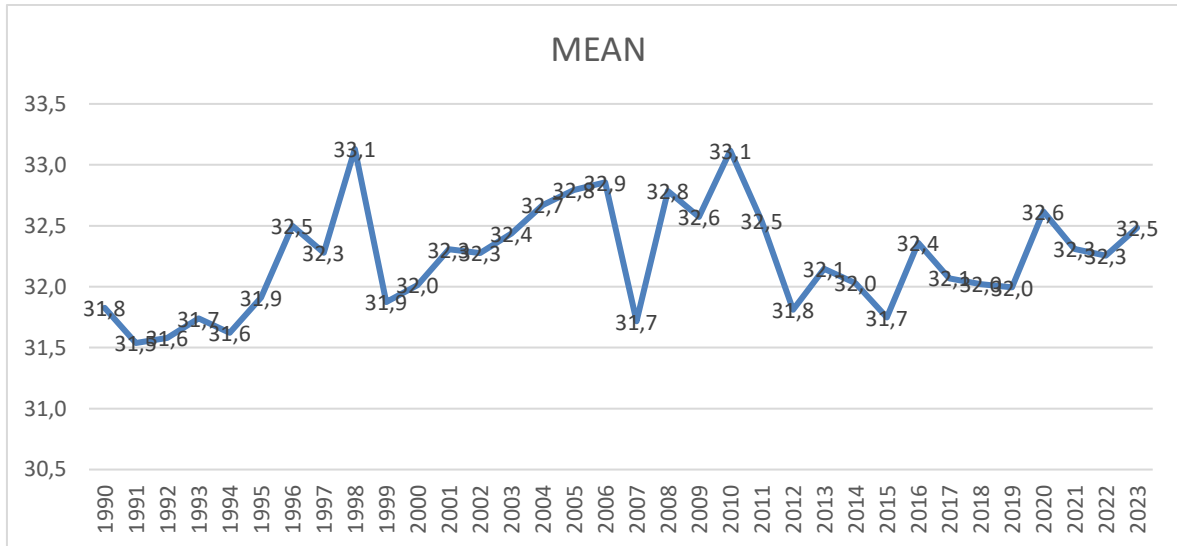


Figure 6. Mean annual maximum temperature from 1990 to 2023 (source: NIMET)

The mean annual maximum temperature (Table 3) shows that, the year with the highest maximum Temperature is 1998 and 2010 with Temperature as 33.1 °C respectively. In contrast, the lowest maximum temperature was observed in 1991 at 31.5.°C. The year 1990 had a temperature of 31.8°C which slightly decreased to 31.5 °C in 1991. From 1991 to 1995, temperature remained relatively stable, with fluctuations. It is noted that a slight upward trend started in 1996 and 1997, followed by a significant peak in 1998. After 1998 the temperature showed variation until another major increase occurred in 2010. After the year, 2010 the temperature declined but continue to fluctuate up to 2023. The study establishes that the temperature pattern shows a general warming trend, particularly between the early and late 1990s and again around 2010, confirming that the annual temperature is increasing. These variability is consistent with pattern of climate change and potential warming in the State.

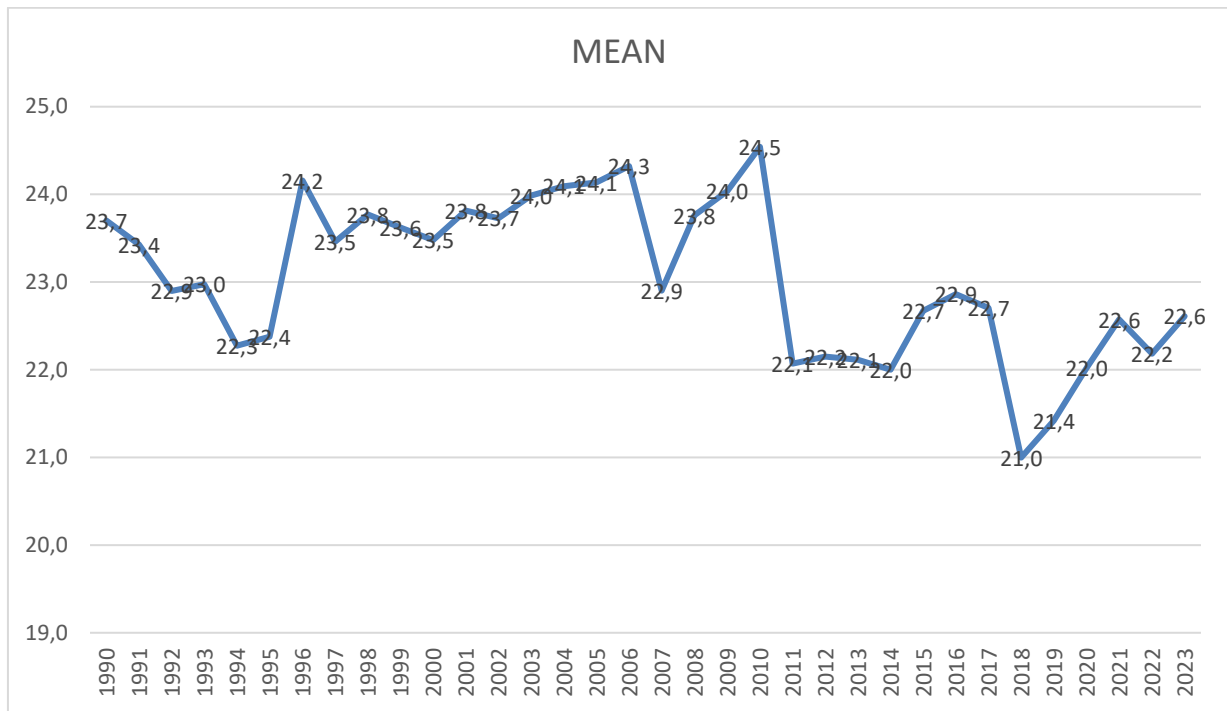


Figure 7. Line Graph for Minimum Temperature from 1990-2023 (source: NIMET)

The mean Annual Minimum Temperature

The mean annual minimum temperature further reinforces the presence of temperature variation in the state. The highest mean annual temperature was recorded in 2010 as 24.5 °C while the year with the lowest minimum temperature is 2018 with temperature as 21.0°C. The research established that there is fluctuations in temperature regimes and variations in rainfall in Imo State, Nigeria during the period under study. These fluctuations not only affect agriculture productivity and human comfort but may be an indicative of regional climate shifts.

Effect of Climate variability and in Imo State, Nigeria

Climate change could be seen as a change in the atmosphere in a particular area over a long period of time. It could also be refer to long term changes in temperature, precipitation, and other atmospheric conditions in a specific region. It could be change in temperature, rainfall. Climate variability encompasses both natural changes and those driven by human activities. Okoreie et al (2012) posited that some historical changes in climate may have resulted from natural causes and variations, it further stated that the strengths of the trends and the patterns of change that have emerged in recent decades indicate that human activities, resulting primarily from increased emission of CO₂ and other green house gases, have now become the dominant factor. Similarly, Alexander& Ndakara, (2021) noted that Climate variability is human induced. Climate change maybe naturally caused as a result of volcanic eruptions, fluctuations in solar radiation and many more, but activities of man has contributed significantly to global warming in recent time through burning of fossil fuels such a coal, oil and gas. Experts believes that anthropogenic causes has led to deforestation, and rapid industrialisation including the use of fossil fuels which has increased carbon dioxide and other greenhouse gases that has trap heat in the Earth's atmosphere, thereby causing temperatures to rise, (Kabir et al, 2023). It could be said that while natural factors contributes to climate change, the dominant causes in Imo State, Nigeria are human activities that has lead to the burning of fossil fuels and the release of greenhouse gases particularly from the oil and gas sector,rapid urbanization, deforestation, and agriculture.

It could be noted that studies in Imo State, Nigeria has shown that the state is not immune to the impacts of climate change. Imo State has witnessed a quite number of flood that has led to loss of lives, destruction of roads, agricultural produce, loss of property and many more as a result of increase in rainfall and temperature rise in the state.



Figure 8. Flood around Works layout in Owerri, Imo state(Photo taken by the reseaecher on 11th January, 2023 at Owerri, Imo State)

The flooded area along this road has caused untold hardship to the people leaving around there. The road is not passable by the motorists thereby impacting transportation and movement of people . As a result of the flood, the economic activities of people leaving in that area were impacted.



Figure. 9 Gully erosion around Ebom –Umuahie road in Mbaitoli LGA(Photo taken by the reseaecher on 12th January, 2023 at Mbaitoli LGA, Imo State).

This picture depicts a gully erosion caused by flood along Ebom-Umuahie road in Mbaitoli LGA of Imo State.



Figure 10. Site of gully erosion on Akwakuma-Umunyali road Owerri-Mbaitoli road, Imo State, Nigeria(Photo taken by the researcher on 13th January,

2023 at Akwakuma-Umunyali road, Imo State).

This picture shows buildings and roads affected by flood in Imo State. Increased rainfall destroys road, properties, concrete culverts, and also put buildings at risk of flooding and collapsing as could be seen in fig.4,5&6. Arthur et al (2022) observed that climate variation in Imo state resulted in the severe rainfall that flooded homes, caused landslides, disruption of economic activities and displacement of some resident of Ikeduru, Oguta and Orlu from their homes in 2006. Climate variations and change not only affects the roads but also agricultural activities in the state. Nwaebob & Egwuonwu (2024) noted that in some communities of Imo State, heavy and continuous rainfall had resulted to flood and exposed rural households to risk. The study further revealed that climate change and variability are becoming a strong threat to food security. Climate variability modifies the temperature and rainfall pattern thus posing a serious danger to agriculture sustainability (Ajidere et al, 2021). The increase in the volume of rainfall or harsh weather condition in a particular season may likely affect agricultural productivity, especially in Imo State Nigeria where most of the farmers relied on rainfall and favourable temperature to have a good harvest. Some study in Imo state on climate variability and climate Change impact on agricultural and findings shows that variability in rainfall and temperature has great impact on agricultural production. Rainfall variability could contribute to the high variations in the productivity and a decline in crop yield. Agriculture is the main source of income to the people of Imo state, so when there is a decline or destruction of crops as a result of climate variability, their purchasing power is affected thereby impoverishing the people. According to Alexander & Ndakara, (2021) climate variability affects agricultural activities and also reduces the income of the people due to seasonal variation that occurs in rainfall and temperature. Akagha et al (2021) in their study on Impact of Climate Variability on Rainfall and Temperature Distribution on Yam Yield (*Dioscorea alata*) in Ngor-Okpala Local Government Area of Imo State, South-Eastern Nigeria established that yam yield reduces as temperature increases during the period under study. Furthermore, climate change makes the livelihood of rural

people difficult in term of damage and low productivity of their various crops (Iheanacho et al, 2023).

