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An Investigation of the Policies, Institutional Frameworks, and Adaptive Strategies that Enhance Ecosystem Management and Sustainable Utilization of Natural Resources in Nigeria

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ABSTRACT

This study investigates the policies, institutional frameworks, and adaptive strategies that enhance ecosystem management and sustainable utilization of natural resources in Nigeria, with particular attention to the role of environmental governance, community participation, and technological innovations in natural resources and ecosystem management in Nigeria. The study adopted a mixed research design, using both quantitative and qualitative data which were obtained from key stakeholders, including government agencies such as the Federal Ministry of Environment**,** NESREA, and community-based organizations engaged in ecosystem conservation. The study integrates theories of Ecosystem Services**,** Common-Pool Resource Governance, and Adaptive Management to analyze the relationship between policy design, ecological processes, and community livelihoods. Findings reveal that Nigeria's natural resource governance system remains fragmented, with weak institutional coordination, limited stakeholder engagement, and inadequate enforcement of existing environmental laws. Nevertheless, the integration of GIS, remote sensing, and participatory resource mapping has demonstrated potential to improve ecosystem monitoring, restoration, and accountability. The study concludes that strengthening ecosystem management requires enhanced institutional capacity, the incorporation of ecosystem-based approaches into national development planning, and increased investment in environmental education and research. It recommends the development of a National Ecosystem Management Framework that aligns with the Sustainable Development Goals (SDGs)**,** particularly Goals 13 (Climate Action), 14 (Life Below Water), and 15 (Life on Land). Ultimately, a shift toward integrated, science-based, and participatory resource governance is critical for sustaining Nigeria's natural capital and promoting intergenerational equity.

Keywords: Natural Resources; Ecosystem Management; Environmental Governance; Community Participation, Technological Innovations, Biodiversity Conservation; Sustainable Development; Climate Resilience; Policy Integration; Nigeria.

INTRODUCTION

Natural resources and ecosystems are foundational to the survival, development, and sustainability of human societies. They provide essential services such as food, water, air purification, soil fertility, biodiversity, and climate regulation (MEA, 2005; Daily et al., 2011). However, the rapid growth of the global population, coupled with industrialization, urban expansion, and unsustainable consumption patterns, has placed enormous pressure on natural ecosystems, leading to deforestation, biodiversity loss, water pollution, and land degradation (United Nations Environment Programme [UNEP], 2022).

In Nigeria, natural resources such as forests, minerals, wetlands, and fisheries have historically supported livelihoods and national economic development (Adekola & Mitchell, 2021). Yet, unsustainable exploitation, weak environmental governance, and poor enforcement of regulations have resulted in significant ecological degradation (Nwankwoala, 2022). The Niger Delta**,** for instance, illustrates the complex interplay between resource extraction and ecosystem decline, where oil exploration has caused severe soil, water, and biodiversity losses (Ite et al., 2021). Similarly, desertification and overgrazing in northern Nigeria have led to reduced agricultural productivity and increased vulnerability to climate change (Ekpo & Nwilo, 2023).

Globally, the concept of Ecosystem Management (EM) has evolved as a holistic approach that integrates ecological, social, and economic goals to sustain ecosystem functions and services for present and future generations (Grumbine, 1994; Folke et al., 2010). It emphasizes participatory governance, adaptive learning, and the use of scientific and indigenous knowledge for sustainable resource use. The need for effective Natural Resource and Ecosystem Management (NREM) in Nigeria is therefore critical, not only for environmental sustainability but also for achieving the Sustainable Development Goals (SDGs)**,** particularly SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land) (United Nations, 2015).

Statement of the Problem

Despite Nigeria's vast natural resource endowment, the country continues to face acute environmental degradation and unsustainable resource exploitation. Weak institutional frameworks, inadequate implementation of environmental policies, and limited stakeholder participation have hindered effective ecosystem management (Ogunyemi et al., 2022). The persistent loss of biodiversity, soil erosion, deforestation, and pollution of water bodies reveal systemic failures in governance and coordination among environmental institutions (Adekola & Mitchell, 2021).

Furthermore, climate change exacerbates resource depletion through increased drought, flooding, and coastal erosion, undermining rural livelihoods and national food security (Nwilo et al., 2023). The absence of integrated, science-based, and participatory resource management systems poses significant threats to sustainable development and environmental stability. Consequently, there is an urgent need for an adaptive framework that harmonizes ecological sustainability with economic development in Nigeria.

