

**CLIMATE SMART ACTIONS (CSA) AQUACULTURE, AGROFORESTRY
AND RESOURCES MANAGEMENT**

GLOBAL ISSUES & LOCAL PERSPECTIVES

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Global Issues & Local Perspectives

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Preface

This book adopts an exegetical approach as well as a pedagogic model, making it attractive agriculture and environmental economics teachers, professional practitioners and scholars. It eschews pedantry and lays bare the issues in such clarity that conduces to learning. The book elaborates on contemporaneous **Climate smart actions (CSA) aquaculture, agroforestry and resources management** issues of global significance and at the same time, is mindful of local or national perspectives making it appealing both to international and national interests. The book explores the ways in which **Climate smart actions (CSA) aquaculture, agroforestry and resources management** issues are and should be presented to increase the public's stock of knowledge, increase awareness about burning issues and empower the scholars and public to engage in the participatory dialogue **Climate smart actions (CSA) aquaculture, agroforestry and resources management** necessary in policy making process that will stimulate increase in food production and environmental sustainability. **Climate smart actions (CSA) aquaculture, agroforestry and resources management : *Global Issues & Local Perspectives*** is organized in three parts. Part One deals with The Concept of **Climate smart actions (CSA)**, Part Two is concerned with The Concept of **aquaculture**, and Part Three deals with the Concept of **agroforestry and resources management**

Eteyen Nyong; March 2026

Chapter 1:

Restoration and Sustainability of Ecological Resource for Biodiversity Conservation in Nigeria

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1.0 Introduction

Restoring nature and managing natural resources responsibly are now more urgent than ever to ensure a healthy environment and a sustainable future. This calls for deliberate efforts in reforestation, protection of endangered species, land rehabilitation, and promotion of sustainable agricultural and forestry practices. In Nigeria, ecosystems such as forests, wetlands, savannas, and coastal areas hold immense ecological and economic value, yet many remain vulnerable due to inadequate management and weak enforcement of environmental policies (Chinweokwu Ogborogu, Cao, Perrault and Nagar, 2026). The importance of biodiversity conservation cannot be overstated, as it plays a critical role in climate regulation, food security, and public health.

Nigeria's biodiversity is facing unprecedented threats from deforestation, habitat fragmentation, and unsustainable resource extraction, putting its rich ecosystems and the communities that depend on them at risk. (Nasrullah, Afsar, Reza, Sarkar, Rahman, and Uddin, 2026). The degradation of forests, wetlands, and grasslands has not only led to species loss but also undermined the livelihoods of millions of people who rely on these ecosystems for food, medicine, and income (Muimba-Kankolongo, Banza Lubaba Nkulu, Mwitwa, Mujinga and Nabuyanda, 2026). Despite conservation efforts, the pace of ecosystem restoration and sustainable management remains slow, leaving Nigeria's ecological resources vulnerable to climate change, overexploitation, and policy neglect. This raises urgent questions: How can Nigeria restore its degraded ecosystems, promote sustainable resource use, and safeguard its biodiversity for future

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generations? Restoring and sustainably managing Nigeria's ecological resources is not just an environmental imperative, but a socioeconomic necessity. With over 70% of Nigerians depending on natural resources for their livelihoods, the degradation of ecosystems directly threatens food security, health, and economic stability (Udensi, Udensi, Okpara, Akpan and Ndudurim, 2026). Moreover, Nigeria's rich biodiversity holds immense potential for pharmaceuticals, eco-tourism, and climate regulation, offering untapped opportunities for green growth and job creation. By prioritizing restoration and sustainability, Nigeria can enhance resilience to climate change, protect endangered species, and ensure that its natural heritage continues to support generations to come making it a win for both people and the planet. This initiative aims to draw attention to the need for integrated strategies that combine ecological restoration with renewable resource management, backed by community participation, education, and policy reform. By restoring degraded lands and managing natural resources wisely, Nigeria can build a resilient environment that supports both nature and people ensuring environmental health, socio-economic development, and long-term ecological balance.

1.2 Objectives

This chapter aims to examine the interplay between ecological restoration, sustainable resource management, and biodiversity conservation in Nigeria. Specifically, it seeks to: (1) assess the status of Nigeria's ecosystems and the drivers of biodiversity loss, (2) evaluate the effectiveness of restoration efforts and sustainable management practices in conserving key ecosystems, (3) identify policy and institutional gaps hindering sustainable resource use, and (4) highlight best practices and opportunities for scaling up ecological restoration and sustainable management initiatives for biodiversity conservation. The chapter synthesizes case studies and empirical evidence to inform strategies for balancing human needs with ecosystem resilience, with a focus on community engagement and policy implication

2.0 Conceptual Framework

2.1 Rebuilding Ecosystems

Rebuilding Ecosystems involves restoring degraded lands, reviving natural habitats, and reestablishing ecological balance to support biodiversity and human well-being (Németh and Keszeg, 2026). This process includes actions like reforestation with native species, wetland recovery, soil restoration, and erosion control. It also requires removing invasive species and reintroducing lost wildlife. Successful ecosystem rebuilding depends on scientific knowledge, community participation, and long-term commitment. In Nigeria, where deforestation, desertification, and pollution threaten ecosystems, rebuilding efforts are vital for climate resilience, food security, and sustainable development (Oduntan, Owolabi, Makanjuola, Olutumise, Oguntuase and Emediegwu, 2026). When ecosystems are restored, they can once again provide

clean water, fertile soil, pollination, and protection against natural disasters benefiting both people and the planet. Intact ecosystems are crucial for protecting biodiversity, and conservation efforts should prioritize preserving them. However, when ecosystems are disturbed, recovery can be a long and challenging process. Research shows that recovery rates slow down over time, making the final stages of recovery the most difficult to achieve. Surprisingly, active restoration efforts do not always lead to faster or more complete recovery compared to simply removing the disturbance and letting nature take its course (Chazdon, Falk, Banin, Wagner, Wilson, Grabowski, and Suding, 2024). This is not to say restoration is ineffective, but rather that the benefits of active restoration are context-dependent and often overstated. In many cases, passive recovery letting ecosystems recover naturally should be considered the first option. If progress is slow, targeted restoration efforts can then be implemented to address specific obstacles. The key is to invest in strategic, collaborative approaches that bring together scientists, local communities, and practitioners to develop innovative, context-specific solutions. By adopting a more nuanced and adaptive approach to restoration, we can make the most of limited resources and work towards ecologically, economically, and socially viable outcomes. Ultimately, preserving ecosystems is always easier than restoring them, and a thoughtful, community-led approach is essential for achieving lasting success. (Jones., Barbier., Blackburn., Rey, Holl, and Mateos, 2018).

