

Sustainable Climate Change Mitigation Strategy: Policies and Technology A Case Study of Abuja, Nigeria

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Abstract

Global economic stability, human health, and ecosystems are all seriously threatened by climate change. More flooding, desertification, rising temperatures, altered precipitation patterns, and a rise in the frequency of extreme weather events that result in food insecurity are just a few of the problems Nigeria faces as one of the nations most at risk from climate change. With an emphasis on Abuja, this study examines the policy frameworks and technology advancements used in Nigeria to mitigate the effects of climate change. It assesses the efficacy of national initiatives, including Nigeria's Nationally Determined Contributions (NDCs) under the Paris Agreement, the Renewable Energy Master Plan, and the National Climate Change Policy and Response Strategy. Additionally, it looks into how energy efficiency initiatives, sustainable urban design, and renewable energy technology might lower greenhouse gas emissions.

Abuja, as the political and administrative capital, presents unique opportunities and challenges in implementing climate action, particularly in transportation, infrastructure development, and energy use. The study highlights the socio-economic factors influencing Nigeria's vulnerability, including poverty, rapid urbanization, and inadequate infrastructure. Using a qualitative case study approach, the research identifies existing gaps in implementation, financing, and public awareness, while also exploring opportunities for improvement. The paper concludes with strategic recommendations to strengthen Nigeria's climate resilience through integrated policies, enhanced technological adoption, and active community participation.

Keywords

Climate, Climate Change, Mitigation Strategy, Policies and Technology

1. Introduction

The environment, economics, and society are all significantly impacted by the worldwide phenomenon known as climate change. Nigeria, a country in West Africa, is especially vulnerable to the negative consequences of climate change because of its varied topography and socioeconomic difficulties. Rising temperatures, unpredictable rainfall patterns, and an increase in the frequency of extreme weather events have all affected the nation, endangering food security and agricultural output [1]. Examining the effects of Abuja, Nigeria's climate change mitigation strategy, policies, and technology is the aim of this study. One of the most important challenges of our day is climate change, which has profound effects on the economy, society, and ecology.

Global warming and disruptive weather patterns are the results of the buildup of greenhouse gases in the atmosphere, mostly from human activities like burning fossil fuels and deforestation. Adopting mitigation methods that seek to lower greenhouse gas emissions and move toward a more resilient and sustainable future is crucial to limiting the worst effects of climate change.

2. Nigeria's Climate Change

Climate change is one of the biggest problems our world is confronting in the twenty-first century (6). A change in the climate system that alters the composition of the climate and can be attributed either directly or indirectly to human activity and climate variability

The functioning of the climatic system is referred to as climate change [2].

This trend has been linked to human activities including burning fossil fuels, bush burning, deforestation, and urbanization that emit carbon (iv) oxide and other GHGs into the climate system [3]. Light trying to escape the globe will be hindered by a larger concentration of greenhouse gases in the atmosphere, trapping the heat and contributing to global warming.

There have been notable regional and chronological changes in the Nigerian climate's variability and evolution. Extreme weather events like heat waves, floods, droughts, and ocean surges have become more frequent. Extreme weather and climate change have a negative impact on the economy and have the potential to harm lives and property, even though their consequences may be gradual.

Floods are becoming a recurring problem that get worse every year, causing enormous losses and trauma. Strong tidal waves and ocean surges cause the nation's low-lying coast to be inundated year-round. According to a 2010 assessment by the National Emergency Management Agency (NEMA), flood catastrophes that devastated numerous villages throughout the nation caused over 250,000 Nigerians to be relocated (NEMA, 2010). According to the Nigeria climate study conducted by the Nigerian Meteorological Agency (NIMET), the rainy (wet) season started between 1941 and 1970, with the exception of a few isolated areas close to Sokoto and Maiduguri, where the season started later. But because of the rainy season's increasingly delayed start, by 1971-2000, a significant portion of the country was experiencing late start rains, with only a tiny area in the middle seeing usual circumstances.

