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The Interrelationship between Disaster Risk Reduction and Climate Adaptation in Nigeria

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ABSTRACT
This study critically examines the interrelationship between disaster risk reduction and climate adaptation frameworks in Nigeria with a focus on policy effectiveness, community resilience, and adaptive capacity. Adopting a mixed-methods approach, the research integrates quantitative data from national disaster databases with qualitative insights from key informant interviews conducted across selected states prone to climate-induced hazards. The study is grounded in Resilience Theory**,** Adaptive Capacity Framework**,** and Systems Theory to analyze the complexity of human–environment interactions and institutional responses to risk (Folke et al., 2016; Nelson et al., 2007). Findings reveal that although Nigeria has made progress in developing institutional frameworks such as the National Disaster Risk Management Policy (2019) and the National Adaptation Strategy and Plan of Action on Climate Change (NASPA-CCN)**,** their practical implementation at local levels remains limited by resource constraints and weak inter-agency coordination (Adejumo & Akinola, 2021). Furthermore, community-based initiatives and indigenous coping mechanisms play a crucial role in enhancing resilience, yet they are often overlooked in formal DRR and adaptation planning (Eze, 2023). The study concludes that achieving long-term climate resilience in Nigeria requires a multi-level governance approach**,** integrating DRR and climate adaptation into national development planning, supported by capacity building, participatory planning, and investment in early warning technologies. The research contributes to policy discourse by proposing a Sustainable Resilience Integration Framework (SRIF) that aligns DRR and adaptation priorities to foster environmental sustainability and socio-economic stability in Nigeria and other climate-vulnerable nations.

Keywords: Disaster Risk Reduction (DRR); Climate Adaptation; Resilience; Vulnerability; Environmental Governance; Sustainable Development; Policy Integration; Nigeria.

INTRODUCTION

The global increase in the frequency and magnitude of disasters—both natural and anthropogenic—has drawn significant attention to the intersection of Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) as vital instruments for achieving sustainable development (UNDRR, 2019). Climate-induced hazards such as floods, droughts, storms, and heatwaves are escalating due to anthropogenic greenhouse gas emissions and environmental degradation, thereby heightening the vulnerability of human and ecological systems (IPCC, 2021; Field et al., 2012). Developing countries, including Nigeria, bear a disproportionate burden of these risks due to weak institutional capacity, poor governance, rapid urbanization, and inadequate planning mechanisms (Adelekan, 2020; Egbebiyi & Oladipo, 2021).

In Nigeria, recurrent floods, droughts, and erosion have devastated farmlands, displaced communities, and disrupted livelihoods. For instance, the 2012 nationwide floods affected over 7 million people and caused economic losses exceeding US$16 billion (NEMA, 2013). Similarly, desertification and droughts in northern Nigeria threaten agricultural productivity and water availability, exacerbating food insecurity and poverty (Adejumo & Akinola, 2021). These challenges underscore the need for integrated DRR and CCA frameworks that enhance resilience and reduce vulnerabilities across social, economic, and environmental dimensions.

Globally, frameworks such as the Sendai Framework for Disaster Risk Reduction (2015–2030), the Paris Agreement (2015)**,** and the Sustainable Development Goals (SDGs) emphasize the interlinkages between climate adaptation and disaster resilience (UNFCCC, 2015; UNDP, 2020). However, the translation of these global frameworks into actionable national and local strategies remains a challenge in Nigeria due to institutional fragmentation, poor funding, and low public awareness (Nkwunonwo et al., 2020; Eze, 2023).

Statement of the Problem

Despite growing recognition of the interdependence between DRR and CCA, their implementation in Nigeria remains largely siloed. Institutions responsible for disaster management, such as the National Emergency Management Agency (NEMA)**,** often operate independently from climate change bodies like the Department of Climate Change (DCC) (Ologunorisa & Abawua, 2022). This institutional disconnect has led to policy incoherence, duplication of efforts, and inefficient use of resources.

Moreover, there is limited integration of local and indigenous knowledge systems in formal adaptation and risk reduction planning (Eze, 2023). Many community-based initiatives that have proven effective in managing drought, flooding, and erosion risks are often overlooked by policymakers. Additionally, weak data collection systems, lack of early warning infrastructure, and inadequate capacity among local institutions further constrain resilience building (Adelekan, 2020).

Therefore, a critical need exists to develop an integrated policy and operational framework that harmonizes DRR and climate adaptation approaches, enhances institutional coordination, and strengthens community resilience against increasing climatic shocks in Nigeria.

