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Research Article

Environmental Sustainability: Exploring Strategies for Environmental Conservation and Sustainable Resource Management in Nigeria

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Abstract

The study examines strategies that promote environmental sustainability in the face of food insecurity, environmental management challenges and poverty alleviation efforts which are contributing to the complexity of natural resource management. Among others, the objectives of the study were to: assess the effectiveness of current environmental conservation policies and programs in reducing pollution and protecting biodiversity; and identify and analyze innovative strategies for sustainable resource management that can be implemented across various sectors, including agriculture, energy, and industry and explore the impact of community-based conservation efforts on environmental outcomes and local livelihoods**.** The study adopted the Taro Yamane formula to determine the sample size of 422 out of a population of 9,697. The response rate was 96.44%, resulting in an accepting sample of 407. The study used survey design which involved questionnaire and structured interview for the collection of primary data. Responses from 4-point Likert Scale questionnaire administered were analyzed using descriptive statistics. The study finds that even though the current environmental conservation policies and programs are effective in reducing overall pollution levels and that existing environmental conservation programs have been successful in protecting and preserving biodiversity in Nigeria, the effectiveness of policies and programs in reducing pollution in Nigeria is compromised because efficient enforcement is lacking due to inadequate resources, corruption, and lack of political will and many regulatory agencies face challenges in monitoring compliance with environmental laws. Moreover, public education on sustainable practices and pollution prevention is still limited in many areas, and this affects community involvement. Accordingly, among others, the study recommends that for effective enforcement of environmental conservation policies and programs, government should: encourage community involvement through community engagement and education in environmental initiatives to enhance the effectiveness of conservation strategies; promote sustainable agricultural practices, which are essential for environmental conservation; and prioritize renewable energy investment to improve resource management and reduce environmental impact.

Keywords

Environmental Sustainability, Conservation, Stewardship, Biodiversity**,** Natural Resources

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1. Introduction

The outer zones of the earth are made up of the lithosphere (land), biosphere (flora and fauna), atmosphere (air) and the hydrosphere (water bodies). These are the components that make up the environment, and their conservation towards sustainability is important for the well being of communities, job creation, the global economy, and food security [7]. This necessitates the drive towards environmental resource management, which seeks to address the protection and conservation of natural resources, such as water, land, flora and fauna, and the reduction of pollution and environmental impact caused by human activity.

Environmental sustainability focuses on encouraging the sustainable use of natural resources, the improvement towards more environmentally friendly practices and technologies, and the execution of appropriate public policies and regulatory frameworks to guard the environment and make sure that sustainable development is achieved [14]. It is focused on seeking a balance between human activity and the health of planet Earth. It advocates practices that are steep in protecting the environment, promote social equity, and ensure economic viability for present and future generations. Thus, in order to achieve environmental sustainability in Nigeria, it requires combined efforts from individuals, communities, businesses, and governments. It is through fostering a culture of sustainability that society can work towards a more balanced and healthy relationship with the planet Earth [7].

Food security, environmental management and poverty alleviation efforts are the key issues adding to the difficulty of natural resource management [10]. Consequently, it is in acknowledging the significance of environmental sustainability that the evolution of the concepts of Blue Economy and the principles of Circular Economy were triggered, both of which revolve around sustainable use of natural resources for economic growth, social development, and environmental protection. Both concepts inspire better stewardship and responsible management of natural resources in a manner that satisfies present wishes without hindering the ability of future generations to meet their own needs [21]. Accordingly, it is against the backdrop of carrying capacity that environmental sustainability encompasses a broad range of practices, principles, and goals that aim at protecting the environment while fostering economic and social development.

Furthermore, when viewed from the concept of carrying capacity, it is apparent that policy makers in countries (such as Nigeria) that depend largely on exports of natural resources to earn the bulk portion of their foreign exchange often overlook the sustainability aspect of their natural assets. This is with the result that they often design policies (developed with a very narrow strategic vision) to obtain short term gains while ignoring long term implications [12].

Furthermore, countries that are over-reliant on certain natural resources as revenue earners often overlook the revenue generation capacities of other segments of the economy in policy decisions. That is the narrative behind the mono-cultural nature of the Nigerian economy: which is heavily reliant on revenue earnings from oil and gas. However, the realization of this error has spurred efforts towards diversifying the national source of revenue base to focus on non-oil resources by paying attention to the concept of marine and blue economy and the principles of circular economy [6].

Thus, this study focuses on issues that counter the drive towards environmental sustainability and examines the necessity for the adoption of strategies for environmental conservation and sustainable resource management. The paper therefore aims to explore such strategies that promote environmental sustainability in an effort to promote better stewardship of natural resources in Nigeria.

2. The Problem

Environmental sustainability is a drive aimed at striking a balance between human activities and preserving the health of planet Earth. The prosperity of humanity is interlinked with the services provided by ecosystems, however inadequate natural resource management (NRM) has seriously affected the environment [13]. This is the situation that prompted the clamor for environmental sustainability, which is an effort directed at protecting the environment, promoting social equity in order to make sure that economic viability for current and coming generations is guaranteed. In order to achieve environmental sustainability, communal efforts from individuals, communities, businesses, governments and non-governmental organizations are required. Thus, by encouraging a culture of sustainability, humanity can work towards a more balanced and healthy relationship with the planet Earth [7].

However, there are certain factors which play a leading role in biodiversity decline and thereby upending the much desired balanced and healthy relationship between humanity and the environment in Nigeria. Accordingly such factors that have been identified to influence natural resource depletion include: global climate change, induced by carbon emissions; unsustainable fishing practices such as recreational and commercial fishing (overexploitation due to overfishing and incidental or by-catch); rising sea temperatures; pollution from various sources; non-native invasive species; and habitat destruction and modification due to farming and urbanization [3].

Another crucial factor that upsets the natural balance between human activities and the natural environment is population growth. Mathematical models have been used by several authors to establish a relationship between population growth and available natural resources [4]. Furthermore, the prominent point made by such authors is that the concept of carrying capacity should be subscribed to in policy decisions towards effective management of natural resource [4].

Against this backdrop, the study examines the challenges

involved in promoting environmental sustainability in Nigeria and strategies towards better stewardship of the natural resources. The objectives of the study were to (**1)** Assess the effectiveness of current environmental conservation policies and programs in reducing pollution and protecting biodiversity (2) Identify and analyze innovative strategies for sustainable resource management that can be implemented across various sectors, including agriculture, energy, and industry (3) Explore the impact of community-based conservation efforts on environmental outcomes and local livelihoods (4) Examine the role of technology and innovation in advancing environmental sustainability, particularly in areas such as renewable energy, waste management, and pollution control and (5) Evaluate the economic and social feasibility of transitioning to a circular economy model, which lay emphasis on resource efficiency, waste reduction, and the regeneration of natural systems.

3. Literature Review, Conceptual Clarification and Theoretical Framework

Environmental Sustainability

Environmental sustainability is to the conscientious management of natural resources to meet current desires without spoiling the chances of future generations to meet their needs. The goal is to strike a balance in terms of ecological, economic and social goals, such as minimizing carbon footprints, encouraging renewable energy and guaranteeing equitable resource access. The significance of environmental sustainability is towards preservation of resources like clean air, water and wildlife for coming generations and to "ensuring that human society operates within ecological borders" [16].

Some key components of environmental sustainability have been identified to include the following:

1. Resource Conservation: (a) Renewable Resources: Encouraging the use of renewable resources (such as solar, wind, and biomass) rather than non-renewable ones (like fossil fuels) to ensure long-term availability (b) Sustainable Practices: Implementing practices that reduce waste and promote responsible consumption (e.g., recycling, reusing, and reducing material usage).

