© JAN 2026 | IRE Journals | Volume 9 Issue 7 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I7-1713859

Public-Private-Partnerships and Sustainable Dam Management in Nigeria: Evaluating the Gurara Hydropower and Water Transfer Model

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Abstract - This study aims to evaluate the role of Public-Private Partnerships (PPPs) in the development and management of the Gurara Water Transfer Project (GWTP), with a particular focus on the effectiveness of the PPP model in supporting sustainable dam management and addressing socio-economic impacts. The methodology employed is a qualitative, secondary data analysis of government reports, project documentation, in-depth interview of major stakeholders associated with the project. The study specifically examines the operational efficiency of the water transfer system, the long delay in the takeoff of the hydropower generation, the socio-economic consequences for displaced communities, and the governance and security challenges affecting the project. The findings reveal that while the PPP framework facilitated private sector involvement in the project, operational inefficiencies, delays in infrastructure completion and security challenges in the project area hindered the achievement of its full potential. The non-completion of the hydropower retrofitting works have also been significant barriers. In conclusion, the study highlights the need for improved governance, better stakeholder engagement, and stronger risk management strategies to optimize PPP outcomes in future large-scale infrastructure projects. It recommends enhancing transparency, inclusivity, and environmental management to ensure that such projects contribute effectively to sustainable development goals.

Keywords: Public-Private Partnerships; Sustainable Dam Management; Gurara Water Transfer Project; Socio-economic Impact; Infrastructure Development

I. INTRODUCTION

Water plays a critical role in sustainable development, serving as the foundation for food production, energy generation, and economic growth, especially in developing countries where population growth, urbanization, and climate variability intensify water-stress (Schmitt & Rosa, 2024; Foudi et al., 2023). In response, dam infrastructure has become a central feature in water-management strategies globally, providing storage, enabling irrigation, supporting hydropower generation, and helping with flood control (Schmitt & Rosa, 2024; Tian et al., 2025).

The Gurara Water Transfer Project (GWTP), located in the Federal Capital Territory (FCT), Abuja, is one such infrastructure initiative designed to address water scarcity issues and provide renewable energy through hydropower generation. This project, which involves transferring water from the Gurara Dam to the Lower Usuma Dam, is intended to provide a sustainable water supply to the Federal Capital Territory (FCT) and generate hydropower to meet the region's energy needs. In addition, the project aims to promote agricultural development, fisheries, and tourism, further contributing to local and national economic growth (Okunlola et al., 2014; Emetere et al., 2021). Despite these ambitious goals, the project has faced significant challenges that have hindered its full potential, particularly in terms of underutilization and its socio-economic impacts on local communities.

Fig. 1: Gurara Dam Embankment
Source: Author (2025)

The primary challenge affecting the Gurara Water Transfer Project is its underutilization, which directly impacts the project's ability to meet its intended objectives. While the project was designed to transfer water to the FCT to improve water supply and support hydropower generation, the actual utilization

of the water and energy resources has been far below expectations. The hydropower component of the project, which was meant to generate 30 MW of electricity is yet to be harnessed, primarily due to issues related to non completion of the retrofitting works in the power plant, transmission lines and the slow pace of system integration. Similarly, the transfer of water from the Gurara Dam to the Lower Usuma Dam, which was expected to bolster the water supply in Abuja, has faced operational challenges, with water distribution infrastructure being vandalized. These inefficiencies have left large portions of the project's potential untapped, raising questions about the long-term sustainability and effectiveness of the investment (Okunlola et al., 2014; Wada et al., 2025).

In addition to underutilization, the resettled populations affected by the project have faced challenges in adapting to their new locations, with limited access to infrastructure, services, and employment opportunities, and documented risks to livelihoods in host communities (Bello et al., 2024). This has increased socio-economic inequality in the region, as many affected individuals struggle to maintain their livelihoods. Local farmers, fishermen, and other community members who depended on the water resources for their traditional activities have experienced disruptions, with evidence of income trade-offs and reduced livelihood diversification linked to irrigation specialization under the Gurara scheme (Ujoh et al., 2024), and mixed socio-economic outcomes from the transfer to the Lower Usuma system, where several variables (e.g., direct/indirect jobs, loss of farmland, infrastructure) showed negative relationships in post-audit assessments (Wada et al., 2025).

Fig. 2: Water Being Discharged into Lower Usman Dam from Gurara Dam

Source: Author (2025)

The security challenges in northern Nigeria which became pronounced in the 2010s escalated to Kaduna State, including Kachia, Kagarko, and regions around the Gurara Dam and Jere Irrigation Project. The attacks by bandits, kidnappers and other criminal elements began to significantly affect the southern parts of Kaduna state, including Kachia and Kagarko. These areas have been targeted due to their strategic importance and vulnerabilities, such as the presence of critical infrastructure like the Gurara Dam and Jere Irrigation Project. Bandits and other armed groups exploited gaps in security to carry out kidnappings, attacks on communities, and other criminal activities. Security challenges have further complicated the sustainable implementation of the Gurara Water Transfer Project. The region surrounding the Gurara Dam and the Lower Usuma Dam has faced growing security concerns, including the presence of armed groups and other criminal activities. These security challenges have made it difficult for the project to operate efficiently and have also hindered the active participation of local communities in project-related activities. The lack of security has also delayed the completion of key infrastructure components, further exacerbating the underutilization of the project's resources (Bello et al., 2024).