Research Aim and Objectives

The aim of this study is to examine the interrelationship between Disaster Risk Reduction and Climate Adaptation in Nigeria and to develop a framework that enhances resilience and sustainability.

The specific objectives are to:

1. Assess the relationship between Disaster Risk Reduction (DRR) and Climate Adaptation.
2. Examine the Principles, Strategies and Community-Based Disaster Risk Management.
3. Evaluate the dimensions of Climate Adaptation**:** Social, Economic, and Ecological Perspectives.
4. Investigate the global perspectives and international frameworks for disaster risk reduction.
5. Evaluate the integration of indigenous knowledge and technological innovations in climate adaptation and disaster risk reduction.
6. Examine the financing mechanisms for climate adaptation and DRR.
7. Identify the barriers to effective DRR and climate adaptation in developing countries.

Research Questions

1. What is the relationship between Disaster Risk Reduction (DRR) and Climate Adaptation?

2. What are the Principles and Strategies of Community-Based Disaster Risk Management**?**
3. What are the dimensions of Climate Adaptation: Social, Economic, and Ecological Perspectives**?**
4. What is the global perspective and international frameworks for disaster risk reduction?
5. How can indigenous knowledge and technological innovations be integrated into climate adaptation and disaster risk reduction?
6. What are the financing mechanisms for climate adaptation and DRR?
7. What are barriers to effective DRR and climate adaptation in developing countries?

Significance of the Study

This study is significant in several ways. Academically, it contributes to the growing body of literature on the integration of DRR and climate adaptation, offering empirical evidence from a developing country perspective. Practically, it informs policymakers and practitioners on effective strategies for harmonizing institutional mechanisms and community actions to enhance resilience (UNDRR, 2019; UNDP, 2020).
Furthermore, the study aligns with Nigeria's commitment to achieving the **SDGs (Goals 11 and 13)** on sustainable cities and climate action. By proposing an integrated resilience framework, the study offers a roadmap for policy coherence, institutional strengthening, and community empowerment in disaster management and climate governance.

Scope and Delimitation of the Study

The study focuses on Nigeria, examining federal, state, and local-level mechanisms for DRR and climate adaptation. Specific attention is given to regions most affected by climate-related disasters such as flooding (Niger Delta and Middle Belt) and drought (northern Nigeria). While the study draws from global best practices, its analytical emphasis remains on Nigeria's institutional, socio-economic, and environmental contexts.
Limitations include time constraints, accessibility of accurate data, and variability in institutional cooperation during data collection.

LITERATURE REVIEW

Conceptual and Theoretical Framework

Concept of Disaster Risk Reduction (DRR)

Disaster Risk Reduction (DRR) refers to the systematic efforts to analyze, manage, and mitigate the causal factors of disasters through reduced exposure to hazards, minimized vulnerability, improved preparedness, and strengthened resilience (UNDRR, 2019). The concept emerged in the late 20th century as a paradigm shift from reactive emergency response toward proactive risk prevention and resilience building (Wisner et al., 2014). According to the Sendai Framework for Disaster Risk Reduction (2015–2030)**,** DRR is essential for sustainable development because it integrates disaster prevention, mitigation, and preparedness into development planning (UNISDR, 2015).
DRR encompasses a broad spectrum of actions, including hazard assessment, early warning systems, land-use planning, and community-based risk management (UNDP, 2020). In developing countries such as Nigeria, DRR focuses on addressing the root causes of vulnerability—poverty, unplanned urbanization, deforestation, and weak institutions (Adelekan, 2020). By integrating DRR into national development and climate strategies, governments can reduce the social and economic costs of disasters and enhance the resilience of vulnerable populations.
climate risks.

Understanding Climate Change and Climate Adaptation

Climate change refers to long-term alterations in temperature, precipitation, wind patterns, and other elements of the Earth's climate system, largely caused by anthropogenic greenhouse gas emissions (IPCC, 2021). Its impacts manifest through extreme weather events such as floods, droughts, storms, and heatwaves, all of which exacerbate disaster risks globally (Field et al., 2012).
Climate adaptation**,** on the other hand, involves the adjustment of natural or human systems to actual or expected climate stimuli to minimize harm or exploit beneficial opportunities (UNFCCC, 2015). Adaptation strategies include infrastructural modifications (e.g., flood defenses), agricultural adjustments,

water resource management, and public health interventions (Smit & Wandel, 2006). In the African context, adaptation often requires both technological innovations and indigenous knowledge systems to cope with varying climatic stresses (Ayoade, 2019).