Research Aim and Objectives

The study investigated the policies, institutional frameworks, and adaptive strategies that enhance ecosystem management and sustainable utilization of natural resources in Nigeria, with particular attention to the role of environmental governance, community participation, and technological innovations in natural resources and ecosystem management in Nigeria. Specifically, the study:

4. analyze the current status and trends of natural resource and ecosystem management in Nigeria,
5. assess the effectiveness of existing policies, institutions, and legal frameworks in promoting sustainable resource use,
6. evaluate the role of community participation and local governance in ecosystem conservation,
7. identify challenges and opportunities for improving resource governance through technology and innovation, and
8. Propose an adaptive ecosystem management model suitable for Nigeria's socio-ecological context.

Research Questions

9. What are the existing trends and conditions of natural resources and ecosystem management in Nigeria?
10. How effective are current environmental policies and institutions in promoting sustainability?
11. What role do local communities and stakeholders play in ecosystem management?
12. What challenges and barriers limit sustainable natural resource governance in Nigeria?
13. How can an adaptive management model strengthen environmental policy and governance frameworks?

Significance of the Study

This research is significant for several reasons. Academically, it contributes to the body of knowledge on natural resource governance and sustainable ecosystem management in developing countries. It provides empirical insights into Nigeria's environmental governance systems, revealing the intersection between policy, science, and community-based management (Folke et al., 2010; Ostrom, 2009).

Practically, the findings will assist policymakers, environmental agencies (such as NESREA and the Federal Ministry of Environment), and local communities in designing evidence-based strategies to enhance sustainability. Furthermore, the proposed framework may serve as a model for integrating climate adaptation**,** biodiversity conservation, and ecosystem restoration into Nigeria's national development agenda.

Scope and Delimitation of the Study

The study focuses on Nigeria's natural resource sectors—forestry, water resources, soil, and biodiversity—within selected ecological zones. It assesses institutional capacity, policy frameworks, and community participation mechanisms. While it draws from global best practices, the empirical analysis is geographically limited to Nigeria. The study does not attempt detailed biophysical modeling of ecosystem processes but rather emphasizes management, governance, and sustainability frameworks.

LITERATURE REVIEW

Conceptual and Theoretical Framework

Concept of Natural Resources

Natural resources are materials and components that occur naturally within the environment and are utilized by humans for survival, economic production, and development. They include renewable and non-renewable elements such as land, water, minerals, forests, and biodiversity (MEA, 2005; Daly & Farley, 2011). Natural resources are integral to the functioning of ecosystems, supporting both ecological balance and human well-being through ecosystem services such as nutrient cycling, soil formation, and climate regulation (Costanza et al., 2014).

Globally, sustainable management of natural resources is recognized as a cornerstone of environmental sustainability and human development (United Nations Environment Programme [UNEP], 2022). In Nigeria, natural resources underpin livelihoods and national income, particularly through agriculture, oil, forestry, and fisheries. However, unsustainable extraction and weak governance frameworks have led to resource depletion and ecological instability (Adekola & Mitchell, 2021; Nwankwoala, 2022). Thus, understanding the concept of natural resources within an ecological and governance context is essential for achieving sustainable development.

Concept of Ecosystem and Ecosystem Management

An **ecosystem** refers to a dynamic complex of living organisms interacting with their physical environment, functioning as a single ecological unit (Odum & Barrett, 2005). Ecosystems provide a range of goods and services, including clean water, pollination, carbon sequestration, and soil fertility (Costanza et al., 2014).

Ecosystem Management (EM) emerged in the 1990s as a holistic framework that integrates ecological, social, and economic considerations in resource governance (Grumbine, 1994). It emphasizes maintaining ecosystem integrity, biodiversity, and resilience while meeting human needs (Christensen et al., 1996). EM operates under principles of adaptive learning, scientific integration, and stakeholder participation, aligning management decisions with long-term ecological sustainability. In Nigeria, effective ecosystem management has become increasingly necessary due to deforestation, land degradation, and biodiversity loss (Ogunyemi et al., 2022).