Against this backdrop, this study examines the role of Public-Private Partnerships (PPP) in the development and management of the Gurara Water Transfer Project, with a particular focus on the challenges and socio-economic impacts it has encountered. It seeks to evaluate the effectiveness of the PPP model in supporting sustainable dam management and the broader objectives of water and energy resource management in Nigeria. The study will specifically explore the extent to which the involvement of public and private stakeholders has contributed to or hindered the project's success. The evaluation covers key aspects such as the operational efficiency of the water transfer system, the underutilization of hydropower generation, the socio-economic impacts on displaced communities, and the governance and security challenges affecting the project. By assessing these factors, this study aims to provide a comprehensive analysis of how the PPP model can be optimized for future infrastructure projects in Nigeria and similar developing countries, ensuring that large-scale projects contribute more effectively to sustainable development goals.

II. LITERATURE REVIEW

2.1. Sustainable Socio-economic Development

The concept of sustainable development, as defined by the World Commission on Environment and Development (WCED, 1987), emphasizes development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable socio-economic development, a central focus of this research, is about achieving economic progress while ensuring that future generations can also thrive. The utilization of impounded raw water in dam reservoirs for various purposes such as water supply, sanitation, irrigated agriculture, power generation, flood control, fisheries, and tourism plays a critical role in advancing the United Nations Sustainable Development Goals (SDGs) (UN, 2015). SDGs such as SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-Being), SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land) are all intricately linked to the effective use of water stored in dam reservoirs (McCully, 2001; World Bank, 2018).

Economic development, as reflected in the effective use of dam reservoirs, involves enhancing productivity and creating wealth. For example, the Gurara project aims to improve water supply for domestic, industrial, and agricultural use, potentially stimulating economic activities in Kaduna State, the Federal Capital Territory (FCT) and environs (World Bank, 2018). The project supports agricultural growth through irrigation, boosts industrial production via reliable water access, and generates renewable energy through hydropower, all of which contribute to broader economic growth (Federal Ministry of Water Resources, 2015). However, achieving sustainable economic development requires ensuring that these gains do not deplete natural resources or generate long-term liabilities (Daly, 1991). This implies that the environmental costs of using dam reservoirs must be minimized, and the benefits should be sustainable over time.

Social equity plays a pivotal role in sustainable development, which must be inclusive, environmentally sustainable, and capable of meeting the needs of both present and future generations. It includes improvements in living standards, access to essential services like healthcare and education, and the fair distribution of resources. The integration of sustainable practices in development projects such as dam construction is essential to balancing economic benefits with environmental conservation and social well-being (Sen, 1999). Ensuring that the benefits from dams are shared equitably among various social groups requires addressing issues such as equitable access to water, the displacement of communities, and livelihood disruptions due to dam construction (Sen, 1999). For instance, the impact of the Gurara Water Transfer Project on local communities in Kaduna State, where the dam is located, must be evaluated alongside its benefits to the FCT (Adeloye & Rustum, 2011).

Environmental sustainability is another crucial aspect of sustainable socio-economic development. The construction of dams and impounded reservoirs can significantly affect ecosystems, influencing water quality, biodiversity, and the flow of downstream water (McCully, 2001). Sustainable development practices require minimizing and mitigating these environmental impacts. Effective water management strategies, environmentally sound dam construction practices, and the protection of aquatic ecosystems are essential for long-term sustainability (Postel & Richter, 2003). The environmental impacts of the Gurara project on the local river ecosystem and downstream habitats must be addressed, with particular attention to issues such as sedimentation, erosion, and changes in water quality (Gordon et al., 2004).

The concept of dams and sustainability highlights the need for the design and management of dams and reservoirs that meet human needs while preserving ecological integrity. This involves ensuring that the benefits of dams are optimized without compromising the ability of future generations to meet their own needs (African Development Bank, 2021). The International Commission on Large Dams (ICOLD) constituted the Technical Committee on Dams and Sustainability to explore how to balance environmental, social, and economic factors in dam projects (ICOLD, 2024). Their goals include promoting sustainability across the entire lifecycle of dams, from planning and design to operation and decommissioning. This committee also addresses the

environmental and social impacts of dams through innovative engineering solutions and policies that support climate change adaptation (ICOLD, 2024).

In the Nigerian context, the need for sustainable socio-economic development is particularly urgent due to the country's rapid population growth, increasing urbanization, and vulnerability to climate change (National Bureau of Statistics, 2020). Impounded dam reservoirs like the Gurara Dam are critical investments in water infrastructure, and their sustainable utilization is vital for addressing water scarcity, supporting economic growth, and improving livelihoods. Achieving sustainability in such projects requires a holistic approach that integrates economic, social, and environmental considerations, underpinned by strong governance and stakeholder engagement (Global Water Partnership, 2000). The assessment of the Gurara Water Transfer Project offers an opportunity to examine the practical application of sustainable socio-economic development principles in a critical water resource project in Nigeria.

2.2 The Nexus Between Impounded Dam Reservoirs and Sustainable Socio-Economic Development

The nexus between impounded dam reservoirs and sustainable socio-economic development is a complex interplay of factors, demanding a balanced approach to resource utilization. Impounded reservoirs, as exemplified by projects like the Gurara Water Transfer Project in Nigeria, hold significant potential to drive socio-economic progress, but their effective management is critical for long-term sustainability (ICOLD, 2022).

Firstly, the economic dimension of this nexus is evident in the enhanced water security these reservoirs provide. Reliable water supplies are fundamental for domestic, industrial, and agricultural sectors. Impounded reservoirs can support irrigation, boosting agricultural output and contributing to food security, a key component of socio-economic stability (Postel & Richter, 2003). They can also foster industrial growth by ensuring consistent water availability for manufacturing and processing. In addition, these reservoirs offer opportunities for hydropower generation, providing a renewable energy source that can drive economic development while reducing reliance on fossil fuels (World Energy Council, 2016). However, this economic utilization must be carefully managed to prevent resource depletion and environmental degradation, aligning with the principles of sustainable development (Daly, 1991).

