The Potential Impact of Carbon Market on Climate Change Mitigation and the Advancement of Sustainable Development Goals in Anambra

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ABSTRACT

This study evaluates the potential impact of carbon markets on climate change mitigation and sustainable development in Nigeria, focusing on stakeholder perspectives in Anambra State. Carbon markets have been recognized as a tool for reducing greenhouse gas emissions and fostering economic growth, but their implementation in Nigeria faces challenges related to regulatory enforcement, institutional readiness, and market stability. Using a mixed-methods approach, stakeholder perceptions were analyzed through descriptive statistics and a one-sample t-test. Findings indicate strong confidence in the effectiveness of carbon markets for climate change mitigation, with a mean score of 3.88, while their role in promoting sustainable development received a higher endorsement, with a mean score of 4.05. The t-test confirmed that both mean values significantly exceeded the neutral midpoint of 3 ($p < 0.001$), demonstrating broad support for carbon trading as a viable policy mechanism. However, concerns remain about enforcement capacity and transparency. The study recommends strengthening regulatory frameworks, investing in monitoring infrastructure, and implementing pilot programs to refine market operations. Further research should explore long-term impacts and sector-specific variations to enhance the adoption and efficiency of carbon markets in Nigeria.

INTRODUCTION

The urgency of addressing climate change has led to the adoption of various mitigation strategies, including regulatory policies, technological innovations, and market-based mechanisms. Among these, carbon markets have emerged as a key economic instrument designed to reduce greenhouse gas (GHG) emissions by assigning financial value to carbon reductions and creating economic incentives for emissions mitigation (Stavins, 2021; Pirard, 2022). While carbon trading schemes have been successfully implemented in developed economies, their effectiveness and feasibility in developing regions remain underexplored (Newell et al., 2013). Nigeria, as a signatory to the Paris Agreement, is expected to enhance its climate policies, and carbon markets are increasingly being considered as a potential mechanism to complement existing mitigation strategies (Federal Ministry of Environment, 2019; Okonkwo et al., 2022). However, the extent to which key stakeholders in Nigeria, particularly in Anambra State, perceive carbon markets as a viable tool for emissions reduction and sustainable development remains largely unknown.

Anambra State faces a range of environmental challenges, including deforestation, industrial pollution, and land degradation, all of which contribute significantly to its carbon footprint (Nwankwo & Onyia, 2020). Although initiatives such as reforestation projects and renewable energy policies have been implemented at various levels, their impact has been constrained by inadequate funding, policy inconsistencies, and limited stakeholder engagement (Olawuyi, 2021; Ani & Ogbo, 2025). Carbon markets, theoretically, offer a market-driven approach that could complement existing strategies by incentivizing emission reductions through

financial transactions between emitters and offset projects (Aldy & Stavins, 2012). However, the effectiveness of this approach is highly dependent on stakeholder perceptions regarding its implementation, economic viability, and alignment with local environmental and socio-economic conditions (Bumpus & Liverman, 2011; Newell et al., 2013). Without a clear understanding of how policymakers, businesses, and community leaders perceive carbon markets relative to other mitigation measures, their successful implementation in Nigeria remains uncertain.

Beyond emissions reduction, carbon markets present potential economic and social benefits that align with Nigeria's broader development objectives. Theoretically, they can stimulate industrial shifts towards low-carbon technologies, foster investment in clean energy, and generate employment opportunities within the green economy (Okonkwo et al., 2022; Pirard & Bellassen, 2023). Studies on carbon markets in emerging economies suggest that well-structured trading systems can drive sustainable development by promoting environmentally responsible investments while offering economic gains to participating industries (Murray & Maniloff, 2015; Zhang et al., 2021). However, practical implementation in Nigeria may be hindered by structural challenges, including policy enforcement, institutional readiness, and market stability (Olawuyi, 2021; Ani & Ogbo, 2025). Understanding stakeholder perspectives on these potential challenges and benefits is essential in evaluating whether carbon markets can serve as an effective tool for balancing economic growth with environmental sustainability in Anambra State.