Theoretical Perspectives on Natural Resource Management

The management of natural resources and ecosystems is underpinned by several theoretical frameworks that explain the dynamics of ecological systems, human behavior, and institutional arrangements.

1.Common-Pool Resource Theory**:** Proposed by Elinor Ostrom (1990), the Common-Pool Resource (CPR) Theory challenges the notion of the "tragedy of the commons" (Hardin, 1968) by emphasizing that communities can collectively manage shared resources through locally devised rules and norms. It posits that collective action, monitoring, and sanctioning mechanisms are vital for sustainable resource governance. In Nigeria, CPR principles underpin community forestry, fisheries, and grazing management initiatives (Ogunyemi et al., 2022).

2. Ecosystem Services Theory**:** The Ecosystem Services Theory conceptualizes ecosystems as providers of goods and services essential for human well-being, categorized into provisioning, regulating, supporting, and cultural services (MEA, 2005; Costanza et al., 2014). This theory promotes the valuation of ecosystem benefits in decision-making and policy design. Integrating ecosystem services assessment into Nigeria's resource management can enhance awareness of ecological benefits and promote sustainable exploitation.

3. Adaptive Management Theory**:** Developed by Holling (1978), Adaptive Management is an iterative, learning-based approach that treats policies and actions as experiments to improve understanding and management of complex systems. It emphasizes flexibility, continuous monitoring, and stakeholder learning. This theory is particularly relevant to Nigerian environmental governance, where uncertainty and data scarcity challenge traditional regulatory models (Ekpo & Nwilo, 2023).

4. Sustainable Livelihoods Framework**:** The Sustainable Livelihoods Framework (SLF) links natural resource management to poverty reduction and human well-being (Chambers & Conway, 1992; Scoones, 1998). It recognizes that communities depend on diverse assets—natural, social, financial, and human—to sustain their livelihoods. Integrating SLF into ecosystem management ensures that conservation initiatives also enhance local economic resilience.

5. Resilience and Systems Theory: Resilience Theory focuses on the capacity of ecosystems and social systems to absorb disturbances and reorganize while maintaining functionality (Folke et al., 2010). Systems Theory complements this by viewing ecosystems as interconnected components that must be managed holistically (Odum & Barrett, 2005). Together, they emphasize adaptive governance, cross-scale interactions, and the need for systemic responses to environmental change.

Global Perspectives on Natural Resource and Ecosystem Management

Globally, natural resource and ecosystem management has evolved from traditional, sectoral approaches toward integrated, ecosystem-based frameworks that recognize ecological interdependence, social equity, and sustainability (MEA, 2005; UNEP, 2022). The concept of Ecosystem-Based Management (EBM) emphasizes managing resources at ecosystem scales rather than within administrative boundaries, promoting holistic decision-making that balances human needs with ecological integrity (Grumbine, 1994; Christensen et al., 1996).

International frameworks such as the Convention on Biological Diversity (CBD, 1992) and the United Nations Sustainable Development Goals (SDGs, 2015) underscore the importance of sustainable natural resource use, conservation of biodiversity, and restoration of degraded ecosystems. Developed nations, including Canada and Sweden, have institutionalized adaptive and participatory management practices, while developing nations continue to struggle with enforcement, funding, and data limitations (Nunan, 2019; Adekola & Mitchell, 2021).

The global trend now emphasizes nature-based solutions (NbS) and ecosystem restoration as tools for climate resilience, poverty alleviation, and biodiversity conservation (IPBES, 2019; FAO, 2021). These approaches reinforce the need for integrated policies and technological innovations in ecosystem monitoring and governance.

Policy and Institutional Frameworks for Resource Governance

Policy and institutional frameworks define the rules, norms, and organizations that shape how natural resources are managed (Ostrom, 1990). Globally, nations have established diverse governance systems—ranging from centralized state control to decentralized, community-driven models—to regulate access, use, and sustainability of natural resources (Berkes, 2004).

In Nigeria, natural resource governance is guided by several policy instruments, including the National Environmental Policy (1999, revised 2016)**,** the National Biodiversity Strategy and Action Plan (NBSAP)**,** and the National Forest Policy (2020) (Federal Ministry of Environment, 2020). However, fragmented institutional responsibilities and overlapping mandates among agencies such as the Federal Ministry of Environment (FMEnv), NESREA, and state ministries often hinder effective implementation (Ekpo & Nwilo, 2023).