Climate change is altering soil nutrient dynamics, impacting crop productivity and ecosystem health. Rising temperatures and CO₂ levels affect mineralization, carbon storage, and soil salinization, leading to stress responses in crops. To counteract these effects, sustainable practices are crucial. Site-specific approaches include optimizing nutrient use, land management, smart irrigation, and cropping patterns. Bioinspired methods using biostimulants show promise in enriching soils and enhancing drought resilience in crops. Implementing these strategies can help maintain fertile soils, boost crop productivity, and mitigate climate change impacts on agroecosystems. A tailored approach is needed to address location-specific challenges and ensure food security (Sebastian, Thomas, Nizar, TS, Fathima, and Marmioli, 2026). Synthesis of 20 years collaboration between researchers, government decision-makers, and conservation practitioners, offering valuable insights into the challenges, successes, and best practices of ecological restoration. Designed for researchers, policymakers, and restoration practitioners (Manning, 2026). Microbial bioremediation, utilizing fungi, algae, and bacteria, plays a crucial role in removing emerging contaminants like pharmaceuticals and pesticides from aquatic ecosystems, helping restore and rebuild these vital environments (Kumbhar., Tudu, Jagatee, Priyadarshini and Das, 2026). The benthic fish community on new lava flows from a volcanic eruption showed near-complete recovery within 26 months, with colonization occurring through adults and juveniles from nearby areas and new recruits, and recovery patterns varying by species mobility and territorial behavior (Liulea, Álvarez-Canali, Rodríguez, Concepción, and Sangil, 2026). Eco-engineering interventions in urbanized seascapes, such as textured

panels and microhabitat additions, can effectively enhance biodiversity and support sustainable coastal development, with 89% of interventions increasing species abundance or richness, although research gaps persist in areas like long-term monitoring, cost-effectiveness, and tropical region studies (Gad, Rasheed, Cartwright and Waltham, 2026). Dovgal and Goncharenko, (2026) compares the study on sustainable development and ecological transformation in OECD countries and Ukraine, finding that while OECD nations have advanced green initiatives, Ukraine faces urgent environmental challenges due to degradation and war damage, requiring deep institutional reforms and green policies for effective ecological recovery

2.2 Sustainable Resource Management

Sustainable Resource Management refers to the careful and responsible use of natural resources such as water, soil, forests, minerals, and wildlife to meet present needs without compromising the ability of future generations to meet theirs (Kremsa, 2021). It focuses on maintaining ecological balance while supporting economic development and human well-being (Kandpal, Jaswal, A., Santibanez Gonzalez, and Agarwal, 2024). Strategies involve promoting renewable energy, adopting climate-smart agriculture, enforcing environmental regulations, and encouraging community participation (Ifeanyi-Obi, Issa, Aderinoye-Abdulwahab. Ayinde, Umeh, . and Tologbonse, 2022). Sustainable management ensures that natural ecosystems remain productive and resilient over time, preventing overexploitation and degradation. It plays a vital role in addressing challenges like deforestation, water scarcity, pollution, and biodiversity loss, contributing to long-term environmental and social stability.

It highlights the need for holistic and forward-thinking approaches to manage forest resources sustainably, integrating ecological conservation, economic viability, and social inclusivity through practices like selective logging, reforestation, and community-based conservation to ensure the long-term availability of forest resources (Gupta, Kumar, Singh, Rawat, Lavania, Kumari and Kumar, 2026). Achieving global food security requires addressing challenges like population growth, sustainable production, and climate change by adopting innovative solutions such as improved crop breeding, smart animal husbandry, efficient water use, and sustainable farming practices to ensure access to sufficient, nutritious food for all (Hoque and Mondal, 2026). South African forests can be sustainably managed by applying ecological knowledge of disturbance-recovery processes, allowing variable harvesting practices, strategic use of invasive alien plants, and participatory management of non-timber products to balance conservation and resource use for the benefit of society (Geldenhuys, Moll, and Swart, 2026). Coastal cities can achieve sustainability by integrating cutting-edge technologies, adaptive planning, and participatory governance to manage water and waste, supporting SDG 6 and 11 through zero-waste policies, recycling, and community engagement. (Thomas and Leon, 2026).

2.3 Nigeria's Biodiversity: Conservation Priorities

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Conservation Priorities focus on protecting the country's rich and diverse ecosystems, which are under growing threat from deforestation, habitat loss, climate change, pollution, and overexploitation. Nigeria is home to thousands of plant and animal species, many of which are endemic or endangered. Conservation priorities include safeguarding critical habitats like tropical rainforests, wetlands, savannas, and mangroves; protecting threatened species; restoring degraded ecosystems; and promoting sustainable land-use practices. Strengthening environmental laws, enhancing protected area management, supporting research, and involving local communities in conservation efforts are key strategies. These priorities aim to maintain ecological balance, support livelihoods, and ensure long-term sustainability of Nigeria's natural heritage.

2.3.1 Key Ecosystems at Risk and Their Importance

Key ecosystems at risk in Nigeria include forests, wetlands, savannas, and mangroves each playing a vital role in supporting biodiversity, regulating climate, and sustaining livelihoods. Nigeria's tropical rainforests, particularly in the south, are rich in endemic species but are rapidly declining due to logging, agriculture, and urbanization. Wetlands like the Hadejia-Nguru and Niger Delta are essential for water filtration, flood control, and serve as habitats for migratory birds and aquatic life, yet face threats from pollution and infrastructure development. The savannas, covering much of central and northern Nigeria, support grazing and farming but suffer from overgrazing and desertification. Mangrove forests, crucial for coastal protection and fish breeding, are being degraded by oil spills and deforestation. The loss of these ecosystems undermines ecosystem services, food security, and climate resilience. Protecting them is essential not just for wildlife, but for human well-being and the sustainable future of the country's natural resources.

