



## Evaluation of Planning Strategies for Water Stress Management and Sustainable Urban Development in Maiduguri Metropolis, Nigeria

<sup>1</sup>Modu Buakar, <sup>2</sup>Rasheed Oladosu & <sup>3</sup>Haruna Baba Bwala

<sup>1,2&3</sup>Department of Urban & Regional Planning Abubakar Tafawa Balewa University, Bauchi, Nigeria

<https://orcid.org/0009-0009-8065-1930>

\*Corresponding author: [modubukar76@gmail.com](mailto:modubukar76@gmail.com)

### ABSTRACT

**Background:** Urban water stress has emerged as a major environmental and planning challenge in many semi- arid cities of Sub-Saharan Africa due to rapid population growth, climate variability, and inadequate infrastructure. Maiduguri Metropolis in north-Eastern Nigeria increasingly experiences water shortages, prompting residents to adopt various coping strategies to meet domestic water needs.

**Objective:** This study evaluated household coping strategies for water stress and examines their implications for sustainable urban development in Maiduguri Metropolis, Nigeria.

**Method:** A cross-sectional descriptive survey design was adopted. Primary data were collected from 380 households using a structured questionnaire administered through stratified random sampling across selected residential wards. Supplementary data were obtained through interviews with officials from the Borno State Water Board. Data were analysed using descriptive statistics, including frequencies and percentages.

**Result:** The findings reveal that the most common coping strategies include walking long distances to fetch water (31%), purchasing water from vendors (25%), and storing water in containers (18%). Less common strategies include rainwater harvesting and private borehole development. These coping mechanisms are largely reactive and unsustainable.

**Conclusion:** The study concludes that water stress in Maiduguri Metropolis is primarily driven by inadequate urban water infrastructure and weak water governance, forcing residents to depend on temporary coping mechanisms.

**Unique contribution:** The study contributes to urban planning literature by demonstrating how household coping practices reflect systemic deficiencies in urban water governance in semi- arid cities.

**Key Recommendation:** The study recommends integrating Integrated Urban Water Management (IUWM) into urban planning policies, expanding decentralised water infrastructure, and strengthening institutional coordination to ensure a sustainable urban water supply.

**Keywords:** Water stress; coping strategies; urban water governance; sustainable urban development; Integrated Urban Water Management (IUWM); Maiduguri Metropolis; Nigeria.



## **INTRODUCTION**

Water is a fundamental natural resource essential for human survival, economic development, and environmental sustainability. Globally, water scarcity has become one of the most pressing environmental challenges of the twenty-first century. According to recent global assessments, more than two billion people currently live under conditions of water stress, and this number is expected to increase due to climate change, rapid urbanisation, and population growth. In Sub-Saharan Africa, the situation is particularly difficult because of weak infrastructure, limited investment in water supply systems, and inefficient water governance structures. Urban areas are increasingly facing water shortages due to rapid population growth and unplanned spatial expansion. Consequently, urban residents often rely on alternative coping strategies such as purchasing water from informal vendors, travelling long distances to access water points, or storing water in large containers.

Nigeria faces significant water supply challenges, especially in rapidly growing cities. In many Nigerian urban centres, water supply infrastructure has not kept pace with population growth and urban development. As a result, residents frequently depend on groundwater sources such as boreholes or informal water vendors. Maiduguri Metropolis, located in the Sudan–Sahel ecological zone of northeastern Nigeria, experiences severe water stress due to its semi-arid climate, rapid population growth, and limited water infrastructure. The increasing water demand has placed considerable pressure on the existing water supply system, forcing many households to adopt coping strategies to meet their daily water needs. Although several studies have examined water scarcity and household coping strategies in developing countries, limited attention has been given to how these coping mechanisms relate to urban planning strategies and sustainable urban development in semi-arid cities. This study, therefore, aims to evaluate household coping strategies for water stress in Maiduguri Metropolis and assesses planning strategies required to support sustainable urban water management.