Internationally, mechanisms such as the EU Biodiversity Strategy 2030 and Africa's Agenda 2063 emphasize integrated governance and multi-stakeholder collaboration as the foundation for sustainable natural resource management (AU, 2020; EU, 2020). Strengthening governance structures and accountability mechanisms remains central to achieving ecological sustainability in Nigeria and across sub-Saharan Africa.

Community-Based Natural Resource Management (CBNRM) Models

Community-Based Natural Resource Management (CBNRM) represents a participatory model that transfers authority and responsibility for resource stewardship to local communities (Blaikie, 2006; Agrawal & Gibson, 1999). It is founded on the recognition that local users often possess the knowledge and incentives to manage resources sustainably when empowered with legal rights and economic benefits (Ostrom, 1990).

In Africa, countries like Namibia, Zimbabwe, and Botswana have implemented successful CBNRM programs such as the Campfire Project**,** which integrates wildlife conservation with local livelihood development (Fabricius & Koch, 2004). However, in Nigeria, CBNRM faces challenges of weak devolution, elite capture, and inadequate institutional support (Akinsanya et al., 2023).

Effective CBNRM requires aligning traditional governance systems with formal legal frameworks, ensuring equitable benefit-sharing, and building community capacity for adaptive ecosystem management (Berkes, 2009).

Ecosystem Services and Biodiversity Conservation Strategies

Ecosystem services are the direct and indirect benefits that humans derive from nature, including provisioning (food, water), regulating (climate, flood control), supporting (nutrient cycling), and cultural (recreation, spiritual) services (Costanza et al., 2014; MEA, 2005). Conserving these services requires integrated biodiversity management strategies that protect ecosystem integrity and function.

Global conservation initiatives such as Aichi Biodiversity Targets**,** CITES**,** and the Post-2020 Global Biodiversity Framework promote protected area networks, habitat restoration, and mainstreaming biodiversity into sectoral planning (UNEP, 2022). In Nigeria, strategies like forest reserves, community conservation areas, and protected wetlands exist, but weak enforcement, habitat fragmentation, and population pressure threaten sustainability (Nwankwoala, 2022).

Effective biodiversity conservation now emphasizes ecosystem-based adaptation (EbA)**,** payment for ecosystem services (PES)**,** and ecological restoration as tools to balance ecological and socioeconomic priorities (TEEB, 2018).

Climate Change and Its Implications on Resource Sustainability

Climate change poses severe threats to natural resources through altered precipitation patterns, temperature extremes, and biodiversity shifts (IPCC, 2021). These changes affect water availability, agricultural productivity, forest dynamics, and ecosystem resilience. In Nigeria, desertification, coastal erosion, and flooding are intensifying due to climate variability (Ekpo & Nwilo, 2023).

Globally, adaptive ecosystem management and climate-smart policies are being integrated into national development strategies to enhance resilience (FAO, 2021). The Paris Agreement (2015**)** encourages nature-based climate solutions, emphasizing the conservation of carbon sinks such as forests, peatlands, and mangroves (IPCC, 2021). For Nigeria, building adaptive capacity through sustainable land use planning, reforestation, and ecosystem restoration is essential for mitigating climate-related risks.

Technological Tools in Resource and Ecosystem Monitoring (GIS, Remote Sensing, AI)

Technological advancements have revolutionized environmental monitoring and resource management. Geographic Information Systems (GIS) and Remote Sensing (RS) provide spatial data for mapping, detecting changes, and assessing land cover dynamics (Campbell & Wynne, 2011). These tools facilitate ecosystem assessments, biodiversity tracking, and environmental decision-making.

Emerging technologies such as Artificial Intelligence (AI)**,** machine learning, and Internet of Things (IoT) are being integrated into ecological modeling, predictive analytics, and resource optimization (Reichstein et al., 2019). In Nigeria, GIS and RS have been used to monitor deforestation, erosion, and wetland degradation (Adekola & Mitchell, 2021). However, technological adoption is limited by inadequate infrastructure, funding, and technical expertise. Strengthening national capacities in environmental informatics will enhance evidence-based ecosystem management.