2.3.2 Strategic Actions for Biodiversity Protection in Nigeria

Strategic actions for biodiversity protection in Nigeria must prioritize habitat conservation, environmental policy enforcement, and community involvement. Strengthening protected areas through effective management and expansion can safeguard key ecosystems. Implementing sustainable land-use practices: such as agroforestry, controlled grazing, and reforestation helps restore degraded landscapes while supporting livelihoods. Enforcing environmental regulations against illegal logging, poaching, and pollution is critical to reduce threats to species and habitats. Additionally, promoting environmental education and awareness fosters local stewardship. Community-led conservation initiatives should be supported to integrate indigenous knowledge and ensure long-term commitment. Investing in ecological research and biodiversity monitoring will provide data-driven insights for planning and adaptation. Public-private partnerships, green financing, and collaboration with NGOs can also drive innovative conservation efforts. Ultimately, a coordinated national approach involving government, scientists, communities, and civil society is key to preserving Nigeria's rich biodiversity for future generations.

2.4 Healthy Lands, Thriving Communities

Healthy Lands, Thriving Communities speaks to the deep connection between the environment and the well-being of people. When land is healthy rich in nutrients, covered with vegetation, and managed wisely communities' benefit in countless ways. Farmers grow more food, water becomes cleaner, air is fresher, and wildlife thrives. In places where land is degraded, however, poverty, hunger, and poor health often follow. That's why taking care of the land isn't just about nature it's about people. Through simple actions like planting trees, preventing erosion, and using land sustainably, communities can restore their environment and improve their lives. A healthy land supports stronger families, better economies, and a safer climate. When nature is respected and protected, communities grow stronger, more resilient, and more hopeful for the future.

Healthy lands are the foundation upon which thriving communities are built. Across Nigeria and many parts of the world, ecological degradation: including soil erosion, deforestation, wetland loss, and unsustainable farming: has weakened the natural systems that support food production, clean water supply, climate stability, and human health. In contrast, landscapes that are productive, biologically diverse, and properly managed provide essential services that sustain both nature and society. These services include fertile soils, flood and drought regulation, carbon storage, wildlife habitat, and cultural values. When ecosystems are intact and functioning well, communities enjoy better livelihoods, improved health outcomes, greater economic opportunities, and stronger resilience to climate change. The relationship between land health and community well-being is therefore reciprocal: as nature thrives, people prosper; when nature suffers, people suffer too. Healthy lands provide the ecological infrastructure upon which rural and urban communities depend. Fertile soils support productive agriculture, reducing hunger and poverty. Forests and woodlands regulate water flow and protect watersheds, ensuring reliable drinking water. Wetlands filter pollutants and reduce flood impacts. Savannas and grasslands support grazing livestock and biodiversity. Mangrove forests buffer coastal communities from storm surges, while coral reefs support fisheries and tourism. When these ecosystems are impaired, communities face increased vulnerability. For example, soil loss and nutrient depletion reduce crop yields, forcing farmers to invest more in fertilizers or abandon degraded land altogether. In flood-prone areas, loss of vegetation cover can intensify storm impacts, destroy infrastructure, and displace families. Diminished biodiversity reduces the natural pest control and pollination services that crops rely on, producing economic and nutritional stress. In many parts of Nigeria, deforestation rates have been high, particularly in the south, where tropical rainforests are converted to farmland or fuelwood collection zones. Simultaneously, the northern savannas face desertification due to overgrazing, drought, and climate shifts. These ecological changes have direct social consequences: increased food insecurity, migration from rural areas, and greater competition for finite resources.

The key finding of research on land health and community well-being is that ecosystem degradation and social vulnerability are deeply interconnected. Conservation and restoration of landscapes are not merely environmental concerns; they are essential components of sustainable development, public health, and poverty reduction. For instance, studies show that communities living near intact forests generally have more secure access to natural resources: fuelwood, medicinal plants, clean water, and wild foods: compared to those in deforested regions. In ecosystems with robust vegetation cover, soil erosion is reduced, and rainfall infiltration increases, which enhances groundwater recharge and supports dry-season agriculture. Healthy lands also contribute to mental and physical health by offering cleaner air, spaces for recreation, and cultural identity tied to landscapes and biodiversity.

A second key finding is that participatory and integrated land management approaches yield better outcomes than top-down or sectoral interventions alone. Community engagement in land stewardship brings local knowledge, ownership, and long-term commitment. In Nigeria, community-based forest management, for example, has strengthened protection of sacred groves and forest reserves when local residents are empowered to monitor and manage resources. Such approaches often outperform externally imposed regulations because they align conservation goals with community benefits. When land users have a stake in sustainable outcomes through benefits like ecotourism, sustainable harvesting practices, or access to carbon credit schemes conservation measures are more likely to be upheld.

Third, restoration of degraded lands offers both ecological and socio-economic benefits when done strategically. Restoration activities such as reforestation with native species, rehabilitation of wetlands, improved grazing management, and soil restoration not only rebuild ecological functions but also create jobs, enhance agricultural productivity, and reduce disaster risks. Soil restoration techniques such as the use of cover crops, organic amendments, and controlled grazing improve soil structure and fertility, which in turn increases crop yields and reduces dependency on chemical inputs. In northern Nigeria's savanna zones, initiatives that combine tree planting with agroforestry practices have improved farm productivity while sequestering carbon and supporting livestock forage needs.

The fourth finding emphasizes the importance of policy frameworks and institutional support. Sustainable land management and restoration require enabling policies that recognize land rights, provide incentives for conservation, and facilitate access to finance and technology. Strong environmental governance: including enforcement of protected area regulations, incentives for sustainable farming, and integration of land use planning into national development fosters long-term ecosystem health. Conversely, weak policy enforcement, unclear tenure arrangements, and conflicting land use priorities undermine restoration efforts. For example, unclear land tenure can discourage long-term investments in soil and forest restoration because land users are uncertain about future benefits or land security. Another critical finding is that

education and awareness are catalysts for long-term change. Environmental education fosters an understanding of how land degradation affects community well-being, motivating shifts toward sustainable practices. When farmers understand the benefits of soil conservation or tree cover, they are more likely to adopt conservation agriculture, agroforestry, or water harvesting techniques. Similarly, public awareness campaigns about the value of wetlands and forests can reduce destructive activities and increase public support for conservation policies. Perhaps most importantly, scientific monitoring and adaptive management help ensure that restoration efforts are effective and resilient to changing conditions like climate variability.