Effective adaptation enhances **resilience**, defined as the capacity of a system or community to anticipate, absorb, recover, and reorganize in response to climate-induced disturbances (Folke et al., 2016). Thus, climate adaptation is a vital mechanism for safeguarding human livelihoods, ecosystems, and infrastructure from escalating

Theoretical Perspectives on DRR and Climate Adaptation

1. Systems Theory: Systems Theory posits that environmental and social systems are interconnected and dynamic, with feedback loops influencing their stability and resilience (Von Bertalanffy, 1968). Within DRR and climate adaptation, systems theory underscores the need for integrated governance and multi-sectoral coordination to manage complex interactions between human activities and natural processes (Walker et al., 2004).

2. Resilience Theory: *Resilience Theory* focuses on the capacity of systems to absorb shocks and maintain functionality (Holling, 1973). Applied to DRR and CA, it emphasizes transformation and adaptation through learning, innovation, and flexibility (Folke et al., 2016). It guides policymakers in designing adaptive institutions capable of managing uncertainty and promoting long-term sustainability.

3. Adaptive Capacity Framework: The Adaptive Capacity Framework explores the socio-economic and institutional determinants that enable systems to adjust to climatic changes (Smit & Wandel, 2006). Key components include access to resources, knowledge dissemination, institutional flexibility, and governance structures. This framework provides a basis for evaluating national and local adaptation readiness.

4. Vulnerability and Risk Governance Model: The Vulnerability and Risk Governance Model highlights the socio-political processes that shape exposure and susceptibility to hazards (Cutter et al., 2008). It views disasters not merely as natural events but as outcomes of social inequalities and governance failures. Integrating this model within DRR and CCA helps identify the root causes of vulnerability and strengthens institutional accountability**.**

5. Sustainable Livelihoods Approach (SLA): The **SLA** (Chambers & Conway, 1992) provides a people-centered framework that links vulnerability reduction to livelihood enhancement. It emphasizes access to five key assets—human, social, natural, financial, and physical capital—which determine adaptive and coping capacities (Scoones, 1998). The SLA is particularly relevant in climate adaptation planning for rural Nigeria, where livelihoods depend on climate-sensitive resources**.**

Relationship between DRR and Climate Adaptation

The nexus between Disaster Risk Reduction (DRR) and Climate Adaptation (CA) lies in their shared objective of minimizing the adverse impacts of natural hazards and climate variability on human and ecological systems (IPCC, 2012; Schipper & Pelling, 2006). Both frameworks emphasize proactive risk management, capacity building, and resilience enhancement. However, while DRR traditionally focuses on short- to medium-term hazard management, CA addresses long-term climatic trends (UNDP, 2020). Key Connections between Disaster Risk Reduction and Climate Adaptation include:

1. Shared Objectives: DRR focuses on reducing existing disaster risks, while CCA addresses the projected impacts of climate change (Wen et al., 2023).
2. Complementary Approaches: Effective DRR can enhance CCA, and vice versa, by addressing the root causes of vulnerability and promoting sustainable development (Islam et al., 2020).
3. Mutual Reinforcement: Integrating DRR and CCA can increase community resilience to climate-related disasters (UNDRR, 2020).

Integration of DRR and CA ensures that adaptation efforts consider hazard reduction and that DRR strategies incorporate future climatic uncertainties. This convergence aligns with the Sendai Framework**,** the Paris Agreement (2015)**,** and the Sustainable Development Goals (SDGs)**,** which advocate for policy coherence and institutional coordination (UNFCCC, 2015; UNDRR, 2019). In Nigeria, integrating these approaches is critical for reducing the vulnerability of rural communities that depend on climate-sensitive sectors such as agriculture, water, and forestry (Nkwunonwo et al., 2020).

Benefits of Integration

1. Enhanced Resilience: Combining DRR and CCA can reduce duplication of efforts and optimize resource allocation (IPCC, 2022).
2. Improved Efficiency: Integrated approaches can promote sustainable development and reduce poverty (Majlingova & Kádár, 2025).
3. Increased Sustainability: Addressing both DRR and CCA can reduce the risk of maladaptation and promote climate-resilient development (Wen et al., 2023).