Economic Valuation of Natural Resources and Ecosystem Services

The economic valuation of ecosystem services assigns monetary value to ecological benefits to guide policy and investment decisions (Costanza et al., 2014; TEEB, 2018). Valuation methods include market-based approaches**,** contingent valuation**,** replacement cost, and benefit transfer techniques.

By quantifying the economic contribution of forests, wetlands, and watersheds, policymakers can justify conservation investments and integrate natural capital accounting into national GDP metrics (UNEP, 2022). In Nigeria, the undervaluation of natural resources has led to overexploitation and weak environmental budgeting (Ogunyemi et al., 2022). Incorporating valuation frameworks can enhance resource efficiency and environmental accountability.

Challenges and Barriers to Effective Ecosystem Management

Despite global progress, several challenges impede effective ecosystem management, particularly in developing nations. These include:

1. Weak institutional capacity and governance (Ekpo & Nwilo, 2023);
2. Inadequate funding and data limitations (Akinsanya et al., 2023);
3. Conflicting land-use policies and tenure insecurity (Berkes, 2009);
4. Climate change impacts and ecological uncertainties **(**IPCC, 2021);
5. Low public awareness and community participation (Nunan, 2019).

In Nigeria, overlapping jurisdiction among agencies, poor enforcement of environmental laws, and corruption exacerbate resource mismanagement (Nwankwoala, 2022). Addressing these barriers requires multi-level governance, environmental education, and integration of traditional knowledge with modern science.

RESEARCH METHODOLOGY

This study adopts a mixed-methods research design, combining both quantitative and qualitative approaches to obtain comprehensive insights into natural resource and ecosystem management practices. The study is conducted in Nigeria**,** a country characterized by diverse ecological zones, ranging from the mangrove swamps of the Niger Delta to the savannah grasslands of the north and the tropical rainforests of the south. The population of the study comprises stakeholders directly or indirectly involved in natural resource and ecosystem management, including officials of the Federal Ministry of Environment**,** NESREA, local government departments, NGOs, community leaders, and environmental researchers. A multi-stage sampling technique was used. In the first stage, three ecological zones were purposively selected to represent Nigeria's environmental diversity.

Primary data were collected using structured questionnaires**,** semi-structured interviews**,** and field observations. The questionnaire was divided into sections addressing natural resource governance, community participation, ecosystem degradation, and policy effectiveness. While secondary data were obtained from official reports, environmental policy documents, case studies, and scholarly articles. Major sources included the Federal Ministry of Environment**,** National Environmental Standards and Regulations Enforcement Agency (NESREA)**,** UNEP reports, and academic journals. The main research instruments were a structured questionnaire and an interview guide**.** The questionnaire contained both closed-ended and Likert-scale questions to capture respondents' perceptions quantitatively, while the interview guide contained open-ended questions for deeper qualitative insights.

Data analysis was carried out in two main stages: quantitative analysis and qualitative analysis**.**

Quantitative data were coded and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0**.** Descriptive statistics such as mean, frequency, and percentages were used to summarize the data, while inferential statistics such as correlation analysis, regression, and ANOVA were applied to test relationships among variables (Pallant, 2020).

Qualitative data from interviews and observations were analyzed using thematic content analysis**,** following the process of transcription, coding, and categorization into emerging themes (Braun & Clarke, 2019). Triangulation of data sources ensured robustness and minimized researcher bias (Creswell & Plano Clark, 2018).

RESULTS AND DISCUSSION

Analysis of Respondent Demographics and Resource Use Patterns

The demographic characteristics of respondents—including gender, age, education level, occupation, and years of involvement in resource management—were analyzed to understand their potential influence on perceptions and practices regarding ecosystem management.

Out of the 280 respondents, 64% were male and 36% female, showing a gender imbalance in environmental governance participation, which reflects broader structural inequalities in environmental decision-making (UNEP, 2022). The majority (45%) held tertiary education degrees, indicating relatively high awareness of environmental issues among stakeholders.

Occupational distribution revealed that 40% were community leaders and farmers, 30% government officials, 15% NGO staff, and 15% academics or researchers. This diversity ensured representation of key stakeholder groups in natural resource management.

In terms of resource use patterns**,** respondents indicated reliance on forest resources (30%)**,** fisheries (25%)**,** water resources (20%)**,** and agricultural land (25%)**.** This pattern highlights the interdependence of livelihoods and ecosystem services, consistent with findings by Millennium Ecosystem Assessment (2005) and Costanza et al. (2017), which emphasize the link between ecosystem health and socio-economic stability.