The social dimension emphasizes the importance of equitable access and distribution of the benefits derived from dam reservoirs. Sustainable socio-economic development necessitates that the advantages, such as improved water access and enhanced livelihoods, are distributed fairly across different social groups (Sen, 1999). This includes addressing potential social disruptions, like displacement of communities and changes in traditional livelihoods, that may result from dam construction and operation (McCully, 2001). Inclusive participation in decision-making processes is crucial to ensure that the needs and concerns of local communities are considered. Moreover, the development of dam reservoirs should contribute to improving living standards, enhancing access to essential services, and fostering social cohesion, as outlined in the United Nations Sustainable Development Goals (United Nations, 2015).

The environmental dimension underscores the critical need to minimize and mitigate the ecological impacts of dam reservoirs. These impacts can include alterations to water quality, loss of biodiversity, and changes in downstream flow regimes (Gordon, McMahon, Finlayson, Gippel, & Nathan, 2004). Sustainable utilization requires the adoption of environmentally sound practices in dam construction and operation, as well as the implementation of effective water management strategies that protect aquatic ecosystems. This includes addressing issues such as sedimentation, erosion, and the disruption of natural hydrological cycles. Furthermore, the nexus requires an understanding of the interconnectedness of water, energy, and food, as seen in the Water-Energy-Food (WEF) Nexus (World Economic Forum, 2011). The water held by the dam can be used for irrigation (food), or to generate power (energy). All of these areas impact each other.

In essence, the nexus between impounded dam reservoirs and sustainable socio-economic development hinges on the ability to balance economic growth, social equity, and environmental sustainability. This requires a holistic and integrated approach to water resource management guided by principles of sustainable development and informed

by an understanding of the complex interactions between different sectors. Through careful planning, effective governance, and stakeholder engagement, impounded dam reservoirs can serve as powerful tools for driving socio-economic progress while safeguarding the environment for future generations.

2.3 The National Policy on Public Private Partnership (PPP) Act, 2009

The National Policy on Public Private Partnership (PPP) Act of 2009 serves as a critical framework for Nigeria's infrastructure development and service delivery. Recognizing the importance of collaboration, the policy actively encourages partnerships between the public and private sectors to bridge the nation's infrastructure gap by leveraging private sector financing and expertise (Infrastructure Concession Regulatory Commission [ICRC], 2009). At its core, the policy is designed to mobilize investment and technical capacity to address Nigeria's pressing infrastructure deficits, particularly in energy, transport, and water resources (World Bank, 2013).

Beyond infrastructure provision, the policy emphasizes the improvement of public service quality and efficiency. By integrating private sector expertise, PPPs are expected to create a more dynamic and responsive service landscape. A guiding principle of the policy is the assurance of value for money, ensuring that projects deliver tangible benefits to citizens while maintaining transparency and accountability (ICRC, 2009). The policy establishes a predictable and transparent environment to foster trust among stakeholders, thereby enhancing investor confidence (Estate Intel, 2016).

The policy is anchored on key principles such as transparency, accountability, equitable risk sharing, and financial viability. It clearly defines the roles of government agencies, with the Infrastructure Concession Regulatory Commission (ICRC) mandated to regulate and oversee PPP projects. The framework provides detailed guidelines for the entire PPP lifecycle, from project identification and appraisal to procurement, implementation, and monitoring (ICRC, 2009).

Recognizing the importance of risk management, the policy highlights strategies for mitigating financial, operational, and social risks in PPP projects. It also underscores the need for stakeholder engagement, promoting consultation and communication throughout the project cycle to ensure inclusivity and public acceptance (World Bank, 2013). Furthermore, the policy prioritizes capacity building, strengthening the public sector's ability to manage complex PPP arrangements effectively (Estate Intel, 2016).

In essence, the National Policy on PPP of 2009 provides a consistent and predictable framework that attracts private sector investment into Nigeria's infrastructure. It contributes to improved service delivery, economic growth, and enhanced national well-being. Importantly, it complements the ICRC Act of 2005, offering a comprehensive approach to PPP governance in Nigeria (ICRC, 2009).

III. METHODOLOGY

This study adopts a qualitative and descriptive research design to assess the effectiveness of the Public-Private Partnership (PPP) framework in the development and management of the Gurara Water Transfer Project (GWTP). By analyzing data from in-depth interviews, secondary data, including project documents, government reports, and related literature, the study evaluates the socio-economic impacts of the project, its alignment with Nigeria's National Policy on PPP (2009), and the overall success of the partnership in achieving the Sustainable Development Goals (SDGs).

3.1 Data Collection

The secondary data for this study, which includes government publications, policy documents, infrastructure reports, and PPP-specific evaluations related to the Gurara Water Transfer Project. The following data sources were consulted:

- Policy Documents: The National Policy on Public-Private Partnership (PPP) Act, 2009, and related regulations from the Infrastructure Concession Regulatory Commission (ICRC).
- Project Reports: The Federal Ministry of Water Resources' reports on the Gurara Water Transfer Project, including feasibility studies, progress reports, and environmental impact assessments.
- Government and Agency Publications: Documents from the ICRC on PPP implementation and regulatory frameworks, which help contextualize how the project

has been managed under the PPP framework.

- Academic Literature: Peer-reviewed journal articles, books, and government publications on PPPs in infrastructure projects, sustainable development, and water resources management in developing countries, particularly Nigeria.
- Official Records: Reports from international bodies such as the World Bank and African Development Bank, which have provided funding and oversight in some capacity for the GWTP.

In addition, data from in-depth interviews of critical stakeholders such as Officials of the Federal Ministry of Water Resources and Sanitation (FMWRS), the Facility Manager (Gams & Abel Ltd) as well as North-South Power Ltd. who manage the power plant were also critical for this study.