Principles, Strategies and Community-Based Disaster Risk Management

Disaster Risk Management (DRM) operationalizes DRR principles through strategic planning, preparedness, and mitigation measures (Alexander, 2018). Its key principles include prevention, mitigation, preparedness, response, and recovery (Coppola, 2015). The **UNISDR (2015)** framework outlines the following DRR strategies:

1. **Risk Identification and Assessment:** Understanding hazards, exposure, and vulnerabilities.
2. **Prevention and Mitigation:** Implementing structural and non-structural measures such as land-use zoning, reforestation, and infrastructure design.
3. **Preparedness:** Enhancing early warning systems and institutional readiness.
4. **Response and Recovery:** Ensuring rapid relief, rehabilitation, and reconstruction with "Build Back Better" principles.

At the community level, participatory approaches—such as Community-Based Disaster Risk Management (CBDRM)—have proven effective in empowering local populations and integrating indigenous coping mechanisms into formal planning (Gaillard & Mercer, 2013).

Community-Based Disaster Risk Management (CBDRM) emphasizes bottom-up approaches where communities are central actors in identifying, analyzing, and addressing disaster risks (Gaillard & Mercer, 2013). Local knowledge and participation are considered vital for building sustainable resilience. CBDRM programs empower local communities through capacity building, risk mapping, and local emergency response planning (Shaw, 2012).

In African contexts, particularly in Nigeria, communities possess long-standing traditional coping strategies—such as the use of elevated granaries, communal flood watch systems, and drought-resistant crops (Eze, 2023). Despite their effectiveness, these practices are often overlooked by formal institutions. Integrating community-based approaches into national DRR frameworks enhances inclusivity and sustainability (Mercer et al., 2010).

Benefits of Community-Based Disaster Risk Management

Community-Based Disaster Risk Management (CBDRM) is an approach that empowers local communities to manage disaster risks and enhance their resilience. According to the United Nations Office for Disaster Risk Reduction (UNDRR), CBDRM involves the participation of local communities in all stages of disaster risk management, from planning to implementation and monitoring (UNDRR, 2019).

Benefits of CBDRM:

i. Improved Risk Assessment: Community members provide valuable insights into local hazards, vulnerabilities, and capacities, enabling more accurate risk assessments (World Bank, 2014).

ii. Increased Community Engagement: CBDRM fosters a sense of ownership and responsibility among community members, leading to increased engagement and participation in disaster risk management activities (UNISDR, 2015).

iii. Enhanced Resilience: Community-led initiatives leverage local resources and knowledge, promoting more effective and sustainable disaster risk management strategies (IPCC, 2012).

iv. Better Decision-Making: CBDRM ensures that disaster risk management decisions are informed by local perspectives and needs, leading to more effective and targeted interventions (UNDRR, 2019).

v. Cost-Effective: CBDRM is often more cost-effective than top-down approaches, as it leverages local resources and capacities (World Bank, 2014).
vi. Sustainable: CBDRM promotes sustainable development by reducing disaster risks and enhancing community resilience (IPCC, 2012).

Key Elements of CBDRM:

a. Community Participation: Community members are involved in all stages of disaster risk management, from planning to implementation and monitoring (UNISDR, 2015) .
b. Risk Assessment: Community-led risk assessments inform disaster risk management planning and decision-making (UNDRR, 2019).
c. Capacity Building: Training and capacity-building programs empower community members to take ownership of disaster risk management initiatives (World Bank, 2014).
d. Inclusive Decision-Making: Community members are involved in decision-making processes to ensure that disaster risk management strategies are tailored to local needs (IPCC, 2012).

Dimensions of Climate Adaptation: Social, Economic, and Ecological Perspectives

Climate adaptation encompasses multiple dimensions:

1. **Social Dimension:** Socially, climate adaptation focuses on the human aspects, including vulnerability, resilience, and adaptive capacity of communities (Adger, 2003; Smit & Wandel, 2006). It involves understanding how different social groups, such as the poor, women, and children, are affected by climate change and developing strategies to support their adaptation efforts (IPCC, 2014). This perspective emphasizes the importance of social justice, equity, and community engagement in climate adaptation (Paavola & Adger, 2006). For instance, climate adaptation initiatives may prioritize the needs of vulnerable populations, such as providing climate-resilient infrastructure, promoting climate-smart agriculture, and supporting climate-informed decision-making processes (UNDP, 2010). It is primarily tinted towards community resilience, social capital, education, and local governance. Social adaptation emphasizes inclusivity, gender equity, and knowledge sharing (Adger et al., 2009).
2. **Economic Dimension:** Economically, climate adaptation involves assessing the costs and benefits of adaptation measures and identifying opportunities for economic growth and development (Stern, 2007; World Bank, 2010). Its primary concerns is on the financial mechanisms that enhance adaptive capacity, including insurance schemes, green financing, and livelihood diversification (Tol, 2018). This perspective considers the impact of climate change on economic sectors, such as agriculture, water, and infrastructure, and develops strategies to minimize losses and maximize gains (IPCC, 2014). Economic adaptation measures may include investing in climate-resilient infrastructure, promoting climate-smart technologies, and developing climate-risk insurance schemes (UNFCCC, 2015). For example, climate adaptation initiatives may support the development of climate-resilient agricultural practices, such as drought-tolerant crops and agroforestry, to enhance food security and reduce poverty (FAO, 2013).
3. **Ecological Dimension:** Ecologically, climate adaptation focuses on the natural systems and ecosystems that support human life and economic activities (Millennium Ecosystem Assessment, 2005). It involves ecosystem-based adaptation (EbA) that uses biodiversity and ecosystem services to reduce vulnerability (Munang et al., 2013). This aspect emphasizes the importance of preserving and restoring natural ecosystems, such as forests, wetlands, and coral reefs, which provide essential ecosystem services, including climate regulation, water filtration, and soil conservation (IPCC, 2014). Ecological adaptation measures may include ecosystem restoration, conservation, and sustainable management practices, such as reforestation, habitat restoration, and sustainable land-use planning (UNEP, 2012). For instance, climate adaptation initiatives may prioritize the protection and restoration of mangrove forests, which provide critical habitat for fisheries and protect coastal communities from storms and sea-level rise (UNDP, 2015).

These social, economic, and ecological dimensions of climate adaptation are interconnected and mutually reinforcing. Effective climate adaptation strategies must consider these multiple perspectives and develop integrated solutions that address the needs of different stakeholders and ecosystems (IPCC, 2014). By adopting a comprehensive and inclusive approach to climate adaptation, we can reduce vulnerability, enhance resilience, and promote sustainable development (UN, 2015). These approach are interdependent and must be managed holistically to achieve sustainable climate resilience (Folke et al., 2016).

Global Perspectives and International Frameworks on Disaster Risk Reduction

Globally, **Disaster Risk Reduction (DRR)** has evolved as a critical component of sustainable development and climate resilience. The increasing frequency and intensity of natural hazards—such as floods, droughts, cyclones, and wildfires—have underscored the urgency for comprehensive risk management strategies (UNDRR, 2019). Over the past three decades, global DRR efforts have shifted from reactive emergency response to proactive risk prevention and preparedness (Wisner et al., 2014).

According to the **United Nations Office for Disaster Risk Reduction (UNDRR)**, global economic losses from climate-related disasters between 2000 and 2019 exceeded USD 2.9 trillion, affecting over 4 billion people (UNDRR, 2019). The DRR paradigm emphasizes hazard mapping, vulnerability assessment, risk-sensitive development planning, and community engagement (Coppola, 2015). Developed nations, such as Japan and New Zealand, have adopted technologically advanced early warning systems, while developing countries continue to face institutional and financial barriers that hinder effective DRR implementation (Adelekan, 2020).

International Frameworks

Three major international frameworks provide the foundation for global DRR and climate adaptation policy integration:

1. **Sendai Framework for Disaster Risk Reduction (2015–2030)** – Adopted at the Third UN World Conference on DRR, it emphasizes understanding disaster risk, strengthening governance, investing in resilience, and enhancing disaster preparedness ("Build Back Better") (UNISDR, 2015).
2. **Paris Agreement on Climate Change (2015)** – This legally binding global treaty seeks to limit global temperature rise to well below 2°C, with explicit recognition of adaptation as a core pillar of climate action (UNFCCC, 2015).
3. **Sustainable Development Goals (SDGs)** – Particularly **SDG 11 (Sustainable Cities and Communities)** and **SDG 13 (Climate Action)** integrate DRR and adaptation within the broader sustainable development agenda (United Nations, 2015).

These frameworks encourage nations to adopt coherent policies that link DRR, climate change adaptation (CCA), and sustainable development. However, implementation remains uneven across developing countries due to limited technical capacity and political will (Egbebiyi & Oladipo, 2021).

Integration of Indigenous Knowledge and Technological Innovations in Climate Adaptation and Disaster Risk Reduction

Indigenous and local knowledge (ILK) offers valuable insights into environmental management and adaptation. According to the IPCC (2022)**,** ILK contributes to ecosystem-based adaptation, resource conservation, and risk mitigation. Indigenous knowledge systems—such as seasonal forecasting, traditional weather indicators, and communal resource governance—help communities anticipate and respond to climatic extremes (Hiwasaki et al., 2014).