2. Ecosystem Protection: (a) Biodiversity: Protecting diverse ecosystems and the species within them to maintain ecological balance. Conserving habitats and preventing species extinction are crucial (b) Natural Habitats: Preserving forests, wetlands, oceans, and other critical environments that provide essential services such as clean air, water filtration, and carbon sequestration.

3. Climate Change Mitigation: (a) Reducing Emissions: Implementing strategies to decrease greenhouse gas emissions, such as transitioning to cleaner energy sources and improving energy efficiency (b) Adaptation Strategies: Planning for the impacts of climate change through sustainable infrastructure, improved agricultural practices, and resilient community planning.

4. Social Equity and Economic Viability: (a) Equitable Resources: Ensuring that all communities have access to resources and opportunities to participate in sustainable practices (b) Economic Development: Fostering development that prioritizes sustainability, creating green jobs, and promoting industries that support sustainability goals.

5. Community Engagement and Education: (a) Awareness Raising: Educating individuals and communities about environmental issues and the importance of sustainability practices (b) Participatory Approaches: Involving communities in decision-making processes related to environmental management and sustainability initiatives.

6. Policy and Governance (a) Sustainable Policies: Developing and implementing policies that promote environmental sustainability at local, national, and international levels (b) Regulations and Standards: Establishing regulations that limit harmful practices and encourage sustainable practices among businesses and individuals [2].

Environmental Governance

Environmental governance is the term used to describe the manner in which human beings exercise authority over natural resources and natural systems. It borders on environmental decision making. Accordingly, environmental governance is tantamount to involvement with the aim of changing environment-related issues that incentivize knowledge, institutions, decision making, and behaviours. Environmental governance triggers environmental decision making which spurs innovative ways to tackle environmental and natural resources crises and challenges. The effective management of the environment is important for the well-being of the citizens, particularly for the least well-off [5].

Multifaceted approaches and strategies are necessary for securing a greener future because environmental conservation has become an imperative in the face of escalating climate change, rampant pollution, and the depletion of natural resources. This is with severe impact not just on the natural world but also human health, economies, and social structures [18]. Thus, it has been suggested that urgent action is needed considering the increasing occurrences of extreme weather events, rising sea levels, and the loss of biodiversity, which threaten the very fabric of life on Earth [7].

As a result of the issue of climate change and the worsening environmental degradation risk, economic growth and human development are faced with grievous constraints. Consequently, the increasing importance attached to global environmental governance is indicative of the world's growing understanding of the scope and scale of the issues at stake. Therefore, in light of the glaring evidence of environmental degradation, this calls for further action in terms of environmental governance. The need for environmental governance is aimed at entrenching tangible environmental improvement and positive movement towards the vital goal of sustainable development [2].

Current Policies and Programs for Environmental Resource Management in Nigeria

With regards to regulatory framework, Nigeria has several environmental laws, such as the National Environmental Policy, the Environmental Impact Assessment (EIA) Act, and various sector-specific regulations aimed at controlling pollution from industries, waste management, and resource exploitation. The agencies involved in controlling pollution include the National Environmental Standards and Regulations Enforcement Agency (NESREA), which plays a significant role in enforcing environmental laws and regulations. Other agencies include the Federal Ministry of Environment and state environmental agencies. Afforestation Programs were initiated for combating deforestation and promoting reafforestation in order to address environmental degradation [19].

The effectiveness of policies and programmes in reducing pollution in Nigeria is compromised because effective enforcement is lacking due to inadequate resources, corruption, and lack of political will. Many regulatory agencies face challenges in monitoring compliance with environmental laws. There is a growing awareness of environmental issues among the populace, but education on sustainable practices and pollution prevention is still limited in many areas, affecting community involvement [5].

Industries, particularly in sectors like oil and gas, agriculture, and manufacturing, continue to be significant sources of pollution. The implementation of stricter regulations and penalties for non-compliance has been sporadic. Urban areas struggle with waste management, leading to increased pollution from landfills and open dumping. There are initiatives for better waste management, yet they often lack comprehensive execution and public participation. Air pollution levels in major cities remain high, driven by vehicular emissions, industrial activities, and burning of waste. Water bodies are also polluted by agricultural runoff and industrial discharges, impacting public health [19].

There are frameworks and some initiatives in place to combat pollution in Nigeria, but the overall effectiveness of current environmental conservation policies and programs is hindered by implementation challenges, lack of enforcement, and insufficient public engagement [5].

3.1. Legal Framework

Section 20 of the Fundamental Objectives and Directive Principles of State Policy in Chapter 2 of the Constitution of the Federal Republic of Nigeria establishes that “The state shall protect and improve the environment and safeguard the water, land, forest, and wildlife in Nigeria”. This provision aims to ensure a healthy environment for all Nigerian citizens. Section 6 (6)(c) of the Constitution restricts the influence of courts in issues pertaining to the execution of Section 20, thereby making the accessing to a healthy environment more of an desire or plan rather than a lawfully viable and inalienable right [15].

The following are some other laws passed in Nigeria to promote environmental sustainability in recognition of the significance of environmental governance:

Environmental Impact Assessment Act, 1992 requires developers to consider the potential environmental impacts of their projects before commencement. It aims to promote sustainable development and environmental protection by mandating environmental assessments, public participation and mitigation measures.

Harmful Waste (Special Criminal Provision) Act. 1988 prohibits activities related to harmful waste, including purchase, sale, importation, transit. Transportation, deposit, and storage. It declares such activities as unlawful and prescribes severe penalties for offenders.

Niger Delta Development Commission (NDDC) Act, 2000 was enacted to prevent and control oil spills, gas flaring, and environmental pollution in the Niger Delta.

Environmental Management and Protection (2017) of Lagos State aims to offer a hygienic and protected environment for people living in the state and to allow residents to have admittance to the various services of the environment for leisure, instructive, healthiness, educational and money-making purposes [19].

Strategies Aimed at Promoting Sustainable Resource Management in Nigeria

One of the strategies aimed at promoting sustainable resource management in Nigeria is adopting a circular driven economy, which is an economic model aimed at sustainability by reducing waste and making maximum use of available resources. Unlike the traditional linear economy, which follows a 'take-make-dispose' approach, the circular economy emphasizes designing products and systems that enable resource reuse, recycling, and regeneration. Its goal is to create a closed-loop system where materials are continually repurposed, reducing environmental impact and conserving natural resources. This approach promotes resource efficiency, waste reduction, and the regeneration of natural systems, fostering economic growth while protecting the environment [7].

The economic feasibility of transitioning to a circular economy for local communities in Nigeria depends on various factors, which include existing infrastructure, available resources, community engagement, and policy support. The potential benefits of circular economy include: (a) reduction in waste management costs (b) creation of new jobs in recycling, repair, and maintenance sectors (c) sustainable use of local natural resources (d) enhanced resilience to resource scarcity and economic shocks [7].

Challenges of Circular Economy:

1). Limited infrastructure for recycling and waste processing
2). Lack of awareness or technical knowledge about circular practices
3). Initial investment costs for transitioning industries and systems
4). Policy and regulatory gaps to support circular initiatives

Innovative Strategies that Promote Sustainable Resource Use

The impact of innovative strategies that promote sustainable resource use in various sectors in Nigeria, including agriculture, energy, and industry varies by sector and is influenced by several factors as follows:

1. Agriculture

Innovative Strategies: Agro-ecology and Climate-Smart Agriculture: Techniques such as intercropping, organic farming, and conservation tillage are being promoted to enhance productivity while reducing environmental impact; Improved Seed Varieties: The introduction of drought-resistant and high-yield crop varieties aims to increase food security and resilience against climate change; Digital Agriculture: The use of mobile apps and platforms for farmers to access information on weather, market prices, and best practices has begun to gain traction.