Climate change affects climate outcomes like average temperature and rainfall. Agricultural production is a climate-dependent sector of the economy since it involves selecting crops that are suited to the local climate and using the right farming methods. As a result, changes in climate outcomes have a direct impact on economic activities like agricultural output. Temperature, precipitation, sunlight, and other agricultural climatic aspects are all altered as a result of climate change's distortion of the agricultural environment.

Rising temperatures and altered rainfall patterns are two effects of climate change that have a variety of effects on crop yields, whether they are rain-fed or irrigated.

Additionally, crops experience significant setbacks because to variations in the amount of time they get sunlight and erratic rainfall, which can either start or stop too early. This leads to abortion of fruits and flowers. Crop yield declines are also caused by insect and disease incidences, which become unpredictable and diversified during extreme weather events [4].

2.1 A Synthesis of Climate Change's Impacts

Nigeria's tropical climate is characterized by distinct rainy and dry seasons. However, climate change has disrupted these cycles, with fatal consequences. Evaporation rates have increased due to warmer temperatures, while drought and flooding have been brought on in some places by changed rainfall patterns. These climatic changes have significant implications for agriculture, water resources, and public health.

2.2 Vulnerability and Adaptation

Nigeria's vulnerability to climate change is exacerbated by socio-economic factors, including poverty, population growth, and inadequate infrastructure. The agricultural sector, which employs a significant portion of the population, is particularly vulnerable to climate variability. Adaptation strategies, such as improved agricultural practices and water management, are essential to mitigate the impacts of climate change.

3. Climate Change Mitigation Policies in Nigeria

When it comes to creating policies to combat climate change, Nigeria has advanced significantly. The government has created a Nationally Determined Contribution (NDC) to cut greenhouse gas emissions by 45% by 2030 and has ratified a number of international agreements, notably the Paris Agreement [5]. The National Climate Change Policy and Response Strategy, which describes Nigeria's strategy to tackling climate change, was also created by the government.

The Renewable Energy Master Plan, which seeks to raise the proportion of renewable energy in the energy mix to 10% by 2025, is one of the main initiatives. The government has also launched the Sustainable Energy for All (SE4ALL) program, which aims to raise the proportion of renewable energy, enhance energy efficiency, and give everyone access to contemporary energy services [6].

Effective climate change mitigation policies play a crucial role in driving the transition to a low-carbon economy. Governments around the world have adopted various policy instruments to incentivize emissions reductions and promote renewable energy sources. One key policy tool is the implementation of carbon pricing mechanisms, such as carbon taxes and cap-and-trade systems, which put a price on carbon emissions and create economic incentives for businesses to reduce their carbon footprint. Additionally, regulatory measures, including emissions standards and renewable energy targets, help to enforce emissions reductions and promote the deployment of clean technologies.

3.1 National Policy Framework

Nigeria's attempts to mitigate climate change are directed by a number of national frameworks and policies. Created in 2012, the National Policy on Climate Change (NPCC) seeks to address climate change issues while advancing sustainable development. The policy highlights the necessity of a multi-sectoral strategy that incorporates climate issues into a number of industries, such as transportation, energy, and agriculture.

3.2 Contributions Determined at the National Level (NDCs)

Nigeria published its Nationally Determined Contributions (NDCs) in 2015, detailing its goals for cutting greenhouse gas emissions as part of its commitment to the Paris Agreement. With an emphasis on areas including waste management, agriculture, and energy, the NDCs aim to reduce emissions by 20% by 2030, with a 47% reduction objective contingent on foreign assistance.

3.3 Institutional Framework

The institutional framework for climate change governance in Nigeria involves various stakeholders, including government agencies, non-governmental organizations, and the private sector. The Federal Ministry of Environment plays a crucial role in coordinating climate change policies and initiatives. Additionally, state governments are encouraged to develop their climate action plans to align with national objectives.

4. Technological Innovations for Climate Change Mitigation

Technology plays a crucial role in climate change mitigation. Nigeria has seen significant investments in renewable energy technologies, particularly solar and wind power. The country has abundant solar resources, and several solar power projects have been developed in recent years. With multiple wind farms slated for development, wind power is also being investigated [7].