3.2 Analytical Approach

This study employs documentary analysis and content analysis techniques to examine and interpret the secondary data collected. The following steps were followed:

i. Document Review: A thorough review of the National PPP Policy (2009), the ICRC Act (2005) and the National Policy on Water Resources and Strategy (2016) provided a comprehensive understanding of Nigeria's regulatory and legal framework for PPPs. This was essential to assess how the Gurara project aligns with national policy and how these regulations have shaped the project's structure and operations.

ii. Content Analysis: A detailed content analysis was conducted on reports from the Federal Ministry of Water Resources and the ICRC, focusing on key indicators such as:
   - Infrastructure development and progress
   - Stakeholder engagement
   - Risk management
   - Socio-economic impacts (e.g., job creation, displacement, and community impacts)
   - Financial viability and sustainability

iii. Comparative Analysis: The study compared the Gurara Water Transfer Project with other similar PPP projects in Nigeria and across Africa. This comparative approach highlights key differences and similarities in project implementation, risk sharing, governance structures, and socio-economic outcomes. It helps contextualize the Gurara project within a broader trend of PPP infrastructure development in developing countries.

iv. Stakeholder Analysis: Given the PPP model's emphasis on collaboration between public and private entities, an analysis of the roles and relationships between various stakeholders (government agencies, private partners, and affected communities) was conducted. This analysis was based on reports and evaluations from the ICRC, the Federal Ministry of Water Resources, and the private sector partners involved in the project.

3.3 Evaluation Framework

The study evaluates the performance of the Gurara Water Transfer Project using a framework of sustainable socio-economic development. The framework focuses on three core dimensions:

1. Economic Sustainability: This dimension evaluates the financial viability of the project, including its impact on local economies, job creation, agricultural productivity, and industrial growth. The framework also examines the PPP model's effectiveness in mobilizing private sector investment for large infrastructure projects.
2. Social Sustainability: This dimension assesses the project's socio-economic impacts, particularly in relation to displacement, compensation, and the well-being of local communities. It also considers how the PPP framework has addressed issues of equity, stakeholder engagement, and social inclusion.
3. Environmental Sustainability: Water quality data were collected from the National Water Quality Reference Laboratory, Minna and were compared with established standards and guidelines to assess compliance and identify potential issues.

IV. FINDINGS

This section presents the findings from the analysis of the Gurara Water Transfer Project (GWTP),

focusing on its implementation under the Public-Private Partnership (PPP) framework and the socio-economic impacts it has encountered. The evaluation aims to provide insights into the effectiveness of the PPP model in supporting sustainable dam management and broader water and energy resource management objectives in Nigeria. The analysis will cover the operational efficiency of the water transfer system, the underutilization of hydropower plant, socio-economic impacts on displaced communities, and the governance and security challenges affecting the project.

4.1 The Role of Public-Private Partnerships in the Gurara Water Transfer Project

The Public-Private Partnership (PPP) framework was central to the development and management of the Gurara Water Transfer Project. The National Policy on PPP (2009) outlined the necessity for leveraging private sector resources, expertise, and efficiency to address Nigeria's infrastructure deficit. Through the establishment of a concession agreement, the Federal Ministry of Water Resources and Sanitation (FMWR) provides overarching policy direction; the FCT Water Board manages urban supply; the Infrastructure Concession Regulatory Commission (ICRC) oversees PPP compliance; North-South Power Limited operates the hydropower component; Gams and Abel Limited has the mandate of the operations and management of the dam, irrigation infrastructure, camp and the water transmission pipeline to Lower Usuma dam. The involvement of private partners was meant to improve efficiency, drive innovation, and optimize resource utilization (ICRC, 2024).

The project's progress reveals a mixed track record of PPP performance. A major challenge confronting the Facility Manager is the vandalization of the pipeline (air valves, washout chambers etc.) from Kaduna State to the FCT. The vandalization if not checked, would affect the transfer of raw water to Lower Usuma Dam reservoir for treatment and delivery to FCT residents. The long delay in the completion of key infrastructure, like the retrofitting of the power plant and the 25km transmission line to Mando, have constituted significant operational inefficiencies. These inefficiencies suggest that the PPP model, while beneficial in theory, encountered difficulties in practical application, particularly in the areas of infrastructure completion, maintenance, and operational coordination.

The PPP arrangement between the Federal Ministry of Water Resources & Sanitation and North South Power Limited to operate the hydropower plant, while promising, has been hindered by these long delays. The plant is now expected to be fully operational by the last quarter of 2024, further underscoring the challenge of turning large infrastructure projects into operational assets under the PPP model.

4.2 Socio-economic Impacts on Displaced Communities

One of the most significant aspects of the Gurara Water Transfer Project is the displacement of local communities. The project involved the relocation of numerous households in the project area. A survey of affected communities revealed that 100% of respondents had been displaced by the project, with 70.8% of them receiving compensation or resettlement assistance. However, 29.2% of respondents reported receiving no compensation, highlighting a significant gap in equitable resettlement efforts.

The displacement had profound socio-economic consequences for local residents. Agricultural activities were significantly affected, with 87.5% of respondents reporting a decline in farming productivity due to the loss of land. Many farmers found themselves without sufficient compensation or adequate alternative farmland, severely disrupting their livelihoods. Despite the provision of infrastructure such as roads, water supply, and schools, the quality and sustainability of these services were often perceived as inadequate, as 87.5% of displaced households acknowledged receiving limited amenities, such as schools and boreholes.