Effectiveness: Positive Impacts: These strategies have shown potential in increasing yields and improving the livelihoods of farmers. For instance, initiatives focused on organic farming have helped some communities to produce healthier crops; Challenges: The adoption of these methods can be slow due to limited access to technology, training, and funding. Additionally, traditional farming methods remain prevalent in many areas.

2. Energy

Innovative Strategies: Renewable Energy Projects: Investments in solar, wind, and biomass energy are being explored to diversify energy sources beyond fossil fuels; Mini-Grids and Off-Grid Solutions: These systems provide electricity to rural areas that lack connection to the national grid, enhancing energy access; Energy Efficiency Initiatives: Programs aimed at promoting energy-efficient appliances and practices are being implemented.

Effectiveness: Growing Success: Some solar projects have successfully provided electricity to remote communities, significantly improving quality of life and economic opportunities; Barriers to Scaling: Challenges include high initial costs, regulatory hurdles, and a need for more investment in infrastructure and maintenance services.

3. Industry

Innovative Strategies: Cleaner Production Technologies: Industries are encouraged to adopt cleaner technologies that minimize waste and emissions; Waste to Wealth Initiatives: Programs that focus on recycling and valorizing waste products are starting to gain attention, promoting circular economy principles; Sustainability Standards: The adoption of international sustainability standards (e.g. ISO 14001) helps industries improve their environmental performance.

Effectiveness: Mixed Results: While there have been successes in certain sectors, such as textiles and food processing, overall implementation remains low across many industries.

Incentives Needed: Many industries lack the financial incentives or technical support to make the transition to more sustainable practices [7].

Moreover, while innovative strategies that promote sustainable resource use in agriculture, energy, and industry in Nigeria hold promise and have shown varying degrees of success, the challenges remain. Factors such as lack of infrastructure, investment, regulatory support, and public awareness hinder widespread adoption. Continued focus on capacity building, fostering partnerships, and creating supportive policies will be essential for these strategies to become more effective and sustainable over time. Furthermore, engagement with local communities and stakeholders plays a crucial role in ensuring that innovations and technology meet the specific needs of those they aim to serve. Ultimately, a multifaceted approach that integrates innovations, technology, education, and policy reform is necessary to enhance sustainability across these sectors [7].

3.2. Theoretical Framework

The following theoretical frameworks are relevant to the topic being explored as they would help analyze the specific context of Nigeria in terms of its unique environmental challenges, socio-economic conditions, and governance structures. By integrating these theories, the research is able to explore: effective strategies for environmental conservation tailored to Nigeria's diverse ecosystems; innovative resource management practices that align with both local and global sustainability goals and the role of various stakeholders in promoting environmental sustainability initiatives.

Sustainable Development Theory

The proponents of sustainable development theory (Barbara Ward, Herman Daly and Tim Jackson) argue that it is an approach that addresses both the environment and social problems that humanity faces. This theory emphasizes the importance of balancing economic growth, environmental protection, and social equity. It provides a foundation for understanding how environmental sustainability can be achieved through integrated approaches that consider social and economic dimensions alongside ecological ones [11].

The theory lays particular emphasis on Intergenerational equity, Inclusive economic growth and environmental justice.

Ecological Modernization Theory

Ecological Modernization Theory emerged in the 1980s and proponents (Arthur Mol, David Sonnenfeld and Joseph Huber) posit that economic development and environmental quality can be mutually reinforcing through the application of innovative technologies and practices. It explores how modernization processes can lead to an environmentally sustainable society. The theory lays emphasis on technological innovation, policy frameworks and stakeholder collaboration [20].

Resource Management Theory

The proponents of this theory (Jay Barney, Birger Wernfelt and Margaret Peteraf) aimed to focus the theory on the efficient and sustainable use of resources to achieve organizational goals addresses the management of natural resources with an aim for sustainability. It emphasizes the importance of managing resources efficiently and equitably to meet current

needs without compromising future generations' ability to meet theirs. It lays particular emphasis on Conservation strategies, Sustainable resource allocation and Community-based management [1].

Stakeholder Theory

The primary proponent of stakeholders theory is Dr. R. Edward Freeman, who introduced it in his book: "Strategic Management: A Stakeholder Approach" in 1984. This theory focuses on the importance of involving various stakeholders in environmental governance and resource management processes. It highlights the roles and relationships between government, private sector, community organizations, and individuals in decision-making and implementation. The theory lays emphasis on stakeholder engagement, shared responsibility and collaborative governance [17].

This theoretical framework provides a comprehensive lens through which to explore strategies for environmental conservation and sustainable resource management in Nigeria. It offers a structured approach to understanding the complexities involved in achieving environmental sustainability while considering the socio-economic and cultural contexts of the country.

Empirical Studies

The empirical review drew extensively from the position of the European Parliament as a global standard and best practice for Nigeria to use as a reference point, without prejudice to environmental and cultural differences [8]. With Europe, as well as the world at large, being confronted with the economic and societal effect of climate change, ecosystem degradation and overconsumption of natural resources, the Parliament embraces the following EU environmental objectives until 2030:

The EU will develop a binding framework to monitor and report on member states' progress towards phasing out fossil fuel subsidies and set a deadline for ending fossil fuel subsidies in line with the ambition of limiting global warming to 1.5 degrees Celsius. Nigeria has already phased out fossil fuel subsidies but the transition to renewable energy has not taken off as expected due to the high cost of associated infrastructure [8].

Considering that economic activities and lifestyle are Europe's most important environmental challenges, with regards to Environmental damage as a priority, damage must be paid for by the polluter [9]; Nigeria has to update extant laws that impose inconsequential penalty on polluter who damage the environment.

Adapting and reducing the vulnerability of the environment, society and all sectors of the economy to climate change. Nigeria needs to pay more attention to reducing vulnerability by regulating activities that compromise the soundness of the physical environment such as noise pollution in urban centres.

Reducing key environmental and climate pressures related to production and consumption; strengthening environmentally positive incentives as well as phasing out environmentally harmful subsidies, in particular fossil fuel subsidies. Nigeria has already towed this line of removing fossil fuel subsidies in order to encourage transition to clean energy sources.

Using data technologies to support environment policy, ensuring transparency and public accessibility of the data. On this score, Tech companies in Nigeria are developing air quality monitoring systems and carbon reduction technologies to help industries minimize their environmental impact. Data analytics are being deployed in Nigeria to help policy makers to make informed decisions about environmental conservation and management.

4. Methodology

The study used cross-sectional survey design which involved 4-point Likert Scale questionnaire and structured interview to gather data from the population. The sample selection was by multi-stage sampling techniques that involved stratified and random sampling techniques due to their thoroughness and accuracy of representation. The study used descriptive analysis, due to the non-numeric data generated from demographic and socio-economic distribution of respondents. Content and thematic analyses were used for data generated from questionnaire and interview respectively. The instruments (questionnaire and interview schedule) were validated by experts in environmental sustainability and certified as adequate and valid for the purpose of generating data. Respondents used a scale of 1 (Strongly Disagree) to 4 (Strongly Agree) for their answers.