A critical component of this study is to examine whether stakeholders believe carbon markets can effectively influence behavioral changes among industries and entities contributing to climate change. The success of market-based mechanisms is contingent not only on policy design but also on the belief that such policies can generate tangible environmental and economic outcomes (Adebayo & Olayemi, 2020; Cacho & Wise, 2022). This raises important questions about whether businesses in Anambra State would be willing to participate in carbon trading and whether they perceive it as a more effective alternative to conventional mitigation measures, such as regulatory policies and voluntary corporate sustainability programs. Previous studies suggest that stakeholder buy-in is crucial for the success of carbon markets, particularly in regions where policy enforcement mechanisms are weak and economic incentives are often misaligned with environmental objectives (Koch et al., 2014; Zhang et al., 2021).

Given these considerations, this study aims to assess stakeholder perspectives on the role of carbon markets in mitigating climate change and advancing sustainable development goals in Anambra State. By examining their views on effectiveness, economic feasibility, and behavioral incentives, this research seeks to provide valuable insights into the potential adoption and implementation of carbon trading in Nigeria. Ultimately, the findings will contribute to the ongoing discourse on market-based climate strategies in developing economies and inform policymakers on how best to align carbon markets with national and regional sustainability objectives.

MATERIALS AND METHODS

Study Area

This study focuses on Anambra State, a key economic and industrial region in southeastern Nigeria, to explore stakeholder perspectives on the potential impact of carbon markets on climate change mitigation and sustainable development. As a rapidly developing state with a diverse industrial sector and growing environmental concerns, Anambra provides a relevant context for examining the feasibility of a sub-national carbon market. The state's economic activities ranging from manufacturing and commerce to agriculture contribute significantly to greenhouse gas emissions, making it a suitable case for investigating how carbon trading mechanisms could influence both environmental and economic outcomes. The selection of Anambra State was purposive, ensuring a targeted examination of key stakeholders, including government officials from the Ministry of Environment, industry representatives, and academic experts in environmental management.