Energy efficiency is another innovative field. Nigeria has put in place a number of energy-efficient appliance and lighting standards that should lower greenhouse gas emissions and energy use. Furthermore, the government has started programs to support climate-smart agriculture and other sustainable farming methods that can lower agricultural emissions.

Significant reductions in greenhouse gas emissions require technological advancements. Moving away from fossil fuels has become more affordable because of developments in renewable energy sources like solar, wind, and energy storage. Similar to this, there are a lot of chances to cut emissions thanks to advancements in energy-efficient building, transportation, and industrial processes.

Furthermore, emerging technologies like carbon capture and storage (CCS) and direct air capture (DAC) show promise in removing carbon dioxide from the atmosphere and mitigating the impacts of past emissions.

Looking ahead, several exciting technological advancements show promise for further enhancing the efficiency and scalability of renewable energy systems. For example, researchers are exploring new materials and designs for solar panels to improve efficiency and reduce manufacturing costs. Breakthroughs in wind turbine technology, such as larger rotor sizes and advanced control systems, are expected to increase the energy output and reliability of wind farms. Additionally, innovations in energy storage technologies, such as flow batteries and solid-state batteries, could revolutionize the way renewable energy is stored and utilized.

4.1 Renewable Energy Technologies

The transition to renewable energy is a critical component of Nigeria's climate change mitigation strategy. The country has abundant renewable energy resources, including solar, wind, and biomass. The Renewable Energy Master Plan (REMP) aims to increase the share of renewable energy in Nigeria's energy mix. Solar energy, in particular, has gained traction due to its potential to provide electricity to remote and underserved areas.

4.2 Energy Efficiency Measures

An further crucial tactic for lowering greenhouse gas emissions is increasing energy efficiency. The National Energy Efficiency Action Plan (NEEAP) and the Energy Efficiency Policy are two of the energy efficiency initiatives that the Nigerian government has put into place. These programs encourage the commercial, industrial, and residential sectors to adopt energy-efficient technologies.

4.3 Sustainable Farming Methods

Agriculture is the main source of greenhouse gas emissions in Nigeria. In an attempt to lower these emissions, the government has backed sustainable farming practices like agroforestry, conservation tillage, and organic farming. These techniques not only reduce emissions but also enhance soil health and climate change resilience. One of the main reasons climate change has remained a global concern is the damage it poses to agricultural productivity.

According to empirical research, Nigeria's typical agricultural output pattern is steadily changing due to the country's higher and more variable temperatures and rainfall patterns over the past ten years. Extreme weather events like drought and floods have become more frequent, causing crises for the agricultural productive system. Given how important food sufficiency is to human life, some academics have concentrated on the connection between food security and climate change. Direct observation, surveys, and meteorological data analysis were used in the majority of these research.

Some academics have also employed the modeling approach to extrapolate future climate scenarios in order to provide policymakers with useful recommendations on how to avoid the effects of climate change in the future.

Climate fluctuation has a negative impact on agricultural productivity, according to certain empirical investigations. examined how food production is affected by rising temperatures, diminishing water supplies, and rising CO₂ emissions. Like the majority of other researchers, they found a strong correlation between low crop production and changing climatic conditions.

Climate change as seen in most scientific literature affects the very first phase of food supply chain which is production.

5. Challenges to Climate Change Mitigation in Nigeria

Nigeria faces significant hurdles in its efforts to mitigate climate change. A primary challenge is the country's heavy reliance on fossil fuels, which are a major source of greenhouse gas emissions and a cornerstone of the national economy. This dependence creates a disincentive to transition to cleaner energy sources, as it would require significant economic restructuring.

Moreover, inadequate funding and a lack of political will hinder the implementation of climate policies. Nigeria's budget for climate change initiatives is often insufficient, and powerful interests can impede progress. The country also grapples with poor governance, corruption, and bureaucratic bottlenecks, which further obstruct the effective execution of climate action plans. Finally, there is a low level of public awareness and limited institutional capacity, which makes it difficult to coordinate and sustain national-level responses to climate change.

