

SUSTAINABLE WATER RESOURCE MANAGEMENT IN NIGERIA: CHALLENGES, INTEGRATED WATER RESOURCE MANAGEMENT IMPLEMENTATION, AND NATIONAL DEVELOPMENT

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ABSTRACT

Water resource management is essential for societal advancement, as water supports various human activities, including domestic, agricultural, industrial, and recreational uses. In Nigeria, the challenges of managing water resources are exacerbated by uneven distribution, population growth, and inadequate infrastructure. Despite Nigeria's significant renewable freshwater resources, only 69% of the population has access to basic water services, highlighting the nation's inefficiencies in water governance. The Integrated Water Resources Management (IWRM) approach offers a framework to address these challenges by promoting sustainable water use, stakeholder involvement, and the protection of ecosystems. However, Nigeria's implementation of IWRM faces hurdles, such as weak governance, conflicting institutional interests, and insufficient stakeholder engagement. This study examines the historical and current state of water resource management in Nigeria, its impact on national development, and the potential benefits of adopting IWRM. It explores lessons learned from global IWRM practices and provides recommendations for improving water governance to achieve the SDGs, particularly SDG 6 (clean water and sanitation) and SDG 11 (sustainable cities and communities). Addressing these challenges will require stronger institutional frameworks, cost recovery mechanisms, and the integration of local insights with international best practices.

Keywords: water resource management; sustainable development; Nigeria; water governance; renewable water resources; climate change; stakeholder engagement; sustainable development goals (SDGs); and water infrastructure.

I. INTRODUCTION

Effective water resource management is essential for societal advancement, as water plays a crucial role in many facets of human activities. Water is essential for various uses, including household, business, manufacturing, farming, and leisure activities. Every developed country has a common background of significant investment in water infrastructure, institutions, and the ability to effectively handle water resources. On the other hand, underdeveloped countries are generally known for lacking sufficient water facilities, ineffective institutions, and inadequate water management [1]. As the demand for limited water resources grows, it is crucial to assess ways to manage water resources for ongoing national development.

Water resource management is a major concern globally, including in Nigeria. Nigeria faces unique challenges in managing its water resources. The Ogallala Aquifer in North America shows the risks of overreliance on groundwater for agriculture.

Excessive use can lead to water level declines, posing threats to food security and agricultural economies [2]. Nigeria, like other regions, relies on water sources for farming and community well-being, highlighting the importance of sustainable water management.

In Nigeria, per capita renewable water resources total 2514 m³/year, but only 69 percent of the population has basic water supply access. Compared to countries like Tunisia, with lower TRWR, Nigeria struggles to provide water supply services nationwide. The limited availability of water and deteriorating sources indicate significant water resource management issues [3]. The Water Resources Ministry, Nigeria, manages water development alongside other ministries, but conflicting interests and poor collaboration hinder efficiency. Excessive use, misuse, and pollution also damage ecosystems. Despite abundant freshwater resources of 286.2 km²/year, their distribution is uneven and varies seasonally. The north experiences high water stress from low rainfall and population density [3, 4]. Urban expansion and a growing

population strain water source, leading to competition even in water-rich regions. The study explores the management of water resources in Nigeria, its impact on national progress, and the benefits of implementing

IWRM for sustainable development while addressing the country's unique characteristics and internal challenges. Figure 1 highlights Nigeria's location in Africa and worldwide [5].