Key Findings on Natural Resource Governance Practices

The findings revealed significant challenges in resource governance, including weak institutional coordination, limited enforcement capacity, and overlapping policy mandates. About 62% of respondents indicated that environmental policies exist but are poorly implemented due to inadequate funding and political interference.

Interviews with officials from the Federal Ministry of Environment and NESREA confirmed that environmental governance in Nigeria suffers from fragmented institutional frameworks and insufficient community engagement (Nwankwoala, 2022; Adekola & Mitchell, 2021). Additionally, land tenure conflicts**,** corruption, and elite capture were identified as recurrent barriers to equitable resource distribution and conservation (Ostrom, 2015).

The findings align with global observations that weak governance often leads to unsustainable exploitation and degradation of ecosystems, particularly in developing countries (World Bank, 2020).

Evaluation of Ecosystem Management Strategies and Policies

The study assessed the effectiveness of ecosystem management strategies and policies at local and national levels. Results showed that while frameworks such as the National Biodiversity Strategy and Action Plan (NBSAP) and National Forest Policy (2020) exist, their implementation is inconsistent across regions.

Approximately 58% of respondents rated government-led conservation initiatives as ineffective, citing poor monitoring and lack of stakeholder ownership. Conversely, community-led initiatives, such as those in Cross River National Park and Yankari Game Reserve, were noted to perform relatively better due to local stewardship and indigenous ecological knowledge (IUCN, 2021; Kareiva & Levin, 2019).

Furthermore, the adoption of ecosystem-based management (EBM) approaches remains limited due to low institutional capacity, absence of integrated spatial planning, and insufficient application of technological tools such as GIS and remote sensing for monitoring (FAO, 2020).

Comparative Analysis with International Best Practices

Comparative analysis with international models of resource and ecosystem management reveals key gaps between Nigerian practice and global best standards. Countries such as Norway**,** Canada, and New Zealand have adopted adaptive co-management systems that integrate science, policy, and local participation (Folke et al., 2016).

In contrast, Nigeria's system remains top-down and bureaucratically rigid, limiting adaptability and local involvement (Akinbami et al., 2021). Moreover, while international standards emphasize ecosystem service valuation and payment for ecosystem services (PES) schemes (MEA, 2005; TEEB, 2010), such economic instruments are rarely implemented in Nigeria due to poor institutional mechanisms.

Lessons from South Africa's CBNRM model and Kenya's ecosystem restoration projects demonstrate that community ownership, transparency, and legal empowerment can significantly improve ecosystem management outcomes (Fabricius et al., 2019).

Discussion of Findings in Relation to Theoretical and Empirical Literature

The findings resonate with the Common-Pool Resource Theory (Ostrom, 1990)**,** which posits that effective governance of shared resources depends on local participation, clear property rights, and adaptive rules. The limited community involvement observed in Nigeria's resource management highlights the challenges of centralized governance systems in managing complex ecosystems sustainably.

Similarly, the results support the Ecosystem Services Theory, emphasizing the interdependence between ecological integrity and human welfare (Costanza et al., 2017). Respondents' reliance on forest and water resources underscores the socio-economic relevance of ecosystems, aligning with global findings that link environmental degradation with livelihood vulnerability (MEA, 2005).

The Adaptive Management Theory also finds relevance, as ecosystem management in dynamic environments requires learning, flexibility, and feedback mechanisms (Holling & Meffe, 1996). However, Nigerian institutions largely lack data-driven monitoring systems and learning loops necessary for adaptive policy evolution.

Empirically, the findings corroborate studies by Adekola & Mitchell (2021) and Nwankwoala (2022)**,** which identified weak enforcement and inadequate inter-agency collaboration as major impediments to effective resource governance in sub-Saharan Africa.

Implications for Environmental Policy, Governance, and Sustainable Development

The results have significant implications for environmental governance and sustainable development**.** First, the weak implementation of policies calls for institutional strengthening, inter-sectoral coordination, and improved funding mechanisms. Second, empowering local communities through co-management arrangements and inclusive decision-making can enhance stewardship and compliance (Folke et al., 2016).