Climate variability/change not only affect agricultural activities of the people of Imo state but also their health Akamuga et al (2022) argued that the evidential analysis on rainfall pattern in Imo state indicated a consequential impact of increase in amount of rains which may have resulted in flooding , landslide, formation of gullies, increase rate of pest and disease, and waste pollution in the environment. Similarly, Okorie (2015) noted that climate variation has caused some coastal erosion, flooding and flood-related disasters like pollution, increased disease vectors, communicable diseases and epidemics in Imo State. It is noted that climate change would continue to affect the health of the people unless urgent steps are adopted to mitigate the effect.

CONCLUSIONS AND RECOMMENDATIONS

Climate change and variability in Imo State are no longer speculative but observable realities with measurable impacts on the environment, agriculture, infrastructure and human health. This study provide strong evidence of climate variability in Imo State, Nigeria. The alternation between high and low rainfall years coupled with irregular patterns in temperature, points to instability in both precipitation and thermal condition. These irregularities suggest ongoing changes in the region's climate system, affecting various socio-economic sectors, especially, agriculture, health and infrastructure. As the impact of climate variability and change intensifies, so will the challenges faced by the people of Imo state, Nigeria. It is very important for policymakers in the state and national to consider these trends in future development strategies, incorporating climate resilience crops, GHG emission reduction, smart agriculture, tree planting, health preparedness, environmental education, and promotion of green energy in other to adapt and mitigate the impact of the climate change.

Further data presentation and analysis

The following tables contained responses elicited from the questionnaire.

Table 2: The Three Senatorial Zone of Respondents

Owerri LGA	Okigwe Zone	Orlu Zone	Unspecified	Total
122	20	59	3	204
Age: above 18	Above 18	Above 18	Above 18	
ColumnTotal(122	20	59	3	204

Source: Field Survey (2023)

From the above table, 122 respondents are from Owerri Senatorial Zone, 20 respondents are from Okigwe Zone , while 59 respondents are from Orlu Zone. The table also show that 3 people are not from Imo State or may not want to disclose the state the hail from but are resident of Imo state.

Table 3: Sex Distribution of the Respondents

Male	81	Total responses (81)
Female	115	115
Unspecified	8	8
Total with specified gender	196	204

Source: Field survey (2023).

From the Table, the number of females that responded to the questionnaire are 115, the number of males are 81 while 8 people did not indicate their gender. The total number of both the males, females and the unspecified that responded to the questionnaire are 204.

Table 4: Worried over the impact of Climate Change

Variables	Frequency	Percentages (%)
Yes	154	75.49
No	50	24.51
Don't Know	0	0
Total	204	100

Source: Field Survey (2023)

From the table above, it showed that 154 respondents denoting 75.49 percent affirmed that they are worried over the impact of Climate Change in the State; while 50 respondents representing 24.51 percent disaffirmed. Therefore, it can be inferred that, the Majority of the people from Imo State are worried over the impact of Climate Change. This conclusion is derived from the above responses received from the population.

Table 5: Have you experienced flooding in your community.

Variables	Frequency	Percentages (%)
Yes	127	62.25
No	75	36.76
Do not know	2	0.98
Total	202	100

Source: Field Survey (2023)

The table 5, shows that 127 respondent with 62.25 percent have experienced flooding in their community, while 75 respondents representing 36.76 said they have not experienced flooding. However 2 people representing 0.98 percent did not respond to the question. From the foregoing it could be concluded that flood has impacted a majority of the residents of Imo State, Nigeria.

Table 6: Impacts of flooding in the community

Variables	Frequency	Percentages (%)
Destruction of properties	86	45.26
Destruction of farmlands	55	28.95
Loss of life	18	16.32
Others	31	9.47
Total	190	100

Source: Field Survey (2023)

This Table shows that 86 respondents which represent 45.26 percent affirmed that destruction of properties is an impact of flooding in their community, 55 respondents representing 28.95 percent are of the view that flooding has causes destruction of farmlands in their community; 18 respondents with 16.32 percent agreed that flooding has led to loss of lives, while 31 respondents representing 9.47 percent affirmed that flooding has impacted other aspect of their community. It could be infer that flooding which is an effect of climate change has caused untold hardship to the residents of Imo State, Nigeria.

Table 7: Do you think that Temperature has changed compared to previous decade?

Variables	Frequency	Percentages (%)
Yes	171	83.82
No	30	14.71
Did not respond	3	1.47
Total	204	100

Source: Field Survey (2023)

The above table has shown that appreciable number of respondents agreed that there is a temperature variation. The breakdown shows that 171 respondents representing 83.82 percent answered in the affirmative, 30

respondents representing 14.71 answered in the negative, while 3 respondents constituting 1.47 percent did not respond. Climate change is altering temperature variability which sometimes leads to extreme weather events.

Table 8: Impact of Climate Change on Agriculture

Variables	Frequency	Percentages (%)
Yes	169	82.84
No	29	14.22
Unanswered	6	2.94
Total	204	100

Source: Field Survey (2023)

Based on the above table, 169 respondents denoting 82.84 percent responded in the positive, while 29 respondents (14.22%) responded in the negative and 6 did not respond (2.94%). Thus, it was maintained that Climate Change Impacts agriculture in Imo State, Nigeria.

Table 9: Worst Threats to the Environment

Variables	Frequency	Percentages (%)
Industries	73	36.68
Government	53	26.63
Individual People	53	26.63
Others	20	10.05
Total	199	100

Source: Field Survey (2023)

From the above table, 73 respondents representing 36.68 percent responded that Industries are the worst threat to the Environment, while 53 respondents (26.63%) responded that Government and Individual people are worst threats to Environment; 20 respondents (10.5%) were of the view that other

factors are the worst threats to the Environment. Thus, it was maintained that Industries are the worst environmental threat, followed by both government and individual people at equal levels and other factors that could pose as threat to the environment.

Table 10: Knowledge of Environmental policies in Imo State

Variables	Frequency	Percentages (%)
Yes	150	75.38
No	49	24.62
Total	199	100

Source: Field Survey (2023)

Given the table above, 150 respondents representing 75.38 percent of the total respondents answered in the affirmative, 49 respondents denoting 24.62 percent responded in the negative. Therefore, it can be inferred that the majority of the residents have the knowledge of environmental policies in Imo State.

Table 11. Environmental laws in the community or at the State

Variables	Frequency	Percentages (%)
Yes	169	86.67
No	26	13.33
Total	189	100

Source: Field Survey (2023)

Based on the tabular information, it can be said that the majority of the people affirmed that there Environmental laws in the State. This assertion corroborated by the above table, in which 169 respondents (86.67%) affirmed that there is environmental laws, 26 respondents (13.33%) denied that there is no environmental laws in Imo State.

Table 12: Has anyone punished for not obeying the environmental laws in your community

Variables	Frequency	Percentages (%)
Yes	126	62.38
No	57	28.22
Do not know	19	9.41
Total	202	100

Source: Field Survey (2023)

From table 12, 126 respondents representing 62.38 percent maintained that they have seen people being punished for not obeying environmental laws, while 57 respondents representing 28.22 percent said they have not seen, 19 respondents representing 9.41 percent said they do not know. Based on the above analysis, it is inferred that people are punished for not obeying the environmental laws in Imo State.

Table 13 Waste generation

Variables	Frequency	Percentages (%)
Yes	170	84.16
No	32	15.84
Total		100

Source: Field Survey (2023)

The above table revealed that 170 respondents representing 84.16 percent answered in the affirmative; while 32 respondents representing 15.84 percent answered in the negative. It can be inferred that majority of the residents in Imo State generate waste.

Table 14 If Climate Change causes rise in sea level

Variables	Frequency	Percentages (%)
Yes	171	83.82
No	26	12.75
Do not know	7	3.43
Total	204	100

Source: Field Survey (2023)

The above table revealed that 171 respondents representing 83.82 percent answered in the affirmative; while 26 respondents representing 12.75 percent answered in the negative; 7 respondent denoting 3.43 answered do not know. It can be inferred that majority of the residents in Imo State agreed that Climate change causes rise in sea level.

Table 15 If pattern of weather is changing

Variables	Frequency	Percentages (%)
Yes	153	75.00
No	9	4.41
Maybe/Do not know	42	20.59
Total	204	100

Source: Field Survey (2023)

Based on the tabular information, it can be said that the majority of the people affirmed that there is changes in pattern of weather in the State. This assertion corroborated by the above table, in which 153 respondents (75.00%) affirmed that there is change in general pattern of weather, 9 respondents (4.41%) denied it; while 42 respondents representing 20.59 percent are not sure.

Test of hypothesis

Hypothesis One (1)

1. Hi: Variability in rainfall in Imo State is associated with Climate Change.
 Ho: Variability in rainfall in Imo State is not associated with Climate Change.

The relevant contingency table is presented as follows:

Table 16: Contingency Table on the Changes in pattern of weather and if the rise in sea level is caused by Climate Change.

Variables	Effect of Climate Change	Changing pattern in weather	Row Total
Yes	171	153	324
No	26	9	35
Don't know	7	42	49
Column Total	204	204	408

Source: Survey 2023

The above observed frequencies were used to determine the expected frequencies and it was presented as follows:

Table 17: Computation of X² Test Statistics for Changes in pattern of weather and if the rise in sea level is caused by Climate Change.