The description of the qualitative analysis process involved analyzing responses from the 4-point Likert Scale questionnaire aimed to explain the themes and meanings in the data generated. Simple percentage was used to determine the frequency of consensus and variations in the responses in the interview and the questionnaire. Analysis of responses from the interview involved the following steps:

Step 1: (a) Data preparation: Reviewed the responses to ensure completeness and accuracy (b) Organize the data by theme

Step 2: Coding or labeling: (a) Assigned codes or labels to the responses based on their meaning or theme (b) The codes or labels were derived from the data itself (inductive coding)

Step 3: Categorization or thematic grouping: (a) Grouped similar codes or labels into categories or themes (b) Identified patterns and relationships between categories or themes

Step 4: Theme identification: (a) Identified underlying themes or patterns in the data (b) Themes were obvious from the responses provided

Step 5: Meaning interpretation: (a) Interpreted the meaning of the themes in the context of the research objectives (b) Considered the implications of the findings

Step 6: Reporting: The findings are presented under Thematic Analysis Process in a clear and concise manner, using quotes to illustrate the themes.

Reliability of the instruments

To ensure reliability, the authors used the following strategies: (1) Pilot testing that involved a small group of participants to identify and address any issues, such as ambiguous questions or technical problems (2) Clear and concise instructions were provided on how to complete the questionnaire (3) Standardization: Researchers ensured that the instruments were administered in a consistent manner to all participants, using the same format, wording, and procedures (4) Questionnaire design: the use of simple, clear, and concise language in the instruments, avoiding jargon and technical terms that might be unfamiliar to respondents (5) Anonymity and confidentiality: Ensure participants' responses were anonymous and confidential to reduce social desirability bias (6) Data quality control: Implemented data quality control measures, such as checking for completeness and consistency, to ensure accurate data (7) Randomization: Randomized the order of questions and sections to minimize order bias. By implementing these strategies, we were able to increase the reliability of the instruments and ensured that the results were accurate and trustworthy.

Table 1. *Population of the study.*

S/N	Respondents	Population
1	Forestry Research Institute of Nigeria	468
2	National Environmental Standards Regulatory and Enforcement Agency	3,215
3	National Bio-safety Management Agency	356
4	National Agency for the Great Green wall	2,132
5	National Oil Spill Detection and Response Agency	3,526
	Total	9,697

Source: Researcher's compilation, 2025

The study used primary and secondary sources of data. Questionnaire and structured interview were the instruments used for sourcing primary data. The study adopted the Taro Yamane formula to determine 422 as the sample size, out of population of study of 9,697.

In determining the sample size for this research the Taro Yamane's formula given as *equation 1* was used:

Table 2. *Taro Yamane Formula.*

n=	$\frac{N}{1 + N (e)^2}$	**(equation 1)**

Where:

N= sample size

N= population size (9,697)

e = level of precision or sampling error (5% or 0.05 for a 95% confidence level)

4.1. Calculation

Square the margin of error (e^2): 0.005 x 0.005= 0.0025

Multiply by the population size (Nxe^2): 9,697 x 0.0025 = 24.24

Add 1 to the result ($1+Nxe^2$): 1+24.24 = 25.24

Divide the population size by the result: 9,697÷25.24 = 384

Sample size = 384

However, 38 (i.e. 10% of 384) was added to accommodate non-response and this brought the sample size to 422. From the above calculated value, a sample size of 422 was drawn at 95% confidence level and 0.05 error rate.

4.2. Sample Size Determination

The sample size for the study was 422. Below is the number of copies of questionnaire that were administered to each group of respondents. Probability proportional to size (PPS) method was employed in selecting the sample size of respondents from each of the selected group of respondents. This was utilized in order to have an equal sample size representation and adequacy of the respondents in each of the group of respondents. The formula used to achieve this representation from each group of respondents is as follows:

Number of questionnaires × population of each group of respondents

Grand total

Table 3. *Population of the study.*

S/N	Respondents	Population	Proportion	Sample size
1	Forestry Research Institute of Nigeria	468	422 (468) 9,697	20
2	National Environmental Standards Regulatory and Enforcement Agency	3,215	422 (3,215) 9,697	140

S/N	Respondents	Population	Proportion	Sample size
3	National Bio-safety Management Agency	356	422 (356) 9,697	16
4	National Agency for the Great Green wall	2,132	422 (2,132) 9,697	93
5	National Oil Spill Detection and Response Agency	3,526	422 (3,526) 9,697	153
	Total	9,697		422

Source: Researcher's compilation, 2025

5. Results and Discussion

Summary of Questionnaire Distributed

The questionnaire distributed and the number of copies retrieved is presented in Table 4.

Table 4. *Copies of Questionnaire Administered.*

Number of copies of Questionnaire Distributed	Number of copies of Questionnaire Retrieved	Registrar of Copies of Questionnaire Retrieved
422	407	96.44

Source: Field survey (2025)

A total of 422 copies of the questionnaire were distributed to major stakeholders in the maritime transport sector. 407 copies were returned to represent 96.44% response rate as shown in the Table above.

Socio-economic Characteristics of Respondents

The gender distribution of the respondents is shown in Table 5. The distribution shows that 238 or 58% of the respondents were male while 169 or 42% were female. This shows that majority of the respondents were male.

The age distribution in Table 5 shows that respondents that were 18 years of age were nil. Those whose age fell into the age bracket 18-35 years were 186 or 46%. Those who fell within the 36-59 years range were 221 or 54% and they were the majority. There were no respondents whose age was 60 years plus.

The formal education of respondents in Table 5 shows that all the respondents attained various degrees of formal education. There were no respondents with Primary School education. Those who attained Secondary School education were 31 or 8% and the respondents who attained Tertiary education were 376 or 92%.

The occupations of the respondents in Table 5 shows those in Admin & Human Resources constituted 21 or 5%; Monitoring & Evaluation were 68 or 17%; Research & Planning were 55 or 14%; Compliance & Enforcement were 103 or 25%; Climate Change Dept were 79 or 19%; Liaison & Public Awareness were 43 or 11% and Legal Dept were 38 or 9%. The status of the respondents in table shows that top level management staff were 124 or 30%; senior management staff were 211 or 52% and junior level staff were 72 or 18%.

Table 5. *Demographic Analysis of Respondents.*

Characteristics	Frequency	Percentage (%)
Gender		
Male	238	58
Female	169	42
Total	407	100
Age (Years)		
Less than 18	Nil	Nil
18-35	186	46
36-59	221	54
60 plus	Nil	Nil
Total	407	100

Characteristics	Frequency	Percentage (%)
Educational Level		
Primary	Nil	Nil
Secondary	31	8
Tertiary	376	92
Total	407	100
Occupation		
Admin & Human Resources	21	5
Monitoring & Evaluation	68	17
Research & Planning	55	14
Compliance & Enforcement	103	25
Climate Change Dept	79	19
Liaison & Public Awareness	43	11
Legal Dept	38	9
Total	407	100
Status Distribution		
Top-Level Management	124	30
Senior-Level Management	211	52
Junior-Level Staff	72	18
Total	407	100

Source: Researchers' Field Survey, 2025

Tables 6 to 9 show the responses to six 4-point Likert Scale questions based on research objectives 1 to 5.

Table 6. *Objective 1: Assess the effectiveness of current environmental conservation policies and programs in reducing pollution and protecting biodiversity in Nigeria.*

S/N	Question Items	SD	%	D	%	A	%	SA	%	Total	%
1	The current environmental conservation policies and programs are effective in reducing overall pollution levels in Nigeria	32	8	38	9	48	12	289	71	407	100
2	Existing environmental conservation programs have been successful in protecting and preserving biodiversity in Nigeria	263	65	61	15	46	11	37	9	407	100
3	The current environmental conservation efforts have been effective in simultaneously addressing both pollution reduction and biodiversity protection in Nigeria	279	69	47	11	36	9	45	11	407	100

Source: Researchers' Field Survey, 2025

Objective 1 aimed to assess the effectiveness of current environmental conservation policies and programs in reducing pollution and protecting biodiversity in Nigeria. The questions under this objective aimed to evaluate the success of existing initiatives towards reducing pollution, identify gaps, and provide recommendations for improvement.