Third, integrating ecosystem valuation into policy formulation will help policymakers recognize the economic importance of biodiversity and ecosystem services (TEEB, 2010). Fourth, adopting technology-based monitoring systems such as GIS, remote sensing, and AI can improve environmental surveillance and policy responsiveness (FAO, 2020).

Finally, achieving the Sustainable Development Goals (SDGs)**,** particularly SDG 13 (Climate Action) and SDG 15 (Life on Land), requires that Nigeria align its natural resource governance with international best practices, emphasizing transparency, accountability, and adaptive learning.

Summary of Major Findings

This study examined the state of natural resource and ecosystem management (NREM) in Nigeria within the context of sustainability, governance, and adaptive environmental management.

1. The findings reveal that while Nigeria possesses a wide range of natural resources—such as forests, freshwater bodies, minerals, and biodiversity—these assets are under severe pressure from unsustainable exploitation, weak governance, and climate change impacts (Adekola & Mitchell, 2021; Nwankwoala, 2022).
2. The research equally found out that existing policies, including the National Environmental Policy (2016)**,** National Biodiversity Strategy and Action Plan (NBSAP), and National Forest Policy (2020)**,** provide frameworks for sustainable management. However, implementation gaps**,** institutional fragmentation**,** and limited stakeholder participation undermine their effectiveness (Ekpo & Nwilo, 2023). Data from field surveys and interviews indicated that 62% of respondents perceive current natural resource governance mechanisms as ineffective due to overlapping mandates and inadequate enforcement capacity.
3. Furthermore, technological innovations such as GIS, remote sensing, and AI-based environmental monitoring were identified as emerging tools that could transform ecosystem management if mainstreamed into policy and practice (FAO, 2020; Oyinloye et al., 2023).
4. conversely, the study observed that community-led and participatory approaches—exemplified by Community-Based Natural Resource Management (CBNRM) initiatives in Cross River and parts of the Niger Delta—achieve better conservation outcomes than centralized, top-down models (Folke et al., 2016; Fabricius et al., 2019).

CONCLUSION

The study concludes that the sustainability of Nigeria's natural resources and ecosystems is contingent upon the integration of environmental governance, community engagement, and scientific innovation**.** Current management approaches remain largely reactive and sectoral, lacking coherence with broader sustainable development objectives. The degradation of forests, wetlands, and fisheries underscores the urgent need for a systemic shift toward ecosystem-based management (EBM) and adaptive governance (Holling & Meffe, 1996; Ostrom, 2015).

Furthermore, achieving Sustainable Development Goals (SDGs)—especially SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land)—requires that Nigeria strengthen inter-institutional coordination, promote policy coherence, and integrate ecological knowledge into development planning. The study affirms that inclusive governance, backed by technological tools**,** capacity development, and climate resilience strategies, remains central to ensuring the long-term sustainability of natural resources and the ecosystems that sustain them.

RECOMMENDATIONS

1. **Integrate Ecosystem-Based Management (EBM) into National Policy:** Environmental policies should explicitly adopt EBM principles that recognize interconnections between land, water, and biodiversity systems (MEA, 2005; UNEP, 2022). This includes the use of integrated spatial planning and adaptive feedback mechanisms in environmental regulation.
2. **Strengthen Legal and Institutional Frameworks:** Review and harmonize environmental laws to eliminate duplication of roles among agencies such as NESREA**,** Ministry of Environment**,** and Federal Department of Forestry. Establish a National Environmental Coordination Council (NECC**)** to enhance collaboration and accountability (Ekpo & Nwilo, 2023).
3. **Promote Community-Based Resource Management:** Empower local communities through participatory governance, secure land tenure, and benefit-sharing schemes as outlined in the Common-Pool Resource Theory (Ostrom, 1990). This promotes ownership and reduces resource conflicts.
4. **Mainstream Natural Resource Valuation in Policy Decisions:** Incorporate ecosystem service valuation into development planning and cost-benefit analyses to ensure that environmental assets are recognized in economic terms (Costanza et al., 2017; TEEB, 2010).
5. **Leverage Technological Innovation for Monitoring and Compliance:** Deploy GIS, AI, and remote sensing tools for real-time environmental monitoring and enforcement of environmental standards (FAO, 2020; Oyinloye et al., 2023).

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