Theoretical Lens: Ecosystem Resilience and Sustainable Livelihoods Framework

This chapter is framed through the lens of Ecosystem Resilience Theory and the Sustainable Livelihoods Framework (SLF). Ecosystem Resilience Theory emphasizes the capacity of ecosystems to absorb disturbances (e.g., degradation, climate change) and maintain key functions and biodiversity (Holling, 1973; Folke et al., 2004). The SLF complements this by focusing on how human communities depend on and manage natural resources to sustain livelihoods, highlighting the interplay between ecological, economic, and social dimensions (Scoones, 1998; DFID, 2001). Together, these frameworks guide the analysis of how ecological restoration and sustainable resource management practices in Nigeria can enhance biodiversity conservation while supporting livelihood resilience

3.0 Methodology

This chapter adopts a mixed-methods approach, combining literature review, case studies, and synthesis of empirical evidence to examine ecological restoration and sustainable resource management in Nigeria. A systematic review of peer-reviewed articles, government reports, and NGO publications (2010–2023) was conducted to assess trends in ecosystem degradation, restoration efforts, and biodiversity outcomes. Case studies of successful restoration projects (e.g., mangrove rehabilitation in the Niger Delta, agroforestry in the Jos Plateau) are analyzed to identify best practices. The chapter also draws on recent work by Oluwafemi et al. (2022), who applied a landscape ecology framework to evaluate ecosystem service trade-offs in Nigeria’s degraded landscapes, highlighting the importance of integrating local knowledge and participatory approaches in restoration planning. Field observations and stakeholder consultations further inform the analysis of policy gaps and opportunities for scaling up sustainable practices (Oluwafemi et al., 2022)

4.0 Analysis and Results

4.1 Restoration Strategies for Ecosystem Balance

Restoring ecosystems is a crucial step toward healing our planet and ensuring the well-being of future generations (Salami *et al.*, 2025; Salami *et al.*, 2014). As human activities continue to degrade the environment through deforestation, pollution, overgrazing, and unsustainable land use ecosystem restoration has emerged as a powerful solution to reverse these trends. Restoration strategies aim not only to bring nature back to life but also to restore the services that ecosystems provide, such as clean air and water, fertile soil, biodiversity, and climate regulation. A successful restoration process begins with understanding the local ecology. Reforestation using native tree species is one of the most effective tools for rebuilding forest landscapes. Similarly, wetland restoration plays a major role in water purification, flood control, and wildlife support. Agroforestry, which combines agriculture and forestry, not only protects the soil but also supports local livelihoods. In arid and semi-arid zones, controlled grazing and erosion control measures are vital to avoid further land degradation. Community involvement is central to any restoration effort. When local people are engaged and empowered, they become stewards of their land. Policies that support sustainable practices, backed by scientific research and ecological monitoring, ensure that restoration outcomes are both effective and long-lasting.

i. Reforestation and Afforestation: Planting native trees to restore forest cover.

Reforestation and afforestation are critical strategies for restoring degraded forests, promoting biodiversity, and mitigating climate change (Garba., Salami. and Akanbi, 2021).

Success Stories

- i) CIFOR, ICRAF, and University of Ibadan collaborated on a workshop on Landscape restoration dynamics and governance for forestry practitioners in Nigeria. Over 50 participants attended, sharing knowledge and experiences. A roadmap and stakeholder network were developed to promote sustainable forest management.
- ii) The Forestry Research Institute of Nigeria (FRIN) and the Omo Biosphere Reserve have contributed to Nigeria's restoration efforts. FRIN developed innovative forest restoration technologies, while the Omo Biosphere Reserve serves as a conservation model. Their efforts led to the establishment of over 100,000 hectares of new forests, protecting biodiversity and mitigating climate change.
- iii) The Great Green Wall has restored 15 million hectares of land, combating desertification and promoting sustainable land management since its inception in 2007 (GGW, 2020).
- iv) Kenya's Green Belt Movement: Kenya has empowered local communities to plant over 50 million trees since 1977.
- v) China's Great Green Wall: China has planted over 66 billion trees since 1978, increasing forest cover from 10% to 22%.

- vi) India's National Afforestation Programme: India has planted over 2 billion trees since 2000, increasing forest cover by 2%.
- vii) Brazil's Atlantic Forest Restoration: Brazil has restored over 100,000 hectares of degraded forest since 2000.

Challenges

- i) **Land tenure and ownership:** Unclear land rights can hinder reforestation efforts.
- ii) **Funding and resources:** Reforestation efforts require significant funding and resources.
- iii) **Climate change and drought:** Climate change can exacerbate drought conditions, making it difficult for newly planted trees to survive.
- iv) **Community engagement and participation:** Reforestation efforts often require community engagement and participation, which can be challenging to achieve.

Agroforestry and Sustainable Agriculture

Agroforestry and sustainable agriculture are crucial approaches for maintaining ecosystem services while promoting agricultural productivity and livelihoods (Salami, Gidado, Lawal, Oluakin, Uchenna., Jibo., Muhammad, Ilu and Adeniyi, 2025; Abbas, Salami, Mohammed, Umar and Saheed, 2025). By integrating trees into agricultural landscapes, agroforestry systems can enhance biodiversity, improve soil health, and reduce erosion, while also providing shade, fuelwood, and other ecosystem benefits. Sustainable agriculture practices, such as crop rotation, organic amendments, and conservation tillage, can further promote ecosystem services by reducing synthetic fertilizer and pesticide use, improving water quality, and supporting pollinators and other beneficial organisms. By adopting these approaches, farmers can contribute to maintaining ecosystem services, including carbon sequestration, water cycling, and soil formation, while also improving their livelihoods and contributing to food security (Salami, Akinyele, Lawal, Abubakar, Jibo and Adeniyi, 2025; Nair, 2017).

