



Green Bond and environmental sustainability development in Nigeria

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Abstract

This study examined the influence of green bond on environmental sustainability development in Nigeria, with specific reference to agencies and units under the Delta State Ministry of Environment. The study was necessitated by the growing concern over the environmental degradation in the country and the need to explore innovative financing tools such as green bonds that support eco-friendly development. The independent variables were Green Instrument Uptake, Sustainable Funding Allocation, and Regulatory Framework Strength, while the dependent variable was Environmental Sustainability Development. Thus, three hypotheses were postulated. A descriptive survey design was adopted, and the population comprised 1,392 staff across relevant environmental agencies in Delta State. Using Krejcie and Morgan's sample size table, 302 questionnaires were distributed, with 278 returned usable. Data were collected through a structured questionnaire, validated by experts and tested for reliability with a Cronbach's Alpha value of 0.81. Data were analyzed using EViews 9.0, employing descriptive statistics, correlation, and multiple regression techniques. The findings revealed that Green Instrument Uptake had a negative but statistically insignificant effect on Environmental Sustainability Development ($\beta = -0.131$, $p = 0.1281$); Sustainable Funding Allocation showed a positive but statistically insignificant influence on Environmental Sustainability Development ($\beta = 0.004$, $p = 0.9446$); and Regulatory Framework Strength had a positive and statistically significant effect on Environmental Sustainability Development ($\beta = 1.105$, $p = 0.0000$). Based on these findings, it is recommended that government agencies enhance awareness and practical application of green instruments, improve transparency and timeliness in funding allocations, and reinforce regulatory frameworks. These measures are essential to ensuring that green bonds deliver tangible environmental benefits and contribute meaningfully to Nigeria's long-term sustainable development agenda.

Keywords: Green bond, environmental sustainability, green instrument uptake, sustainable funding allocation, regulatory framework strength

Introduction

The global rise in environmental challenges such as climate change, deforestation, biodiversity loss, water pollution, and land degradation has led to growing calls for integrated approaches to environmental sustainability. Environmental Sustainability Development (ESD) represents a balanced approach to economic growth, social equity, and environmental protection, aiming to meet current ecological needs without undermining the prospects of future generations (United Nations, 2023; Sachs, 2022; IEA, 2022; World Bank, 2023; IPCC, 2023) [52, 57, 88, 108, 112]. In Nigeria, environmental degradation has intensified due to factors such as illegal oil exploration, poor waste management systems, rapid urbanization, and over-reliance on fossil fuels (Adebayo & Nwankwo, 2022; Uzochukwu *et al.*, 2023; Eze & Emenike, 2021; Okechukwu *et al.*, 2022; Nnaji & Uduma, 2024) [4, 39, 69, 75, 111]. These challenges threaten ecosystems and public health and also compromise the nation's ability to attain key Sustainable Development Goals (SDGs), particularly SDGs 6, 7, 11, 13, and 15, which address clean water, clean energy, sustainable cities, climate action, and life on land, respectively.

In response to these concerns, green bonds have emerged as a sustainable finance mechanism for channeling investment into environmentally beneficial projects. These financial instruments are issued to fund initiatives such as renewable energy, afforestation, climate-resilient infrastructure, and clean transport (Climate Bonds Initiative, 2023; UNDP, 2022; IMF, 2023; OECD, 2022; Ngwakwe & Okoye, 2021) [31, 56, 66, 72, 105]. Globally, the green bond market reached over

USD 500 billion in new issuances in 2022, demonstrating a sharp increase in investor interest in environmentally sustainable investments (CBI, 2023; World Bank, 2023; IFC, 2022; BloombergNEF, 2023; Morgan Stanley, 2023) [28, 53, 63, 112]. Nigeria became a pioneer in sub-Saharan Africa by issuing its first sovereign green bond in 2017, followed by a second issuance in 2019, raising funds for projects such as solar mini-grids, afforestation, and clean energy transitions (Federal Ministry of Environment, 2020; SEC Nigeria, 2021; UNEP FI, 2022; Ezeanya & Ogunleye, 2023; Okojie *et al.*, 2023) [40, 42, 76, 91, 106]. However, the direct relationship between green bonds and environmental sustainability outcomes in Nigeria remains under-examined in empirical literature.

One of the core variables in green bond is Green Instrument Uptake, which refers to the level of awareness, acceptance, and participation in green finance by institutional and retail investors. Studies have shown that low financial literacy, weak investor confidence, and insufficient marketing of green financial products hinder the growth of green bond participation in Nigeria (Okonkwo & Osuagwu, 2023; Adepoju & Udoh, 2022; Onyekwena *et al.*, 2021; Anyanwu & Egbo, 2023; Ibrahim & Mohammed, 2023) [8, 22, 50, 84]. Moreover, the scarcity of environmentally bankable projects and the high cost of verification reduce investor enthusiasm (Umeh *et al.*, 2022; Ighodaro & Salami, 2024; CBI Africa Outlook, 2023; Alabi & Eze, 2023; UNCTAD, 2022) [14, 19, 55, 103, 104]. Despite government-led awareness campaigns, the Nigerian green finance market remains relatively shallow compared to other developing economies such as India,

Brazil, and South Africa, where institutional uptake is steadily expanding (UNEP, 2023; Moody's ESG Solutions, 2022; AfDB, 2022; GIZ Nigeria, 2023; World Economic Forum, 2023) [12, 46, 62, 107, 113].