O	E	(O-E)	(O-E) ²	$\frac{(O-E)^2}{E}$
171	162	9	81	0.5
26	17.5	8.5	72.3	4.1
7	24.5	-17.5	306.2	12.5
153	162	-6	36	0.2
9	17.5	-8.5	72.3	4.1

42	24.5	17.5	306.3	12.5
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$$X^2 = 33.9$$

Therefore, the computed Chi-Square was

$$X^2 = \sum(O - E)^2$$

$$\text{-----} = 33.9$$

E

To determine the degree of freedom (df) we use the formula:

$$df = (r-1)(c-1)$$

$$df = (3-1)(2-1)$$

$$= 2 \times 1$$

$$= 2$$

The critical/table value of Chi-Square (X_c^2) using two (2) degree of freedom (df) at 0.05 level of significance is 5.991.

Decision

The calculated value of chi-square (X_c^2) was 33.9 which exceeded the critical value (table value of chi-square) 5.991. The null hypothesis was therefore rejected. The conclusion reached was that Variability in rainfall is associated with Climate Change.

Hypothesis Two (2): The hypothesis is stated as follows:

Hi: There is a significant relationship between Climate issues and Environmental Governance in Imo State.

Ho: There is no significant relationship between Climate issues and Environmental Governance in Imo State.

The table below was used to derive the X^2 . It was obtained from the field work as detailed in tables 4.6 and 11 above.

Table 18: Contingency Table for increase in temperature and the punishment for not obeying environmental laws in Imo State.

Variables	Climate issues indicator(Temperature)	Environmental Governance indicator	Row Total
Yes	171	126	297
No	30	57	87
Don't know	3	19	22
Column Total	204	202	406

From the list of observed scores above, the research then derived a similar set of expected scores. To get the expected scores, the following formula was employed:

$$\text{Row Total} \times \text{Column Total}$$

$$\text{Grand Total.}$$

$$= 297 \times 204$$

$$406$$

The same calculation should be performed for each of the observed scores. The Chi-Square computed table is presented as follows:

Table 19: Computation of X2 Test Statistics for Increase in Temperature and Punishment for not obeying Environmental laws.

O	E	(O-E)	(O-E) ²	$\frac{(O-E)^2}{E}$
171	149.2	21.8	475.2	3.2
30	43.7	-13.7	187.7	4.3
3	11.1	-8.1	65.6	5.9
126	147.8	-21.8	475.2	3.2
57	43.3	13.7	187.7	4.3
19	10.9	8.1	65.6	6.0

$$X^2 = 26.9$$

Based on the above, the computed Chi-Square was

$$X^2 = \sum \frac{(O - E)^2}{E}$$

$$\dots\dots\dots = 26.9$$

E

The next step is to determine the degree of freedom (df). The degree of freedom is given by the following formula:

$$Df = (r-1)(c-1) \text{ which means}$$

“r” stands for number of rows minus (-) one (1) which is always constant while “c” stands for number of columns minus (-) one (1).

$$\text{Therefore } df = (3-1)(2-1)$$

$$= 2 \times 1$$

$$= 2$$

We determined the critical/table value of the Chi-Square (χ^2) using two (2) degree of freedom (df) at 0.05 level of significance which gives 5.991. while the calculated value of Chi-square (χ^2) is 26.9 which is > (greater than) the table value of Chi-Square.

Decision

Given the computation above, the calculated value of chi-square was greater than the critical value (table value of chi-square), hence the null hypothesis was rejected which presupposes the acceptance of alternative hypothesis. The conclusion reached was that there is a significant relationship between Climate issues and Environmental Governance in Imo State.

DISCUSSION OF FINDINGS FROM THE DATA

Demographic Characteristics of Respondents

The distribution of respondents according to their senatorial zones revealed that the majority, 122 respondents, were from Owerri Zone, followed by 59 respondents from Orlu Zone, and 20 respondents from Okigwe Zone. Additionally, 3 respondents either did not disclose their place of origin or were not indigenes of Imo State but reside in the state. In terms of gender, 115 respondents identified as female, 81 as male, while 8 did not specify their gender. The total number of participants was 204, which provided a diverse and representative sample for the study.

On Concerns about Climate Change, The findings indicated that a significant proportion of the respondents were worried about the impact of climate change in Imo State. The result suggests a high level of climate awareness and concern among the general populace, pointing to a population that is not only informed but also potentially motivated toward climate action and resilience.

On the Experience of Flooding and Its Impacts: The greater portion of the respondents confirmed they had experienced flooding in their community, this is a prevalent issue in the State. The implications are that flooding is a major environmental challenge affecting a majority of the population. Flooding had led to the destruction of properties, farmlands, loss of lives and other devastating impacts in the State. These results underscore the multi-dimensional nature of flooding, which affects not only livelihoods and assets but also life and food security. The frequency and severity of flooding in Imo State align with global concerns about climate-induced extreme weather events.

Temperature Variation: The study revealed that 171 respondents (83.82%) agreed there has been variation in temperature, while 30 (14.71%) did not observe such changes and 3 (1.47%) did not respond. This aligns with the broader scientific consensus that climate change is affecting temperature patterns, leading to longer dry seasons, more intense heat waves, and irregular rainfall.

Impact of Climate Change on Agriculture: 169 respondents (82.84%) believed that climate change negatively impacts agriculture, which is the backbone of the economy in many communities in Imo State. This finding emphasizes the vulnerability of rural livelihoods to climate variability, especially for those dependent on rain-fed farming.

On perceived Environmental Threats, the respondents pointed primarily to Industries as the highest environmental threat followed by Government and Individual people respectively and also other factors. These responses reflect a broad public perception of institutional and industrial irresponsibility, alongside individual contributions to environmental degradation. It suggests that respondents see both top-down (government and industry) and bottom-up (individual behavior) factors as key drivers of environmental harm.

On Knowledge and Enforcement of Environmental Policies: The tables presented above suggest that environmental laws in Imo State are known and somewhat enforced. The responses implies that while awareness of laws is relatively high, enforcement remains partially visible, which may affect compliance and effectiveness.

On Waste Generation: The data indicated that 170 respondents (84.16%) acknowledged that they generate waste, which is an important self-awareness metric in environmental studies.

On Perceived Impact of Climate Change: Additionally, 171 respondents (83.82%) agreed that climate change contributes to sea level rise, whereas 26 respondents (12.75%) disagreed and 7 respondents (3.43%) were uncertain. These figures reflect a high level of awareness about climate science, especially concerning rising sea levels—a key indicator of global climate disruption.

On perceived Change in Weather Patterns: The study suggests that the majority of respondents have observed irregularities in climate patterns, consistent with both local experience and global climatic data.

These findings provide compelling evidence that climate change and environmental degradation are recognized, experienced, and deeply felt by the people of Imo State. They also highlight areas where policy awareness, community engagement, and government intervention can be strengthened for improved climate adaptation and environmental protection.

In summary, the hypothetical statements made at the outset of this research were tested which indicated that there is a strong relationship between climate issues and environmental governance and that variability in rainfall is associated with climate change.

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5. CONSIDERAÇÕES FINAIS

Os resultados estabelecem que a variabilidade/mudanças climáticas são realidades tangíveis no Estado de Imo e na Nigéria em geral. Essas mudanças estão diretamente ligadas à instabilidade socioeconômica, insegurança alimentar, crises de saúde e degradação ambiental. A forte relação entre questões climáticas e governança ambiental destaca a urgência de integrar a resiliência climática às estratégias de desenvolvimento estaduais e nacionais. Embora a população esteja altamente ciente dos riscos climáticos, a fraca capacidade institucional e a fraca aplicação das leis/políticas ambientais prejudicam os esforços de adaptação e mitigação. Abordar essas lacunas é crucial para reduzir a vulnerabilidade e garantir o desenvolvimento sustentável.

O estudo também estabelece que as mudanças climáticas exercem impactos significativos e multidimensionais nas comunidades do Estado de Imo. As evidências mostram que as inundações surgiram como uma consequência importante, manifestando-se na destruição de propriedades, terras agrícolas, perda de vidas e outras perturbações socioeconômicas. Coletivamente, esses resultados apontam para as dificuldades generalizadas que as mudanças climáticas impõem aos moradores. Em essência, os resultados indicam que, embora as áreas urbanas e rurais do Estado de Imo sejam adversamente afetadas pelas mudanças climáticas, os impactos se manifestam de forma diferente; As áreas rurais sofrem principalmente perdas agrícolas e degradação ambiental, enquanto as áreas urbanas são mais propensas a inundações, danos materiais e riscos associados à elevação do nível dos rios/mares. Isso ressalta a urgência de estratégias adaptativas específicas e intervenções políticas para proteger os meios de subsistência e aumentar a resiliência em todo o estado.

Os resultados da pesquisa indicam que múltiplos fatores contribuem para a insegurança ambiental no estado de Imo, como indústrias, governo e indivíduos. Embora as atividades industriais representem o maior perigo para o meio ambiente, refletindo preocupações com poluição, descarte de resíduos e práticas insustentáveis, ações governamentais e individuais também foram

consideradas contribuintes críticos. Embora possa haver outros fatores, a insegurança ambiental no estado de Imo é impulsionada principalmente por atividades industriais, mas é agravada por governança fraca, aplicação inadequada de políticas e práticas individuais insustentáveis. Essas descobertas enfatizam a necessidade de uma regulamentação mais forte das operações industriais, maior responsabilização governamental e maior responsabilidade pública para proteger o meio ambiente.