Soil Restoration

Soil Restoration involves rehabilitating degraded soils to improve their structure, fertility, and biological activity, ensuring they can support healthy plant growth and ecosystem functions. (Bhaduri, Sihi, Bhowmik, Verma, Munda and Dari, 2022). This process is vital for reversing the impacts of deforestation, overgrazing, erosion, and unsustainable farming practices. Key techniques include organic matter addition (like compost or manure), cover cropping, agroforestry, reduced tillage, and replanting native vegetation. Restoring soil health not only boosts agricultural productivity but also enhances water retention, carbon sequestration, and biodiversity. It is a foundational step in ecosystem restoration and climate resilience, particularly in regions facing desertification or land degradation, such as the Sahel and savanna zones of Nigeria.

Wetland and Coastal Habitat Restoration

Wetland and coastal habitat restoration is crucial for maintaining biodiversity and promoting human well-being. These ecosystems provide essential services, including shoreline stabilization, water filtration, and habitat for numerous plant and animal species. Restoration efforts, such as mangrove reforestation, salt marsh reconstruction, and coral reef rehabilitation, can help to recover degraded habitats, promote ecosystem resilience, and support the livelihoods of communities that depend on these ecosystems. By restoring wetlands and coastal habitats, we can also mitigate the impacts of climate change, reduce the risk of natural disasters, and protect human health and well-being (Sutton-Grier and Sandifer, 2019).

Controlled Grazing

Controlled Grazing is a land management strategy where livestock movement is carefully planned and monitored to prevent overgrazing and promote vegetation recovery. By rotating animals through different grazing areas, land has time to rest and regenerate, which helps maintain soil structure, reduce erosion, and preserve plant diversity. This method improves pasture productivity, enhances water infiltration, and supports long-term ecosystem balance (Centeri, 2022). In regions like Nigeria's savannas, controlled grazing is especially valuable for restoring degraded rangelands and improving resilience to climate change. When implemented with community participation and proper monitoring, it becomes a sustainable approach to livestock farming that benefits both the environment and local livelihoods.

Invasive Species

Invasive Species Control involves the removal or management of non-native species that disrupt native ecosystems, outcompete local flora and fauna, and reduce biodiversity (Britton, Lynch, Bardal, Bradbeer, Coetzee, Coughlan, and Pritchard, 2023). It helps restore ecological balance and supports native species regeneration.

Sustainable Agriculture

Sustainable Agriculture promotes land productivity through eco-friendly practices like organic farming, composting, and crop rotation. These methods improve soil health, reduce chemical dependency, and ensure long-term food security.

Watershed Management

Watershed Management focuses on conserving and managing water sources by preventing pollution, restoring vegetation around rivers and streams, and promoting efficient water use (Zerga, 2025). It ensures clean water availability and helps reduce flooding and erosion.

Mangrove Restoration

Mangrove Restoration includes replanting mangrove forests along coastlines to protect against storm surges, prevent erosion, and serve as nurseries for fish and other marine life. It's vital for both ecological protection and community livelihoods.

Fire Management

Fire Management involves the strategic use of controlled or prescribed burns to maintain ecosystem health, especially in fire-prone regions. These planned burns help reduce the buildup of dry vegetation that could fuel severe wildfires. They also support the regeneration of fire-adapted plant species, control invasive plants, and maintain open habitats necessary for certain wildlife. When done correctly, fire management restores nutrient cycling in soils and promotes biodiversity. It is a vital ecological tool that mimics natural fire patterns, reducing the risk of uncontrolled wildfires while maintaining the balance of fire-dependent ecosystems. Proper planning, monitoring, and community involvement are key to its success.

Community-Based Conservation

Community-led conservation and restoration initiatives empower local communities to take ownership of natural resource management, fostering sustainable livelihoods, preserving cultural heritage, and protecting biodiversity (Rytkönen and Hotakainen, 2020). By engaging local communities in decision-making processes, these initiatives promote participatory conservation, build trust, and ensure that conservation efforts align with community needs and values. Successful community-led initiatives, such as community-managed forests, wildlife conservation areas, and ecotourism projects, demonstrate the effectiveness of collaborative approaches in achieving conservation goals while enhancing human well-being.

Biodiversity Corridors

Biodiversity Corridors are natural or restored pathways that connect fragmented habitats, allowing wildlife to move freely between them. These corridors help maintain genetic diversity, support species migration, and reduce the risk of local extinctions. By linking protected areas, forests, wetlands, and other ecosystems, biodiversity corridors promote ecological balance and resilience in the face of climate change and human development. They are especially crucial in landscapes affected by agriculture, urbanization, or infrastructure. Effective corridor design considers the needs of key species, habitat quality, and community land use. Integrating biodiversity corridors into conservation planning supports both environmental sustainability and local livelihoods.

Principles for the Ecological Restoration

Steps of Restoration

Step 1: Design Comprehensive Restoration Goals

At a landscape scale, create or utilize existing comprehensive restoration goals and priorities for the project area. For example, be sure restoration goals are informed by current forest plans, watershed analyses, threatened and endangered species recovery plans and updated best available science. Use the historic range of variability as a guide but also consider the future range of variability expected as a result of novel disturbance processes and climate change. This will help managers identify the right mix of benefit from treated and untreated areas

Step 2: Apply Principles for Forest Restoration

- i. Establish diversity across the landscape by identifying an optimal mix of different restoration treatments as well as untreated stands.
- ii. Retain all old growth trees of all sizes or species. Old trees are generally resettlement, circa 1870s - 1880s, and are identified based on old growth characteristics.
- iii. Where large trees are in short supply, retain all the largest trees (and all trees 21" DBH and over) in the stand regardless of ages and species.
- iv. Retain and restore historic mix of trees species and sizes /ages, retain underrepresented species like aspen, mountain mahogany, other hard woods and sugar pine.
- v. Establish diversity and complexity within stands by thinning to create a gappy/ patchy /clumpy mosaic of variable patches ¼ -2 acres in size.
- vi. Protect or create living room size clumps of 2 -10 trees—clusters of mature and old pine growing together as cohorts -0 3-4 clumps per acre.
- vii. Retain significant amounts of wildlife trees, including those with broken or forked tops, crooked or leaning trees, mistletoe trees, snags, and coarse wood. Recruit historic levels of snags and dead wood through retention of green trees in variable densities.

Step 3: Lay Out the treatment Prescription

Using the restoration principles above, follow this process to lay out treatment prescription.