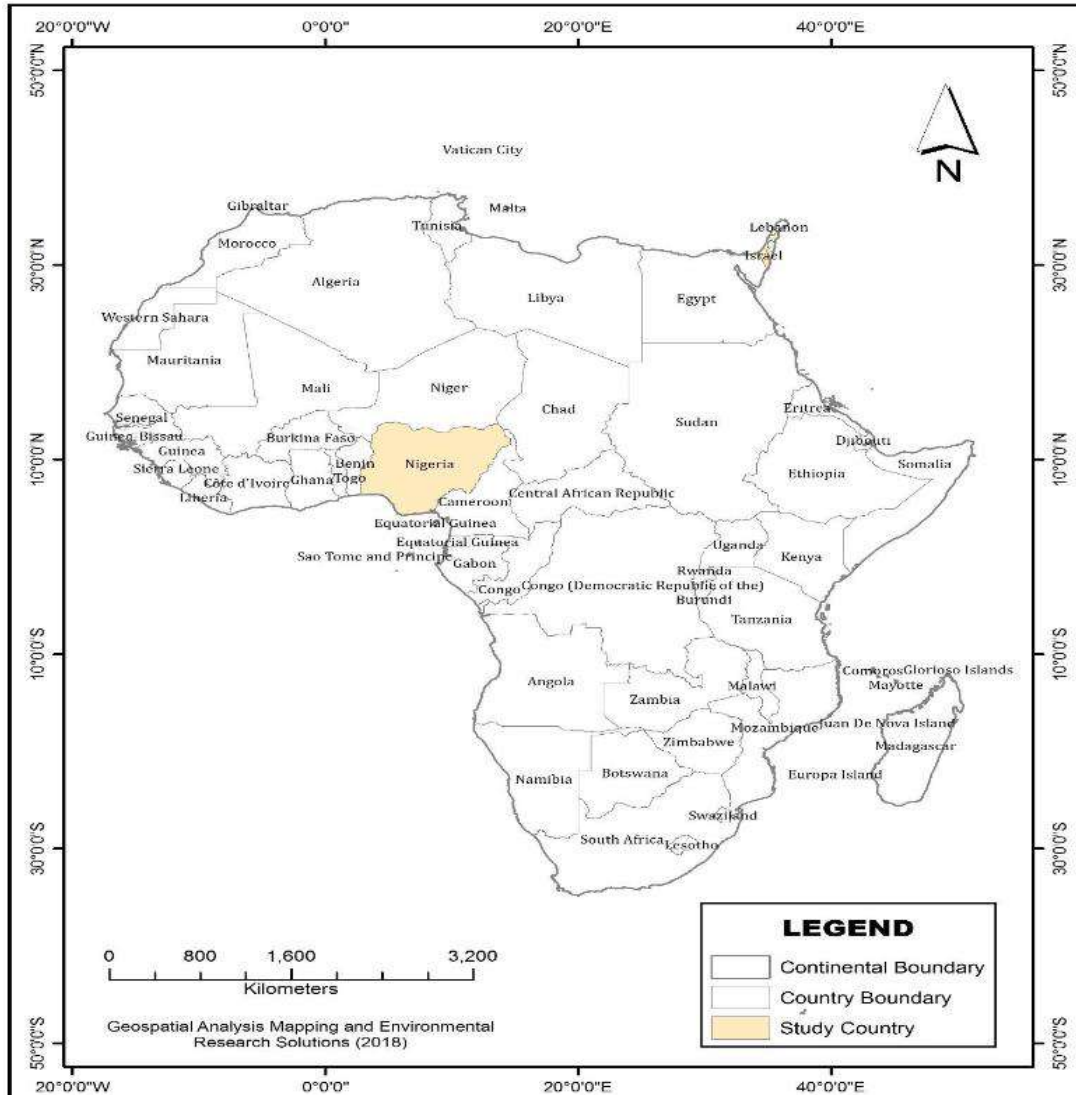


Figure 1. Map of Africa, highlighting study country

The management principle of water resources in Nigeria has been practiced since before independence in 1960, including the collection and storage of rainwater for household purposes since 1849. Improvements resulted in the extraction of water from rivers and an intricate network of pipelines [6]. The increase in population in the 1950s led to the establishment of a water services division within the public service unit, which later joined the Ministry of

Works of Nigeria post-independence. Water management is currently monitored by the Water Resources Ministry as well as the state-level Ministry of Works [7].

1.1 The Study Objectives

1. Assess the water resource current management in Nigeria, focusing on challenges related to infrastructure, governance, and accessibility.

2. Evaluate the implementation and effectiveness of IWRM in Nigeria, identifying key barriers to its success.
3. Analyze the role of institutions, policies, and stakeholder engagement in shaping water governance and resource allocation in the country.
4. Examine the impact of water resource management on national development, including agriculture, industry, and urban expansion.
5. Identify lessons from global IWRM practices that can inform Nigeria's water management strategies for sustainable development.
6. Propose recommendations for improving water governance in Nigeria, aiming to meet SDGs, particularly SDG 6 and SDG 11.