Por fim, os resultados também indicam que a governança ambiental no estado de Imo é funcional, mas permanece moderadamente eficaz no enfrentamento de questões relacionadas ao clima. As evidências do estudo mostram que os entrevistados afirmaram ter testemunhado punições para indivíduos que violaram as leis ambientais, sugerindo que mecanismos de fiscalização estão em vigor e são implementados em certa medida. No entanto, a persistência de desafios relacionados ao clima, como inundações, degradação ambiental, destruição de terras agrícolas e danos materiais, implica que, embora existam leis e mecanismos de fiscalização ambientais, sua implementação não se traduziu totalmente em mitigação efetiva dos problemas relacionados ao clima. Assim, a governança ambiental no estado de Imo pode ser considerada parcialmente eficaz, embora leis e mecanismos de fiscalização estejam presentes e sejam reconhecidos pela maioria dos residentes, mas ainda existam lacunas na execução de políticas, no cumprimento público e nas estratégias de adaptação climática.

Recomenda-se o fortalecimento da capacidade institucional para melhorar a fiscalização das leis ambientais, combatendo a corrupção, as falhas de governança e o financiamento inadequado das agências reguladoras. A agricultura resiliente ao clima, como variedades de culturas resistentes à seca e de alto rendimento, práticas agrícolas inteligentes e sistemas de irrigação para salvaguardar a segurança alimentar, deve ser promovida. O governo deve investir mais em planejamento urbano, sistemas de drenagem, infraestrutura de controle de enchentes e sistemas de alerta precoce para mitigar os riscos de

enchentes e também intensificar os esforços na área de educação ambiental para criar mais conscientização pública sobre a necessidade de desistir de ações que degradam o meio ambiente e melhorar a conformidade com as políticas ambientais.

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APPENDICES

APPENDIX A

Article The Dynamics Of Climate Change And Environmental Security In Nigeria

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Article

The Dynamics of Climate Change and Environmental Security in Nigeria

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ABSTRACT

Climate change and environmental security are ongoing challenges in Nigeria. This literature review explores the dynamics of climate change and environmental security alongside proposed solutions. The study employs qualitative research, primarily drawing on reports from international NGOs that address climate change and ecological security in Nigeria. It also utilizes content analysis based on literature, additional bibliographies, and published academic works. The results indicate that the issue of climate change in Nigeria still requires further exploration, as no reports provide in-depth investigations. However, they also show the emergence of debates concerning the problem in both the political and academic spheres. Regarding official documentation, they highlight that Nigeria has adopted policies aimed at significant domestic adaptations to international agreements and treaties to mitigate the effects of climate change. However, research indicates that these efforts have not effectively addressed the consequences of climate change, resulting in more significant environmental degradation. The article highlights the shortcomings in the ways government agencies and other institutions have addressed climate change in Nigeria, including legal and institutional limitations, corruption, and governance deficiencies.

Keywords: environmental policies, global warming, climate change, Nigeria.

RESUMO

Mudanças climáticas e segurança ambiental são desafios constantes na Nigéria. Esta revisão de literatura explora a dinâmica das mudanças climáticas e segurança ambiental juntamente com soluções propostas. O estudo emprega pesquisa qualitativa, principalmente com base em relatórios de ONGs internacionais que abordam mudanças climáticas e segurança ecológica na Nigéria. Ele também utiliza análise de conteúdo com base na literatura, bibliografias adicionais e trabalhos acadêmicos publicados. Os resultados indicam que o tema sobre as mudanças climáticas na Nigéria ainda precisa ser mais bem explorado, não existindo relatórios com investigações mais profundas. Mas também já indica a emergência de debates no ambiente político e acadêmico sobre o tema. No que se refere a documentação oficial, elas enfatizam que a Nigéria tem adotado políticas voltadas às adaptações domésticas significativas a acordos e tratados internacionais para mitigar os efeitos das mudanças climáticas. No entanto, a pesquisa indica que esses esforços não abordaram efetivamente as consequências das mudanças climáticas, resultando em degradação ambiental mais significativa. O artigo destaca as deficiências nas maneiras como agências governamentais e outras instituições abordaram as mudanças climáticas na Nigéria, incluindo limitações legais e institucionais, corrupção e deficiências de governança.

Palavras-chave: políticas ambientais, aquecimento global, mudanças climáticas, Nigéria.



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Introduction

In contemporary discourse, climate change has become a central focus of study among scholars, governments, and non-government institutions (Kniess et al 2022, Domenech 2017, Teso Alonso & Fernández-Reyes 2020, Faustino, Mantovaneli Junior & Barbosa 2024). Dominant literature suggests that there have been varied considerations concerning the causes of climate change. According to Fakana (2020), many factors, both anthropogenic and natural activities, are drivers of climate change; it is deeply rooted in factors such as changes in the sun's activity, significant volcanic eruptions, and changes in the Earth's orbit; others contend that it primarily results from human activities. Scholars such as Mitchell et al. (2020) posit that human activities predominantly cause climate change. Hesmati (2020), in another direction, offers a similar perspective, positing that humans and their activities have significantly transformed natural systems, leading to a net accumulation of carbon dioxide in the atmosphere.

The viewpoint mentioned earlier corroborates NASA's stance, which attributes the increase in global warming trend to human activities that have released substantial amounts of greenhouse gases into the atmosphere (NASA, 2002). National Academy of Social Sciences (NASS) reveals that the Earth's temperature was approximately 2 degrees Fahrenheit (or about 1.11 degrees Celsius) higher than the late 19th-century average, representing global climate change. This significant shift in climate is already impacting every inhabited region worldwide, contributing to various observed changes in weather patterns and climate extremes (IPCC, 2021).

Considering the foregoing, it is observed that Nigeria, as a country, has not been immune to the severe consequences of life-threatening climate conditions and shifts in weather patterns. These changes in weather patterns are noticeable in apparent variations in heavy rainfall, extreme heat, and cold temperatures, resulting in floods, landslides, droughts, rising sea levels, and air pollution. Perhaps this is why Ogbo et al. (2013) reasoned that the increasing incidence of disasters in Nigeria, including floods, landslides, droughts, rising sea levels, and air pollution, poses significant challenges to Nigeria's national sustainability. In a seeming corroborative stance, Amobi et al. (2015) postulate that some of these natural and human-induced disasters have detrimental impacts on Nigerian society, affecting areas such as health, food production, the economy, and human security.

On the other strand of contemplation, environmental security focuses on freedom from military threats and political coercion to encompass non-military concerns, according to Romm (1993). The implication of the stand is well explicated within the bounds of scholars such as Buzan (1991), Egwu (2001), and Palei (2008) postulations that traditional security is rooted in the belief that National Defense considerations dominate national security ethos. It is interesting to note that the belief, as mentioned earlier, aligns with the viewpoint of Walt (1991), which asserts that security revolves around the examination of threats, the utilization of military force, and control. It is, however, imperative to note that these prevailing approaches to the traditional perception of security, as highlighted above, draw inspiration from Lipmann's perspective that security involves a state possessing sufficient military capabilities to deter the risk of having to compromise core values to prevent war and, if challenged, to secure victory in such a conflict (Lipmann 1943). Thus, one can infer that Lipmann's contemplation raises a fundamental question concerning the crucial state requirement of sufficient military capability to avert threats to its "core values."

Miller (2008) took a different approach, attempting to classify, clarify, and explain this ambiguity. He insightfully identified two distinct approaches to studying security: the traditional concept of security and security in the post-Cold War era. According to Miller, in the conventional idea of security, the primary threats are neighboring nations or great power rivals, with military capability at the forefront. In contrast, in the post-Cold War concept of security, the threats are non-state, encompassing domestic and trans-border issues. These

include economic, domestic, political, and transnational or global challenges such as immigration, drugs, diseases and environmental concerns, proliferation of weapons, crime, and terrorism.

Considering the foregoing, this paper is grounded in the contrasting view presented by Miller (2008), which posits that the most profound threats are non-state in nature, encompassing both domestic and trans-border issues such as economic, domestic, political, and transnational or global challenges such as immigration, drugs, diseases, and environmental concerns. Furthermore, through a literature review approach, the paper aims to shed light on the evolving nature of climate change and its relationship with ecological security within the Nigerian State. The vulnerability of Nigeria to climate change poses significant threats across various sectors, including food security, poverty reduction, energy, infrastructure, and overall economic development. Eze (2010:8) highlights the alarming risk in the Sudan-Sahel region, where up to 133,994 square kilometers of arable land may be jeopardized, with an estimated capital value at risk of about US\$6.4 billion. The Niger Delta region, already suffering from the detrimental effects of oil and gas exploration, faces further environmental degradation as oil spills and chemical pollution continue to disrupt local biodiversity and the livelihoods of the inhabitants. The compounding effects of climate change in this region underscore the country's broader human security challenges, potentially exacerbating the already precarious conditions for millions of Nigerians. This grave outcome of insecurity and its detrimental impact on national development underscores the urgent need for a comprehensive and adaptable security strategy. It is observable in this direction that the National Security Strategy (NSS) of Nigeria outlines the core national interests, which include the security and welfare of its people, the defense of territorial integrity, and the promotion of peace, democracy, economic growth, and social justice (Centre for Security Studies, 2018). Thus, in the context of this paper, the traditional security paradigm, which has primarily focused on military and territorial defense, is no longer sufficient.

Considering the foregoing, this paper beams a searchlight on Climate change as it presents a particularly pressing and complex challenge to Nigeria's security landscape. In Nigeria, where the effects of climate change are already being felt, integrating environmental considerations into security planning is not just a matter of policy—it is necessary to ensure the country's future stability and prosperity. We argue that climate change is a serious concern for Nigeria's environmental security, considering its impact on Nigeria's security, economic, social, infrastructure, and well-being. It has brought a growing burden to existing environmental concerns, including deforestation and land degradation, which have unfavorably affected Nigeria's agricultural output. It is also argued that Climate change will worsen if various international protocols to combat its effects are not adhered to or correctly enforced and if the anthropogenic nature of man's activities is not curtailed through sustainable practices. However, this research reviewed relevant literature based on qualitative data, with the primary sources being reports from international non-governmental organizations that have produced reports and other studies on climate change and environmental security in Nigeria.