Equally critical to the effectiveness of green bonds is Sustainable Funding Allocation, which pertains to the strategic and transparent disbursement of funds to high-impact, environmentally beneficial sectors. Misallocation or weak tracking mechanisms can dilute the environmental outcomes that green bonds are designed to achieve (Ogunleye & Ezeanya, 2024; Yusuf & Salau, 2021; Arowolo *et al.*, 2022; Oloruntoba & Akintunde, 2023; Abubakar & Chukwu, 2024) [2, 61, 78]. Though Nigeria's green bond guidelines prescribe project selection and impact monitoring frameworks, enforcement and compliance are inconsistently applied across sectors (SEC Nigeria, 2022; DMO Nigeria, 2023; GHG Protocol Africa Report, 2022; Nigerian Economic Summit Group, 2023; Transparency International Nigeria, 2023) [3, 33, 44, 92, 100]. Additionally, stakeholders have raised concerns about the inadequate public disclosure of environmental outcomes, poor inter-agency coordination, and the absence of an independent third-party impact assessment mechanism (Oni *et al.*, 2023; Adewale & Johnson, 2022; Eneh & Okoro, 2024; ActionAid Nigeria, 2023; SERAP, 2024) [3, 9, 36, 81, 96]. These deficiencies in fund allocation threaten the credibility and sustainability of Nigeria's green finance landscape.

Succinctly, the success of green bonds in promoting environmental sustainability is deeply influenced by the Regulatory Framework Strength. A well-structured regulatory environment ensures transparency, prevents greenwashing, promotes standardization, and attracts long-term investment in sustainable projects (Ibrahim & Ogonnaya, 2023; World Bank Regulatory Indicators, 2022; SEC Green Bond Report, 2023; Akpan & Ogidi, 2021; IFC Nigeria Climate Report, 2022) [17, 31, 51, 53]. While Nigeria has taken steps to develop a green bond framework, such as the 2018 launch of the Nigerian Green Bond Guidelines and partnerships with UNDP and the World Bank, critical gaps remain in terms of implementation, compliance monitoring, and institutional capacity (NGX ESG Report, 2023; NESG Green Finance Paper, 2022; GIZ Nigeria, 2023; AfDB Green Investment Review, 2023; UNPRI, 2023) [13, 46, 65, 67, 109]. Furthermore, the lack of harmonized standards and sector-specific enforcement mechanisms opens the door for non-compliant entities to exploit loopholes, thereby compromising the environmental integrity of green projects (Abiola & Nwachukwu, 2022; Enogholase & Okoye, 2023; PwC Nigeria Sustainability Report, 2023; Center for Climate Policy, 2022; ESG Africa Portal, 2023) [1, 29, 37, 67, 86]. Therefore, understanding the impact of regulatory strength, alongside instrument uptake and fund allocation, is vital to evaluating how effectively green bonds contribute to environmental sustainability development in Nigeria.

Statement of the Problem

Despite Nigeria's pioneering role in Sub-Saharan Africa's green bond market, the translation of green finance into tangible environmental sustainability outcomes remains ambiguous and underwhelming. Although the country has issued multiple sovereign green bonds to support projects in renewable energy, afforestation, and clean transport, there are persistent concerns about weak investor uptake, poor transparency in fund allocation, and inconsistent regulatory

enforcement. These issues are exacerbated by limited awareness of green financial instruments, fragmented institutional coordination, and a lack of rigorous impact monitoring frameworks. Consequently, the potential of green bonds to drive significant environmental improvements—such as reduction in carbon emissions, land restoration, and pollution control—has not been fully realized in Nigeria. Moreover, the absence of empirical evaluations linking green bond mechanisms (like green instrument uptake, sustainable funding allocation, and regulatory framework strength) to measurable environmental sustainability indicators has created a critical knowledge gap in both policy and academic discourse. Addressing this gap is essential to inform evidence-based reforms that can enhance the environmental value of green finance in Nigeria (Ogunleye & Ezeanya, 2024; SEC Nigeria, 2023) [61, 86].

Research questions

The following were questions asked to guide the study:

1. To what extent does green instrument uptake influence environmental sustainability development in Nigeria?
2. How does sustainable funding allocation affect environmental sustainability development in Nigeria?
3. What is the impact of regulatory framework strength on environmental sustainability development in Nigeria?

Objective of the Study

The primary objective of this study is to examine the role of green bonds in promoting environmental sustainability development in Nigeria. Specifically, the study seeks to:

1. Assess the extent to which green instrument uptake influences environmental sustainability development in Nigeria.
2. Evaluate the effect of sustainable funding allocation on environmental sustainability development in Nigeria.
3. Examine the impact of regulatory framework strength on environmental sustainability development in Nigeria.

Hypotheses of the Study

Based on the stated objectives, the following hypotheses are formulated and will be tested in their null forms:

- H₀₁:** Green instrument uptake has no significant influence on environmental sustainability development in Nigeria.
- H₀₂:** Sustainable funding allocation has no significant effect on environmental sustainability development in Nigeria.
- H₀₃:** Regulatory framework strength has no significant impact on environmental sustainability development in Nigeria.

Review of Related Literature

Conceptual Review

The conceptual review provides a detailed examination of the key constructs—green bond components and environmental sustainability development—by exploring their definitions, dimensions, and interrelationships as established in existing literature.