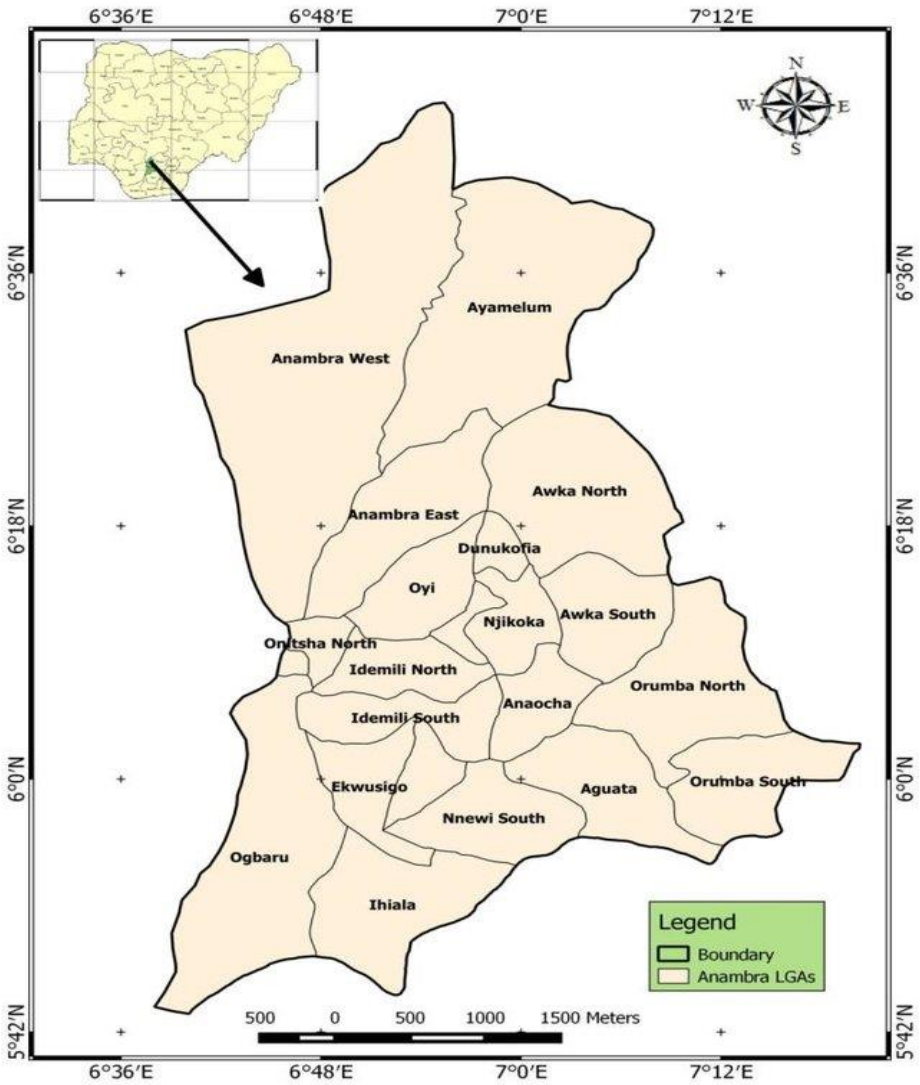

Fig 1: Map of Anambra State

Research Design

This study employs a descriptive research design, combining quantitative and qualitative methods to assess stakeholder perceptions. A structured questionnaire was used to collect quantitative data on stakeholders' views regarding the effectiveness, feasibility, and potential benefits of carbon markets. Additionally, unstructured interviews were conducted to provide deeper insights into their opinions, concerns, and expectations regarding the adoption of carbon trading mechanisms. The study examines two primary variables: stakeholders' perceptions of the effectiveness of carbon markets for emissions reduction and their perceived potential for supporting sustainable development.

Population and Sample Size

The study population consists of key stakeholder groups involved in environmental policy, industrial activities, and academic research in Anambra State. To establish a representative sample, industry data was obtained from the Anambra State Ministry of Trade and Commerce, which provided an initial list of 159 industries. Following initial discussions on the study's objectives, 147 industries agreed to participate. Additional participants were drawn from the Anambra State Ministry of Environment and selected academic institutions, specifically faculty members from the Department of Environmental Management at Nnamdi Azikiwe University and Chukwuemeka Odumegwu Ojukwu University. Department heads facilitated the distribution of questionnaires to ensure comprehensive participation from these academic institutions. This diverse sample allows for a robust analysis of stakeholder perspectives on carbon markets and their implications for both climate policy and sustainable development in Anambra State.

Table 1.

S/N	Stakeholders	Target Group	Population Size	Sample Size	Sample Size %
1	Regulators	Ministry of Environment, Anambra State	43	43	100%
2	Participating Industries	Management Staff in Industries in Anambra State	159	147	92.5%
3	Academia/ Experts	Lecturers from UNIZIK and COOU	38	38	100%
	Total		228	228	100%

Study Population

Knowledge Assessment

To enhance the reliability of stakeholder responses, a preliminary knowledge assessment was conducted before administering the main survey. This assessment included five screening questions aimed at evaluating respondents' baseline understanding of carbon markets. Only participants who achieved a minimum score of 40% were included in the final analysis, following methodological precedents established by Ruhimat and Ruhimat (2021) and Erwinsyah (2022). By implementing this filtering process, the study ensured that responses were informed and reflective of a foundational comprehension of carbon trading mechanisms. Given that the majority of respondents had no prior formal training on carbon markets, this step was essential to minimize inaccuracies and enhance the validity of the data collected.

Table 2: Knowledge Assessment

S/N	Stakeholders	Target Group	Sample Size	Returned	Knowledgeable
1	Regulators	Ministry of Environment, Anambra State	43	42	42
2	Participating Industries	Management Staff in Industries in Anambra State	147	126	90
3	Academia/ Experts	Lecturers from UNIZIK and COOU	38	36	36
	Total		228	204	168

It is important to note the reduction in the sample size due to the exclusion of respondents lacking sufficient knowledge of carbon markets. 168 (82.3%) of the 204 returned questionnaires met the knowledge criteria, representing 73.7% of the initial target population of 228 respondents. This reduction does not negatively impact the survey's outcome, as the focus is on knowledgeable stakeholders who can provide meaningful insights. Ensuring that only informed participants were included enhances the validity and value of the research, especially in a stakeholder-focused study such as this.

Data Analysis

To assess stakeholder perspectives on the potential impact of carbon markets on climate change mitigation and sustainable development in Anambra State, we employed a combination of descriptive and inferential statistical techniques. Descriptive statistics were used to compute composite scores for each respondent, providing a structured analysis of their views on the effectiveness, feasibility, and potential benefits of carbon trading mechanisms.