II. OVERVIEW OF WATER RESOURCE CHALLENGES

Nigeria, just like many other areas, encounters difficulties in handling its water resources. The movement from UN-MDGs to UN-SDGs has highlighted the significance of ensuring global access to good-quality water. Research conducted in Ado-Odo Ota, Nigeria, identified challenges related to the presence, cost, and confidence in governmental water services. Private water sources are heavily relied upon because they are seen as having good quality and being easily accessible [8]. To enhance water accessibility, government regulations need to be reviewed, and methods such as subsidies and rainwater harvesting should be considered. South Korea has modified its water policies to tackle urbanization and environmental worries, underscoring the significance of proactive management in dealing with water resource challenges and socio-economic effects [9]. The water resource management challenges in Southwest Nigeria are multifaceted, encompassing physical, environmental, socio-economic, and cultural dimensions. Addressing these issues needs a technical approach that considers the region's unique characteristics while drawing on global experiences. By integrating local insights with lessons learned from other parts of the world, a more effective strategy for managing water resources can be developed [10].

2.1 Principle of IWRM

Water is fundamental to human survival, and effective management of this vital resource is crucial given its limited availability and uneven distribution. The growing threat of global water crises has driven water resource managers to seek efficient strategies that can meet future demands while safeguarding existing water supplies [11]. The focus has increasingly been on finding a balance between water supply and demand to maximize the benefits of water resources

while also protecting the environment for future generations [12]. In Nigeria, as in many countries that are developing, there is considerable skepticism towards demand-oriented water management strategies. These approaches are often viewed as initiatives imposed by international donor organizations—such as the World Bank, World Health Organization, and International Monetary Fund—potentially perpetuating poverty in developing economies [13].

Subsequently, the 1992 world summit on water resource management and environmental sustainability in Dublin, Ireland, established four principles that have underpinned many reforms in the water sector. These principles emphasize that: water is a vital, limited, and fragile resource; all stakeholders should be involved in water management; the participation of women is crucial for optimizing the water sector's potential; and water should be regarded as an economic asset [12]. The purpose of IWRM is to distribute water and water infrastructure in ways that minimize waste and support environmental sustainability. This approach is critical because water is an important earth resource that underpins many aspects of human progress, including economic development, agriculture, mining, domestic use, transportation, commerce, communication, naval operations, energy production, wealth creation, and political dynamics. These contributions are universally significant, highlighting the importance of efficient water management [13].

In Nigeria, as in many other countries, IWRM has gained traction despite some criticisms about its practicality, especially in developing nations. The concept of IWRM has increasingly been recognized for its potential to address current water needs while ensuring that resources are preserved for future generations [14]. This growing global acceptance reflects IWRM's role in balancing immediate demands with long-term sustainability.

2.2 Attributes of Integrated Water Resource Management in Nigeria

In general, politics in Nigeria play roles in the initiation of new water projects, frequently overshadowing expert recommendations [14]. This tendency leads to a preference for large-scale infrastructure projects over softer approaches such as policy reform and institutional changes. Signs of missteps in project selection include the failure to implement cost recovery mechanisms, reliance on outdated irrigation techniques without water conservation measures, and inadequate stakeholder representation in water management discussions, all of which are essential components of SDGs [15]. The prevalent approach to water management in Nigeria

emphasizes centralization and minimal involvement from non-government sector, exacerbating the country's water challenges. Despite the gradual reduction of government control in favor of private entities, both small and large companies face significant hurdles in contributing effectively to the sector. These challenges include ensuring equitable resource distribution across the country and navigating political issues such as providing subsidies to less affluent regions. The perception of water as a public good, the financial investments required, and the lack of private property rights complicate private sector involvement in the water supply [16]. In Nigeria, the concept of IWRM is seen as imposed by financial institutions, lacking emphasis on long-term environmental sustainability. The Authorities of Nigeria River Basin Development manage Nigeria's groundwater and surface water to enhance agriculture and water supply, as outlined in the National Water Policy. Muller et al. [17] outline the core principles of IWRM, emphasizing a holistic approach to managing all water resources within a country, with river basins serving as the primary management units. This approach involves coordinating various water users and aligning water development with the national framework. Additionally, IWRM aims for cost-effectiveness, equitable water distribution among vulnerable populations, and the promotion of environmental sustainability, particularly in the aspect of climate change challenges and adaptations.