In Nigeria, indigenous early warning mechanisms and cultural norms play critical roles in shaping adaptive behavior in rural communities (Eze, 2023). However, Western-oriented adaptation policies often marginalize these systems, limiting their integration into national planning. Bridging scientific and indigenous knowledge enhances adaptive capacity and ensures culturally sensitive interventions (Nyong et al., 2007).

Technological Innovations

Technological innovation is transforming DRR through the development of Early Warning Systems (EWS)**,** Remote Sensing**,** Geographic Information Systems (GIS), and Artificial Intelligence (AI) for hazard prediction and monitoring (Cutter et al., 2015). In Japan and the Philippines, multi-hazard EWS integrate meteorological, hydrological, and geospatial data to issue timely alerts (Basher, 2006).

In Nigeria, the adoption of modern technologies remains limited due to poor infrastructure and data-sharing mechanisms. Nonetheless, agencies like **NiMet** have improved climate forecasting accuracy and community outreach (Nkwunonwo et al., 2020). Expanding data networks, integrating AI-based predictive analytics, and enhancing local access to digital platforms are crucial steps toward technological mainstreaming in DRR (Ahmed et al., 2022).

Financing Mechanisms for Climate Adaptation and DRR

Financing climate adaptation and disaster risk reduction is a critical issue, particularly for vulnerable countries in Africa. For instance, sustainable financing is essential for implementing DRR and CCA programs include: climate finance**,** insurance schemes**,** green bonds**,** and international aid (Tol, 2018). Global funds such as the Green Climate Fund (GCF) and the Global Environment Facility (GEF) provide financial support for adaptation and resilience-building projects in developing countries (OECD, 2020). According to Zero Carbon Analytics (2023), the financing mechanisms for climate adaptation and disaster risk reduction can be broadly categorized into public and private sources. Public financing mechanisms include grants, concessional loans, and national budgets, which are crucial for supporting adaptation projects and climate resilience efforts. Grants from foreign governments, development finance institutions, and multilateral climate funds are essential for adaptation projects, while low-interest loans from multilateral development banks and climate funds help countries invest in climate resilience (World Resources Institute, 2023).

Private financing mechanisms, including private sector investment, insurance, and bonds, also play a significant role in climate adaptation and disaster risk reduction. Companies are investing in climate resilience, such as infrastructure projects and climate-smart agriculture, while climate risk insurance products are helping countries and communities manage climate-related risks. Additionally, green bonds, catastrophe bonds, and resilience bonds are raising capital for climate adaptation projects.

Innovative financing mechanisms, such as debt-for-climate swaps, climate risk insurance pools, and pay-for-success instruments, are also being explored to address climate adaptation and disaster risk reduction challenges. These mechanisms can help countries swap debt for climate-related investments, provide affordable insurance coverage for climate-related disasters, and incentivize private investors to achieve specific climate adaptation outcomes (Biennial Digital Report, 2023; World Resources Institute, 2023).

Despite these efforts, there is still a significant funding gap, with the annual adaptation finance gap in developing countries estimated to be $310-365 billion by 2035 (Zero Carbon Analytics, 2023). African nations face challenges in accessing these funds due to bureaucratic bottlenecks, limited institutional capacity, and lack of bankable projects (Akinbami & Fadeyi, 2021). In Nigeria, domestic funding for DRR is constrained by competing priorities and inadequate budgetary allocations. Strengthening public–private partnerships and creating national adaptation trust funds can enhance financial sustainability (Adelekan, 2020). Similarly, increasing private sector investment is crucial to bridge this gap, and improving transparency and tracking of climate finance flows is essential for effective allocation of resources.

Barriers to Effective DRR and Climate Adaptation in Developing Countries

Despite global progress, several barriers hinder the integration and implementation of DRR and CCA in developing countries:

1. **Institutional Fragmentation and Weak Institutional Capacity:** Overlapping mandates and poor coordination among agencies (Adejumo & Akinola, 2021). Weak institutional capacity, including inadequate policies, laws, and regulations, hinders the implementation of DRR and climate adaptation measures (IPCC, 2014).