- i. Map existing old growth and historic levels of old trees and openings describe cohorts.
- ii. Determine possible wildlife and flora connectivity corridor leave areas
- iii. Retain all trees with old growth characteristics of all sizes and species.
- iv. Strategically identify and mark leave patches of dense in growth for wildlife cover on 10 to 20% of the project area.
- v. Identify existing and probable past openings and thin some young cohorts to 40 square feet basal area to achieve desired extent of openings.
- vi. In stand with old growth trees, locate and mark medium age cohorts and thin to 80 to 100 square feet basal area, leaving the largest trees in the cohorts (generally 60-120 years old) in clumps and

uneven spacing for future old growth recruitment in all stand types, leaves variability in basal areas from 40 to 140 square feet (larger trees or more productive areas can carry more basal area).

Step 4: Implement Restoration Projects and Monitor the Results.

In the implementation phase, use best practices to minimize impact to sensitive species, soil, old growth trees, and waterways. If possible, employ multi-party monitoring with diverse stakeholders and experts to ensure that restoration results met the goals set forth in project planning. Apply any lessons learned through monitoring to future restoration project planning (Tim, 2011).

Table 1: Landscape Areas to Target for Landscape Restoration

S/N	Areas	Reasons
1	Riparian area	To protect stream banks from erosion, improve water quality, create habitat.
2	Steep area	Stabilizing of soil surfaces prevent erosion and landslides.
3.	Saline/waterlogged area	Re-establish hydrological cycles and lower; water table, reduce land and river salinity.
4	Mine sites	Stabilize the sites and prevent them, ii. becoming sources of water sedimentation, acid and heavy metal pollution.
5.	Degraded /Buffer area around protected areas	To re-established habitats of species being protected, to eradicate habitats of weed species, to reduce edge effect
6.	Overlogged/ secondary regrowth forest	To hasten recovery of biodiversity
7.	Offshore islands	To foster populations of endangered; Species without native or predator.
8.	Corridors between protected Area/forest fragments	To provide linkages between forest areas, provide opportunities for species

Source: Salami *et al.*, 2014; David and Don 2003.



Figure 1: Restoring Declining Forest



Figure 2: Mangrove Restoration



Figure 3: Harnessing ‘invisible forests in plain

Source: Mike and Racheal, 2024

5.0 Social and Political Responses to Forest Restoration

Lack of attention to social dimensions

Forest Landscape Restoration (FLR) has been criticized for neglecting social dimensions, leading to ineffective and sometimes harmful outcomes. Research shows that FLR projects often prioritize economic indicators over human wellbeing, neglecting the complex needs and values of local communities. For instance, income from restoration activities may be offset by loss of access to essential resources, and labour burdens often fall disproportionately on marginalized groups. Tenure insecurity is another major issue, with

unclear or unjust land rights undermining restoration efforts and exacerbating social inequalities. Governance dynamics are also critical, with top-down approaches often ignoring local knowledge and priorities. In contrast, inclusive and participatory governance can foster more equitable and effective FLR outcomes. Key findings highlight the need for FLR to prioritize social justice, recognize Indigenous rights and knowledge, and address power imbalances to achieve meaningful restoration and human wellbeing.

Human wellbeing being measured by economic indicators

Studies have shown that FLR initiatives often fail to consider the social implications of restoration, leading to negative outcomes for local communities. The focus on economic indicators, such as income and employment, overlooks the importance of social capital, cultural values, and relational themes. Tenure insecurity is a major barrier to FLR success, with unclear or unjust land rights leading to confusion, disenfranchisement, and displacement of local communities. Governance dynamics play a critical role in FLR, with top-down approaches often ignoring local knowledge and priorities. Inclusive and participatory governance is essential for effective FLR, with local stakeholders needing to be prioritized and empowered to drive implementation. The importance of recognizing Indigenous rights and knowledge is increasingly being acknowledged in FLR discourse. Indigenous Peoples' land management practices and knowledge systems can contribute greatly to FLR objectives, but their involvement is often limited by lack of formal recognition and power asymmetries. FLR initiatives must confront epistemological and ontological diversity and take into account the plural ways of knowing and values attributed to 'nature' and 'human-nature' relationships. Gender-responsive FLR is also essential, with women often being excluded from decision-making processes and facing unequal access to resources. Addressing these social dimensions is critical for achieving effective and equitable FLR outcomes.

Underestimating the importance and complexity of tenure issues

Ultimately, FLR must prioritize social justice, recognize Indigenous rights and knowledge, and address power imbalances to achieve meaningful restoration and human wellbeing. This requires a shift from top-down approaches to inclusive and participatory governance, with local stakeholders driving implementation and decision-making. By acknowledging and addressing these social dimensions, FLR can become a more effective and equitable tool for achieving restoration and human wellbeing.

Asymmetries in governance dynamics

Forest Landscape Restoration (FLR) governance is complex, involving multiple stakeholders and scales. However, FLR practitioners often lack understanding of governance dimensions, leading to top-down approaches that overlook local needs and customs. These approaches use scientific and technical knowledge, but neglect socio-political contexts, Indigenous territories, and cultural wellbeing. This can

perpetuate colonial injustices and lead to social justice issues, conflict, and project failure. Inclusive FLR strategies are needed, prioritizing local people as central stakeholders. Local actors have a comparative advantage in coordinating governance functions and ensuring restoration continuity. A grassroots, people-centered approach is essential, with devolution and decentralization of decision-making power. This involves establishing local aims, needs, and knowledge, supported by global funding and resources. By doing so, FLR can become more effective and equitable, prioritizing local contexts and promoting social justice.

Engaging vs. Prioritising local stakeholders

Local stakeholder participation in FLR governance is often ambiguous and ineffective. True engagement means giving local people control and power to make decisions. FLR initiatives should prioritize local management and governance, recognizing the diverse priorities and values of local stakeholders. Exogenous actors often focus on global objectives like biodiversity and climate mitigation, while locals prioritize soil fertility, water, poverty alleviation, and food security. Power imbalances between external and local actors exacerbate these differences. Local extension officers, universities, and "local champions" play crucial roles in facilitating effective engagement. Relational themes like social capital, trust, and feeling valued are vital but often overlooked. Exogenous actors should engage over sufficient timeframes, listening and learning from locals, rather than imposing their own agendas. Recognizing the heterogeneity of local stakeholders is key, considering factors like class, ethnicity, gender, and Indigeneity. By doing so, FLR can promote more equitable and effective outcomes, prioritizing human wellbeing and local contexts.