5.1 Financial Constraints

The absence of sufficient funds is one of the main obstacles to Nigeria's efforts to mitigate climate change. Adoption of new technology and the execution of climate policy are hampered by a lack of funding. To close these budgetary deficits, the government has looked for outside investment and assistance. Improving Financial Mechanisms for Mitigation of Sustainable Climate Change.

Implementing sustainable climate change mitigation solutions requires efficient financial structures. The development and implementation of climate-friendly practices and technology can be aided by the mobilization of financial resources from the public and private sectors. Financial flows toward mitigation initiatives can be improved by policies that foster favorable conditions for green investments, such as carbon pricing, green bonds, and climate funds [8].

Access to climate finance can help developing nations embrace low-carbon practices and technology, promoting sustainable development. In order to help nations with limited financial resources carry out climate change adaptation and mitigation programs, international climate finance structures such as the Green Climate Fund are essential.

Improving climate finance's accountability and openness can also increase how well financial systems work to achieve mitigation objectives. Effective use of financial resources can help nations move more quickly toward low-carbon, sustainable development.

5.2 Weaknesses of the Institution

Coordination between different parties and a lack of institutional capability are major obstacles to Nigeria's effective climate governance. Implementing policies in an inefficient manner might result from fragmented methods and unclear roles and responsibilities. To improve climate action, institutional structures must be strengthened.

5.3 Public Awareness and Engagement

For climate change mitigation initiatives to be successful, public engagement and knowledge are essential. The general public, however, is not well-informed about the effects of climate change and the significance of mitigation measures. More engagement in climate action can be encouraged by raising public awareness through outreach and education initiatives.

Raising Public Knowledge of Mitigation Strategies for Sustainable Climate Change. For sustainable climate change mitigation techniques to be implemented effectively, public awareness must be raised. Public awareness of the effects of climate change, available mitigation strategies, and the significance of individual acts can influence behavior and increase support for climate legislation. Campaigns to raise public awareness can emphasize the advantages of sustainable activities, like cutting back on energy use, switching to renewable energy, and encouraging environmentally friendly transportation.

Involving communities in climate change discussions and decision-making processes can enhance ownership and engagement in mitigation efforts. Media and digital platforms play a crucial role in disseminating climate information and raising awareness among diverse audiences [9].

By increasing public awareness, governments and organizations can build support for climate policies and encourage individual actions that contribute to mitigation goals. This collective effort can lead to significant reductions in greenhouse gas emissions and promote sustainable development.

6. Recommendations for Enhancing Climate Change Mitigation in Nigeria

Nigeria, highly vulnerable to the impacts of climate change, faces significant challenges including flooding, desertification, and food insecurity. To effectively enhance climate change mitigation, a multi-pronged approach is necessary, focusing on the energy, agriculture, and policy sectors.

Firstly, accelerating the transition to renewable energy is paramount. The energy sector is the largest source of emissions in Nigeria, accounting for over 60% of the national total. While the country has immense potential in solar, wind, and biomass energy, these resources remain largely underutilized due to financial, infrastructural, and policy challenges. Government initiatives like the Economic Sustainability Plan, which aims to install solar power in millions

of homes, are positive steps, but need robust implementation and funding. The focus should shift away from fossil fuels, particularly gas, which is a major part of Nigeria's current energy strategy, towards a rapid scaling up of renewable sources.

Secondly, sustainable land-use and agricultural practices must be widely adopted. Climate change has severely impacted agricultural productivity, a critical sector for Nigeria's economy and food security. Strategies such as agroforestry, conservation agriculture, and reducing the open burning of crop residues are crucial for reducing emissions and building resilience. This requires effective communication and capacity-building programs to educate farmers on these practices, as well as providing financial incentives and support for their adoption [10].

Finally, strengthening climate policy and governance is essential. The Nigerian Climate Change Act of 2021 provides a legal framework for action, including a system for carbon budgeting. However, translating these policies into concrete, actionable frameworks is vital. This involves a strong collaboration between government bodies, the private sector, and academia to ensure policies are evidence-based and effectively implemented. Additionally, international cooperation and climate finance are needed to support these mitigation efforts and overcome the financial constraints that have hindered progress. Recommendations for Enhancing Climate Change Mitigation in Nigeria

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6.1 Strengthening Policy Frameworks

To enhance climate change mitigation efforts, Nigeria should strengthen its policy frameworks by integrating climate considerations into all sectors of the economy. This includes developing sector-specific action plans that align with national climate goals.