2.3 Assessability IWRM in Nigeria

The report from the UN [18] shows that the progress of the IWRM program in several African nations, including Nigeria, is mostly rated as medium to low, ranging from 31 to 50%. As per the progress report, countries in this category have implemented most aspects of IWRM at 41% but are unlikely to reach the global target unless there is a significant increase in progress [19]. The global adoption of IWRM aims to influence conversations and policy development on sustainable water resource management without an alternative plan. IWRM's key characteristics are integrating water issues with policy goals, practicing good governance, involving stakeholders in decision-making, ensuring fair resource management and access through cost recovery, and promoting

sustainable demand management [19]. Concerns arise about the IWRM principle as a universal solution due to diverse economic, social, and environmental contexts globally [14]. Nigeria's water management faces challenges due to cultural differences, unequal resource access, funding, skills, and institutional setups. Variations in governance, legal frameworks, decision-making processes, and institutional effectiveness further complicate water management in Nigeria. RBDA's in Nigeria play a significant role in IWRM, with 12 authorities covering specific geographic areas as shown in Table 1; Figure 2; and Figure 3.

At first, the RBDA's were established to offer agricultural water supply in large quantities. Nevertheless, their roles have grown to encompass the gathering and organization of important hydrological, hydrogeological, and meteorological data in their designated territories [20]. Akpabio et al. [4] revealed that the CRBDA was unable to fulfill its duties due to insufficient resources and a lack of technical expertise in collecting and storing water resource data. Other RBDA's and water management agencies in Nigeria encounter the same issues of insufficient technical assistance for successful functioning.

The underdevelopment of dam projects in Nigeria's Southeast region, despite the existence of around 200 dams nationwide, highlights significant weaknesses within the country's managing water resource system. These issues are largely attributed to the centralized nature of governance, which has contributed to the inefficiencies observed in water resource sector institutions [21].

Several key challenges have emerged in the northern part of Nigeria. These include the overuse of surface water resources, disruptions in river channels that hinder downstream water accessibility, and the negative effects of dams on water flows from rivers. There is also a noticeable groundwater reduction in certain basins, a reduction in the availability and effectiveness of hydrological patterns and a lack of sufficient focus on the collection and management of groundwater data [16].