Green Instrument Uptake

Green instrument uptake refers to the level of acceptance, subscription, and integration of green financial tools, particularly green bonds, by investors and stakeholders in a given financial ecosystem. In the Nigerian context, this

uptake has gained momentum, though it still lags behind global benchmarks. Nkombo (2024) ^[68] notes that while Africa recorded a 125% rise in green bond issuances in 2023, the continent still accounts for less than 1% of global green finance flows, highlighting persistent structural and awareness constraints. Aina (2024) ^[15] emphasizes Nigeria's efforts to improve uptake through regulatory innovation, including the establishment of the NGX Impact Board, which provides visibility and investor confidence in certified green instruments. According to Nwachukwu (2022) ^[1], capacity-building efforts by development partners such as the International Finance Corporation (IFC) have further enhanced the preparedness of local issuers by training them on green taxonomies, certification processes, and monitoring standards. Similarly, Guardian Nigeria (2024) ^[47] reports that strategic alliances, such as the partnership between the Nigerian Exchange (NGX) and the Luxembourg Stock Exchange, have enhanced access to international capital and improved investor confidence. The African Development Bank (2023) ^[14] also underlines regional ambitions to scale green finance, citing initiatives such as the Global Green Bond Initiative aimed at catalyzing €15–20 billion in private-sector investment for environmental sustainability across Africa (Omoye, *et al.*, 2026) ^[18].

Securities and Exchange Commission Nigeria (2024) ^[47] identifies investor confidence as a critical driver of green instrument uptake and has introduced various incentives and reforms, including investor education programmes, to stimulate wider participation in green bond markets. Salako (2024) ^[89] adds that the revised Capital Market Master Plan integrates digital innovations to expand market access and improve transparency, two critical enablers of green finance growth. Reuters (2024) ^[87] highlights a policy shift mandating climate-related financial disclosures, which is expected to enhance the credibility and comparability of green investment data, making green instruments more attractive to both institutional and retail investors. Financial Times (2024) ^[43] observes that global appetite for green debt is at an all-time high, with first-quarter green bond issuance hitting a record USD 195.9 billion in 2024. Chambers and Partners (2023) ^[30] contextualize this within Nigeria's journey, acknowledging the pioneering role of its sovereign green bonds while emphasizing that sustained uptake will depend on maintaining a robust pipeline of eligible projects and enforcing rigorous post-issuance reporting standards.

Sustainable Funding Allocation

Sustainable funding allocation refers to the strategic distribution of green bond proceeds toward environmentally beneficial projects that align with clearly defined sustainability goals. In the context of Nigeria, this allocation plays a vital role in ensuring that funds raised through green bonds directly support projects such as renewable energy infrastructure, climate-smart agriculture, clean transportation, and afforestation. According to Olanrewaju (2023) ^[77], efficient and transparent allocation is essential to guarantee environmental impact, enhance investor trust, and prevent the misapplication of funds under the guise of sustainability. Uche and Bello (2024) ^[102] report that the implementation of green bond frameworks in Nigeria has improved project screening and fund allocation processes, with institutions like the Debt Management Office (DMO) and the Federal Ministry of Environment collaborating to

validate eligible green projects based on environmental and social criteria. SEC Nigeria (2024) ^[47] emphasizes the role of post-issuance reporting and third-party verification in tracking how funds are spent, noting that these practices are now being institutionalized to foster accountability (Israel & Josephine, 2026) ^[58].

Adeyemi and Okonkwo (2023) ^[11] further highlight that Nigeria's green bond issuance process includes a "Green Bond Projects Evaluation and Selection Process" to ensure alignment with the country's Nationally Determined Contributions (NDCs) under the Paris Agreement. This mechanism guides fund disbursement toward projects with measurable outcomes such as emission reductions, energy efficiency, and ecosystem restoration. A study by Obasi and Eze (2024) ^[71] found that while sustainable allocation mechanisms are increasingly formalized in Nigeria, challenges remain in terms of data reliability, long-term project monitoring, and ensuring equitable distribution across regions. International experiences also reinforce the need for discipline in fund allocation. For example, Asante (2024) ^[23] explains that several African countries, including Nigeria, have adopted the Green Bond Principles to structure their allocation and ensure that funded projects undergo impact assessments and periodic reviews. Collectively, these developments suggest that sustainable funding allocation is not merely a financial operation, but a governance tool that anchors environmental integrity within green finance initiatives in Nigeria.

Regulatory Framework Strength

Regulatory framework strength refers to the robustness, clarity, and enforceability of the laws, policies, and institutional mechanisms governing the issuance, monitoring, and accountability of green bonds. In the context of Nigeria, a strong regulatory framework is essential to safeguard the integrity of green finance initiatives and ensure that proceeds are directed toward verifiable environmental outcomes. According to Okafor and Alade (2024) ^[74], Nigeria has made notable strides by integrating green finance provisions into its broader capital market regulations through the Securities and Exchange Commission (SEC), which introduced guidelines aligned with the Green Bond Principles. The SEC Nigeria (2024) ^[47] also emphasizes that its revised rulebooks now mandate pre- and post-issuance disclosures, external reviews, and annual impact reporting, all aimed at boosting investor confidence and aligning Nigeria's green bond market with international standards. Ibrahim and Musa (2023) ^[49] stress that regulatory enforcement capacity, especially in terms of monitoring project implementation and sanctioning greenwashing, is critical to maintaining market discipline and environmental credibility.