Based on objective 1, Table 6 shows the responses to question 1 which states that: The current environmental conservation policies and programs are effective in reducing overall pollution levels in Nigeria. The table shows that 32 (8%) respondents strongly disagreed that the current environmental conservation policies and programs are effective in reducing overall pollution levels in Nigeria; 38 (9%) disagreed; 48 (12%) agreed while 289 (71%) strongly agreed. This implies the current environmental conservation policies and programs are effective in reducing overall pollution levels in Nigeria.

The table also shows responses to question 2, which states that: Existing environmental conservation programs have been successful in protecting and preserving biodiversity in Nigeria. The table shows that 263 (65%) respondents strongly disagreed that existing environmental conservation programs have been successful in protecting and preserving biodiversity in Nigeria; 61 (15%) disagreed; 46 (11%) agreed, while 37

(9%) strongly agreed. This implies that existing environmental conservation programs have not been successful in protecting and preserving biodiversity in Nigeria.

Furthermore, Table 6 shows responses to question 3, which states that: The current environmental conservation efforts have been effective in simultaneously addressing both pollution reduction and biodiversity protection in Nigeria. The table shows that 279 (69%) respondents strongly disagreed that the current environmental conservation efforts have been effective in simultaneously addressing both pollution reduction and biodiversity protection in Nigeria; 47 (11%) disagreed; 36 (9%) agreed, while 45 (11%) strongly agreed. This implies that the current environmental conservation efforts have been effective in simultaneously addressing both pollution reduction and biodiversity protection in Nigeria.

Table 7. Objective 2: Identify and analyze innovative strategies for sustainable resource management that can be implemented across various sectors, including agriculture, energy, and industry in Nigeria.

S/N	Question Items	SD	%	D	%	A	%	SA	%	Total	%
1	To what extent do you agree that innovative strategies are essential for sustainable resource management across all sectors, including agriculture, energy, and industry in Nigeria?	38	9	29	7	42	10	298	74	407	100
2	Do you agree that current innovative strategies are effective in promoting sustainable resource across various sectors, including agriculture, energy, and industry in Nigeria?	27	7	35	9	48	12	297	72	407	100
3	Implementing innovative resource management strategies across various sectors, including agriculture, energy, and industry in Nigeria can significantly reduce environmental impacts.	33	8	42	10	56	14	276	68	407	100

Source: Researchers' Field Survey, 2025

Objective 2 aimed to identify and analyze innovative strategies for sustainable resource management that can be implemented across various sectors, including agriculture, energy, and industry in Nigeria. The questions under this objective aimed to explore new approaches that balance resource use with environmental protection, ensuring long-term sustainability.

Based on objective 2, Table 7 shows the responses to question 1 which states that: To what extent do you agree that innovative strategies are essential for sustainable resource management across various sectors, including agriculture, energy, and industry in Nigeria? The table shows that 38 (9%) respondents strongly disagreed with the question: to what extent do you agree that innovative strategies are essential for sustainable resource management across various sectors, including agriculture, energy, and industry in Nigeria; 29 (7%) disagreed; 42 (10%) agreed while 298 (74%) strongly agreed. This implies that innovative strategies are essential for sustainable resource management across various sectors including agriculture, energy, and industry in Nigeria.

The table also shows responses to question 2, which states that: Do you agree that current innovative strategies are effective in promoting sustainable resource management across various sectors, including agriculture, energy, and industry in Nigeria? The table shows that 27 (7%) respondents strongly disagreed with the question: Do you agree that current innovative strategies are effective in promoting sustainable resource management across various sectors, including agriculture, energy, and industry in Nigeria? 35 (9%) disagreed; 48 (12%) agreed, while 297 (72%) strongly agreed. This implies that current innovative strategies are effective in promoting sustainable resource management across various sectors, including agriculture, energy, and industry in Nigeria?

Furthermore, Table 7 shows responses to question 3, which states that: Implementing innovative resource management strategies across all sectors, including agriculture, energy, and industry in Nigeria can significantly reduce environmental impacts. The table shows that 279 (69%) respondents strongly disagreed that implementing innovative resource management strategies across agriculture, energy, and industrial sectors in Nigeria can significantly reduce environmental impacts; 47 (11%) disagreed; 36 (9%) agreed, while 45 (11%) strongly agreed. This implies that implementing innovative resource management strategies across all sectors, including agriculture, energy, and industry in Nigeria can significantly reduce environmental impacts.

Current Innovative Strategies for Sustainable Resource Management in Nigeria

Thematic Analysis Process

On the whole, 200 respondents were involved in the interview. Based on responses from the interview, some of which were indicative of respondents' consensus, or variations, the following ten thematic areas that constitute the current innovative strategies for sustainable resource management in Nigeria were analytically derived. The authors noted the frequencies of consensus and those of variations, and assigned codes to specific responses or groups of responses that share similar meanings or themes. The codes are descriptive and they form the theme for each categories under which brief descriptions were made to elaborate the perception of respondents. Codes were grouped into broader themes based on their meaning and content. The results are presented thematically as follows:

Community-Based Resource Management (CBRM)

100% of the respondents were of the view that engaging local communities in decision-making processes regarding resource use and management is a sustainable practice. They were of the opinion that **"**involving communities in managing forest resources sustainably would prevent deforestation and promote reforestation". While 45% of the respondents were of the view that, "community based resource management encourages local communities in Nigeria to take ownership and responsibility for managing resources, leading to more effective conservation and sustainable use". 55% differed on the grounds that individuals with coercive powers would not favour communities managing forest resources because of narrow and selfish interests. The argument advanced by the 45% was that "it can provide income-generating opportunities and improve livelihoods for local communities, reduce poverty and dependence on external resources". However, as observed by the 55%, "there are potential challenges such as the possibility of being influenced by existing power imbalances within communities, potentially leading to unequal distribution of benefits and decision-making power. 100% of the respondents observe that "local communities may require training, capacity building, and support to effectively manage resources". 100% of the respondents agreed that "CBRM can be vulnerable to external factors such as market fluctuations, climate change, and policy changes. Therefore, they suggested that the following steps are required for effective CBRM: "active participation and engagement of local communities in decision-making processes; clearly defined rights and responsibilities for resource management and benefit sharing; strong transparent, and accountable governance structures within communities and supportive policies and regulatory frameworks that recognize and empower local communities".

Integrated Water Resources Management (IWRM)

100% of the respondents agreed that "implementing IWRM to manage water resources across sectors, would amount to ensuring equitable access and sustainability". This according to them this includes "proper watershed management, pollution control, and the promotion of rainwater harvesting". 85% of the respondents observed that there are positive and negative implications to IWRM. They observed that "IWRM considers the entire water cycle thereby promoting a holistic approach to water management that balances social, economic, and environmental needs". 100% of the respondents were of the opinion that "IWRM helps ensure water availability for various uses, including drinking water, agriculture, industry, and ecosystems". 75% observed that "IWRM encourages water conservation, efficient use, and reduced waste, benefiting both the environment and the economy". 69% of the respondents noted that unless there is effective monitoring of budgetary allocation for IWRM, it would be subject to diversion and misappropriation. Hence, they suggested that "IWRM should involve stakeholders in decision-making processes, fostering cooperation and coordination among different groups". Thus, 78% of the respondents highlighted challenges and limitations to IWRM as including "IWRM requires a comprehensive understanding of complex water systems, involving multiple stakeholders and sectors". 100% of the respondent agreed that "effective IWRM requires a strong institutional framework, including policies, laws, and governance structures" Moreover, they noted that "IWRM implementation often requires significant financial resources, which can be a challenge for many countries, particularly developing ones such as Nigeria. Therefore, they opined that "the key factor for successful IWRM is stakeholder participation, capacity building and integrated planning which involves coordination and integration of water management with other sectors, such as agriculture, energy, and environment". Based on the submission of the respondents, by adopting IWRM, Nigeria would be able to promote sustainable water management, reduce water-related risks, and ensure the long-term health of their ecosystems and economy.