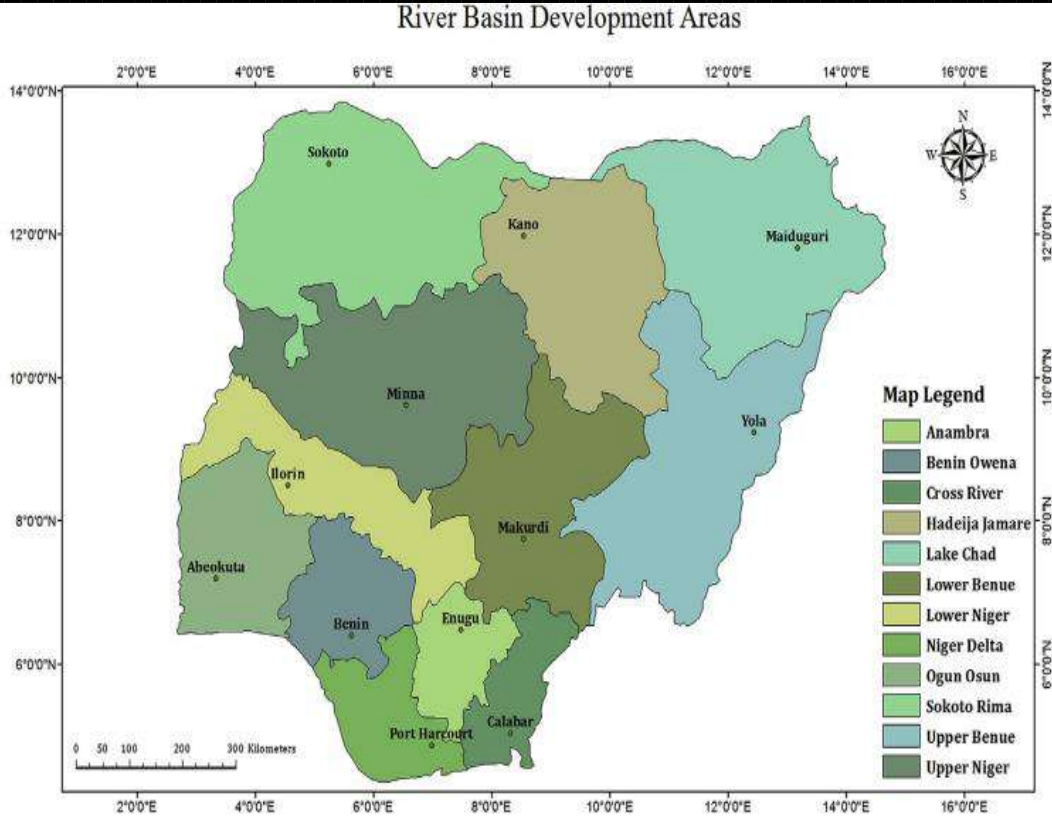


Figure 2. Map showing 12 RBDAs across Nigeria

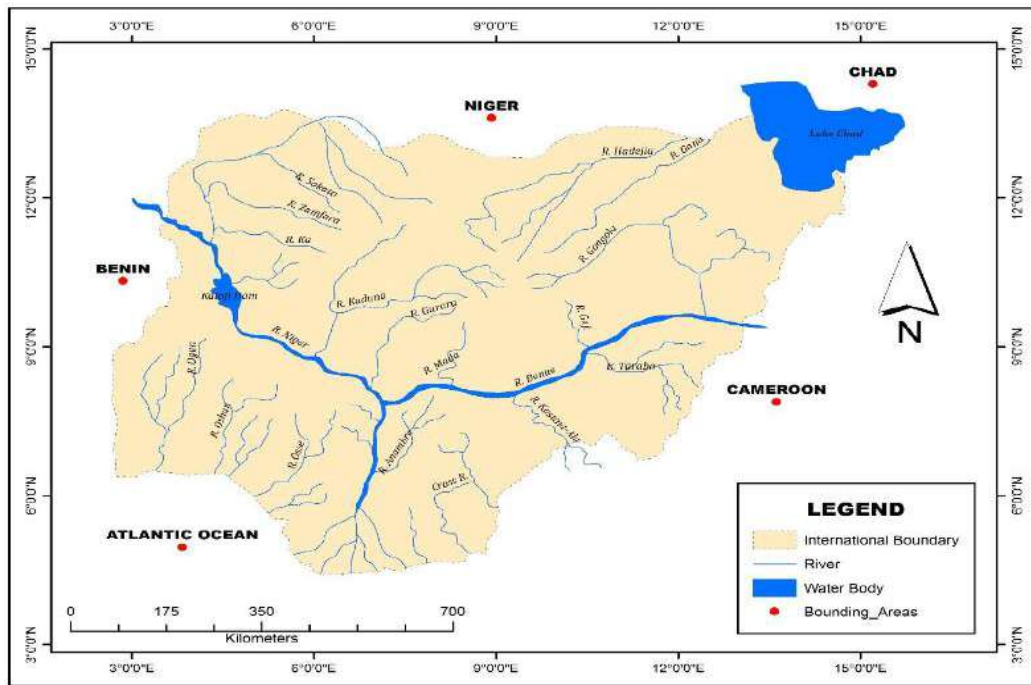


Figure 3. Nigeria's major rivers and streams

Table 1. List of RBDA's in Nigeria

S/N	RBDA	Operation Areas	Office
1	Anambra-Imo River Basin Development Authority (AIRBDA)	Abia, Anambra, Ebonyi, Enugu and Imo States	Oweri
2	Benin Owena River Basin Development Authority (BORBDA)	The regions of River Benin and Owena and a senatorial district in Delta State	Benin-City
3	Chad Basin Development Authority (CBDA)	Borno, Yobe State and northern part of Adamawa State	Maiduguri
4	Cross River Basin Development Authority (CRBDA)	Akwa Ibom and Cross River States	Calabar
5	Hadejia Jama' are River Basin Development Authority (HJRBDA)	Kano, Jigawa States and north and central parts of Bauchi State	Kano
6	Lower Benue River Basin Development Authority (LBRBDA)	The catchment states of Benue, Plateau, Nassarawa States and Kogi State East of the River Niger	Makurdi
7	Lower Niger River Basin Development Authority (LNRBDA)	Entire geographical boundaries of Kwara State and a part of Kogi State, west of the River Niger	Ilorin
8	Niger Delta Basin Development Authority (NDBDA)	Delta and Bayelsa States	Port Harcourt
9	Ogun-Osun River Basin Development Authority (OORBDA)	Lagos, Ogun, Oyo and Osun States	Abeokuta
10	Sokoto-Rima River Basin Development Authority (SRBDA)	Katsina, Zamfara, Sokoto and Kebbi States	Sokoto
11	Upper Niger River Basin Development Authority (UNRBDA)	Niger, Kaduna States and the FCT	Minna
12	Upper Benue River Basin Development Authority (UBRBDA)	Gombe, Taraba, two senatorial districts of Adamawa State and one senatorial district of Bauchi State	Yola

III. PROFFER SOLUTION OF WATER PROBLEMS IN BASIN-SCALE IN NIGERIA USING IWRM TECHNIQUES

Problems often serve as catalysts for development and innovation, a reality evident in Nigeria's Northeast region, where severe water shortages are exacerbated by insecurity and terrorism, including attacks by herdsmen on farmers as well as activities by Boko Haram and terrorist groups. Over the past three

decades, Lake Chad, located in the Sahel region of Africa, which encompasses Nigeria, has seen its area diminish by 75%, shrinking from 25,000 square kilometers above 2,000 km². This drastic reduction is not only due to recurring droughts but also to extensive water diversion for irrigation purposes [5]. The collapse of the lake's once-thriving fisheries exemplifies the consequences of unsustainable

freshwater resource exploitation, raising concerns about future water availability.