Social and cultural impacts were equally concerning. 91.6% of respondents reported disruption of cultural activities, including the loss of traditional festivals, rituals, and sacred sites. This aligns with the broader findings from other large-scale dam projects, where the cultural disruption caused by displacement leads to long-term social tensions and loss of community cohesion (McCully, 2001; Aliyu & Bose, 2022). Furthermore, insecurity within the resettled areas, largely due to inadequate provision of security and governance, exacerbated the already difficult socio-economic conditions for the affected communities. 94% of respondents reported conflicts within the

communities, often related to land disputes, farmer-herder clashes, and general insecurity.

These findings are consistent with previous studies on dam projects in Nigeria, such as the Kainji Dam, where displacement has been linked to significant social and economic disruption (Adamu & Yusuf, 2019). They underscore the importance of inclusive planning, effective compensation mechanisms, and the need for socio-economic recovery programs to address the aftermath of displacement in large infrastructure projects.

4.3 Environmental Impacts and Sustainability

The environmental sustainability of the Gurara Water Transfer Project is another key aspect of its performance. Water quality analysis of the Gurara Dam and Lower Usuma Dam reveals varying trends in water parameters such as Total Oxidized Nitrogen (TON), Turbidity, Dissolved Oxygen (DO), and E. coli levels over the period from 2019 to 2023. For instance, the Gurara Dam saw a decline in Dissolved Oxygen levels, particularly in the dry season, which could indicate eutrophication and organic pollution resulting from reduced water flow, stagnation, or high temperatures (Postel & Richter, 2003). In contrast, the wet season showed slight improvements, attributed to natural water replenishment and higher oxygenation levels from rainfall. However, the overall decline in DO levels remains a concern for aquatic life and biodiversity (Gordon et al., 2004).

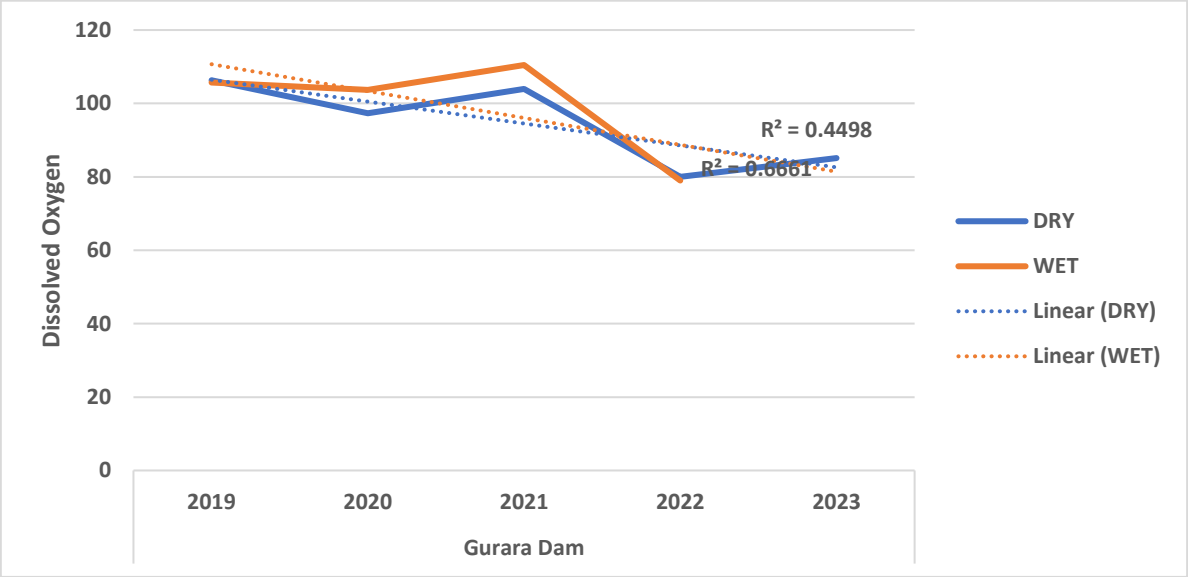

Fig. 3: 2019 – 2023 Dissolved Oxygen Analysis of Gurara Dam Reservoir

Source: Author (2025)

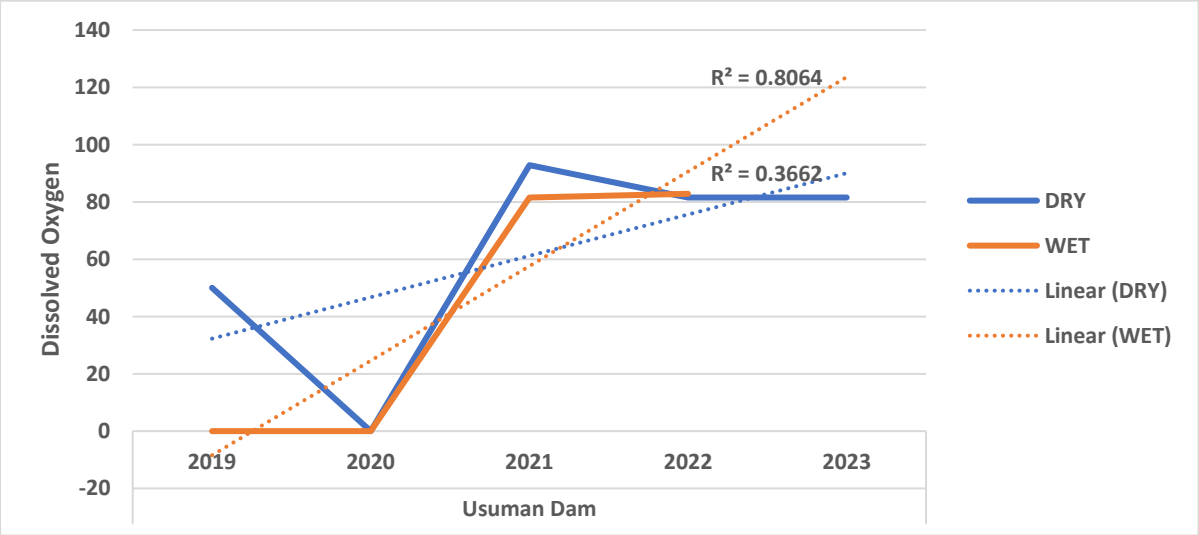

Fig. 4: 2019 – 2023 Dissolved Oxygen Analysis of Lower Usuma Dam Reservoir

Source: Author (2025)