## **LITERATURE REVIEW**

### **2.1 Concept of Water Stress**

Water stress refers to a situation where the demand for water exceeds available supply within a specific period or when poor water quality restricts its use for human consumption, agriculture, or industrial purposes. It has become one of the most critical environmental challenges of the twenty-first century due to increasing population growth, climate change, and rapid urbanisation (Falkenmark, 1989). Recent global assessments indicate that more than two billion people currently live under water-stressed conditions, and this number is expected to increase significantly as climate change intensifies hydrological variability and increases water demand worldwide (UN-Water, 2023).

In Sub-Saharan Africa, water stress is further exacerbated by inadequate water infrastructure, weak institutional capacity, and heavy reliance on irregular rainfall patterns (WWAP, 2020). Rapid urbanisation across the region has placed additional pressure on existing water resources, making it increasingly difficult for cities to provide reliable water supply services. Studies have shown that urban water stress is becoming more pronounced in semi-arid regions where climate variability and limited investment in water infrastructure combine to create severe water supply challenges (Ayanlade, 2024).



## **2.2 Urban Water Scarcity and Its Causes**

Urban water scarcity has become increasingly common in developing countries where population growth and urban expansion outpace infrastructure development. Rapid urbanisation places significant pressure on existing water supply systems, resulting in unreliable water services and unequal access to safe water (Guppy & Anderson, 2017). As urban populations continue to expand, water demand increases significantly, often exceeding the capacity of existing water infrastructure.

In Nigeria, many cities experience frequent water shortages due to ageing water supply infrastructure, contamination of surface water sources, and overdependence on groundwater extraction through privately drilled boreholes (Ayoade, 2018). Northern Nigerian cities such as Maiduguri face additional challenges due to their semi-arid climatic conditions, limited rainfall, and increasing population pressure. Furthermore, conflict-induced displacement in the North-East region has significantly increased urban population density in Maiduguri, thereby intensifying water demand and widening disparities in access to water resources (Okonkwo & Oladipo, 2021).

Recent studies have also highlighted the role of climate change, weak governance systems, and inadequate urban planning in contributing to urban water scarcity across African cities (Anghileri et al., 2024). These factors undermine the efficiency of urban water systems and limit the ability of cities to provide a reliable water supply to their residents.

## **2.3 Household Coping Strategies to Water Scarcity**

In situations where formal water supply systems fail to meet household demand, residents often adopt coping strategies to secure water for their daily activities. Coping strategies are temporary or adaptive responses adopted by households to manage the effects of unreliable water supply (Onyenechere, 2010). Common coping mechanisms include purchasing water from vendors, storing water in containers, drilling private boreholes, harvesting rainwater, and reducing water consumption.

Although these coping strategies help households manage water shortages, they often create socio-economic challenges. Studies have shown that reliance on informal water markets can reinforce inequality because low-income households tend to spend a larger proportion of their income on water purchased from private vendors (Akpabio, 2012). Similarly, research conducted in Maiduguri Metropolis found that many households travel long distances to fetch water from public taps due to the uneven spatial distribution of water supply infrastructure (Muktar & Abubakar, 2019).

More recent studies indicate that households in water-stressed urban areas frequently combine multiple coping strategies to manage unreliable water supply systems (Rosado et al., 2024). While these strategies provide temporary relief, they do not address the underlying structural deficiencies in urban water supply systems.



## **2.4 Integrating Water Management into Sustainable Urban Development**

Sustainable urban development emphasizes the efficient use and management of natural resources in order to meet present needs without compromising the ability of future generations to meet their own needs (WCED, 1987). In urban environments, water management plays a critical role in achieving environmental sustainability and improving urban resilience.

Urban planners increasingly advocate for the integration of water-sensitive planning approaches such as Water-Sensitive Urban Design (WSUD) and Integrated Urban Water Management (IUWM). WSUD integrates water management with urban planning through strategies such as rainwater harvesting, stormwater management, wastewater recycling, and groundwater recharge (Brown et al., 2009). These approaches aim to reduce water demand while improving environmental sustainability in urban areas.

Similarly, IUWM promotes the coordinated management of water supply, wastewater, and stormwater systems within a comprehensive planning framework. This integrated approach improves water efficiency, reduces environmental degradation, and enhances the resilience of urban water systems to climate change (UN-Habitat, 2020). For water-stressed cities such as Maiduguri, adopting decentralised water infrastructure, strengthening institutional frameworks, and promoting sustainable water management practices are essential strategies for long-term urban sustainability (Mokone et al., 2025).