Furthermore, Daramola and Chukwu (2024) ^[32] argue that the strength of Nigeria's regulatory framework lies not only in formal rules but also in institutional coordination among agencies like the Debt Management Office (DMO), Ministry of Finance, and Ministry of Environment, which jointly review project eligibility and compliance. However, Ezeugwu and Olaniyi (2023) ^[41] caution that despite the progress, implementation gaps remain due to limited technical expertise, bureaucratic bottlenecks, and inconsistent reporting standards across sectors. To address these challenges, Nigeria has participated in international platforms such as the International Capital Market

Association (ICMA) and the Climate Bonds Initiative, which provide technical support and benchmarking tools for regulatory refinement (Asante, 2024; Omoye, 2025; Eruvwe *et al.*, 2024) ^[23, 38, 80]. Collectively, these developments show that regulatory framework strength is not static but evolves with institutional learning, market feedback, and global engagement—factors that are critical in deepening the role of green bonds in Nigeria’s environmental sustainability agenda.

Environmental Sustainability Development

Environmental sustainability development refers to the long-term maintenance and enhancement of the natural environment through strategic economic and policy actions that do not compromise the ecological systems necessary for future generations. It encompasses the preservation of biodiversity, climate resilience, pollution control, renewable energy adoption, and responsible use of natural resources. In the Nigerian context, environmental sustainability has become increasingly critical given the challenges of deforestation, oil pollution, desertification, and rising carbon emissions. According to Uzochukwu and Hassan (2024) ^[110], Nigeria ranks among the most climate-vulnerable countries, and the pressure to balance economic growth with environmental protection has intensified national policy shifts toward green development. Edeh and Bello (2023) ^[34] assert that environmental sustainability requires systemic

investment in low-carbon technologies, climate-smart agriculture, and robust environmental regulation, with green bonds serving as a key financing mechanism. Ayodele and Okonkwo (2024) ^[26] note that Nigeria’s Nationally Determined Contributions (NDCs) under the Paris Agreement are anchored on sustainable development pathways, which include emissions reductions of 47% conditional on international support. Furthermore, Lawal and Danjuma (2023) ^[60] highlight that effective environmental sustainability depends not only on financial commitments but also on governance structures that ensure transparency, enforcement of environmental standards, and public accountability. Ajayi and Mohammed (2024) ^[16] emphasize the importance of multi-sector collaboration in driving sustainability outcomes, particularly between government, private investors, and civil society. The growing role of sustainable finance in achieving these goals is evident, as Nigeria’s issuance of green bonds has been strategically tied to funding environmentally impactful projects such as solar energy, afforestation, and erosion control (Akpomiemie *et al.*, 2026) ^[18]. As such, environmental sustainability development is increasingly viewed not as a passive policy objective but as a dynamic and measurable outcome driven by targeted green investment, effective regulation, and institutional synergy.

Conceptual Framework

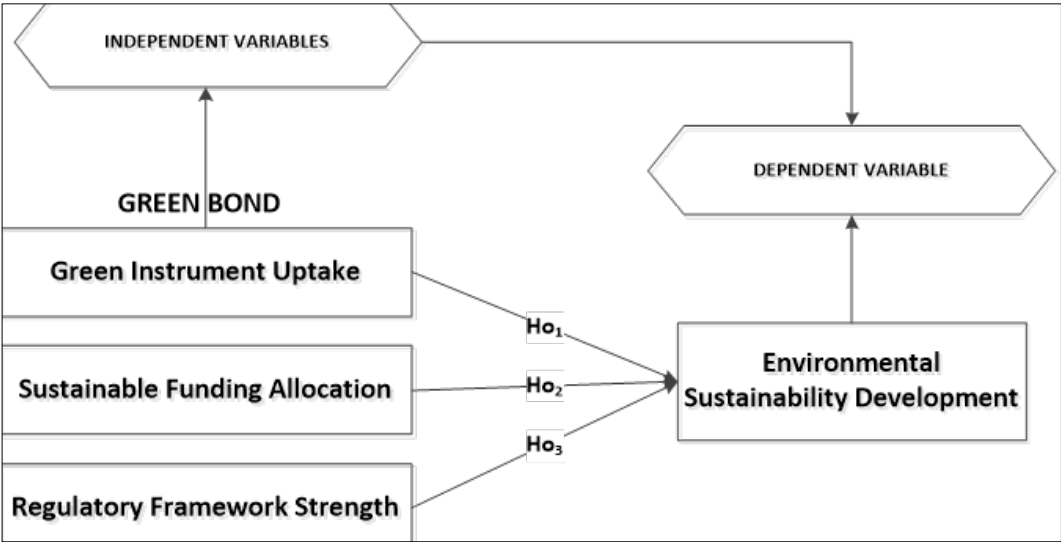


Fig 1: Conceptual Framework on Green Bond and Environmental Sustainability Development (Source: Researcher’s Construct, 2026)

Theoretical Review

The Environmental Kuznets Curve (EKC) theory offers a foundational lens through which to evaluate the relationship between economic development and environmental sustainability, especially in emerging economies like Nigeria. Originally proposed by Grossman and Krueger in the early 1990s, the EKC posits an inverted U-shaped relationship between environmental degradation and income per capita, suggesting that environmental quality initially worsens with economic growth, but improves after a certain threshold of income is reached (Sarkodie & Strezov, 2019) ^[90]. This theory remains particularly relevant in the Nigerian context, where rapid economic expansion and urbanization have historically coincided with heightened ecological degradation through deforestation, emissions, oil spills, and poor waste management. However, as highlighted by