A one-sample t-test was performed to determine whether stakeholders' perceptions significantly deviated from a neutral stance. Specifically, we tested the hypothesis:

H_{01}: Stakeholder opinions on the potential impact of carbon markets on climate change mitigation and the advancement of sustainable development goals in Anambra State does not vary significantly.

This was assessed by examining whether stakeholder responses significantly differed from the midpoint score of 3 on a five-point scale, where 3 represents a neutral position. A significant shift from this mean value would

indicate a strong consensus, either positive or negative, regarding the viability and expected impact of carbon markets in the region.

Data Presentation

Table 35: The potential impacts of carbon markets on climate change mitigation and the advancement of sustainable development goals in Nigeria

S/N	Issue raised	Mean	Remark
1	How effective do you believe carbon market will be in reducing greenhouse gas emission in Nigeria?	3.88	Effective
2	Compare to other climate change mitigation strategies in Nigeria, how likely is it that carbon markets will significantly contribute to achieving the country's climate goals	3.86	Likely
3	To what extent do you agree that carbon markets can incentivize positive changes in behavior to address climate change in Nigeria from industries and entities	3.74	Agree
4	How beneficial do you believe carbon market will be for promoting sustainable development in Nigeria?	4.05	Beneficial
5	How likely is it that carbon market will create new opportunities for economic growth while addressing environmental concerns in Nigeria	3.93	Likely
6	To what extent do you agree that carbon markets can contribute to achieving a balance between economic development and environment protection in Nigeria	4.09	Agree

DISCUSSION

The findings of this study indicate that stakeholders in Anambra State perceive carbon markets as a viable mechanism for mitigating climate change and promoting sustainable development. Across all measured indicators, respondents expressed confidence in the potential of carbon trading to contribute to environmental and economic objectives. The generally high mean scores, ranging from 3.74 to 4.09 on a five-point scale suggest that stakeholders recognize the value of carbon markets in curbing greenhouse gas emissions, incentivizing greener industrial practices, and balancing economic growth with environmental responsibility.

Perceived Effectiveness of Carbon Markets in Emissions Reduction

Stakeholders believe that carbon markets can play a meaningful role in reducing greenhouse gas emissions in Nigeria, as reflected in the mean score of 3.88. This suggests that there is confidence in the ability of market-based mechanisms to enforce emission limits and encourage industries to transition toward cleaner production processes. This aligns with global evidence that well-regulated carbon markets can incentivize emission reductions by imposing costs on polluting activities and rewarding sustainable alternatives (Döbbeling-Hildebrandt et al., 2024).

Similarly, the perceived contribution of carbon markets to achieving Nigeria's broader climate goals received a mean score of 3.86. While this indicates a positive outlook, it is slightly lower than other indicators, suggesting that stakeholders acknowledge potential implementation challenges, such as regulatory bottlenecks, monitoring limitations, and the need for strong policy enforcement. Nevertheless, the data suggest that carbon markets are seen as complementary to Nigeria's existing climate policies, including renewable energy investments and energy efficiency initiatives (Olawuyi, 2021).

Encouraging Positive Behavioral Change and Economic Growth

Stakeholders also view carbon markets as an effective tool for incentivizing behavioral change among industries and businesses, as reflected by a mean score of 3.74. This is consistent with existing research indicating that placing a price on carbon emissions can encourage businesses to invest in cleaner technologies, adopt resource-efficient processes, and integrate sustainability into their operations (Gupta et al., 2023; International Energy Agency [IEA], 2022).

Beyond their environmental impact, carbon markets are also perceived as an opportunity for economic growth. With a mean score of 3.93, stakeholders believe that carbon trading can create new economic opportunities while addressing environmental concerns. This suggests optimism that market-driven climate policies can attract investments, spur innovation in green technologies, and generate employment, particularly in sectors such as renewable energy, waste management, and afforestation (Gupta et al., 2023; Wang et al., 2023; Begum et al., 2020).

Potential for Sustainable Development and Economic-Environmental Balance

The strongest endorsements from stakeholders pertain to the role of carbon markets in sustainable development and their ability to balance economic growth with environmental protection. The mean score of 4.05 for sustainable development highlights the belief that revenue from carbon trading could be reinvested into infrastructure, environmental conservation, and social welfare programs, supporting Nigeria's sustainable development goals.