## **2.5 Planning Strategies for Managing Water Scarcity**

Effective management of water scarcity requires coordinated planning strategies across international, national, and local levels. According to UN-Water and FAO (2009), water scarcity should be addressed through multidisciplinary approaches that integrate environmental, social, economic, and institutional considerations.

At the international level, countries are encouraged to cooperate in managing transboundary water resources such as rivers, lakes, and aquifers through frameworks such as Integrated Water Resources Management (IWRM). This approach promotes equitable allocation of water resources and collaborative decision-making among stakeholders.

At the national level, governments must develop policies that address increasing water demand while ensuring equitable access to water resources. Institutional coordination among water management agencies and stakeholder participation in decision-making processes are essential for improving water governance and resolving water-related conflicts.

At the local level, urban planning interventions play a crucial role in enhancing water security. These interventions may include the development of new water infrastructure, promotion of water conservation technologies, expansion of rainwater harvesting systems, and capacity building in water resource management (UN-Water, 2017). Research indicates that combining infrastructure development with effective governance and community



participation is essential for achieving sustainable water management in rapidly growing cities (Ayanlade, 2024).

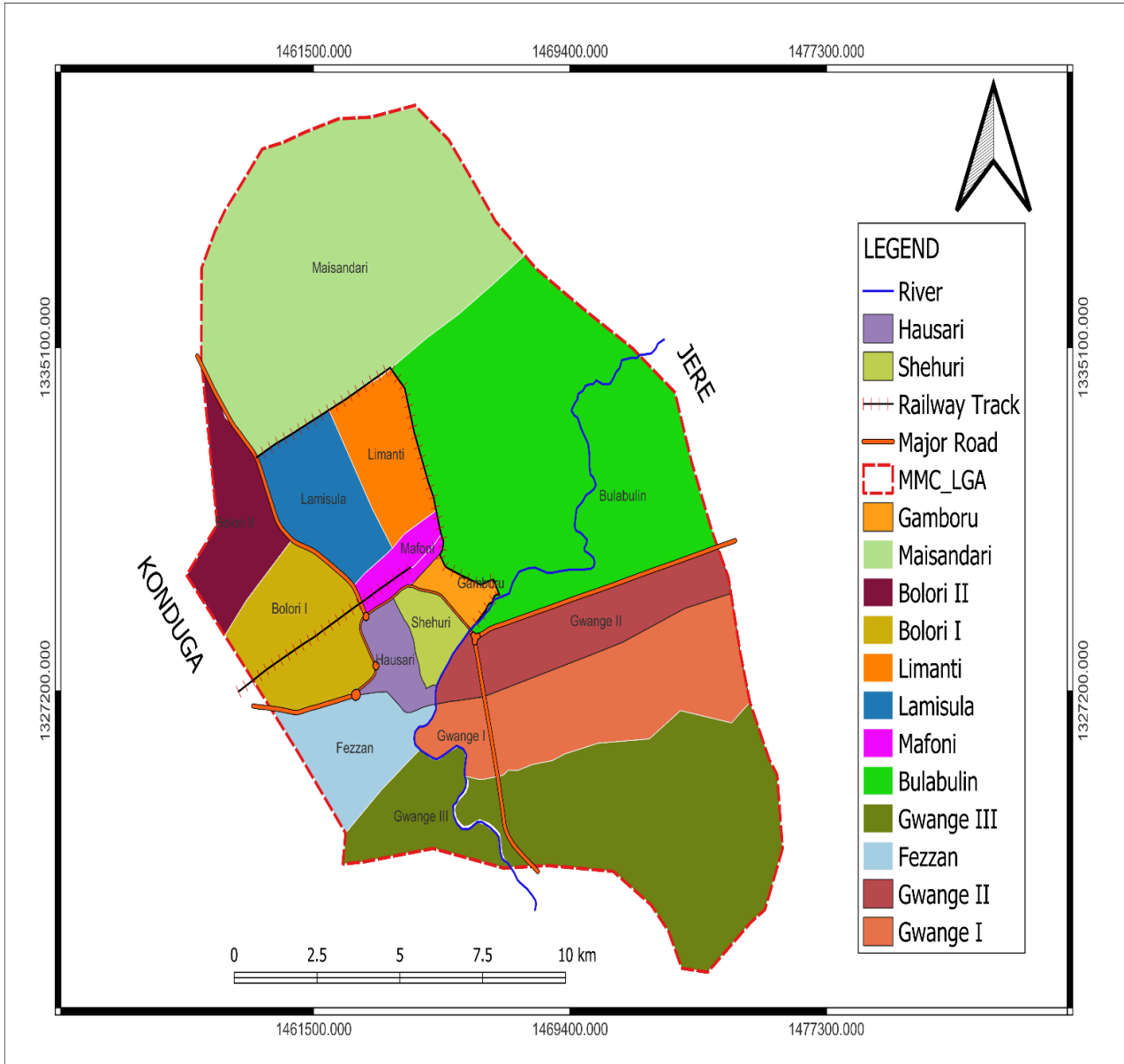
Overall, the literature suggests that although household coping strategies may temporarily alleviate water shortages, sustainable solutions require integrated planning approaches that combine infrastructure development, institutional reform, and community participation. Such strategies are essential for ensuring a reliable water supply and promoting sustainable urban development in water-stressed cities such as Maiduguri Metropolis.