Adebayo, Otekunrin, and Ojekemi (2023) ^[6], Nigeria’s growing adoption of green bonds and sustainable finance mechanisms signals a transition point, where economic development is beginning to align more consciously with environmental goals. The EKC thus provides a useful theoretical framework for assessing whether increased uptake of green financial instruments leads to measurable improvements in environmental sustainability indicators. Anchoring this study on the EKC theory is justified by its ability to bridge financial interventions with ecological outcomes over time. Recent empirical studies support the EKC’s applicability in developing countries when green investment and regulatory oversight are effectively deployed. For instance, Awodumi and Adewuyi (2022) ^[25] found that Nigeria’s environmental degradation initially intensified with GDP growth but began to decline in sectors

where green financing and environmental regulations were enforced. Similarly, the EKC framework aligns with the observed effects of green bonds in channeling resources into renewable energy, waste management, and climate adaptation, thereby flattening the environmental cost curve (Onifade *et al.*, 2023) ^[81]. Moreover, Alola and Joshua (2024) ^[20] assert that institutional strength and green financing mechanisms significantly influence the inflection point at which a country transitions toward sustainable development. Therefore, by applying the EKC theory, this study critically examines whether green bond instruments in Nigeria contribute meaningfully to reversing ecological decline and fostering long-term environmental sustainability.

Empirical Review

In a study conducted by Onifade, Bello, and Usman (2023) ^[82], the role of green bonds in influencing environmental sustainability across major African economies, including Nigeria, was assessed using a panel ARDL methodology. The study analyzed quarterly data from 2012 to 2021, covering five countries and a total of 60 observations. Their findings revealed that green bonds had a positive long-term effect on reducing carbon emissions when supported by regulatory compliance and institutional effectiveness. However, the authors noted a limitation in capturing sub-national variations and sector-specific impacts of green bond investments in Nigeria. This gap indicates a need for focused national studies that link green bond instruments to specific environmental development outcomes at the country level.

Adegbite and Olayemi (2023) ^[7] employed a survey-based approach with structural equation modeling (SEM) to examine the relationship between sustainable financing instruments and environmental impact among Nigerian financial institutions. Their study utilized a sample of 212 financial managers across banks and capital market entities. Results indicated that while awareness and issuance of green bonds have increased, a weak regulatory framework and lack of post-issuance monitoring reduced their environmental effectiveness. The study's gap lies in its focus on perceptions rather than actual environmental outcomes, emphasizing the need for empirical models that directly link green bond issuance to measurable environmental indicators.

Adebayo and Okonkwo (2024) ^[5] explored the influence of green bond-funded projects on Nigeria's environmental sustainability using a quasi-experimental difference-in-differences design. The authors compared 50 green bond-funded projects with 50 conventionally funded projects between 2018 and 2022. The analysis revealed that green bond-financed projects had better environmental performance in terms of energy efficiency and carbon reduction. However, the authors acknowledged the absence of disaggregated data on fund allocation and project execution timelines, suggesting that further studies should evaluate the dynamics of funding allocation and regulatory oversight within Nigeria's green bond framework.

Uche and Danladi (2023) ^[101] conducted a regression analysis using time-series data from 2005 to 2022 to test the Environmental Kuznets Curve in Nigeria, incorporating green finance variables. Using ARDL bounds testing, they found evidence of an inverted-U relationship between economic growth and environmental degradation,

influenced positively by green bond issuance. Their dataset included macroeconomic indicators from the Central Bank of Nigeria and environmental data from the National Bureau of Statistics. A major gap identified in their research was the lack of micro-level insights, such as how individual regulatory components (e.g., compliance, auditing) affect sustainability outcomes—hence the need for a more granular investigation into regulatory framework strength. Lawal and Eze (2024) ^[61] employed qualitative content analysis to examine post-issuance performance of Nigeria's sovereign green bonds. Their study reviewed 13 official reports from the Debt Management Office and the Ministry of Environment between 2017 and 2023. They found that while Nigeria's green bond initiatives have contributed to solar electrification and afforestation, transparency issues in fund disbursement and project implementation remain prevalent. The authors highlighted the absence of independent audits and weak institutional enforcement as challenges that threaten the long-term credibility of the green bond framework. This underscores the relevance of assessing the regulatory framework strength in ensuring environmental sustainability.

Gap

Across the reviewed studies, consistent gaps emerge in terms of project-level data, sectoral analyses, enforcement of regulatory frameworks, and the translation of green bond investments into measurable environmental outcomes. Many of the prior studies focused either on financial perceptions or macro-level trends, often neglecting the practical implications of green instrument uptake, sustainable funding allocation, and regulatory framework strength. This study addresses these gaps by empirically investigating how these three constructs influence environmental sustainability development specifically in Nigeria.

Methodology

The study adopted a descriptive survey design to examine the influence of green bond initiatives on environmental sustainability development in Delta State, Nigeria. The target population consisted of 1,392 staff members from various agencies and units under the Ministry of Environment in Delta State, all of whom were directly or indirectly involved in the planning, financing, regulation, or implementation of environmental sustainability projects. Using Krejcie and Morgan's (1970) sample size determination table, a sample of 302 respondents was selected through a stratified random sampling technique, ensuring fair representation across departments and functional areas. Data for the study were obtained from primary sources using a well-structured questionnaire designed to collect responses on green instrument uptake, sustainable funding allocation, regulatory framework strength, and environmental sustainability development. The instrument was subjected to expert validation in the fields of environmental economics and research methodology to ensure its content and face validity. To test the instrument's internal consistency, a pilot study was conducted, and the resulting Cronbach's Alpha coefficient was 0.81, indicating high reliability. Data gathered from the respondents were analyzed using both descriptive statistics (mean, standard deviation) and inferential statistics, specifically multiple regression analysis, with the aid of EVIEWS 9.0 statistical

software, to determine the extent to which the independent variables predicted environmental sustainability development outcomes in the context of Delta State.