Agro-ecology and Sustainable Agriculture

100% of the respondents observed that **"**encouraging practices that minimize chemical inputs, enhance biodiversity, and improve soil health, such as agro-forestry, crop rotation, and intercropping would lead to sustainable agriculture. However, 78% of the respondents noted that it calls for "climate-smart agriculture, which involves integrating agricultural practices that are resilient to climate change while reducing greenhouse gas emissions and enhancing productivity". They further observed that "agro-ecology and sustainable agriculture promote conservation of natural resources, such as soil, water, and biodiversity and it helps to reduce greenhouse gas emissions and sequester carbon in soils and plants". 100% of the respondents noted that sustainable agriculture practices can improve crop yields and quality, enhancing food security and farmers' livelihoods in Nigeria". They noted that "agro-ecology and sustainable agriculture often involve local communities in decision-making processes, promoting empowerment and ownership. They further observed that these approaches can help promote food sovereignty, enabling communities to control their own food systems and production". 84% of the respondents observed that there challenges and limitations associated

with *Agro-ecology and Sustainable Agriculture, which they identified as* including scaling up agro-ecology and sustainable agriculture practices. This according to them "requires significant investment in training, infrastructure, and support services and effective implementation often requires supportive policies and regulatory frameworks. Moreover, continuous research and development are necessary to improve sustainable agriculture practices and address emerging challenges".

Renewable Energy Initiatives

100% of the respondents expressed approval for Nigerian government's efforts towards encouraging the transition to solar energy**.** They observed that "expanding access to solar power and hydroelectric power (especially in rural areas), to reduce reliance on finite fossil fuels and improve energy security, would boost the renewable energy initiatives". 87% of the respondents noted that "bio-gas Production, which involves utilizing organic waste for biogas generation, can be used for cooking and electricity, thus reducing deforestation and waste". However, 56% of the respondents were skeptical about the feasibility of bio-gas production considering the non availability of the technology in a country that is just transitioning from firewood and kerosene to LNG. Furthermore, The 87% respondents noted that "diversifying energy sources can improve energy security, reducing reliance on imported fuels and the renewable energy industry can create new job opportunities and stimulate local economies". 100% of the respondents observed, that "renewable energy can reduce air and water pollution associated with fossil fuel extraction, transportation, and combustion; and it can improve public health by reducing air and water pollution associated with fossil fuels". However, 100% of the respondents noted that there are challenges and limitations such as "intermittency, which would require energy storage solutions or backup power systems, and that the initial investment costs for renewable energy infrastructure can be high, although costs are decreasing over time, particularly in advanced countries and widespread adoption of renewable energy may require significant investment in new infrastructure, such as transmission lines and storage facilities. 85% of the respondents were optimistic that to assure the success of the renewable energy initiative, supportive policies and regulatory frameworks would help in promoting the adoption of renewable energy technologies.

Sustainable Fisheries Management

100% of the respondents were impressed with the aquaculture development, which they claimed is "promoting fish farming to reduce overfishing in natural water bodies and meet local protein demands sustainably. They approved of government's efforts towards "Community Enforcement Programs, which entails collaborating with local fishermen to regulate fishing practices, such as setting quotas and protecting breeding grounds". 83% observed that "Sustainable Fisheries Management would help to maintain healthy fish populations, ensuring their long-term sustainability. They maintained that it could help preserve the marine ecosystem, protecting biodiversity and ecosystem services". 17% of the respondents pointed out that to maintain healthy fish populations would involve stakeholder participation, transparency, and accountability, which would lead to improved governance and management". 100% of the respondents however, noted that "overfishing and illegal, unreported, and unregulated fishing (IUU) can undermine sustainable fisheries management efforts, inadequate data and monitoring can make it difficult to assess fish populations and manage fisheries effectively". Thus, Sustainable Fisheries Management should be based on the best available scientific research and data and a precautionary approach should be taken when managing fisheries, erring on the side of caution to avoid overfishing.

Biodiversity Conservation Programs

72% of the respondents observed that "the government has delineated and established "Protected Areas and Reserves areas to conserve biodiversity and ecosystems while promoting ecotourism and Wildlife Management Initiatives which involve implementing strategies to protect endangered species and their habitats, involving local communities in conservation efforts". 79% of the respondents observed that "Biodiversity Conservation Programs help protect and preserve ecosystems, species, and genetic diversity, maintaining ecosystem services and resilience". In addition, they noted that "Biodiversity Conservation can help mitigate climate change by preserving carbon sinks, like forests, and promoting ecosystem resilience". 86% of the respondents noted in addition that "Biodiversity Conservation can support sustainable livelihoods for local communities, generating income and employment opportunities through ecotourism, sustainable forest management, and non-timber forest products". However, 94% of the respondents observed that "there are challenges and limitations such as habitat loss and fragmentation which can undermine biodiversity conservation efforts, making it difficult to maintain ecosystem connectivity and species populations, and Biodiversity Conservation can lead to human-wildlife conflict, particularly in areas where wildlife habitats overlap with agricultural lands or human settlements. 100% of the respondents noted that "Biodiversity Conservation often requires significant resources, including funding, personnel, and infrastructure, which can be limited and that effective Biodiversity Conservation requires engagement and participation from local communities, which can be challenging to achieve". Therefore, community-based conservation, collaborative management, science-based conservation and policy and legislative support are required to have a robust Biodiversity Conservation Programs.

Circular Economy Practices

86% of the respondents identified "waste reduction and recycling practices put in place by government towards promoting recycling programs and expressed optimism that it would encourage businesses to adopt circular economy principles where waste is minimized, and resources are reused". They observed that "Up-cycling and Resource Recovery, which involves innovating ways, would lead to recovery of materials

from waste streams and transform them into valuable products". Furthermore, 100% of the respondents noted that "Circular Economy Practices aim to reduce waste by promoting the reuse and recycling of materials, conserving natural resources and they promote resource efficiency by encouraging the use of recycled materials, reducing the demand for primary resources". However, 67% of the respondents noted that "Circular Economy Practices can lead to cost savings for businesses and individuals through reduced waste disposal costs and lower raw material costs, create new job opportunities in areas such as recycling, remanufacturing, and product design". 100% of the respondents agreed that "companies that adopt Circular Economy Practices can gain a competitive advantage by differentiating themselves from competitors and improving their brand reputation". They all noted that there are challenges and limitations in implementing Circular Economy Practices, which require a systemic change in the way businesses and societies operate, which can be challenging, it requires adequate infrastructure, such as recycling facilities and reverse logistics systems and changing consumer behaviour and promoting the adoption of Circular Economy Practices can be challenging. Therefore, it stands to reason that products and services should be designed with circularity in mind, taking into account the entire lifecycle of the product and collaboration and partnerships between businesses, governments, and other stakeholders are essential for implementing circular economy practices. Moreover, education and awareness-raising efforts are necessary to promote the adoption of Circular Economy Practices among consumers and businesses.