Climate Change and Environmental Security in Imo state: Anthropogenic and Natural Drivers Discourse

Some scholars have traditionally viewed environmental security in international relations through the lens of geopolitical power. David Haglund (1992:15) argued that the proponents of this concept emphasized the "man-milieu relationship," suggesting that the environment, understood as a multifaceted framework influencing states and leaders, played a pivotal role in international relations. This perspective refined long-standing practices linking geography, a quintessential environmental factor, with power distribution and influence on the global stage.

However, Haglund (1992:16) took another direction. He pointed out that what is noteworthy in contemporary discussions on security is the emphasis on environmental degradation as both a consequence

and a catalyst of interstate conflicts. In a similar vein, Porter (1995:218) observed that environmental security introduces a significant departure from traditional notions of national security. It addresses two distinct issues: the environmental factors that can potentially lead to violent conflicts and the impact of global environmental degradation on the well-being of societies and economies. The idea that environmental degradation can be considered a security issue when it serves as a cause of violent conflict aligns with the conventional definition of national security.

The points mentioned earlier emphasize that environmental security is a pressing reality and a global threat to the entire system. The increasing pressures on the Earth's ecological support systems will likely have profound consequences for human well-being and health, potentially as severe as traditional military threats. Recognizing the shifts in ecology and climate patterns and the resulting implications, nations have developed strategies to mitigate and adapt to the adverse effects of climate change.

As Mathew (1989:362-340) aptly noted, environmental challenges that transcend national boundaries are already eroding the conventional concept of national sovereignty to the extent that they should be regarded as our era's most critical security issues. She further highlighted that the proponents of ecological security attribute the depletion of the ozone layer, which shields humanity from harmful ultraviolet radiation to destructive environmental practices such as the indiscriminate destruction of tropical forests and the release of hazardous gases like Chlorofluorocarbon (CFCs) and halons by industries. According to her, it is to prevent national and global catastrophes resulting from environmental-related crises and the disruption of the planet's natural heritage that advocates for ecological security and calls for new forms of diplomacy, institutions, and regulatory frameworks to address the world's increasing environmental interdependence.

Climate change is one of the most significant challenges of the 21st century, particularly for developing countries like Nigeria. Nigeria is not exempt from its adverse impacts, which threaten environmental security, human livelihoods, and sustainable development. This research paper deploys vulnerability theory as a guiding theoretical framework to provide a lens through which to understand the nexus between climate change and environmental security in Nigeria.

In this direction, the Vulnerability Theory serves as a cornerstone for understanding the susceptibility of Imo State to climate change (Figure 1). Vulnerability is the degree to which a system is susceptible to and unable to cope with the adverse effects of climate change, including climate variability and extremes (IPCC, 2014). This theory posits that vulnerability is a function of exposure, sensitivity, and adaptive capacity. In the context of Imo State, the theory can be applied to examine how different communities within the state are exposed to climate-related hazards such as flooding, erosion, and extreme weather events and how their socio-economic conditions influence their sensitivity and adaptive capacity.



Figure 1: Map of Nigeria's administrative boundaries, highlighting Imo State. Source: Giovanni Borgionni, Lahac, UniEVANGELICA, 2024

The influence of human activities on climate change is profound and well-documented. The European Commission on Climate Action (2010) underscored that industrial activities such as burning fossil fuels, deforestation, and intensive livestock farming are principal contributors to global climate alterations. These activities emit significant quantities of greenhouse gases, particularly Methane and Carbon Dioxide (CO₂), which are instrumental in trapping heat within the Earth's atmosphere, thereby exacerbating global warming. As IPCC (2021) highlighted, these greenhouse gases are the primary agents of climate change, creating an imbalance in the Earth's natural systems by enhancing the greenhouse effect. This disruption is further intensified by the increase in global emissions driven by heightened consumption of fossil fuels, as articulated by Perera (2018), leading to significant environmental consequences such as rising sea levels and extreme weather events.

In the light of the foregoing, evidence overwhelmingly supports the assertion that human activities are the central forces driving geological, biological and ecological changes in the Earth's system. Thus, rapid urbanization, industrial expansion, over-exploitation of natural resources, and deforestation are myriad activities altering the planet's climate. Deforestation, in particular, is critical as it reduces the number of trees that can absorb CO₂, a crucial mechanism in regulating the environment. Furthermore, the extensive use of synthetic fertilizers in agriculture releases additional greenhouse gases, compounding the problem. The anthropogenic footprint on the environment is also evident in the escalating extinction rates of various animal species, both terrestrial and aquatic, which are directly linked to habitat loss and climate change.

While human activities are significant, natural factors also influence climate variability. According to a report by the United States Government (USG, 2019), natural events such as volcanic eruptions also temporarily alter climate patterns by releasing vast quantities of Sulphur dioxide (SO₂), water vapor, dust, and

ash into the atmosphere. These volcanic aerosols have a short-term cooling effect on the Earth's climate and contribute to ozone layer depletion. NASA (2010) also acknowledges that before the Industrial Revolution, Earth's climate changes were predominantly driven by natural forces such as variations in solar radiation and volcanic activities. The Nigerian Hydrological Services Agency, as referenced by Umar and Gray (2022), emphasizes that natural factors, including extreme weather patterns influenced by climate change, soil moisture levels, and topographical features, are key contributors to flooding in Nigeria. Trenberth (2011) further argues that climate change, exacerbated by these natural factors, has led to altered precipitation patterns, affecting the distribution and intensity of rainfall, thereby increasing the frequency and severity of flooding.

Nigeria, despite being less prone to certain natural disasters associated with global warming, is not immune to the impacts of climate change. Rising sea levels and coastal erosion are evident consequences, leading to devastating flooding in various parts of the country. For instance, the flooding in Imo State in September 2023, which resulted in significant loss of life and property, underscores the severity of climate change impacts in Nigeria. A community Leader reported that this flooding, which occurred over six weeks, displaced numerous communities, highlighting the vulnerability of Nigeria's infrastructure and population to climate-induced disasters. Furthermore, in Imo State, the effects of climate change are starkly visible through widespread gully erosion, which has ravaged the land and led to severe environmental and socio-economic consequences. It is important to note that despite challenging incidents in Nigeria, flooding appeared to be the most severe the country has encountered in the past decade.

The forgoing discourse implies the stark visibility of climate change's consequences. Worthy note is that they extend beyond immediate physical impacts to broader socio-economic challenges. Thus, the interplay between anthropogenic and natural factors continues to drive climate change in Nigeria, with far-reaching impacts on the environment and society. Addressing these challenges requires a comprehensive approach that integrates mitigation, adaptation, and resilience-building strategies to safeguard Nigeria's environmental security and ensure sustainable development.

International Environmental Laws: Evolution and Regulatory Challenges

A significant focus in the discourse on international environmental regulation can be found in the United Nations Framework Convention on Climate Change document. According to this document, the Kyoto Protocol was adopted on December 11, 1997, but did not come into force until February 16, 2005. The document outlines that the Kyoto Protocol operationalized the United Nations Framework Convention on Climate Change by obligating industrialized countries and transitioning economies to limit and reduce their greenhouse gas (GHG) emissions according to agreed-upon individual targets. The Convention requires these countries to adopt mitigation policies and measures and report on them periodically. As of 2022, the UNFCCC had 198 parties, and its highest decision-making body, the Conference of the Parties (COP), convenes annually to assess progress in addressing climate change. However, due to key signatory states not adhering to their commitments, the UNFCCC has faced criticism for its perceived failure to reduce carbon dioxide emissions since its inception.

In essence, the Kyoto Protocol is built upon the principles and provisions of the Convention and follows its annex-based structure. It exclusively binds developed countries and places greater responsibility on them under the principle of "common but differentiated responsibility and respective capabilities" because it acknowledges their significant role in the current high levels of GHG emissions in the atmosphere.

In their writings, Falola and Heaton (2008), highlights that Nigeria's origin as a nation can be traced back to the conquest of Lagos in 1851 and its subsequent annexation in 1861. Notably, Nigeria's focus on environmental regulation did not become significant until the country gained independence in 1960. This

observation was primarily based on the perception that ecological problems were predominantly the concerns of Western industrialized nations. Adegoke and Adegoroje (1994) posited that this contributed to Nigeria's neglect of environmental issues. Akin (1964) suggested that the British colonial rulers were more motivated by economic interests like commerce rather than environmental concerns. Rebecca (2005) echoed a similar sentiment, asserting that the colonial powers were primarily focused on exploiting the region for their national interests.

This perspective became evident in Oluwasegun's (2017) view, which emphasized that the colonial approach was primarily concerned with public health rather than broader environmental issues. Within the context of colonial medicine ideology, colonial administrations used public health concerns to legitimize their rule and enact racial segregation. The colonial era was also marked by establishing legislation and public health laws, such as the Criminal Code Law of 1916 and the Public Health Act of 1917, which aimed to address public health violations.

However, it is worth noting that starting in 1960, the discovery and exploitation of oil in Nigeria became a major source of environmental issues, particularly related to gas flaring and oil spillage, with significant impacts on oil-producing communities. Ogbodo (2010) argued that the drilling, exploitation, and processing of oil in Nigeria gave rise to a range of environmental challenges even in Imo State, Southeast Nigeria such that necessitated the development of environmental regulations and laws.

However, Nigeria appears to lack clear national policy objectives for the country's environment. Nevertheless, Nigeria has enacted various policies to align with multiple international conventions and protocols on the environment. Interestingly, Section 20 of the 1999 Nigerian Constitution articulates the underlying principles of environmental protection and management. This section states, "the state shall protect and improve the environment and safeguard the water, air, land, forest, and wildlife of Nigeria." Unfortunately, this constitutional provision is non-justiciable, meaning that the Nigerian government cannot be compelled to enforce these provisions to safeguard the environment. Numerous legislative statutes have been enacted to address this constitutional limitation, and several international treaties have been ratified to protect and preserve Nigeria's environment. It is important to note that Nigeria's statutes encompass acts, laws, decrees, edicts, and ordinances. An act passed by the Federal Legislature is called an "Act," while a statute passed by a state's House of Assembly is called a "law." Decrees are enactments by the central military government, while edicts are those of the state military government. Ordinances are laws passed by the Nigerian Central Legislative Assembly before October 1, 1954, when Nigeria adopted a Federal Constitution.