6.2 Promoting Technological Innovation

Nigeria must invest in innovative technology research and development if it is to advance climate change mitigation. In order to encourage innovation in sustainable agriculture, energy efficiency, and renewable energy, the government ought to work with private companies and academic institutions.

Encouraging Innovation in Technology for Sustainable Climate Change Mitigation

Sustainable climate change mitigation plans rely heavily on technological innovation, which helps nations cut greenhouse gas emissions while fostering economic expansion. Countries may lessen the effects of climate change by making investments in energy efficiency, sustainable land use, and renewable energy technologies. Progress depends on policies that encourage technical innovation, such as funding for research and development and tax breaks for green technologies.

Through the use of climate-smart technology, encouraging technical innovation can improve climate resilience and lower emissions in developing nations like Nigeria. Investments in wind and solar energy, for example, can lessen emissions by reducing reliance on fossil fuels. Furthermore, while reducing their negative effects on the environment, agricultural technology advancements like precision farming and climate-resilient crop varieties can increase food security.

Promoting international collaboration and public-private partnerships can help hasten the creation and application of technologies that mitigate climate change.

6.3 Strengthening Financial Systems

Creating cutting-edge financing tools like climate funds and green bonds can aid in raising money for initiatives aimed at mitigating the effects of climate change. To obtain funds, the government should also look into joint ventures with private investors and foreign organizations. Improving Financial Mechanisms for Mitigation of Sustainable Climate Change.

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Access to climate finance can help developing nations embrace low-carbon practices and technology, promoting sustainable development. In order to help nations with limited financial resources carry out climate change adaptation and mitigation programs, international climate finance structures such as the Green Climate Fund are essential.

Improving climate finance's accountability and openness can also increase how well financial systems work to achieve mitigation objectives. Effective use of financial resources can help nations move more quickly toward low-carbon, sustainable development.

6.4 Raising Awareness in the Public

Promoting a sustainable culture requires increasing public knowledge of climate change and its effects. To encourage awareness and action on climate challenges, the government should launch educational campaigns and community participation programs. Raising Public Knowledge of Mitigation Strategies for Sustainable Climate Change

For sustainable climate change mitigation techniques to be implemented effectively, public awareness must be raised. Public awareness of the effects of climate change, available mitigation strategies, and the significance of individual acts can influence behavior and increase support for climate legislation.

Campaigns to raise public awareness can emphasize the advantages of sustainable activities, like cutting back on energy use, switching to renewable energy, and encouraging environmentally friendly transportation.

Communities' ownership and involvement in mitigation initiatives can be increased by involving them in climate change debates and decision-making processes. Digital channels and the media are essential for spreading climate knowledge and increasing awareness among a variety of audiences.

Governments and organizations can boost support for climate policies and promote individual activities that help achieve mitigation goals by raising public knowledge. By working together, we can significantly lower greenhouse gas emissions and advance sustainable development.

6.5 Best Practices and Case Studies

Numerous nations and areas have effectively enacted climate change mitigation plans that might be used as templates by others.

For example, the European Union has set ambitious targets for reducing greenhouse gas emissions and increasing the share of renewable energy in its energy mix. Through a combination of policy measures, such as the Emissions Trading System (EU ETS) and renewable energy directives, the EU has made significant progress in decarbonizing its economy. Similarly, countries like Norway and Costa Rica have focused on forest conservation and restoration as a key strategy for mitigating climate change.

7. Conclusion

Climate change poses significant challenges to Nigeria, necessitating urgent and effective mitigation strategies. This paper has analyzed the policies and technological innovations implemented in Nigeria to address climate change. While progress has been made, several challenges remain, including financial constraints, institutional weaknesses, and public awareness. By strengthening policy frameworks, promoting technological innovation, enhancing financial mechanisms, and increasing public awareness, Nigeria can improve its climate change mitigation efforts and contribute to global sustainability.

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