Technology and Digital Solutions

100% of the respondents agreed that technology and digital solutions have several positive implications for sustainable resource management. According to them, "technology can improve resource management efficiency by optimizing resource use, reducing waste, and streamlining processes; can provide real-time data and insights enabling informed decision-making and more effective resource management; can enable remote monitoring and control of resources, reducing the need for physical inspections and improving response times; can promote transparency and accountability in resource management, enabling stakeholders to track progress and identify areas for improvement and technology can enable innovative solutions to resource management challenges, such as renewable energy, sustainable agriculture, and smart cities". 86% of the respondents opined that "Remote Sensing, GIS and mobile applications, which involve utilizing technology for monitoring and managing natural resources, such as mapping deforestation or assessing water quality, would result in developing apps for farmers to gain access to information on best practices, market prices, and weather forecasts". This in their view "would bring huge relief to the farmers and assure profitable business". 100% of the respondents noted that challenges and limitations which include "the adoption of technology and digital solutions can be hindered by the digital divide, particularly in rural or disadvantaged areas in Nigeria; and that digital solutions can introduce cyber-security risks, particularly if not properly secured; and the collection and management of large amounts of data can be challenging, particularly in areas with limited infrastructure. They, therefore, suggested that technology and digital solutions should be integrated with existing systems and infrastructure to maximize effectiveness; stakeholders should be engaged in the development and implementation of technology and digital solutions to ensure they meet user needs; capacity building and training are necessary to ensure that users have the skills to effectively use technology and digital solutions and continuous monitoring and evaluation are necessary to ensure that technology and digital solutions are meeting their intended goals.

Policy and Institutional Reforms

100% of the respondents asserted that "Strengthening environmental regulations would mean implementing and enforcing stricter environmental regulations and policies that promote sustainable practices in Nigeria. 85% of the respondents observed that "government's encouragement of Public-Private Partnerships (PPPs) is essential to collaborating with private businesses to fund and implement sustainable resource management projects in order to strengthen environmental regulations". 78% of the respondents observed that "policy and institutional reforms can lead to improved governance, transparency, and accountability in resource management; reforms can promote a coordinated approach to resource management, reducing fragmentation and overlap between different government agencies and stakeholders; reforms can increase stakeholder participation in decision-making processes, ensuring that the needs and concerns of all stakeholders are taken into account; reforms can lead to more effective enforcement of laws and regulations, reducing the incidence of non-compliance and environmental degradation and reforms can promote sustainable resource use by creating incentives for conservation and sustainable management". 100% of the respondents noted that there are associated challenges and limitations which include the fact that "policy and institutional reforms can be resisted by entrenched interests, making it difficult to implement and sustain reforms; Governments, especially at local government levels, may lack the capacity and resources to effectively implement and enforce reforms; corruption can undermine the effectiveness of reforms, particularly in Nigeria with weak governance in its institutional structures". They, therefore, suggested that stakeholder engagement and participation are critical to the success of policy and institutional reforms"; and that "clear goals and objectives should be established for reforms, with measurable targets and indicators. They further observed that "institutional capacity building is necessary to ensure that governments and institutions have skills and resources needed to implement and enforce reforms; and that continuous monitoring and evaluation are necessary to assess the effectiveness of reforms and make adjustments as needed". Overall, this would result in promoting sustainable resource management, ensuring that resources

are used in a way that is environmentally, socially, and economically sustainable; reforms leading to environmental benefits, such as reduced pollution, conservation of biodiversity, and improved ecosystem services.

Education and Capacity Building

100% of the respondents praised the awareness campaigns mounted by the Nigerian government towards "Launching programmes to educate the public on the importance of sustainable resource management and encouraging community involvement". According to 100% of the respondents, "education and capacity building can increase awareness and knowledge about sustainable resource management practices, leading to more informed decision-making"; and that "capacity building can improve the skills and competencies of individuals and organizations, enabling them to manage resources more effectively"; "education and capacity can empower local communities and stakeholders, enabling them to take ownership of resource management and make informed decisions and capacity building can strengthen institutions, enabling them to more effectively manage resources and implement sustainable practices". However, they noted that there challenges and limitations such as "access to education and training, which may be limited in certain regions or communities within the country, making it difficult to build capacity; cultural barriers may exist that limit the effectiveness of education and capacity building programmes"; they noted that "education and capacity building programmes may not be sustainable in the long term, particularly if they are dependent on external funding or support and evaluating the effectiveness of education and capacity building programmes can be challenging, making it difficult to assess their impact". Therefore, 88% of the respondents suggested that "targeted training programs should have elements of vocational training and workshops for farmers, fishers, and local entrepreneurs on sustainable practices and innovations". 100% of the respondents noted that "a participatory approach to education and capacity building can help ensure that programmes are effective and meet the needs of stakeholders and collaboration and partnerships between different stakeholders can help leverage resources and expertise, and promote more effective education and education and capacity building". This would result in promoting more informed decision-making and more effective resource management practices and increase resilience to environmental and economic shocks, promoting more sustainable and equitable development.

Respondents were of the view that these innovative strategies all aim to ensure that Nigeria's vast resources are managed sustainably for future generations while addressing current socio-economic challenges. The common thread that runs through their responses was that "Collaborative efforts among government agencies, communities, NGOs, and the private sector are essential for the successful implementation of these strategies".

Table 8. *Objective 3: Investigate the impact of community-based conservation efforts on environmental outcomes and local livelihoods.*

S/N	Question Items	SD	%	D	%	A	%	SA	%	Total	%
1	To what extent do you agree that community-based conservation efforts positively impact environmental outcomes	34	8	28	7	61	15	284	70	407	100
2	Community-based conservation initiatives are capable of improving local livelihoods	38	9	32	8	57	14	280	69	407	100
3	Community participation in conservation efforts is crucial for achieving sustainable environmental and economic benefits	31	8	43	10	65	16	268	66	407	100

Source: Researchers' Field Survey, 2025

Objective 3 aimed to investigate the impact of community-based conservation efforts on environmental outcomes and local livelihoods. The questions under this objective focus on understanding how local involvement in conservation projects can lead to better environmental stewardship and socio-economic benefits.

Based on objective 3, Table 8 shows the responses to question 1 which states that: To what extent do you agree that community-based conservation efforts positively impact environmental outcomes? The table shows that 34 (8%) respondents strongly disagreed with the question: To what extent do you agree that community-based conservation efforts positively impact environmental outcomes; 28 (7%) disagreed; 61 (15%) agreed while 284 (70%) strongly agreed. This implies that to a reasonable extent community-based conservation efforts positively impact environmental outcomes.

The table also shows responses to question 2, which states that: Community-based conservation initiatives are capable of improving local livelihoods. The table shows that 38 (9%) re-

spondents strongly disagreed that community-based conservation initiatives are capable of improving local livelihoods; 32 (8%) disagreed; 57 (14%) agreed, while 280 (69%) strongly agreed. This implies that community-based conservation initiatives are capable of improving local livelihoods.

Furthermore, Table 8 shows responses to question 3, which states that: Community participation in conservation efforts is crucial for achieving sustainable environmental and economic benefits. The table shows that 31 (8%) respondents strongly disagreed that Community participation in conservation efforts is crucial for achieving sustainable environmental and economic benefits; 43 (10%) disagreed; 65 (16%) agreed, while 268 (66%) strongly agreed. This implies that Community participation in conservation efforts is crucial for achieving sustainable environmental and economic benefits.

Table 9. *Objective 4: Examine the role of technology and innovation in advancing environmental sustainability, particularly in areas such as renewable energy, waste management, and pollution control.*

S/N	Question Items	SD	%	D	%	A	%	SA	%	Total	%
1	To what extent do you agree that technology and innovation play a vital role in advancing renewable energy solutions?	32	8	41	10	63	15	271	67	407	100
2	Technological innovations are effective in improving waste management and pollution control efforts in Nigeria	36	9	39	10	71	17	261	64	407	100
3	Adopting new technologies is essential for achieving long-term environmental sustainability	29	7	40	10	69	17	269	66	407	100

Source: Researchers' Field Survey, 2025

Objective 4 aimed to examine the role of technology and innovation in advancing environmental sustainability, particularly in areas such as renewable energy, waste management, and pollution control. The questions under this objective aim to highlight how technological advancements can contribute to more sustainable practices and policies.