## **METHODOLOGY**

This study adopted a cross-sectional descriptive survey design to examine household coping strategies for water stress in Maiduguri Metropolis, Borno State, Nigeria. Maiduguri lies within the Sudan–Sahel ecological zone, which is characterised by low annual rainfall and high evapotranspiration, conditions that contribute significantly to water scarcity in the region. The target population comprised household heads residing in selected residential wards of the metropolis. A sample size of 380 households was selected using stratified random sampling to ensure adequate representation of different residential areas experiencing water stress.

Primary data were collected through a structured questionnaire administered to the selected households, capturing information on household socio-economic characteristics, sources of water supply, accessibility to water, and coping strategies adopted during periods of water shortage. In addition, key informant interviews were conducted with officials from the Borno State Water Board and the Urban Planning Board to obtain supplementary information on urban water supply and management practices. The research instrument was validated through expert review and pilot testing to ensure clarity and reliability. Data collected were analysed using descriptive statistical techniques, specifically frequencies and percentages, to identify the dominant coping strategies and patterns of water access among households in Maiduguri Metropolis.

**Map of the study area**



*Figure 1: Map of Maiduguri metropolis*

**Source:** Author (2025)

**3. RESULTS**

Table 1 presents the distribution of coping strategies adopted by households in the study area.