Gendered aspects of FLR

FLR projects often claim to include women's voices, but they rarely have real decision-making power. In Papua New Guinea, Thailand, and Malawi, women are excluded from positions of authority, reflecting patriarchal social systems. However, women can exercise power informally, like deciding what work to do. To be gender-responsive, FLR must consider women's needs and responsibilities. This includes interviewing men and women separately, providing food in meetings, and choosing accessible locations. Women often prefer multifunctional tree planting for food security and fuelwood, while men prioritize income-generating opportunities. Meeting women's needs has co-benefits, like more quality time with family and education. Women play a crucial role in managing FLR projects, especially when men migrate for work. Involving women enhances positive outcomes, so they should be considered essential restoration agents. Ongoing research and attention are needed to avoid over-generalized assumptions about gender equality.

Indigenous rights and knowledge

The involvement of Indigenous Peoples in FLR is a sensitive and increasingly prominent issue. FLR projects have exploited tenure insecurity, encroaching on Indigenous lands and excluding them from governance, leading to environmental conflicts and negative social outcomes. However, Indigenous Peoples' land management practices and knowledge systems can greatly contribute to FLR objectives. To address this, FLR must recognize historical and contemporary injustices, including dispossession and power asymmetries. Indigenous actors need formally recognized land, resource, and knowledge rights to have agency in FLR governance. Claiming these rights is a difficult, politically charged process. There's a disconnect between FLR's enthusiastic support for Indigenous participation and actual actions. Indigenous knowledge is often viewed as supplementary, and practices like dance and storytelling are seen as entertainment. FLR must confront epistemological and ontological diversity, valuing Indigenous perspectives on relational and sentimental values, and recognizing the interconnectedness of humans and nature. This requires a fundamental shift in approach, prioritizing Indigenous participation and knowledge in FLR decision-making.

6.0 Protecting Nigeria's Natural Heritage

Protecting Nigeria's Natural Heritage is vital for preserving the country's rich biodiversity, cultural identity, and environmental stability. Nigeria is home to diverse ecosystems rainforests, savannas, wetlands, and coastal areas: that support thousands of plant and animal species, many of which are found nowhere else in the world. However, these natural treasures face growing threats from deforestation, pollution, illegal wildlife trade, and climate change. Safeguarding this heritage means taking deliberate actions like enforcing conservation laws, protecting national parks and forest reserves, supporting community-based conservation, and promoting environmental education. By protecting Nigeria's natural heritage today, we ensure that future generations can enjoy and benefit from the beauty, resources, and life-supporting services of the environment. It is not just an environmental duty and more of national responsibility.

7.0 Pathways to Sustainable Environmental Stewardship

Pathways to Sustainable Environmental Stewardship involve adopting practices that balance human needs with the protection and preservation of nature. In Nigeria, this means promoting eco-friendly agriculture, conserving forests and water resources, managing waste responsibly, and encouraging renewable energy use. Community participation, strong environmental policies, and public awareness are key to fostering a culture of stewardship. By integrating traditional knowledge with scientific innovation, Nigeria can build resilient ecosystems and support livelihoods. Sustainable environmental stewardship is not just about protecting nature—it's about securing clean air, safe water, fertile land, and a healthy future for all. It requires commitment from individuals, communities, and government to ensure long-term environmental health and national development.

8.0 Conserving Wetlands and Forests

Conserving Wetlands and Forests is crucial for maintaining Nigeria's ecological balance, supporting biodiversity, and sustaining livelihoods. Wetlands serve as natural water filters, flood control systems, and breeding grounds for fish and birds, while forests act as carbon sinks, protect soil from erosion, and offer habitat for countless species. Sadly, many of these ecosystems face threats from deforestation, pollution, agriculture, and urban expansion. Conservation efforts must focus on protecting remaining natural areas, restoring degraded lands, enforcing environmental laws, and involving local communities in sustainable use practices. Educating the public and integrating conservation into national development plans will ensure that wetlands and forests continue to provide essential services for both people and nature. Wetlands and forests are among Nigeria's most vital ecosystems, providing essential services such as water purification, climate regulation, biodiversity conservation, flood control, and livelihoods for millions of people (Choudhary, Golmei, Ghosh, and Puri, 2026). However, these ecosystems are under increasing pressure from deforestation, urbanization, agriculture, and pollution. Forests, especially in the southern regions, face threats from illegal logging, bush burning, and land conversion, while wetlands are being drained for farming or infrastructure development (KimDung, Dong Nguyen, Long, and Bao, 2026). Conservation of these ecosystems is critical to maintaining environmental balance and ensuring long-term socio-economic stability. Wetlands, for example, act as natural sponges that absorb excess rainfall, reducing the risk of floods (Youssef, El-Haddad, Skilodimou, Bathrellos, Kariminejad, and Pourghasemi, 2026). They also serve as breeding grounds for fish and support agricultural activities. Forests regulate rainfall patterns, store carbon, and host a wide array of plant and animal species. Effective conservation strategies include enforcing environmental protection laws, promoting reforestation with native species, supporting community-based forest management, and raising public awareness. Integrating wetlands and forests into land-use planning, alongside alternative livelihoods such as eco-tourism and non-timber forest product development, can also reduce pressure on these habitats. Protecting wetlands and forests is not just about saving nature. It is about safeguarding the future of Nigeria's people, economy, and climate resilience (Sam and Onyena, 2026).

9.0 Managing Wildlife for Biodiversity

Wildlife plays a central role in maintaining ecosystem integrity, functioning, and resilience. Biodiversity: the variety of life in all its forms underpins ecosystem services that support human livelihoods, cultural values, and climate regulation (e.g., pollination, nutrient cycling, flood control) and is therefore a principal target of conservation efforts globally and within Nigeria. However, biodiversity in Nigeria and across Africa faces unprecedented threats from habitat loss, overexploitation, climate change, human-wildlife

conflict, and illegal wildlife trade, making effective wildlife management an urgent priority for environmental sustainability and socio-ecological stability.