The Federal Environmental Protection Agency (FEPA) Act was enacted in 1988 in response to the Koko toxic waste dump incident, during which approximately 3,000 tons of toxic waste were illegally dumped in Koko port by Italian businessmen. The establishment of FEPA can be seen as the initial step in Nigeria's environmental governance. However, following substantial criticism, FEPA was abolished in 1999, and its responsibilities were transferred to the Ministry of Environment. Subsequently, the Act was revised to pave the way for enacting the National Environmental Standards and Regulations Enforcement Agency (NESREA) Act in 2007. The mandate for active participation in the evolving global environmental protection process was conferred upon Nigeria, along with many other countries, at the Stockholm Conference in 1972. Besides the Stockholm Conference, numerous other international treaties, protocols, and conventions hold significance in environmental governance in Nigeria. Some notable examples include the Universal Declaration of Human Rights in 1948, the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter in 1972, the International Convention for the Prevention of Pollution of the Sea by Oil in 1954 (amended in 1962 and 1969), the Convention on the High Seas in 1958, the United Nations Conference on Desertification (UNCOD) in 1977, the International Conference on the Establishment of an International

Fund for Compensation for Oil Pollution Damages in 1978, the African Charter on Human and Peoples' Rights in 1983, the Convention for Cooperation in the Petroleum and Development of the Marine and Coast Environments of West and Central Africa in 1984, the United Nations Conference on Environment and Development (UNCED) in 1992, the United Nations Convention to Combat Desertification in 1994, the Vienna Convention for the Protection of the Ozone Layer, the Rio Declaration on Environment and Development, and several others.

To implement the Environmental Policy, Nigeria has formulated specific policies and action plans that, if effectively executed, could support the country's national climate change adaptation responses, particularly in areas such as drought and desertification, erosion and flood control, coastal zone management, national sanitation, forestry, and biodiversity protection. For instance, the National Policy on Drought and Desertification acknowledges the potential intensification of drought and desertification in the country's northern regions due to climate change. Consequently, the policy outlines strategies to mitigate the adverse impacts of climate change on drought and desertification. To address climate change-related challenges, the policy emphasizes the need to equip relevant agencies, institutions, and citizens with the necessary tools to collect, analyze, and utilize climate data effectively for drought and desertification mitigation. Moreover, the policy promotes land-use practices that enhance carbon dioxide sequestration, such as afforestation and agro-forestry, with the added benefits of reducing soil erosion and increasing crop productivity, thus supporting climate change adaptation and economic development. Additional long-term integrated strategies are detailed in the National Action Programme (NAP) to Combat Desertification and Mitigate the Effects of Drought, which was developed in 2000 and remains the primary implementation framework for drought and desertification policies.

The National Forest Policy has been finalized, and Nigeria has established the National Forestry Action Program (NFAP). NFAP is designed to prioritize sustainable forest management, encourage participatory development processes, facilitate private sector engagement in forestry development, and adopt an integrated approach. This comprehensive program comprises three subprograms: forest management, social forestry, and forest industries. Effective implementation of these initiatives can significantly expand Nigeria's forest cover, contributing to climate change mitigation and adaptation efforts and positioning the country to benefit from the global REDD+ program. The primary aim of the National Biodiversity Strategy and Action Plan (NBSAP) is to create a suitable framework and program tools for the preservation of Nigeria's biological diversity. This includes promoting its sustainable use to enrich the country's biodiversity and leverage its positive impact on climate change adaptation and mitigation strategies. NBSAP seeks to encourage the integration of biodiversity considerations into national planning, policies, and development plans (NBSAP, 2015).

On the other hand, the National Erosion and Flood Control Policy and its Action Plan aim to ensure a systematic and coordinated approach to managing and controlling erosion and flood hazards. The goal is to minimize their adverse impacts on the population and the environment.

Additionally, Nigeria introduced a new agricultural policy in 2001, aiming to achieve self-sufficiency in essential food supplies, boost agricultural raw material production for industries, enhance the production and processing of export crops using advanced technologies, and create job opportunities (AfDB 2005, FMARD 2001, Manyong et al 2003). This policy also seeks to reduce risks and uncertainties in agriculture, including those related to natural hazards like climate change, which can impact agricultural production and investment security. The policy framework covers various areas vulnerable to climate change impacts, including crops, livestock, fisheries, agro-forestry production, pest control, water resources, and irrigation.

Nigeria has an extensive coastline that stretches over 800 kilometers, featuring diverse geomorphological characteristics that are highly vulnerable to the impacts of climate change. Although a specific policy for coastal

zone management has yet to be developed, the country is actively participating in the UNDP/UNEP/UNIDO/GEF project aimed at addressing coastal area degradation and the depletion of living resources within the Guinea Current Large Marine Ecosystem (GCLME) through regional initiatives. A significant result of this project is establishing a Strategic Action Programme to promote sustainable environmental management across the sub-region. Several measures within this initiative present promising opportunities for proactive adaptation responses to climate-induced changes in Nigeria's coastal environment.

In energy policy and planning, Nigeria's National Energy Policy outlines guidelines to protect the environment during fossil fuel exploitation. It highlights the importance of exploring renewable and alternative energy sources, particularly solar, wind, and biomass. Nigeria envisions a future in which renewable energy plays a crucial role, aiming for sustainable and affordable renewable sources to supply half of the nation's total energy demand by mid-century. This strategy will significantly help reduce greenhouse gas emissions and decrease the country's reliance on fossil fuels.

The health policy of Nigeria is closely linked to climate change adaptation, given the expected increase in climate-related health issues. The National Health Policy (NHP) 's primary aim is to improve Nigerians' health status and achieve health-related Millennium Development Goals (MDGs). Supporting the NHP's implementation are policies such as the National Adolescence Health Policy, the National Reproductive Health Policy, and the forthcoming Nigerian Health Promotion Policy. These policies collectively seek to lower disease morbidity and mortality rates, tackle communicable diseases, and enhance Nigerians' overall quality of life and life expectancy in light of the challenges posed by climate change (National Climate Change Policy for Nigeria, 2021).

Moreover, Nigeria's transport sector faces vulnerability issues heightened by adverse weather conditions. The transport sector struggles with challenges such as a collapsed rail system, a weak civil aviation framework, and a poorly maintained road transportation network. Nigeria's comprehensive transport policy aims to tackle issues related to the economic regulation of urban transport, funding, land use and transportation planning, safety enforcement, institutional framework, and public-private partnerships within the transportation sector. Effectively implementing this policy is crucial for improving Nigeria's readiness to handle more severe weather conditions due to climate change. (National Climate Change Policy for Nigeria, 2021)

Department of Climate Change Unit (DCC): Nigeria has established a Department of Climate Change Unit (DCC) within the Federal Ministry of Environment in Abuja. The primary role of the DCC is to implement activities related to the Convention and protocols on climate change. It also serves as the coordinating body for the Inter-ministerial Committee on Climate Change, which includes representatives from various ministries such as Finance, Agriculture, Water Resources, the Energy Commission, the Nigeria National Petroleum Corporation (NNPC), Foreign Affairs, the Nigerian Meteorological Agency (NIMET), industry, NGOs like the Nigerian Environmental Study/Action Team, and academia. (National Policy on Climate Change, 2020)

Regarding afforestation initiatives, it is essential to recognize that afforestation serves as a significant response to mitigate the effects of climate change, with the Nigerian government actively participating in various afforestation programs. Nigeria is involved in the African Union Commission's "Green Wall Initiative," which aims to create a "green wall" of trees across the country's arid regions. This initiative seeks to combat deforestation while promoting agriculture and sustaining livelihoods in the Sudano-Sahelian zone, addressing climate change in alignment with the United Nations Millennium Development Goals. Additionally, the Presidential Initiative on the Afforestation Program for Environmental Sustainability has established ambitious targets to plant approximately 40 million trees annually. The government acknowledges the urgent need to address climate change challenges and has prioritized them on the national development agenda. Efforts are being intensified to integrate climate risk considerations into national development projects and strategies,

including NEEDS/SEEDs and the Economic Blueprint known as Vision 20:2020 (Casimir, Omeh, Ike 2014, Igbuzor 2009).

Related to Long-Term, Low-Emission Development Strategies (LT-LEDS), Nigeria, as a signatory to the Paris Agreement (PA), recognizes the crucial role of transitioning to low-emission development to achieve sustainable economic growth and reduce greenhouse gas (GHG) emissions while also yielding broader social, economic, and environmental benefits. In addition to its Nationally Determined Contributions (NDCs) outlining climate actions until 2030, the Paris Agreement, under Article 4.19, encourages all Parties to strive to develop and communicate LT-LEDS. This process considers common but differentiated responsibilities and respective capabilities, taking into account varying national circumstances. To fulfill this commitment, the Federal Government of Nigeria has initiated the development of its LT-LEDS, starting with an initial focus on a Long-Term Vision extending to 2050 for the nation. This vision provides a clear sense of direction for all stakeholders, guiding them in effectively managing the transition to a low-carbon economy. This transition aims to stimulate the growth of existing and emerging sectors, creating new jobs and economic opportunities for the country.

Challenges and Strategies for Enforcing Environmental Laws in Nigeria

The enforcement of environmental laws in Nigeria encounters significant challenges that undermine efforts to tackle environmental degradation and foster sustainable development. It has been identified that poverty, selfishness, insecurity, militancy, low levels of environmental awareness, and corruption are key factors contributing to the limited implementation of environmental regulations in the country. These challenges are intensified by weak institutional capacity, a lack of political will, insufficient funding, and the absence of regulations. Consequently, the lack of awareness about environmental laws complicates enforcement efforts, leading to widespread environmental non-compliance.