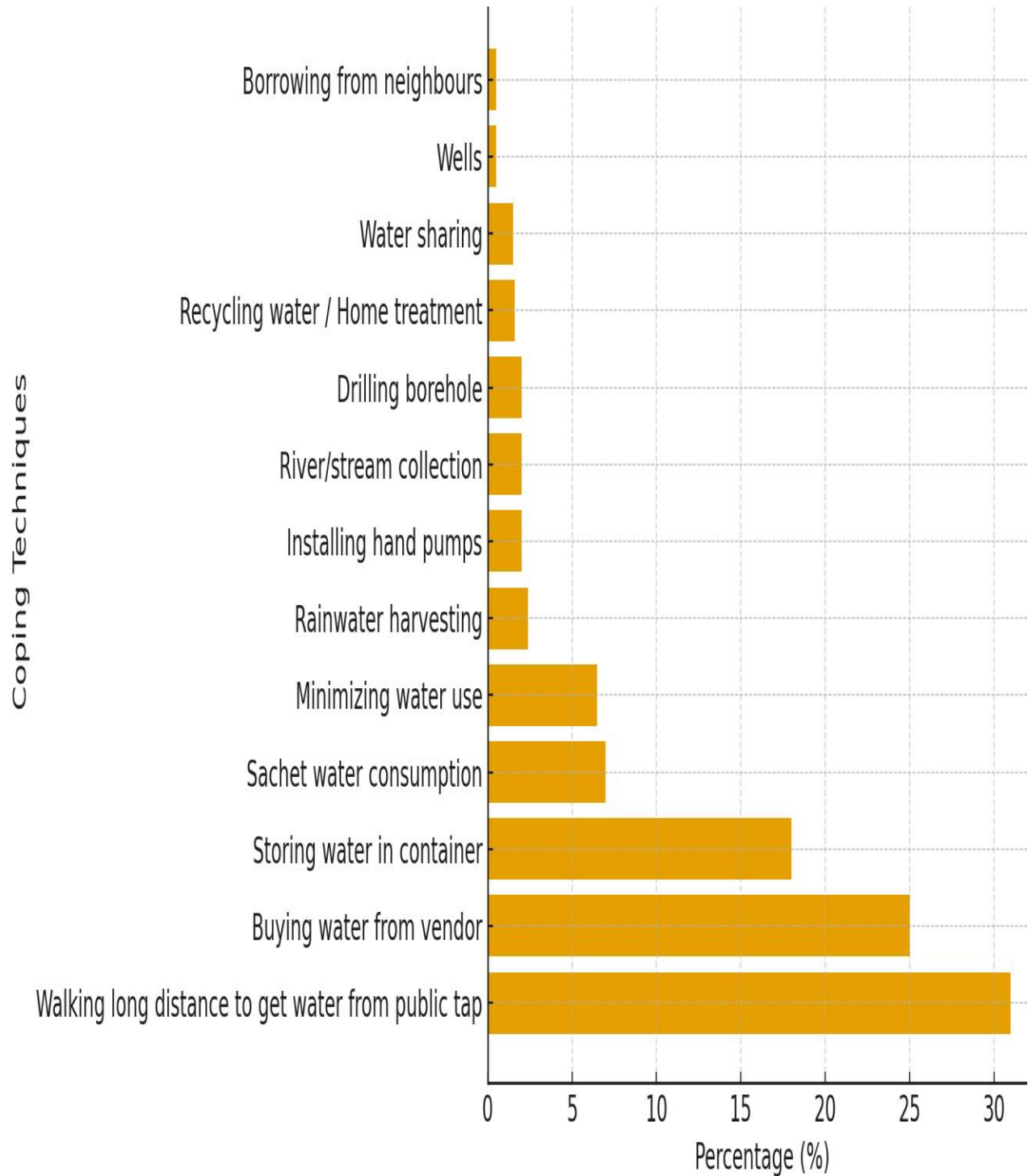


Figure 2: Techniques for Coping with Water Scarcity in Maiduguri Metropolis.



#### 4. DISCUSSION

The results reveal that households in Maiduguri Metropolis adopt a wide range of coping strategies to manage water stress, with some strategies being far more prevalent than others. The most dominant coping practice identified in this study is walking long distances to access water from public taps (31%), followed by purchasing water from vendors (25%) and storing water in containers (18%). Other coping strategies, such as sachet water consumption (7%), minimising water use (6%), and rainwater harvesting (3%), were moderately practised, while strategies such as installing hand pumps, river/stream collection, drilling boreholes, home water treatment, water sharing, and borrowing from neighbours were relatively less common.

The high proportion of households walking long distances to fetch water indicates serious spatial and infrastructural deficiencies in the urban water supply system. This finding aligns with previous studies conducted in water-stressed cities of Sub-Saharan Africa, where households frequently travel significant distances to obtain water due to limited access to a piped water supply (Mukhtar & Abubakar, 2019; UN-Habitat, 2020). Similarly, Okonkwo and Oladipo (2021) observed that households in northeastern Nigerian cities often rely on distant public water points as a result of inadequate urban water infrastructure. The dominance of this coping strategy in Maiduguri suggests that water supply facilities are unevenly distributed across residential neighbourhoods, forcing residents to depend on physically demanding water collection practices.

The second most common coping mechanism—purchasing water from vendors (25%)—highlights the growing role of informal water markets in meeting urban water demand. This result supports the findings of Akpabio (2012), who noted that water vendors often emerge as alternative suppliers in cities where formal water utilities fail to provide reliable services. However, reliance on water vendors may have negative socio-economic implications because low-income households typically pay higher prices for water purchased from informal vendors compared to households connected to formal piped systems. The relatively high proportion of households purchasing water in Maiduguri, therefore, suggests that water scarcity is not only an infrastructural challenge but also an economic burden for urban residents.