In the 1970s, the construction of Tiga dam and Challawa Gorge dam severely degraded the Komadugu Yobe River basin, which was a critical source for recharging Lake Chad. This degradation led to a 35% reduction in flow, significant water abstraction for irrigation purposes on a large scale and contributed to regional climate aridification. The resulting impacts have adversely affected fishing, agriculture, and livestock farming activities [20]. The situation was triggered because of inadequate government institutions to address the communities' basic amenities across the six Nigerian states within the Chad Basin.

In the early 2000s, Federal and State Water Resources Ministry in Nigeria, alongside development partners, launched intervention strategies to tackle the confronted issues by Nigeria's water basins. The approach began with making assessment results accessible to all stakeholders, ensuring transparency and commitment. This was followed by pilot projects aimed at delivering tangible benefits to affected communities, such as clearing aquatic weeds, dredging water and river channels, and early warning of flood. To address the issues of disorganized and uncoordinated basin management, IWRM committees were established in each state, drawing on lessons from previous fragmented approaches [21]. This initiative accelerated decision-making at the basin level by fostering consensus among stakeholders on necessary strategic actions for restoration and sustainable water resource development. This experience underscores the importance of applying IWRM on a larger scale, supported by policy adjustments, legal reforms, and institutional restructuring [21].

IV. SUSTAINABLE OF NATIONAL DEVELOPMENT BY IWRM

Water resources are crucial for socio-economic development, serving multiple purposes such as agriculture, electricity generation, crop production, household use and for industries purposes. However, these diverse uses often compete, and poor management of IWRM principle can hinder human development [1].

In 2015, the United Nations came together to adopt agenda of 20230 SDGs, which includes seventeen (17) SDGs with 169 targets focusing on issues like environmental sustainability, economic growth, and social well-being of humans. Water resources is crucial in achieving these goals, particularly through SDG 6, which is interconnected with several other goals. Achieving SDG 6 is key to building (SDG 11),

(SDG 1), (SDG 10), (SDG 3), (SDG 5), (SDG 13), and (SDG 12).

The importance of managing water resources is further underscored by SDG target 6.5, which calls for the incorporation of the IWRM principles at all areas, including transboundary cooperation, by 2030. This target play an important role for a holistic method of water management to achieve sustainable development globally [1, 21]. Although the IWRM concepts predate the 1990s, their introduction in the SDGs has elevated their importance on the global agenda. This recognition is expected to drive deliberate actions that will lead to better water resource management, enhanced water security, and significant environmental and socio-economic benefits.