Similarly, the highest mean score of 4.09 indicates strong agreement that carbon markets can help strike a balance between economic development and environmental sustainability. This suggests that stakeholders see carbon trading as a structured approach to harmonizing industrial growth with responsible environmental stewardship, ensuring that economic expansion does not come at the expense of ecological degradation (Olawuyi, 2021; UNFCCC, 2023).

Statistical Confirmation of Stakeholder Confidence

The results of the one-sample t-test further reinforce these perceptions. The analysis confirms that all mean scores significantly exceed the neutral midpoint of 3 ($p < 0.001$), indicating a broad consensus among stakeholders that carbon markets are a promising tool for both emissions reduction and economic progress. The large effect sizes (Cohen's $d > 0.8$) highlight a strong divergence from neutrality, underscoring the confidence stakeholders place in the capacity of carbon markets to drive meaningful change.

However, the slightly lower mean for contributions to achieving Nigeria's climate goals (3.86) suggests that while stakeholders are optimistic, they also recognize potential barriers such as enforcement weaknesses, infrastructural constraints, and the complexity of integrating carbon trading into existing regulatory frameworks. These concerns reflect the broader challenges faced by emerging economies in implementing carbon markets, particularly in the absence of strong institutional mechanisms for monitoring and compliance.

Policy Implications and Future Considerations

The findings of this study have significant implications for policy and implementation in Anambra State and beyond. Given the generally favorable perceptions of carbon markets, policymakers, industry leaders, and environmental agencies should capitalize on this support to design a system that is transparent, efficient, and inclusive. A well-regulated carbon market, supported by strong institutional oversight, can maximize stakeholder confidence and encourage active participation.

To sustain the optimism surrounding carbon markets, investments should be made in capacity building, public awareness campaigns, and the development of technological infrastructure to support emissions monitoring and verification. Transparent governance frameworks must also be established to ensure fairness in credit allocation and trading, preventing exploitation and market distortions.

Ultimately, the success of carbon markets in Anambra State will depend on their ability to deliver tangible economic and environmental benefits. If effectively implemented, carbon markets could serve as a cornerstone of Nigeria's broader climate strategy, offering a pathway to sustainable industrial growth while advancing global climate commitments. By aligning economic incentives with environmental goals, carbon markets have the potential to transform the way businesses and industries engage with climate action, ensuring that economic prosperity does not come at the cost of environmental degradation.

CONCLUSION AND RECOMMENDATION

The findings of this study indicate strong stakeholder confidence in the potential of carbon markets to mitigate climate change and promote sustainable development in Anambra State. Respondents believe that carbon trading can effectively reduce greenhouse gas emissions, incentivize industries to adopt greener practices, and create economic opportunities. However, challenges such as policy enforcement, regulatory transparency, and infrastructure for monitoring emissions remain critical barriers to successful implementation. Addressing these gaps is essential to ensuring that carbon markets achieve their intended environmental and economic benefits.

To enhance the effectiveness of carbon markets, a strong regulatory framework must be established, ensuring clear guidelines and efficient enforcement mechanisms. Capacity-building programs should be implemented to improve stakeholder understanding and participation, while investments in monitoring infrastructure will enhance credibility and compliance. Additionally, financial incentives for businesses adopting low-carbon technologies will encourage widespread adoption. A phased approach, beginning with pilot projects in key sectors, will allow policymakers to refine strategies before full-scale implementation.

Further research is needed to compare stakeholder perceptions across different regions in Nigeria and assess how local economic conditions influence market adoption. Longitudinal studies should examine the real impact of carbon markets on emissions reduction and economic growth over time. Additionally, sector-specific analyses will provide deeper insights into how industries respond to carbon pricing mechanisms. Exploring social and behavioral factors affecting participation can help policymakers design strategies that encourage broader engagement.

In conclusion, while carbon markets hold significant promise for Nigeria's climate and economic goals, their success will depend on strong institutional support, strategic incentives, and continuous stakeholder engagement. By addressing key challenges and refining policy mechanisms, carbon markets can become a transformative tool for sustainable development in Nigeria.

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