Another notable coping strategy identified in the study is storing water in containers (18%), which reflects household adaptation to intermittent water supply. This finding is consistent with studies in other developing cities where households store water to manage irregular supply schedules (Rosado et al., 2024). The widespread use of water storage containers in Maiduguri suggests that households anticipate water shortages and attempt to secure water whenever it becomes available. However, prolonged water storage may also raise concerns about water quality and public health risks.

Moderately practised strategies such as minimising water use (6%) and sachet water consumption (7%) represent behavioural adjustments by households attempting to cope with water scarcity. These findings suggest that residents are actively modifying their water consumption patterns in response to limited supply. Similar behavioural adaptations have been documented in other water-stressed urban environments where households ration water to extend limited supplies (Ayanlade, 2024).



In contrast, relatively few households reported adopting more sustainable coping strategies such as rainwater harvesting (3%), installing hand pumps (2%), or drilling private boreholes (2%). The limited adoption of these strategies may be attributed to financial constraints, technical barriers, or limited institutional support for decentralised water systems. Rainwater harvesting, for example, requires adequate storage facilities and seasonal rainfall, both of which may be limited in semi-arid regions such as Maiduguri. Similarly, drilling private boreholes requires significant financial investment, which may be beyond the capacity of many households.

Overall, the findings suggest that most coping strategies adopted by households in Maiduguri are reactive and short-term responses rather than sustainable long-term solutions. The dominance of physically demanding or economically costly strategies indicates significant gaps in urban water governance and infrastructure provision. While previous studies have documented similar coping strategies in developing cities, this study extends existing knowledge by providing empirical evidence on the relative prevalence of different coping mechanisms within a semi-arid urban context. By highlighting the spatial, economic, and behavioural dimensions of household responses to water scarcity, the study contributes to the broader literature on urban water governance and sustainable urban development in water-stressed cities.

The findings, therefore, emphasise the urgent need for integrated urban water management strategies that address infrastructural deficiencies, strengthen institutional coordination, and promote sustainable water management practices in Maiduguri Metropolis.

## **5. CONCLUSION**

This study examined household coping strategies adopted to manage water stress in Maiduguri Metropolis and evaluated their implications for sustainable urban development. The findings reveal that residents rely heavily on short-term coping mechanisms such as walking long distances to fetch water from public taps, purchasing water from vendors, and storing water in containers. These strategies reflect the inadequacy and uneven distribution of urban water supply infrastructure within the metropolis. The dominance of these coping practices suggests that the formal water supply system is unable to meet the growing demand of the urban population.

Based on the results, the study concludes that water stress in Maiduguri Metropolis is primarily driven by inadequate infrastructure, weak water governance, and increasing population pressure. As a result, households depend on reactive coping strategies that are often physically demanding, economically costly, and unsustainable in the long term. While these strategies temporarily address water shortages, they do not provide a lasting solution to the structural challenges affecting urban water supply in the city. Achieving sustainable urban development in Maiduguri, therefore, requires integrated planning interventions that strengthen water governance, expand water infrastructure, and promote sustainable water management practices.



## 6. RECOMMENDATIONS

Based on the findings of the study, the following recommendations are proposed:

**Expansion of Urban Water Infrastructure:** The government should invest in the expansion and rehabilitation of water supply infrastructure, including pipelines, treatment plants, and public water distribution networks, to improve access to reliable water supply across all residential areas of Maiduguri.

**Adoption of Integrated Urban Water Management (IUWM):** Urban planning authorities should incorporate Integrated Urban Water Management approaches into city planning to ensure coordinated management of water supply, wastewater, and stormwater systems.

**Promotion of Decentralised Water Supply Systems:** Decentralised systems such as community boreholes, rainwater harvesting systems, and small-scale water treatment facilities should be encouraged to supplement the formal water supply system.

**Strengthening Institutional Coordination:** Improved collaboration between the Borno State Water Board, urban planning authorities, and other relevant agencies is necessary to enhance effective water governance and policy implementation.

**Public Awareness and Water Conservation Programs:** Community education programs should be implemented to encourage water conservation practices and promote sustainable water use among residents.

**Support for Sustainable Household Water Solutions:** Government and development partners should support households through subsidies or technical assistance to adopt sustainable water solutions such as rainwater harvesting and household water treatment technologies.