A critical aspect of improving environmental law enforcement in Nigeria is enhancing the welfare of enforcement officers. Undeniably, better compensation, capacity-building incentives, and providing necessities such as food, clothing, and shelter for enforcement officers could contribute to achieving sustainable development goals. The rationale behind this approach is that well-compensated and motivated officers are more likely to perform their duties, thereby improving enforcement outcomes diligently.

However, addressing endemic corruption within enforcement agencies is crucial. It is important to note that tackling corrupt practices among enforcement officers requires stringent penalties, including dismissal, to deter others and uphold the integrity of environmental law enforcement. Failing to address corruption severely undermines environmental security and worsens climate change issues in Nigeria, as it allows for the continued violation of ecological laws without consequences. Furthermore, modern technology can be transformative in monitoring and enforcing environmental regulations. Technologies such as satellite imagery, Geographic Information Systems (GIS), and drones can provide real-time data and evidence of environmental violations, thereby improving the ability of enforcement agencies to detect and address infractions. However, despite the availability of such technologies, their use has been limited due to institutional and financial challenges.

A notable challenge in enforcing environmental laws in Nigeria is the gap between international multilateral ecological treaties and their domestic incorporation. Although Nigeria is a signatory to numerous international environmental agreements, many of these treaties have not been fully integrated into domestic law, which undermines the country's legal framework for environmental governance. This gap hinders enforcement agencies' ability to hold violators accountable under international standards and limits the legal remedies available within the domestic legal system.

Institutional efficiency is also worth mentioning. It is a critical determinant of effective environmental law enforcement in Nigeria. The National Environmental Standards and Regulations Enforcement Agency (NESREA) is the primary institutional agency responsible for environmental governance in the country. NESREA's mandate includes formulating ecological research and technology policies, conserving biodiversity, promoting the sustainable development of natural resources, and providing advisory support to the Federal Government on environmental issues (Njoku and Enebeli, 2023: 144).

Despite NESREA's broad mandate, the agency has encountered significant challenges in enforcing environmental laws. The difficulty in apprehending and prosecuting violators has resulted in ongoing environmental degradation. Moreover, NESREA's limited success in enforcing environmental regulations underscores the more significant issue of institutional inefficiency within Nigeria's environmental governance framework. This inefficiency stems partly from inadequate funding, bureaucratic delays, and poor inter-agency coordination, which undermines the agency's ability to fulfill its mandate effectively. Therefore, while NESREA plays a critical role in environmental governance in Nigeria, the enforcement challenges need urgent attention. Improved enforcement mechanisms, stricter adherence to environmental regulations, and institutional reforms are essential for addressing the persistent environmental issues faced by Nigeria. Strengthening the enforcement of environmental laws is crucial for protecting the environment, promoting sustainable development, and mitigating the impacts of climate change in Nigeria.

Final Remarks

Given the preceding discussion, a wealth of literature exists that presents various studies and opposing viewpoints on the effects of climate change on environmental security and whether climate-induced environmental stress serves as a catalyst for interstate conflicts. Notably, there seems to be considerable consensus among security policy experts and multiple non-governmental organizations that view climate change as a threat multiplier in conflict scenarios.

It is undeniable that climate change represents a tangible and undeniable phenomenon that the global community is grappling with. The repercussions of climate change and its role as a threat multiplier are observable in both the northern and southern hemispheres, albeit with varying degrees of impact influenced by each continent's unique characteristics and the effectiveness of their adaptive and mitigating measures. The effects of climate change and its potential catalysts have led to severe consequences for Nigeria's environment.

These consequences include dwindling fish stocks, loss of biodiversity and ecosystem services, exacerbated poverty, diminished freshwater resources, heightened disease burdens, infrastructure damage, resource scarcity, crop failures, and reduced agricultural yields, which result in food insecurity. Furthermore, climate change exacerbates gender inequalities, as women often bear the brunt of providing for their families under increasingly challenging circumstances.

Furthermore, climate change's adverse impact includes the depletion of forest reserves and wetland destruction, which results in the loss of essential ecosystem services, such as food, medicine, and carbon sequestration. From a perspective aimed at addressing climate change threats, the Nigerian National Security Strategy (NSS), launched in 2019, recognizes forests as critical national assets and forest conservation as a strategic imperative.

Effectively addressing climate change adaptation requires the collective response of both state and non-state actors. It is widely acknowledged that state actors alone cannot adequately confront the challenges posed by climate change. In response, the Nigerian government has established various institutional frameworks and formulated numerous policies to mitigate climate change and its effects on human security. Despite achieving

significant milestones, environmental agencies in Nigeria have struggled to apprehend and prosecute offenders, leading to further environmental degradation.

The overarching inability of responsible agencies to protect the environment through the effective implementation and enforcement of relevant regulations and laws arises from several factors. These factors include deficiencies in the legal framework, institutional bottlenecks, corruption, inadequate funding, governance issues, intimidation, and a lack of awareness. Despite the numerous environmental protection laws, enforcing the right to a clean and healthy environment remains a work in progress in Nigeria. Consequently, addressing climate change challenges also involves addressing security threats. States must tackle the underlying causes of climate change to mitigate these security risks effectively.

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Statement Declaration

I affirm that the content in this article is my original work, properly cited where necessary. All information is accurate to the best of my knowledge, and no financial interests are directly or indirectly related to this work.

Data Availability Statement

Data supporting this study is included in the article.

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [Kelechi Nwanegwo], [Udochu Eke] [JAMES Fajemoroye] and [Sandro Dutra]. The first draft of the manuscript was written by [Kelechi Nwanegwo] and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

APPENDIX B

Questionnaire On Climate Change And Environmental Security In Nigeria (Responses)

Name	Are you above 18?	Gender	Are you from Imo state?	Have you heard about Climate Change?
IWUOHA EJIKE	Yes	Male	Yes	Yes
NNAEMEKA	Yes	Male	Yes	Yes
CHIBUEZE CHIDERA ROSEMARY	Yes	Female	Yes	No
EZUNIKE PRECIOUS CHIMEMEZUWO	No	Female	Yes	No
ONYEKACHI CHIEMELA MARY	Yes	Female	Yes	Yes
IHEKWUEME EBERE	Yes	Female	Yes	Yes
CHIJOKE CHINWEWENDU J.	Yes	Male	Yes	Yes
CHUKWU ABRAHAM OZIOMA	Yes	Male	Yes	Yes
EMERENINI CHIJOKE JOHN	Yes	Female	Yes	Yes
FRANCIS MIRIAN MMESOMA	Yes	Female	Yes	Yes
FRANCIS GERALD UCHE	Yes	Male	Yes	Yes
EZURUIKE FAVOUR CHINATUOKWU	Yes	Female	Yes	Yes
EZURUIKE CHIBUDOM KELECHI	Yes	Male	Yes	Yes
ORIAKU CHRISTY		Female	Yes	Yes
OGUOMA OSINACHI	Yes	Male	Yes	Yes
NWAEVULE INNOCENT		Male	Yes	Yes
OKERE PASCAL C		Male	Yes	Yes
EZEKIE STELLA U.	Yes	Female	Yes	Yes
OKPULOR SOPHIA ISEOMA		Female	Yes	Yes
AYOZIE CHINAZA	Yes	Female	Yes	Yes
CHIGERE KINGSLEY TOBECHI	Yes	Male	Yes	Yes
OPARAH ANYAEHIE HIENANN	Yes	Male	Yes	Yes
Kelechi Opara	Yes	Male	Yes	Yes
AZUOMA CHINAZA	Yes	Male	Yes	Yes
REVD. OKORO THANKGOD	Yes	Male	Yes	Yes
CHIKA	Yes	Female	Yes	Yes
WILFRED NJOKU	Yes		Yes	Yes
MATINA OGU	Yes		Yes	Yes
NIKIRU ORIYEAGOGCHA	Yes		Yes	No
NWADIKE ONYINYECHI	Yes		Yes	Yes
EZINNE MMADU	Yes		Yes	Yes
CHIBUEZE BLESSING CHIKADIBIA	No	Female	Yes	No
GABRIEL IWUCHUKWU	Yes		Yes	Yes
PAUL OKPARA	Yes		Yes	Yes
CHINAKU GEORGE N.	Yes	Female	Yes	Yes
NNODI DESMOND	Yes	Male	Yes	Yes
EKWULONU IJEOMA A.	Yes	Female	Yes	Yes
ADIMEKWE THERESA CHIZOBA	Yes	Female	Yes	Yes

ANOZIE MADUABUCHI	Yes	Male	Yes	Yes
UZOMA OKWARA	Yes	Male	Yes	Yes
EZENWA NELSON	Yes	Male	Yes	Yes
UKAGA VIVIAN	Yes	Female	Yes	Yes
EFUGHI JOY	Yes	Female	Yes	Yes
GLORY NNAJI	Yes	Female	Yes	Yes
OHIRI S. CHUKWU	Yes	Male	Yes	Yes
NWOZUZU CHISOM		Male	Yes	Yes
IZUROBI ONYINYECHI	Yes	Female	Yes	Yes
ICHE ANTHONY O.	Yes	Female	Yes	Yes
Okoro Amarachi Victoria	Yes	Female	Yes	Yes
Nwanne miracle adanso	Yes	Female	Yes	Yes
Akushie Patrick	Yes	Male	Yes	Yes
Ekwegbalu Obinna Victor	Yes	Male	Yes	Yes
Amaka Omenukwa	Yes	Female	Yes	Yes
Akadiro Chinagorom Martins	Yes	Male	Yes	Yes
Innocent Azubuikwe Okeagu	Yes	Male	Yes	Yes
Daniel Anyanwu	Yes	Male	Yes	Yes
Chibueze Ughala	Yes	Male	Yes	Yes
Kachi	Yes	Male	Yes	Yes
Ogonnaya Ogechi Chioma	Yes	Female	Yes	Yes
Helen	Yes	Female	Yes	Yes
Nkemjika Ibeawuchi	Yes	Male	Yes	Yes
Ifeoma Mbonu	Yes	Female	Yes	Yes
Chikobi mercy chizetelu	Yes	Female	Yes	Yes
Emezuom Maryann chiamaka	No	Female	Yes	Yes
Nwanekezi kelechukwu justice	Yes	Male	Yes	Yes
TASIE PRINCE UGOCHUKWU	Yes	Male	Yes	Yes
OGBONNA CHINEDU	Yes	Male	Yes	Yes
OKPO EMMANUEL	Yes	Male	Yes	Yes
EKEMEDO STANLEY		Male	Yes	Yes
Peter chimezie	Yes	Male	Yes	Yes
UKAH FENIAN O.	Yes	Male	Yes	Yes
Victor favour yaanat	Yes	Female	No	Yes
Onuchukwu Blossom Chimbuonyenchen	Yes	Female	Yes	Yes
Hillary happiness uchechukwu	Yes	Female	Yes	Yes
Emmanuel chiamaka miracle	Yes	Female	Yes	Yes
IBEAWUCHI PECULIA HHR NMESOMA	Yes	Female	Yes	Yes
EMMANUEI Nwansoike EKE	Yes	Male	Yes	Yes
EMMANUEI Nwansoike EKE	Yes	Male	Yes	Yes