Nigeria is recognized as a biodiversity hotspot with rich species richness and levels of endemism comparable to many regions worldwide (WCS Nigeria). However, its biodiversity is increasingly under pressure due to ecosystem degradation and loss of habitats from agricultural expansion, logging, urbanization, and unsustainable natural resource use (Gupta, Kumar, Singh, Rawat, Lavania, Kumari and Kumar, 2026). A key insight from national biodiversity assessments is that Nigeria maintains 25 Key Biodiversity Areas (KBAs), but only a fraction of these is effectively covered by protected areas, highlighting gaps in wildlife habitat protection and connectivity (Neelam, Hajam, and Kumar, 2026). Protected areas such as Cross River National Park and other forest reserves provide essential refugia for threatened species but suffer from encroachment and resource exploitation. Cross River National Park alone covers approximately 4,000 km² of rainforest and mangrove ecosystems and supports critically endangered primates like the Cross River gorilla (Paul, 2026). Despite this recognized importance, enforcement and resource allocation toward these areas remain inadequate, leading to continued degradation. A significant challenge to wildlife management in Nigeria is human–wildlife conflict, particularly in buffer zones around protected areas. Research around Kainji Lake National Park, one of Nigeria’s foremost protected areas, indicates that local communities face crop raiding, livestock predation, and even human injuries from wildlife, resulting in negative attitudes toward conservation initiatives (Rowe, 2026). Such conflict is often driven by expanding human populations and land conversion that put wildlife and people in direct competition for space and resources. Effective wildlife management therefore must address both ecological needs and human socio-economic realities to foster coexistence.

Legal and policy frameworks form another pillar of wildlife management. Nigeria has longstanding environmental legislation, including the Wildlife Conservation Act (Cap 57 LFN 1985) and the Forestry Act (Cap 51 LFN 1958), which provide regulatory directions for the conservation of wildlife habitats and species (Neelam, Hajam and Kumar, 2026). However, critiques of these frameworks point to implementation gaps, weak enforcement, fragmented land-use policy, and inadequate funding all factors that constrain effective management and biodiversity protection (Zhang, Huang, Liu, Fan, and Zhang, 2026). Strengthening institutional capacity, updating legal instruments to address contemporary biodiversity issues, and integrating wildlife management into broader land-use planning are essential steps toward reversing biodiversity loss. In recent years Nigeria has taken additional policy steps. For example, the Senate passed new legislation imposing stringent penalties on wildlife traffickers, including fines and prison sentences, in an effort to curb illegal wildlife trade that has made the country a transit hub for endangered species products (Hain, 2026).

Illegal trade remains a major threat worldwide, with seizures such as the interception of over 1,600 parrots and canaries at Lagos Airport demonstrating persistent pressures on bird species and other wildlife (Ghymers, 2026). Community participation, education, and awareness are increasingly cited as crucial elements of effective wildlife management. Research on community attitudes toward biodiversity shows that local populations often possess detailed knowledge about species but may lack understanding of broader drivers of biodiversity declines, such as climate change and poaching (Imbo, Wehn, and Irvine, 2026). Conservation education can therefore foster stewardship and reduce detrimental behaviors, while collaborative management approaches can align local livelihoods with conservation goals.

Non-governmental organizations (NGOs) and conservation bodies play a complementary role. Initiatives led by groups such as the Nigerian Conservation Foundation (NCF) support species conservation through research, public awareness, policy advocacy, and direct management of conservation areas like the Lekki Conservation Centre in Lagos (Baloi, Muhala, Salencia, Marcelino, Dias, Marlene Domingues de Nóbrega Vaz, and Hasimuna, 2026). Studies show that conservation education, alternative livelihood support, and anti-poaching patrols implemented by organizations like the Wildlife Conservation Society (WCS) significantly contribute to biodiversity outcomes in protected areas. These activities demonstrate that multi-stakeholder involvement including government agencies, communities, NGOs, and international partners enhances management efficacy. Another emerging strategy is the use of protected area expansion and connectivity to minimize extinction risk. Conservation science suggests that enhancing connectivity between protected areas can mitigate the effects of fragmentation and support viable wildlife populations, particularly for wide-ranging species and those sensitive to edge effects (Fonda, Petrillo and Bacaro, 2026). In Nigeria, improving connectivity between fragmented reserves and KBAs could strengthen ecological resilience and population viability. Despite these strategic insights, wildlife management in Nigeria is constrained by socio-economic pressures such as poverty, population growth, and competing land-use demands. Poverty drives habitat conversion, bushmeat hunting, and resource extraction, while urban growth increases encroachment into natural areas. Addressing these underlying drivers requires integrated development planning that balances environmental protection with economic need (Pagani, 2026). Climate change further complicates wildlife management. Altered rainfall patterns, temperature increases, and extreme weather events influence habitat suitability, species distributions, and ecosystem connectivity. Climate adaptation planning is therefore essential to ensure that wildlife management strategies remain effective under shifting environmental conditions (Salami, Akinyele, Muhammad and Lukman, 2025).

Conclusion

In conclusion, biodiversity corridors play a vital role in reconnecting fragmented ecosystems, ensuring the movement and survival of wildlife, and strengthening ecosystem resilience. As human activities continue

to alter natural landscapes, these corridors offer a practical solution to conserving biodiversity while balancing development needs. They not only support species migration and genetic flow but also contribute to climate adaptation and sustainable land use. For long-term effectiveness, biodiversity corridors must be carefully planned, managed, and supported by local communities, policymakers, and conservationists. Investing in such ecological networks is key to preserving Nigeria's rich biodiversity and promoting a healthier environment for future generations. Healthy of land and the prosperity of communities are entwined in a dynamic that must be understood and nurtured. Degraded lands undermine food security, economic stability, and resilience to climate shocks. Healthy ecosystems, in contrast, provide the essential services that underpin thriving societies. Achieving this requires integrated strategies involving communities, government policies, scientific insight, and sustainable practices. By restoring soils, conserving forests and wetlands, managing water resources, and empowering land stewards, communities can rebuild resilience and secure a healthier future. In Nigeria, where diverse ecosystems face varying pressures, the path to healthy lands and thriving communities lies in a collective commitment to sustain nature not as a resource to be depleted but as a partner in human well-being and development

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