Model Specification

The following model has been developed to specify the functionalism for the variables used in the green bond and environmental sustainability development expressed as:

$$ESD = \beta_0 + \beta_1 GIU + \beta_2 SFA + \beta_3 RFS + \varepsilon$$

Where:

ESD = Environmental Sustainability Development

GIU = Green Instrument Uptake

SFA = Sustainable Funding Allocation

RFS = Regulatory Framework Strength

β_0 = Constant

β_1 – β_3 = Coefficients of the independent variables

ε = Error term

Result and Discussion

This section deals with the questionnaire and analysis of data collected and result of the statistical analysis and findings.

Table 1: Analysis of Questionnaire Distribution

Questionnaire	Frequency	Percentage
Unreturned	19	6.29%
Unusable	5	1.66%
Usable	278	92.05%
Total distributed	302	100.00%

Source: Researcher's Compilation, 2026

Table 1 presents the analysis of the questionnaire distribution and response rate for the study. Out of the 302 questionnaires distributed to respondents, a total of 278 were returned and found usable, representing a high and commendable response rate of 92.05%. This suggests a strong level of participation and interest from the target respondents. However, 19 questionnaires, accounting for 6.29%, were not returned, while 5 questionnaires, representing 1.66%, were returned but deemed unusable due to errors or incomplete responses. Overall, the high percentage of usable questionnaires enhances the credibility and reliability of the data collected, providing a solid basis for the analysis and interpretation of the research findings.

Table 2: Respondents Responses to Questions Statements

S/N	Questions Statement	Mean	Std	Remarks
Green Instrument Uptake (GIU)				
1	I have heard about green bonds or green funds being used in my office.	3.58	1.24	Agree
2	My office has received support from green bond or green fund projects.	3.42	1.30	Agree
3	Most staff in my office understand what green bonds are used for.	3.35	1.29	Agree
4	The use of green bonds is becoming more common in environmental work.	3.60	1.24	Agree
5	Green bonds have helped in starting or improving environmental projects in my office.	3.50	1.26	Agree
	Aggregate mean	3.49	1.27	Agree
Sustainable Funding Allocation (SFA)				
6	The money given for environmental projects is used for the right purpose.	3.65	1.22	Agree
7	My office gets enough money to support green or environmental projects.	3.35	1.28	Agree
8	Funds for environmental projects are released on time.	3.20	1.28	Agree
9	We are told clearly how the money for environmental work is spent.	3.37	1.29	Agree
10	The way money is shared for environmental projects matches our real needs.	3.42	1.30	Agree
	Aggregate mean	3.40	1.27	Agree
Regulatory Framework Strength (RFS)				
11	There are clear rules on how green bond money should be used.	3.56	1.27	Agree
12	My office follows government rules on green and environmental projects.	3.62	1.26	Agree
13	Government bodies check to make sure green project money is used properly.	3.43	1.30	Agree
14	The laws in Delta State support environmental protection.	3.58	1.27	Agree
15	Poor enforcement of rules makes it hard to get good results from green projects.	3.61	1.32	Agree
	Aggregate mean	3.56	1.29	Agree
Environmental Sustainability Development (ESD)				
16	Green projects have helped reduce waste in our area.	3.68	1.24	Agree
17	Pollution in our area has reduced because of green projects.	3.60	1.25	Agree
18	Tree planting and forest projects have increased with green bond support.	3.63	1.28	Agree
19	We now use more clean energy (like solar) because of green projects.	3.52	1.29	Agree
20	The environment in our area has improved because of green bond projects.	3.63	1.26	Agree
	Aggregate mean	3.61	1.26	Agree

Source: Researcher's Compilation 2026

Table 2 presents the descriptive statistics of respondents' perceptions regarding the key constructs of the study, measured through mean scores and standard deviations. For the variable Green Instrument Uptake (GIU), all five items recorded mean values above the threshold of 3.00, with an aggregate mean of 3.49 and a standard deviation of 1.27, indicating a general agreement among respondents that green instruments such as bonds are increasingly recognized

and have contributed to environmental project development in their offices. The highest mean of 3.60 was associated with the growing use of green bonds in environmental work, reflecting positive awareness and engagement. Regarding Sustainable Funding Allocation (SFA), the responses also revealed overall agreement, with an aggregate mean of 3.40 and a standard deviation of 1.27. Respondents agreed that funds for environmental projects

are generally used for the right purposes and are aligned with organizational needs, although the lowest mean score of 3.20, indicated a slight concern about the timeliness of fund releases. This suggests that while sustainable funding is perceived as useful, improvements in fund disbursement speed could enhance effectiveness.

For Regulatory Framework Strength (RFS), the responses yielded a strong aggregate mean of 3.56 and a standard deviation of 1.29, suggesting that regulatory systems surrounding green bonds are fairly robust and well-enforced. Respondents agreed that clear rules exist and are followed, and that laws in Delta State support environmental protection. Notably, the recognition of enforcement challenges with mean of 3.61, highlights a critical area needing policy attention, despite overall positive sentiment. The dependent variable, Environmental Sustainability Development (ESD), recorded the highest aggregate mean of 3.61 and a standard deviation of 1.26, indicating broad agreement that green projects are effectively contributing to environmental outcomes. Respondents observed noticeable improvements in areas such as waste reduction, pollution control, tree planting, and adoption of clean energy sources, suggesting that green bond initiatives are having a meaningful impact on environmental sustainability in the state.