Uwalaka precious chiamaka	Yes	Female	Yes	Yes
Emenike henrietta nmerichukwu	Yes	Female	Yes	Yes
Emenike henrietta nmerichukwu	Yes	Female	Yes	Yes
Ekpe Gift Uzoma	Yes	Male	Yes	Yes
Abogu favour chidinma	Yes	Female	Yes	Yes
Njoku promise	No	Male	Yes	Yes
Duruaku Chinwendu precious	Yes	Female	Yes	Yes
Okwara Glory Amarachi	Yes	Female	Yes	No
NDUKA OBIANUJU PRECIOUS	Yes	Female	Yes	Yes
NGEJEME CHIAMAKA FAVOUR	Yes	Female	Yes	Yes
Chima Joy Oluebube	Yes	Female	Yes	Yes
Iwu chisom wisdom	Yes	Male	Yes	Yes
NGANWUCHU PIUS CHIAGOZIE	Yes	Male	Yes	Yes
	Yes	Male	Yes	Yes
Edmund Bright Ihechukwu	Yes	Male	Yes	No
Onyeanu Mmesoma Tochukwu	Yes	Female	Yes	Yes
ORJI OLUOMACHI AUGUSTINA	No	Female	No	Yes
Egbufoama chinwendu Stephenie	Yes	Female	Yes	Yes
Nwachukwu chisom Maryjane	Yes	Female	Yes	No
Olivia	Yes	Female	Yes	Yes
Oparaugo margaretmery chinaememma	Yes	Female	Yes	Yes
Ugochi Osuji	Yes	Female	Yes	No
Ohaneje Happiness Arunika	Yes		Yes	Yes
Chukwuemeka Chidera Stella	Yes	Female	Yes	No
Uzoma Christabel Ebubechukwu	No	Female	Yes	Yes
Ibegunam chisaram Stephanie	Yes	Female	Yes	No
Igwe chijindu	Yes	Female	Yes	Yes
ODOEMENAM ONYINYE FELICIA	Yes	Female	Yes	Yes
NKWOCHA LIGHT CHUKWUDI	Yes	Male	Yes	Yes
	Yes	Female	Yes	No
OKECHUKWU CHIDINMA JENNIFER	Yes	Female	Yes	Yes
Ukachi Sunday chibuzo	Yes	Male	Yes	Yes
UZOR MMESOMA BLESSING	No	Female	Yes	Yes
	Yes	Female	Yes	Yes
Grace Sunday	Yes	Female	No	Yes
Nwosu Angel chinyeremaka	Yes	Female	Yes	Yes
Egwim chibuanyi janet	Yes	Female	Yes	Yes
Azorji chibuike Emmanuel	Yes	Male	Yes	Yes
Njoku Emmanuella ginikachi	Yes	Female	Yes	Yes
Ekeh Joyfrancisca Ifunanya	No	Female	Yes	Yes

Ugoji Ruth Chinanuizu	Yes	Female	Yes	Yes
OPARA SOPHIA CHIDIEBUBE	Yes	Female	Yes	Yes
Onyeji Chigozie Kennedy	Yes	Male	Yes	Yes
Anyanwu simeon chinonso	Yes	Male	Yes	Yes
Igbokwe chukwuebuka chrysogonus	Yes	Male	Yes	Yes
OSUJI NNEOMA MARY	Yes	Female	Yes	Yes
Eugene Samuel	Yes	Male	Yes	No
Mbanu Chigaemezu Blossom	Yes	Female	Yes	Yes
Duru ebuka Henry	Yes	Male	Yes	No
Maduwuba ifeanyi hope	Yes	Male	Yes	No
TRANSCEND RIBINSON CHIDINMA	No	Female	Yes	Yes
Okorie favour nzubechukwu	Yes	Male	Yes	Yes
Nwankwo chinwe prisca	No	Female	Yes	Yes
ANYIAM PROMISE ONYIYECHI	Yes	Male	Yes	No
Okolie Maureen	Yes	Female	Yes	Yes
Michael Adaeze Divine	Yes	Female	Yes	Yes
Okere Emmanuel Chinoyerem	Yes	Male	Yes	Yes
Ogike chinwendu marynoel	Yes	Female	Yes	Yes
Emerenini Ruth ujunwa	Yes	Female	Yes	No
DURU SAMUEL CHUKWUEBUKA	Yes	Male	Yes	Yes
Nwanne miracle adanso	Yes	Female	Yes	Yes
Nebo ebube Mary	Yes	Female	Yes	Yes
ANAYO JOY	Yes	Female	Yes	Yes
Emeruwa Roseline ogechi	Yes	Female	Yes	Yes
OBIWURU ROSEMARY IFUNANYA	Yes	Female	Yes	Yes
Amadi Chibueze Emmanuel	Yes	Male	Yes	Yes
Anyiam promise onyiyechi	Yes	Male	Yes	Yes
Eze chisom daniella	Yes	Female	Yes	Yes
David onyinye favour	Yes	Female	Yes	Yes
Oshieke chidimma immaculata	Yes	Female	Yes	Yes
Michael precious	Yes	Female	Yes	Yes
IHUGBA JUDITH MMESOMA	Yes	Female	Yes	Yes
JERRIS HENRY C.	Yes	Male	Yes	Yes
CHRIS OKOLIE	Yes	Male	Yes	Yes
ADEBAYO TEMITOPE	Yes	Female	Yes	Yes
IKPEAWUJO CHIGOZIE FAVOUR	Yes	Female	Yes	Yes
EJKOFOR CHRISTIAN	Yes	Female	Yes	Yes
Obasi favour	Yes	Female	Yes	Yes
Aguocha uchechi genevieve	Yes	Female	Yes	Yes
OKURUDU U. VICTOR	Yes	Male	Yes	Yes

Chukwuemeka Emmanuel chibuike	Yes	Male	Yes	Yes
Nwachukwu Udochukwu	Yes	Male	Yes	Yes
CHUKWUEMEKA PECULIAR AMARAC	Yes	Female	Yes	Yes
Michelle	Yes	Female	Yes	No
Aleke chinecherem Lilian	Yes	Female	Yes	Yes
Uzowuru Paschal Chigbomkpa	Yes	Male	Yes	Yes
EZURUIKE CONFIDENCE ONYEZE	Yes	Male	Yes	Yes
Osuji chimereucheya serah	Yes	Female	Yes	Yes
Ogubuike Clinton oluebube	Yes	Male	Yes	No
Maranwanne ugochi Gabriella	Yes	Female	Yes	Yes
Egeonu Stella maris odiche	Yes	Female	Yes	Yes
Akuneziri Jessica	Yes	Female	Yes	Yes
Dr. M. C. N. Ihemadu	Yes	Male	Yes	Yes
Isaac Precious Sharon	Yes	Female	Yes	Yes
Emmanuel Destiny	Yes	Male	Yes	Yes
Iwu Victor chukwunaechetam	Yes	Male	Yes	Yes
Chibueze Nmesoma mercy	No	Female	Yes	Yes
Emedo Miracle oluebube	Yes	Female	Yes	Yes
Solomon Ogechi faith	No	Female	Yes	No
Nwokedi Jessica Ifunanya	Yes	Female	Yes	Yes
Kalu obinna augustine	No	Male	Yes	Yes
Anyaehe Chibugo Genevieve	Yes	Female	Yes	Yes
Chinedu Confidence Ugoeze	Yes	Female	Yes	Yes
Collins	Yes	Male	Yes	Yes
Amadi Destiny lbe	Yes	Male	No	Yes
Asagwara Esther Chioma	Yes	Female	Yes	No
Agim Franklin Mmesomachukwu	No	Male	Yes	Yes
Nwachukwu Chidera Sandra	Yes	Female	Yes	No
Nduka Eric Chukwuebuka	Yes	Male	Yes	Yes
OKEAMA PRECIOUS	Yes	Female	Yes	Yes
Okereke chidiebube Esther	Yes	Female	Yes	No
Iheanacho Victor osita	Yes	Male	Yes	Yes
Ogoamaka Elvis Sochinemerem	Yes	Male	Yes	Yes
Ahaonye Ngozi Chimdiya	Yes	Female	Yes	Yes
Azubuiké chiduruem destiny	Yes	Male	Yes	Yes
	No	Female	No	Yes
Ngobiri queen precious	Yes	Female	Yes	Yes
	Yes	Male	Yes	Yes
	Yes	Male	Yes	Yes
Steve ORJI Nephi	Yes	Male	No	No

EMMANUEI Nwansoike EKE	Yes	Male	Yes	Yes
Ndukwu Joy Akudo	Yes	Female	Yes	Yes
OPARA GIFT CHIGOZIRIM	No	Female	Yes	Yes
Onyechere Gift Chidinma	No	Female	Yes	No
Jibie Chidinma Esther	Yes	Female	Yes	Yes
AMADI CHIOMA VICTORIA	Yes	Female	Yes	Yes