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DOI: https://doi.org/10.64388/IREV9I7-1713859

Similarly, the turbidity levels at Gurara Dam indicated fluctuations, with a strong decrease in the wet season and a slight increase in the dry season. This suggests improvements in water quality during the wet season due to higher inflows but also highlights the potential impact of sedimentation and runoff from upstream agricultural activities during the dry months. These findings align with global experiences, where sedimentation and nutrient loading pose significant challenges to dam reservoirs' long-term sustainability and require ongoing monitoring and mitigation (McCully, 2001).

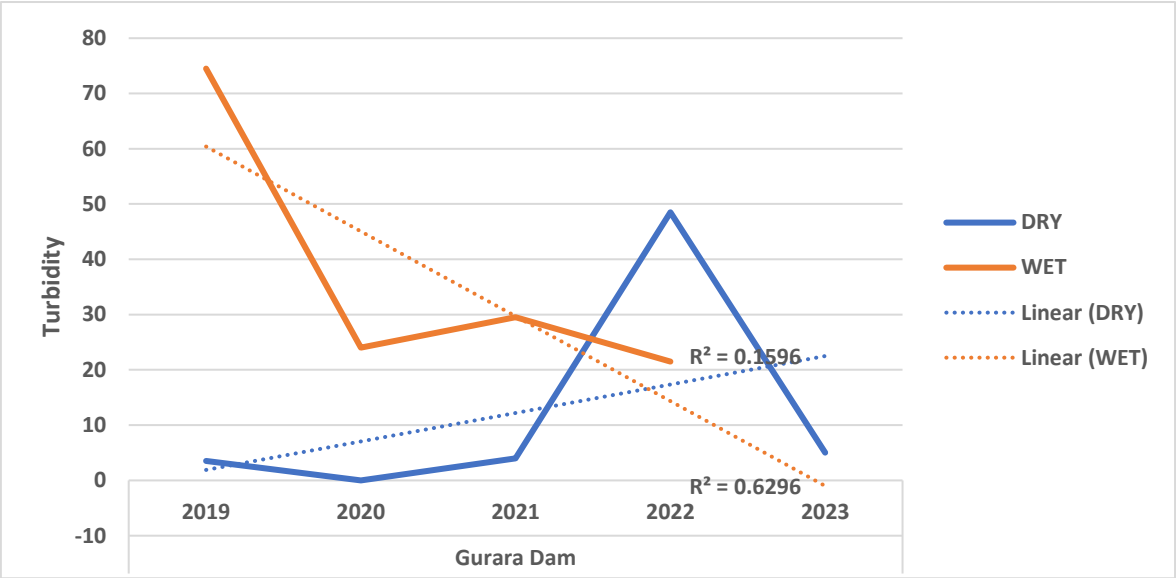

Fig. 5: 2019 – 2023 Turbidity Analysis of Gurara Dam Reservoir
Source: Author (2025)

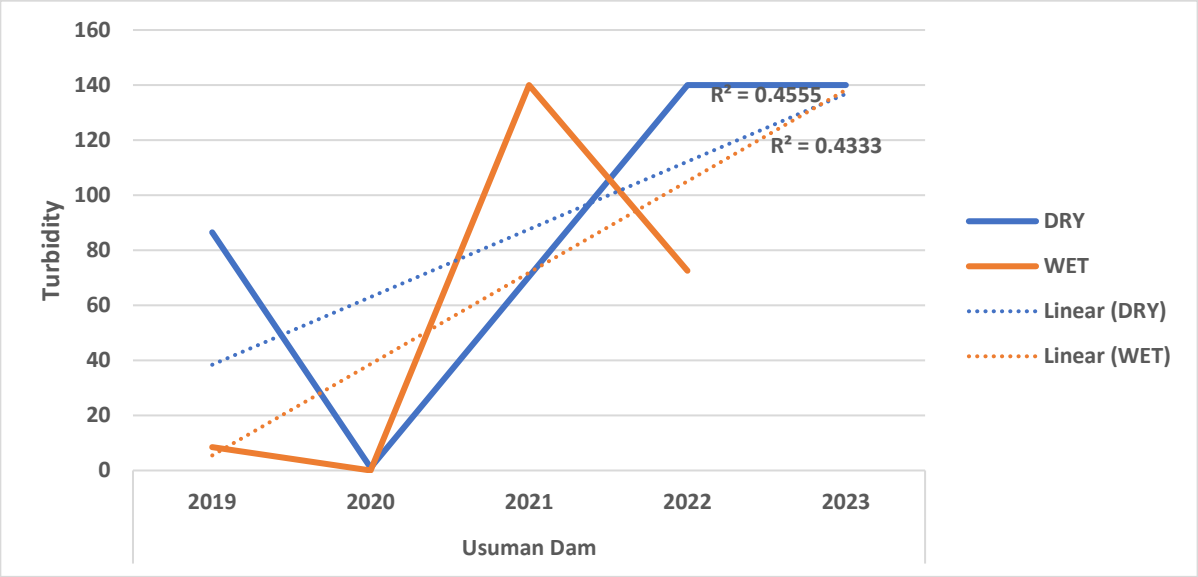

Fig. 6: 2019 – 2023 Turbidity Analysis of Lower Usuma Dam Reservoir
Source: Author (2025)

At the Lower Usuma Dam, the analysis of Total Oxidized Nitrogen (TON) and Orthophosphate levels revealed a moderate increase in nutrient pollution during the dry season, while the wet season showed more variable patterns. This underscores the need for better management practices, especially in terms of controlling nutrient runoff and sedimentation. Although the project aims to improve water supply to Abuja, it is clear that environmental sustainability must be prioritized alongside water distribution goals to maintain ecosystem health and water quality over time (Gordon et al., 2004).