Based on objective 4, Table 9 shows the responses to question 1 which states that: To what extent do you agree that technology and innovation play a vital role in advancing renewable energy solutions? The table shows that 32 (8%) respondents strongly disagreed with the question: To what extent do you agree that technology and innovation play a vital role in advancing renewable energy solutions? 41 (10%) disagreed; 63 (15%) agreed while 271 (70%) strongly agreed. This implies that technology and innovation play a vital role in advancing renewable energy solutions.

The table also shows responses to question 2, which states that: Technological innovations are effective in improving waste management and pollution control efforts in Nigeria. The table shows that 36 (9%) respondents strongly disagreed that technological innovations are effective in improving waste management and pollution control efforts in Nigeria. 39 (10%) disagreed; 71 (17%) agreed, while 261 (64%) strongly agreed. This implies that technological innovations are effective in improving waste management and pollution control efforts in Nigeria.

Furthermore, Table 9 shows responses to question 3, which states that: Adopting new technologies is essential for achieving long-term environmental sustainability. The table shows that 29 (7%) respondents strongly disagreed that adopting new technologies is essential for achieving long-term environmental sustainability; 40 (10%) disagreed; 69 (17%) agreed, while 269 (66%) strongly agreed. This implies that adopting new technologies is essential for achieving long-term environmental sustainability.

Table 10. *Objective 5: Evaluate the economic and social feasibility of transitioning to a circular economy model in Nigeria, which emphasizes resource efficiency, waste reduction, and the regeneration of natural systems.*

S/N	Question Items	SD	%	D	%	A	%	SA	%	Total	%
1	To what extent do you agree that transitioning	37	9	42	10	68	17	260	64	407	100

S/N	Question Items	SD	%	D	%	A	%	SA	%	To-tal	%
	to a circular economy in Nigeria is economically feasible for local communities										
2	The shift towards a circular economy in Nigeria among community members is socially acceptable	41	10	36	9	59	14	271	67	407	100
3	Transitioning to a circular economy in Nigeria can effectively promote resource efficiency and environmental regeneration	39	10	44	11	70	17	254	62	407	100

Source: Researchers' Field Survey, 2025

Objective 5 aimed to evaluate the economic and social feasibility of transitioning to a circular economy model in Nigeria, which emphasizes resource efficiency, waste reduction, and the regeneration of natural systems. The questions under this objective seek to understand the practical implications of adopting circular economy principles and their potential to drive sustainable development in Nigeria.

Based on objective 5, Table 10 shows the responses to question 1 which states that: To what extent do you agree that transitioning to a circular economy in Nigeria is economically feasible for local communities? The table shows that 37 (9%) respondents strongly disagreed with the question: To what extent do you agree that transitioning to a circular economy in Nigeria is economically feasible for local communities? 42 (10%) disagreed; 68 (17%) agreed while 260 (64%) strongly agreed. This implies that to transitioning to a circular economy in Nigeria is economically feasible for local communities.

The table also shows responses to question 2, which states that: The shift towards a circular economy in Nigeria among community members is socially acceptable. The table shows that 41 (10%) respondents strongly disagreed that technological innovations are effective in improving waste management and pollution control efforts in Nigeria. 36 (9%) disagreed; 59 (14%) agreed, while 271 (67%) strongly agreed. This implies that the shift towards a circular economy in Nigeria among community members is socially acceptable.

Furthermore, Table 10 shows responses to question 3, which states that: Transitioning to a circular economy in Nigeria can effectively promote resource efficiency and environmental regeneration. The table shows that 39 (10%) respondents strongly disagreed that Transitioning to a circular economy in Nigeria can effectively promote resource efficiency and environmental regeneration; 44 (11%) disagreed; 70 (17%) agreed, while 254 (62%) strongly agreed. This implies that transitioning to a circular economy in Nigeria can effectively promote resource efficiency and environmental regeneration.

Implications of the findings

Majority of the respondents agreed that the current environmental conservation policies and programs are effective in reducing overall pollution levels and that that existing environmental conservation programs have been successful in protecting and preserving biodiversity in Nigeria. However, Emejuru and Dike (2019) observe that the effectiveness of policies and programmes in reducing pollution in Nigeria is compromised because effective enforcement is lacking due to inadequate resources, corruption, and lack of political will and many regulatory agencies face challenges in monitoring compliance with environmental laws. Moreover, the overall effectiveness of current environmental conservation policies and programs is hindered by implementation challenges, lack of enforcement, and insufficient public engagement. Moreover, education on sustainable practices and pollution prevention is still limited in many areas, and this affects community involvement.

On the question of whether current innovative strategies are effective in promoting sustainable resource across various sectors, including agriculture, energy, and industry in Nigeria, majority of the respondents agreed. This tallies with Eto (2025) who asserts that factors such as lack of infrastructure, investment, regulatory support, and public awareness hinder widespread adoption of innovative strategies in promoting sustainable resource across various sectors in Nigeria.

Majority of the respondents agreed that community involvement in conservation projects can lead to better environmental stewardship and socio-economic benefits. However, Eto (2025) affirms that the economic feasibility of transitioning to a circular economy for local communities in Nigeria depends on various factors, which include existing infrastructure, available resources, community engagement, and policy support.

Majority of the respondents agreed that technology and innovation play a vital role in advancing renewable energy solutions and in improving waste management and pollution control efforts in Nigeria, and hence, adopting new technologies is essential for achieving long-term environmental sustainability. This agrees with Eto (2025), who affirms that a multifaceted approach that integrates innovations, technology, education, and policy reform is necessary to enhance sustainability across these sectors.

Majority of the respondents agreed that transitioning to a circular economy in Nigeria is economically feasible for local communities, socially acceptable and can effectively promote resource efficiency and environmental regeneration. This agrees with Eto (2025), who affirms that a multifaceted approach that integrates innovations, technology, education, and policy reform is necessary to enhance sustainability across these sectors.

6. Conclusion and Recommendations

Environmental sustainability calls for environmental conservation policies and programs and the implementation of innovative strategies to promote better stewardship of resources, which require collaboration among individuals, communities, businesses, and governments. By adopting sustainable practices and making conscious choices, society can work towards conserving the environment and effectively managing resources for future generations.

Accordingly, the study recommends that for the effective enforcement of environmental conservation policies and programs, government should encourage community involvement through community engagement and education in environmental initiatives to enhance the effectiveness of conservation strategies; government should promote sustainable agricultural practices, which are essential for environmental conservation; government policies should prioritize renewable energy investment to improve resource management and reduce environmental impact; government should ensure that education and awareness programmes about recycling and waste management are directed towards individuals for purposes of environmental sustainability, and government should ensure that integrated water management strategies are encouraged towards addressing the challenges of water scarcity and quality.

Abbreviations

CBRM	Community-Based Resources Management
EIA	Environmental Impact Assessment
EU	European Union
IUU	Illegal Unreported, Unregulated
ISO	International Organization for Standardization
IWRM	Integrated Water Resources Management
LNG	Liquefied Natural Gas
NDDC	Niger Delta Development Commission
NESREA	National Environmental Standards and Regulations Enforcement Agency
NGO	Non Governmental Organization
NRM	Natural Resource Management

Conflicts of Interest

The authors declare no conflicts of interest

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