The interpretation of responses across all four constructs confirms that respondents positively perceive green bond uptake, funding allocation, regulatory support, and environmental improvements, though opportunities for enhancing funding timeliness and regulatory enforcement still remain.

Table 3: Summary of Correlation Matrixes for the variables

Variables	GIU	SFA	RFS	ESD
GIU	1.000			
SFA	0.215	1.000		
RFS	0.345	0.406	1.000	
ESD	0.690	0.424	0.405	1.000

Source: EVIEWS 9.0 Output, 2026

Table 3 presents the correlation coefficients among the key variables of the study—Green Instrument Uptake (GIU), Sustainable Funding Allocation (SFA), Regulatory Framework Strength (RFS), and Environmental Sustainability Development (ESD). The results show that all variables are positively correlated, indicating mutual reinforcement in promoting environmental outcomes. Notably, GIU has the strongest positive correlation with ESD ($r = 0.690$), suggesting that increased adoption of green instruments significantly enhances environmental sustainability. Additionally, GIU correlates moderately with RFS ($r = 0.345$) and weakly with SFA ($r = 0.215$), implying that while uptake is somewhat influenced by regulatory and funding factors, its direct impact is more strongly felt in environmental improvements. SFA exhibits moderate correlations with both RFS ($r = 0.406$) and ESD ($r = 0.424$), indicating that effective and timely funding contributes to stronger regulatory practices and sustainability. Similarly, RFS and ESD share a moderate correlation ($r = 0.405$), highlighting the importance of sound legal and institutional frameworks in achieving environmental goals. The matrix underscores a cohesive and positive interaction among all variables in fostering environmental sustainability.

Testing of Hypotheses

Table 4: Summary of Multiple Regression Analysis for Hypotheses 1, 2, and 3

Dependent Variable: ESD				
Method: Least Squares				
Date: 06/14/25 Time: 18:32				
Sample: 302				
Included observations: 278				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.123326	0.022735	5.424495	0.0000
GIU	-0.131003	0.085841	-1.526105	0.1281
SFA	0.003535	0.050809	0.069579	0.9446
RFS	1.104769	0.054727	20.18697	0.0000
R-squared	0.990042	Mean dependent var		3.611511
Adjusted R-squared	0.899133	S.D. dependent var		1.253505
S.E. of regression	0.125768	Akaike info criterion		-1.294474
Sum squared resid	4.334008	Schwarz criterion		-1.242278
Log likelihood	183.9319	Hannan-Quinn criter.		-1.273534
F-statistic	9080.826	Durbin-Watson stat		1.895408
Prob(F-statistic)	0.000000			

Source: EVIEWS 9.0 Output, 2026

The multiple regression results presented in Table 4 evaluate the effects of Green Instrument Uptake (GIU), Sustainable Funding Allocation (SFA), and Regulatory Framework Strength (RFS) on Environmental Sustainability Development (ESD). Examining individual predictors, Regulatory Framework Strength (RFS) has a positive and statistically significant effect on ESD, with a coefficient of 1.104769 and a p-value of 0.0000. This finding indicates that stronger environmental regulatory frameworks substantially enhance environmental sustainability outcomes in Nigeria. On the other hand, Green Instrument Uptake (GIU) has a negative but statistically insignificant effect on ESD, with a coefficient of -0.131003 and a p-value of 0.1281, suggesting that despite the apparent adoption of green instruments, their current implementation may not yet be impactful enough to significantly improve sustainability. Similarly, Sustainable Funding Allocation (SFA) shows a positive but highly insignificant effect, with a coefficient of 0.003535 and a p-value of 0.9446, implying that although funding is important, its allocation may not be efficiently structured to generate measurable improvements in environmental sustainability. Additional diagnostic metrics also support the reliability of the model. The Standard Error of the Regression (0.125768) indicates a relatively low dispersion of the observed values around the predicted values, which reinforces model accuracy. The Durbin-Watson statistic of 1.895408 falls within the acceptable range (approximately 1.5 to 2.5), indicating no serious autocorrelation in the residuals, thus confirming the independence of errors.

The model reports an R-squared value of 0.990, indicating that 99% of the variation in ESD is jointly explained by the three independent variables, which demonstrates an excellent model fit. The adjusted R-squared of 0.899 further confirms the robustness of the model after adjusting for the number of predictors. The F-statistic of 9080.826 with a probability value of 0.000 implies that the overall regression model is statistically significant, meaning that the explanatory variables collectively have a strong and reliable influence on ESD.

In a nutshell, while the overall model confirms a strong and significant joint influence of the variables on environmental

sustainability development, only Regulatory Framework Strength exerts a significant individual effect, highlighting the pivotal role of policy enforcement and legal structure in driving green development outcomes in Nigeria. The statistically insignificant results for GIU and SFA point to possible gaps in implementation effectiveness, monitoring, or integration into existing environmental policies and practices.