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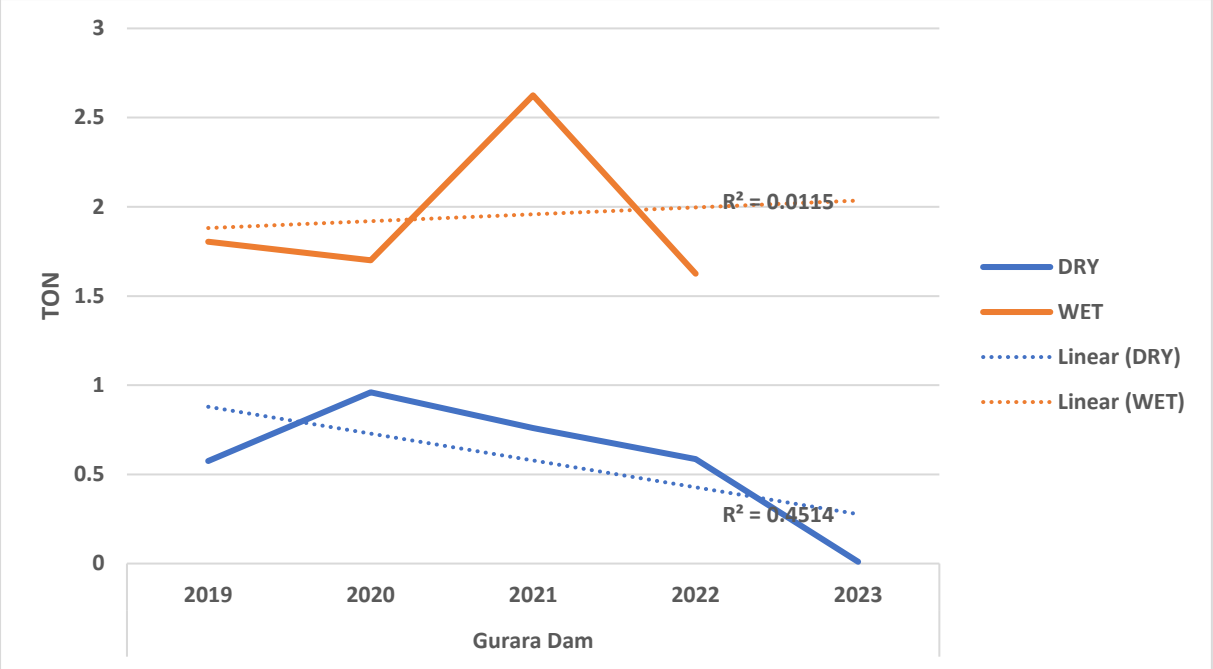

Fig. 7 – 2023 TON Analysis of Gurara Dam Reservoir
Source: Author (2025)

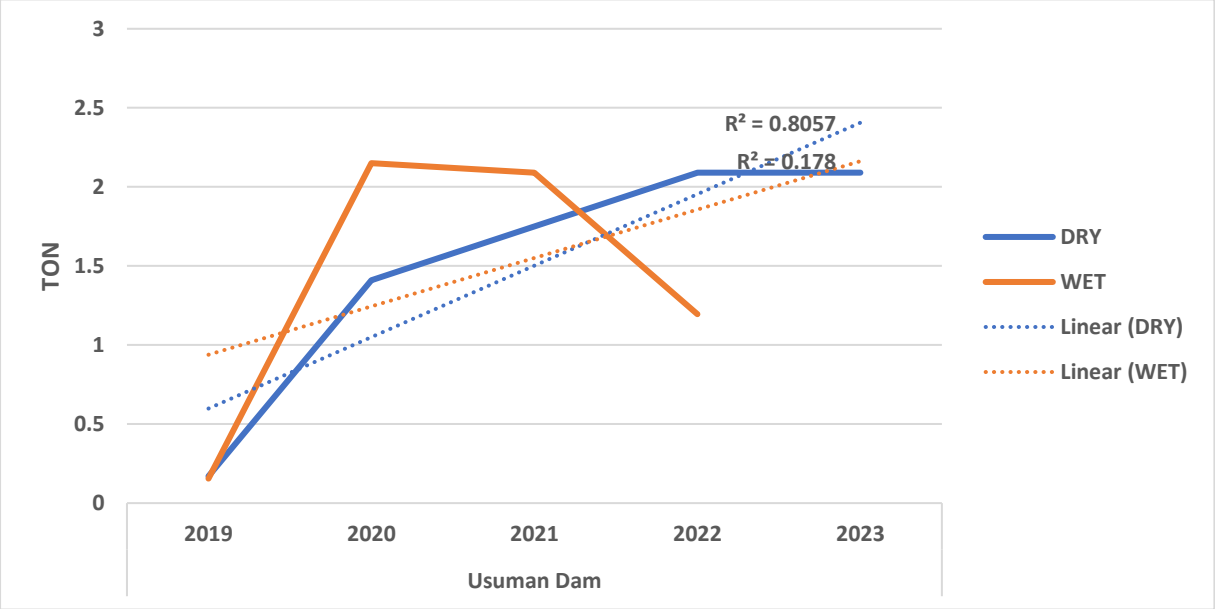

Fig. 8: 2019 – 2023 TON Analysis of Lower Usuma Dam Reservoir
Source: Author (2025)

4.4 Governance, Security, and Project Management Challenges

The governance and security challenges surrounding the Gurara Water Transfer Project have had a profound impact on its operation and success. As highlighted in the findings, security issues in Kaduna State and surrounding areas escalated in the 2010s, severely affecting the project's progress. The banditry, kidnappings, and armed conflicts in regions near the Gurara Dam delayed construction, disrupted operations, and forced the suspension of several critical activities at the dam site (Adewale & Bello, 2023). Despite efforts to address the situation by deploying the Nigeria Civil Defence and Security Corps and later the military, the insecurity remains a significant challenge to the sustainability of the project.