### **Ethical clearance**

Ethical consent was obtained from all participants involved in this study. Participation was voluntary, and respondents were informed that the research was conducted strictly for academic purposes.

### **Acknowledgements**

The author acknowledges the support of the Borno State Water Board and residents of Maiduguri Metropolis who participated in the survey.

### **Sources of Funding**

This research did not receive any specific grant from funding agencies.

### **Conflict of Interest**

The author declares no conflict of interest.

### **Authors' Contributions**

Modu Bukar conceived the study, collected the data, analysed the results, and prepared the manuscript

### **Data Availability Statement**

The datasets used for this study are available from the author upon reasonable request.

### **Citation**

Bukar, M. (2026). *Evaluation of planning strategies for water stress management and sustainable urban development in Maiduguri Metropolis, Nigeria. International Journal of Sub-Saharan African Research*, 4(1), 282-293



## REFERENCES

- Akpabio, E. M. (2012). Water supply and sanitation services sector in Nigeria: The policy trend and practice constraints. *ZEF Working Paper Series*, 93, 1–24.
- Anghileri, D., Castelletti, A., & Soncini-Sessa, R. (2024). Urban water scarcity and climate change challenges in Sub-Saharan Africa. *Journal of Environmental Management*, 342, 118024. <https://doi.org/10.1016/j.jenvman.2024.118024>
- Ayanlade, A. (2024). Climate variability and urban water supply challenges in West Africa. *Climate and Development*, 16(3), 256–268. <https://doi.org/10.1080/17565529.2023.2264270>
- Ayoade, J. O. (2018). *Climate change and water resources in Nigeria*. Ibadan University Press.
- Brown, R. R., Keath, N., & Wong, T. H. F. (2009). Urban water management in cities: Historical, current and future regimes. *Water Science and Technology*, 59(5), 847–855. <https://doi.org/10.2166/wst.2009.029>
- Cochran, W. G. (1977). *Sampling techniques* (3rd ed.). John Wiley & Sons.
- Falkenmark, M. (1989). The massive water scarcity now threatening Africa—Why isn't it being addressed? *Ambio*, 18(2), 112–118.
- Guppy, L., & Anderson, K. (2017). *The global water crisis: Addressing an urgent security issue*. United Nations University Institute for Water, Environment and Health.
- Mokone, N., Nhamo, G., & Mabhaudhi, T. (2025). Water security and governance challenges in Southern Africa. *Frontiers in Water*, 7, 112–126. <https://doi.org/10.3389/frwa.2025.112126>
- Muktar, A., & Abubakar, S. (2019). Household water accessibility and coping mechanisms in Maiduguri Metropolis, Borno State, Nigeria. *Journal of Environmental Studies*, 4(2), 45–59.
- Nsude, I. & Nwafor, K. A. (2016). Environmental Education: A Communication Impact Analysis. *IDOSR Journal of Communication and English* 1(1), 24-44. Available online at: <https://www.idosr.org/wp-content/uploads/2017/01/IDOSR-JCE-24-44.pdf>
- Okonkwo, C. N., & Oladipo, A. E. (2021). Water insecurity and sustainable development challenges in Northern Nigeria. *African Journal of Environmental Management*, 15(1), 89–103.
- Onyenechere, E. C. (2010). Climate change and spatial planning for sustainable water management in Nigeria. *Journal of Human Ecology*, 32(3), 175–182.
- Rosado, D., Marques, R. C., & Costa, L. (2024). Household coping mechanisms to urban water scarcity: Evidence from developing countries. *Water Resources Management*, 38(5), 2141–2156. <https://doi.org/10.1007/s11269-024-03567-1>



UN-Habitat. (2020). *World cities report 2020: The value of sustainable urbanisation*. United Nations Human Settlements Programme.

UN-Water. (2017). *Wastewater: The untapped resource*. United Nations World Water Development Report. UNESCO.

UN-Water. (2023). *United Nations world water development report 2023: Partnerships and cooperation for water*. UNESCO.

WCED (World Commission on Environment and Development). (1987). *Our common future*. Oxford University Press.

WWAP (World Water Assessment Programme). (2020). *The United Nations world water development report 2020: Water and climate change*. UNESCO.