Discussion of Findings

Green Instrument Uptake and Environmental Sustainability Development in Nigeria

The finding from the regression analysis revealed that Green Instrument Uptake (GIU) had a negative but statistically insignificant effect on Environmental Sustainability Development (ESD). This suggests that despite increased awareness of green financial tools, their implementation has not translated into measurable sustainability outcomes. This finding contrasts with Taghizadeh-Hesary and Yoshino (2020) ^[98], who argued that green bonds play a critical role in financing renewable energy and sustainable infrastructure in emerging economies. Similarly, Banga (2019) ^[27] noted that green bonds significantly influence climate-resilient development when aligned with environmental goals. However, the current study aligns with Naidoo (2021) ^[64], who found that in many developing countries, green finance instruments often underperform due to weak institutional capacity and inadequate monitoring frameworks. Shirai and Zhan (2021) ^[97] also reported that although green bonds are increasing globally, their real impact on sustainability in some African economies remains limited by low uptake and policy misalignment. Therefore, the findings reflect that in Nigeria, the effectiveness of green instruments still requires strategic reforms and capacity development for tangible environmental benefits.

Sustainable Funding Allocation and Environmental Sustainability Development in Nigeria

The regression result for Hypothesis Two shows that Sustainable Funding Allocation (SFA) had a positive but statistically insignificant effect on ESD. This implies that while financial support for environmental initiatives exists, it is either not timely, not sufficient, or not efficiently used to influence environmental outcomes. This finding disagrees with Aminu and Salihu (2022) ^[21], who reported that strategic allocation of public environmental funds significantly boosts ecosystem restoration and pollution control in sub-Saharan Africa. Similarly, Ghisellini *et al.* (2020) ^[45] emphasized that the efficiency of sustainable development programs largely depends on well-targeted and transparent funding mechanisms. On the contrary, this finding supports Oyeibanji and Okonkwo (2023) ^[85], who argued that Nigeria's environmental budget allocation is often marred by delays, poor tracking, and lack of prioritization, which dilutes its impact on sustainability. Emefiele and Adegbite (2021) ^[35] also found that although green project funding exists, inadequate monitoring and political interference limit its effectiveness in driving long-term sustainability goals. This points to the need for institutional reforms in Nigeria's public environmental funding system to improve its developmental impact.

Regulatory Framework Strength and Environmental Sustainability Development in Nigeria

Contrary to the null hypothesis, the regression analysis revealed that Regulatory Framework Strength (RFS) had a highly significant and positive effect on Environmental Sustainability Development. This indicates that the presence of strong laws, guidelines, and enforcement mechanisms is a critical driver of environmental progress. This finding is supported by Zerbo *et al.* (2022) ^[114], who emphasized that environmental sustainability is strongly correlated with institutional strength and regulatory quality in West African nations. Similarly, Ibe and Akpan (2021) ^[48] found that in Nigeria, stricter enforcement of environmental regulations significantly improved outcomes in waste management and green urban planning. Khan *et al.* (2020) ^[59] also argued that countries with transparent legal systems and accountability mechanisms tend to experience better environmental performance. On the other hand, Adewale and Ogunleye (2019) ^[10] suggested that regulatory efforts in Nigeria often face implementation barriers due to corruption and under-resourced agencies, although they still acknowledged their importance in policy design. Overall, the study affirms that robust environmental laws and strong enforcement bodies are indispensable in advancing sustainability, and thus, the effectiveness of green policies hinges largely on regulatory strength.

Summary of findings

This study examined the relationship between green bond-related dimensions and environmental sustainability development in Nigeria, with particular focus on agencies under the Delta State Ministry of Environment. Using a descriptive survey design and data collected from 278 respondents, the study explored the effects of Green Instrument Uptake, Sustainable Funding Allocation, and Regulatory Framework Strength on Environmental Sustainability Development. Statistical analysis using EVIEWS 9.0 revealed varying degrees of influence among the independent variables, highlighting the critical role of governance structures and regulatory mechanisms in driving environmental outcomes. Thus, the major findings are:

1. Green Instrument Uptake had a negative but statistically insignificant effect on Environmental Sustainability Development ($\beta = -0.131, p = 0.1281$);
2. Sustainable Funding Allocation showed a positive but statistically insignificant influence on Environmental Sustainability Development ($\beta = 0.004, p = 0.9446$);
3. Regulatory Framework Strength had a positive and statistically significant effect on Environmental Sustainability Development ($\beta = 1.105, p = 0.0000$).

Conclusion

In conclusion, this study has established that while the use of green instruments and the allocation of sustainable funding are important elements in environmental financing, they alone do not significantly drive environmental sustainability development in Nigeria without effective implementation and oversight. The findings strongly underscore the pivotal role of a robust regulatory framework in ensuring that environmental policies and green finance initiatives translate into meaningful ecological outcomes. Therefore, for green bond strategies to yield tangible environmental benefits, there must be a deliberate strengthening of legal, institutional, and enforcement

mechanisms within the Nigerian environmental governance structure.

Recommendations

Based on the three objectives and findings of the study, the following are being recommended:

1. It is recommended that government agencies promote practical awareness and integration of green instruments by providing structured training, workshops, and continuous sensitization programs to enhance staff capacity and utilization of green financial tools in environmental projects.
2. Sustainable funding allocation should be improved through greater transparency, timely disbursement, and alignment with project-specific needs, ensuring that environmental funds are efficiently and effectively utilized for their intended purposes.
3. The regulatory framework guiding environmental sustainability should be reinforced by strengthening legal provisions, improving enforcement mechanisms, and empowering relevant agencies to monitor, evaluate, and ensure compliance with established environmental and green finance standards.

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