These findings support the idea that infrastructure projects in conflict-prone regions need integrated

security measures and community engagement strategies. The security concerns highlighted in this study emphasize the need for robust risk management and preventive mechanisms when planning large-scale infrastructure projects, especially in volatile areas. Without peace and stability, it is nearly impossible to achieve the long-term objectives of infrastructure development, particularly for projects involving the displacement of communities and significant resource management.

V. CONCLUSION

The Gurara Water Transfer Project stands as a significant infrastructure initiative designed to address Nigeria's growing needs for water, energy, and agricultural development. This study has examined the role of Public-Private Partnerships (PPP) in the project's development and management, focusing on the challenges and socio-economic impacts it has encountered. By evaluating the effectiveness of the PPP model, the study has highlighted the project's successes and limitations, particularly in terms of the long delay in the operation of the hydropower plant, displacement of local communities, and governance challenges. These findings provide valuable insights into the sustainability of such large-scale infrastructure projects and underscore the critical importance of robust planning, transparent governance, and comprehensive early stakeholder engagement.

The Gurara Water Transfer Project has demonstrated the potential of PPP arrangements to mobilize private sector investment and expertise in addressing the country's infrastructure deficit. However, the project has also exposed key weaknesses in its execution, including delayed operational components, particularly the hydropower plant, and the socio-economic impacts of displacement, which have not been adequately mitigated. The ongoing security concerns in the project area further hinder its effectiveness and long-term success. Therefore, the experience of the Gurara Water Transfer Project serves as a valuable case study for the future implementation of PPP projects, offering lessons that can be applied to similar infrastructure development initiatives both in Nigeria and other developing nations.

The Gurara Water Transfer Project provides several valuable lessons that can guide future infrastructure projects, particularly those relying on the Public-Private Partnership (PPP) model:

i. Importance of Strong Governance Mechanisms: The Gurara Project underscores the need for early engagement of all stakeholders and robust governance structures to ensure that PPP projects are implemented effectively. Clear accountability, transparency, and institutional oversight are critical for the success of large-scale infrastructure projects. The involvement of multiple stakeholders, including public and private entities, requires careful coordination to align objectives, resources, and timelines. Strong governance ensures that the project remains on track and that stakeholders, particularly local communities, are not left behind.
ii. Comprehensive Planning and Risk Management: The long delay in the operation of the hydropower component and the delays in critical infrastructure highlight the need for comprehensive project planning and effective risk management strategies. These elements should be integrated into the project lifecycle from the feasibility phase through to implementation and operation. Additionally, robust mechanisms for risk-sharing between public and private partners should be designed to mitigate unforeseen challenges, such as delays in infrastructure completion or security issues.
iii. Prioritization of Environmental Management: Environmental sustainability is often sidelined in large infrastructure projects, but it is crucial for their long-term success. The Gurara Water Transfer Project has shown that environmental impacts, such as water quality degradation and ecosystem disruption, must be continuously monitored and mitigated. Future projects must include comprehensive environmental assessments, sustainable water management strategies, and ongoing monitoring to reduce adverse ecological effects, ensuring the preservation of biodiversity and the health of surrounding ecosystems.
iv. Enhancing Operational Efficiency: The Gurara Project's operational inefficiencies, especially regarding hydropower generation and, irrigated agriculture, indicate the need

for improved maintenance and management systems. Future PPP projects must emphasize the development of effective maintenance frameworks that ensure the smooth functioning of infrastructure over time. The role of private operators, particularly in managing critical infrastructure like hydropower plants, irrigated agriculture infrastructure should be clearly defined, with performance metrics and timelines to ensure that facilities are operational as planned.

v. Improved Security Measures for Infrastructure Sustainability: The security crisis surrounding the Gurara Dam significantly disrupted the project's operations. As infrastructure projects often require long-term stability, ensuring security in regions prone to conflict is essential. Future water infrastructure projects should integrate security planning into the project's operational framework, with provisions for community engagement and conflict resolution strategies to address security risks.

vi. Capacity Building and Institutional Strengthening: For PPP projects to succeed, there must be significant investments in capacity building within public sector institutions. This includes strengthening the ability of government agencies to manage complex projects and partnerships, as well as ensuring that local communities are equipped with the skills to take advantage of the opportunities created by such projects. The Gurara Project illustrated that poor institutional capacity can hinder effective management and long-term sustainability. Therefore, training and capacity-building initiatives must be a core component of all large-scale infrastructure projects.

In conclusion, the Gurara Water Transfer Project offers valuable insights into the challenges and opportunities presented by Public-Private Partnerships in infrastructure development. While the project has achieved significant milestones in improving water supply to thew FCT, it has encountered substantial barriers related to governance, security, and socio-economic impacts on displaced communities. The lessons learned from the Gurara Project can inform the design and implementation of future PPP projects in Nigeria and other developing countries, ensuring that these initiatives contribute to long-term, sustainable development goals. By addressing gaps in governance, stakeholder engagement, environmental management, and security, future projects can maximize their potential to drive economic growth, improve public services, and contribute to the well-being of affected communities.

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