4.1 Importances Water resources in Nigeria sustainability development

Since the first UN International meeting on human-environment sustainability in 1972, addressing environmental issues caused by human activities and promoting collaborative efforts for environmental preservation have become central to the global agenda [18]. The UN has led numerous initiatives, including the Earth Summit in 1992, climate change studies since 1988, the Commission on Development Sustainability in 1989, and a comprehensive assessment of Earth's ecosystems from 2000 to 2005. In 2003, the Global Water Development report resulted in the Water for Life in 2005 program called International Decade for Action.

The importance of water resources with conducive environment is highlighted in achieving SDG6, crucial for achieving other SDGs [18]. Large dam projects in countries like Japan, India, Egypt, Turkey, and Brazil have driven economic growth and food production, emphasizing that national development can be properly through water resource management [18, 22]. However, global freshwater scarcity is increasing because of the rapid population and resource depletion, making water a significant political and economic challenge by the mid-21st century. Prioritizing sustainable water practices is essential to achieve sustainable development and meet UN SDGs by 2030.

4.2. Obstacles to water resource management and sustainable development in Nigeria

As per the GWP, and IWRM seeks to synchronize water resource management with a country's economic and developmental strategy by incorporating social element, technology method, and environmental elements. This method will guarantee the water resource to meet present demands as well as future needs [23, 24]. It aligns with the strategic objective of

SDG 6 by emphasizing the utilization of innovative technologies to ensure quality water and good sanitation while protecting the environment.

In Nigeria, RBDAs encounter various obstacles in achieving sustainable water resource development, which are typical in developing nations but unique to Nigeria's socio-economic development. Primary difficulties consist of:

1. With 12 RBDAs managing a population of over 180 million across 923,000 km², there is a shortage of personnel to effectively achieve the goal.
2. Development approach can as a form involvement of stakeholders, leading to potential loss of focus.
3. National planning by Joint Federal and State Ministry of Water Resources often neglects important of stakeholders, contractors, and end-users.

V. CONCLUSION

Other countries IWRM successful stories starts with clear policies, but Nigeria's water legislation is inadequate and lacks a practical framework for IWRM. Nigeria's national IWRM commission lacks effective implementation strategies, revealing a disconnect between policy and commitment. To enhance water management, policymakers must tackle key sector issues and adopt an integrated approach suited to the country's needs. This approach must involve all sectors, and most especially the women, who are the key water end users, to align with all the SDGs and ensure water security. Building responsive and adaptable institutions is essential for effective water governance. They must have the tools and expertise to manage hydrological data effectively. Encouraging efficient water use and reducing waste can help shift the perception of public water supply from free to a resource requiring accountability. By learning from international experiences, Nigeria can enhance its water management strategies, support SDG 6, and contribute to sustainable and clean cities and local communities (SDG 11) by 2030. To future recommendation the following are important to work on.

1. **Strengthened Institutional Framework:** Establishing stronger institutions with clearly defined roles and responsibilities will enhance the efficiency of water resource management and governance.
2. **Improved Stakeholder Collaboration:** Enhanced coordination between federal, state, and local governments, as well as the private sector, can lead to more efficient water resource management and equitable access to water.
3. **Sustainable Water Infrastructure Development:** Investing in modern, climate-resilient water

infrastructure, such as dams, irrigation systems, and water treatment facilities, will ensure long-term water supply and quality.

4. **Adoption of Advanced Water Technologies:** Leveraging emerging technologies such as remote sensing, data analytics, and smart water management systems can improve water monitoring, conservation, and distribution efficiency.
5. **Promoting principles of IWRM:** Expanding IWRM principles nationwide, including decentralized water management approaches, will allow for more sustainable and adaptive practices across regions.
6. **Public Awareness and Community Participation:** Increasing public awareness on water conservation and management, along with active community participation, can help reduce water wastage and pollution.
7. **Alignment with SDGs:** Continued efforts to align Nigeria's water resource management with SDG 6 and SDG 11 will drive national progress towards global water resource security and sustainable environment by 2030.

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