2. **Knowledge Gaps:** Weak data collection and limited access to climate information (Nkwunonwo et al., 2020).
3. **Socioeconomic Inequalities:** Poverty and marginalization heighten vulnerability to disasters (Wisner et al., 2014).
4. **Political Instability, Corruption and Governance issues:** Governance challenges impede long-term resilience planning (Egbebiyi & Oladipo, 2021). Corruption and governance issues can undermine the effectiveness of DRR and climate adaptation measures (Transparency International, 2020).
5. **Limited Financial Resources**: Developing countries often lack the financial resources to invest in DRR and climate adaptation measures, making them more vulnerable to disasters and climate change impacts (UNDRR, 2019). Conversely, the OECD (2020) also lends its voice to the issue of limited access to adaptation finance and inadequate national budgets.
6. **Limited Access to Technology:** Limited access to climate-resilient technologies and data hinders the development of effective DRR and climate adaptation strategies (World Bank, 2020).
7. **Poor Data and Information:** Inadequate data and information on disaster risks and climate change impacts make it difficult to develop effective DRR and climate adaptation plans (UNDRR, 2019).
8. **Limited Community Engagement:** Limited community engagement and participation in DRR and climate adaptation planning and implementation can lead to ineffective and unsustainable solutions (IPCC, 2014).
9. **Limited Human Resources:** Limited human resources, including lack of skilled personnel and expertise, hinder the implementation of DRR and climate adaptation measures (UNDP, 2020).
10. **Competing Priorities:** Competing priorities, such as poverty reduction and economic development, can divert attention and resources away from DRR and climate adaptation (World Bank, 2020).
11. **Dependence on External Aid:** Dependence on external aid can create uncertainty and undermine the sustainability of DRR and climate adaptation efforts (UNDRR, 2019).
12. **Climate Change Impacts:** The increasing frequency and severity of climate-related disasters can overwhelm the capacity of developing countries to respond and recover (IPCC, 2014).

Strategies for addressing these barriers

Addressing these barriers requires institutional reforms, capacity development, and international collaboration to strengthen adaptive governance and reduce systemic vulnerability. According to the United Nations Office for Disaster Risk Reduction (UNDRR, 2019), strengthening institutional capacity is crucial for effective DRR and climate adaptation.

1. Strengthening Institutional Capacity
   i. Policy and Legislative Frameworks: Develop and implement policies and laws that support DRR and climate adaptation, as emphasized by the Intergovernmental Panel on Climate Change (IPCC, 2014).
   ii. Institutional Coordination: Establish clear roles and responsibilities among government agencies, NGOs, and other stakeholders, as highlighted by the World Bank (2020).
   iii. Capacity Building: Provide training and capacity-building programs for government officials, communities, and other stakeholders, as recommended by the United Nations Development Programme (UNDP, 2020).
2. Enhancing Financing Mechanisms
   i. Domestic Resource Mobilization: Increase domestic funding for DRR and climate adaptation, as suggested by the International Monetary Fund (IMF, 2020).
   ii. International Cooperation: Secure international funding and technical assistance, as emphasized by the United Nations Framework Convention on Climate Change (UNFCCC, 2020).

iii. Innovative Financing: Explore innovative financing mechanisms, such as climate insurance and green bonds, as discussed by the World Bank (2020).

3. Promoting Community Engagement
   i. Community-Based DRR: Support community-led DRR initiatives, as highlighted by the Asian Disaster Preparedness Center.
   ii. Awareness and Education: Raise awareness and educate communities about DRR and climate adaptation, as emphasized by the United Nations Children's Fund (UNICEF, 2020).
   iii. Inclusive Planning: Ensure inclusive planning processes that involve vulnerable groups, as recommended by the IPCC (2014).
4. Improving Early Warning Systems
   i. Early Warning Systems: Establish and strengthen early warning systems, as emphasized by the World Meteorological Organization.
   ii. Data and Information: Improve data collection and sharing, as highlighted by the United Nations Environment Programme.
   iii. Communication: Enhance communication and dissemination of early warnings, as recommended by the International Federation of Red Cross and Red Crescent Societies.

Summary of the Findings

Based on the reviewed research questions the following are the findings of the study:

1. The study found out the relationship between disaster risk reduction and climate adaptation. The study observed that, both disaster risk reduction and climate adaption help in minimizing the adverse impacts of natural hazards and climate variability on human and ecological systems (IPCC, 2012; Schipper & Pelling, 2006).
2. The study equally found out that, the principles to disaster risk reduction are prevention, mitigation, preparedness, response, and recovery (Coppola, 2015). While at the community level, participatory approaches—such as Community-Based Disaster Risk Management (CBDRM)**—** have proven effective in empowering local populations and integrating indigenous coping mechanisms into formal planning (Gaillard & Mercer, 2013).
3. Furthermore, the study found out the dimensions of climate adaptation to include: social, economic, and ecological perspectives.
4. Conversely, the study found out that globally disaster risk reduction (DRR) has evolved as a critical component of sustainable development and climate resilience with the tendency of dealing with natural hazards—such as floods, droughts, cyclones, and wildfires. While study observed that, the international framework for disaster risk reduction encompasses the following: Sendai Framework for Disaster Risk Reduction (2015–2030)**,** Paris Agreement on Climate Change (2015)**,** and Sustainable Development Goals (SDGs)
5. Similarly, the study found out that Indigenous and local knowledge (ILK) contributes to ecosystem-based adaptation, resource conservation, and risk mitigation. Indigenous knowledge systems—such as seasonal forecasting, traditional weather indicators, and communal resource governance—help communities anticipate and respond to climatic extremes (Hiwasaki et al., 2014). While on the technological level, the study observed that technological innovation has transformed DRR through the development of Early Warning Systems (EWS)**,** Remote Sensing**,** Geographic Information Systems (GIS)**,** and Artificial Intelligence (AI) for hazard prediction and monitoring (Cutter et al., 2015).
6. Correspondingly, the study found out that financing climate adaptation and disaster risk reduction is a critical issue, particularly for vulnerable countries in Africa. The study avered that, sustainable financing is essential for implementing DRR and CCA programs include: climate finance**,** insurance schemes**,** green bonds, and international aid **(**Tol, 2018). Global funds such as the Green Climate Fund (GCF) and the Global Environment Facility (GEF) provide financial support for adaptation and resilience-building projects in developing countries (OECD, 2020).

7. Conclusively, the study found out that despite global progress, several barriers such as institutional fragmentation and weak institutional capacity**,** knowledge gaps, social economic inequalities, political instability, corruption and governance issues etc. hinder the integration and implementation of DRR and CCA in developing countries.

CONCLUSION

This research concludes that Disaster Risk Reduction and Climate Adaptation are interdependent and mutually reinforcing components of sustainable development. The findings affirm that building resilience requires integrating environmental governance, socio-economic planning, and institutional capacity in a coherent framework (Folke et al., 2016; Cutter et al., 2015).
In the Nigerian context, DRR and climate adaptation are constrained not by policy absence but by weak implementation mechanisms**,** inadequate resource allocation**,** and low local participation**.** These challenges reflect what the Resilience and Systems Theories describe as "systemic vulnerability"—a situation where interdependent institutional weaknesses amplify disaster impacts (Walker & Salt, 2012).
The study also emphasizes that achieving sustainable resilience necessitates bottom-up, community-driven approaches that blend indigenous knowledge with scientific innovation. Effective DRR and climate adaptation must therefore be multi-level, inclusive, and dynamic—aligning with the Sendai Framework for Disaster Risk Reduction (2015–2030), the Paris Agreement (2015)**,** and the 2030 Agenda for Sustainable Development.

RECOMMENDATIONS

Based on the findings of the study, the following are recommended:

1. Mainstreaming DRR and Climate Adaptation into National Policy Frameworks**:** DRR and climate adaptation should be institutionalized across all sectors—agriculture, health, urban planning, and infrastructure—through a unified national framework. The Federal Ministry of Environment and the National Planning Commission should ensure that adaptation and risk reduction goals are included in state development plans and annual budgets (Adejumo & Akinola, 2021).
2. Strengthening Legal and Institutional Mandates**:** The roles of NEMA, NiMet, and related agencies should be redefined to minimize duplication. Establishing a National Council for Resilience and Adaptation (NCRA) could enhance inter-agency coordination and harmonize data-sharing and policy implementation (Egbebiyi & Oladipo, 2021).
3. Enhancing Financing Mechanisms**:** The government should create a Disaster Risk Reduction and Climate Adaptation Fund to support preventive measures and community-based projects. Leveraging international climate finance mechanisms, such as the Green Climate Fund (GCF**)** and Adaptation Fund, can bridge resource gaps (UNDRR, 2019).
4. Promoting Science-Based Decision Making**:** Investments in climate data infrastructure**,** GIS**,** remote sensing**,** and AI-based risk modeling should be scaled up to improve forecasting and risk mapping (Nkwunonwo et al., 2020).
5. Integrating Gender and Social Inclusion: Policies must prioritize gender-sensitive and socially inclusive approaches, recognizing that women, youth, and marginalized groups are both vulnerable and key agents of resilience (Mercer et al., 2010).

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