ZIBELINE INTERNATIONAL™ PUBLISHING

**Water Conservation & Management (WCM)**

*DOI: http://doi.org/10.26480/wcm.02.2025.249.256*

***ISSN: 2523-5664 (Print)***
***ISSN: 2523-5672 (Online)***
***CODEN: WCMABD***

*REVIEW ARTICLE*

# MANAGING URBAN WATER BODIES FOR SUSTAINABLE DEVELOPMENT IN RAPIDLY URBANIZING WEST AFRICAN CITIES: INSIGHTS FROM BURKINA FASO

**Idrissa Kaboré**

***Laboratoire de Biologie et Ecologie animales (LBEA), UFR/SVT, Université Joseph KI-ZERBO, 03 BP 7021 Ouagadougou 03 (Burkina Faso)***
****Corresponding Author Email : idrissa_kabore@ujkz.bf***



**ARTICLE DETAILS**

***Article History:***

Received 23 February 2025
Revised 18 March 2025
Accepted 03 April 2025
Available online 10 April 2025

**ABSTRACT**

Uncontrolled urbanizations, combined with lack of management strategies in low-income countries, have raised big concern about the sustainability of urban centers, particularly in West Africa. The increasing human pressures, climate variability, and inconsistency of policies have exacerbated the urban crisis in West Africa. For this reason, we have updated the reviews of potential threats in urban environments, including water bodies, and addressed holistic approaches for successful integrated management of urban centers. To do so, the method used in the study is based on a detailed tracking of specific keywords in the literature using Google Scholar, ResearchGate, Academia.edu, ScienceDirect, and Scopus. Based on recent relevant literatures, we have conceptualized knowledge on pressures in urban areas and their interactions with their relationships to water quality. We found that urban centers in West Africa are under severe threats, including water contamination by faecal and heavy metals, physical environment degradation by waste dumps resulting in smelling waters and undesirable air, and soiled vegetables. The results also showed that microbiological contamination in vegetables and water columns largely exceeded the reference standards. Therefore, following the conceptual framework of building a new paradigm, including policy implementation, creating a new urban landscape design through well adapted urban engineering and integrated water management, good management of municipal waste, and educating citizens about environmental responsibility are crucial for long-terms sustainability of urban centers. This research outputs may help to increase awareness and state-of-the-art development of suitable cities for the well-being of the population in Burkina Faso.

**KEYWORDS**

Urbanization, Waterbodies, Pollution, Sustainability, West Africa.

## 1. INTRODUCTION

Worldwide, large cities have to adapt to rapid population growth resulting from natural increases and rural-urban migration. Such rapid growth is the basis of industries growing and other activities in cities. Water systems in an urban area contribute substantially to urban welfare, but rising population density and economic development are driving an increasing demand for intense urbanization, resulting in increased environmental damage (Everard et al., 2012; Collier et al., 2015; Sado-Inamura et al., 2018; Ferreira et al., 2018; Richardson and Soloviev, 2021; Odume et al., 2022). Therefore, better management of big cities has become a big concern for citizens, governments, and the international community (Xia et al., 2014; Beißler and Hack, 2019; Mehta and Jade, 2024; Bhonde et al., 2024).

In developing countries, particularly in West african region, urban water bodies are among the most threatened, exacerbating the urban environmental crises (Capps et al., 2015; Odume et al., 2022; Mishra and Saxena, 2024). Indeed, surface waters are under several human-manifold pressures derived from human activities that affect ecological conditions and cause public health problems (Kaboré et al., 2018, 2023; Haarstrick and Sharma, 2024). Thus, industrial pollution including the impacts of poorly managed hazardous wastes, imposes serious health impacts to urban areas. In addition, the lack of robust surface water management strategies, unplanned urbanization, and major research deficits (e.g. quantifying the negative impacts of urban activities) pose serious problems for the development of West African cities (Obeng- Osawe and Ojeifo, 2019; Okafor et al., 2025). While, urban centers have undergone substantial growth and spatial landscape change, urban hydrosystem management has been longtime neglected (Olatunji et al., 2019). This constitutes an additional potential threat to urban welfare, aquatic organisms and human health. Many river systems and water storages within the West Africa cities, and notably in Burkina Faso are facing an extreme pollution challenge. Most urban water bodies in Burkina Faso are in very poor conditions and are seriously polluted by various sources of perturbations (e.g., heavy metals, oils, organic compounds, pesticides, anions and cations, sewage), and harbor several tolerant species (Tampo et al., 2021; Kaboré et al., 2022). They are often infected by microorganism pathogens, responsible for many diseases in local area (Kaboré et al., 2023, 2024). The proliferation of waterborne diseases due to human non-ecofriendly behaviors and practices (e.g. uncontrol municipality wastes, dumps, faecal discharge) resulting in serious sanitary risk issues for the citizens. However, the well-being of the urban population is related to water sanitation, and it is a basis for the suitable development of nations. In Burkina Faso, the most recorded issues, such as unguided population growth, the weak policies, citizens' ignorance, as well as the lower capacities of managers can deeply contribute to the severe degradation of urban cities and water quality. The evidence of governance system (e.g. instability, holistic institutional nomadism) contrast the existing regulations and do not facilitate the active engagement of local entities in urban environmental management and water quality governance. All these

| Quick Response Code | Access this article online | |
|---|---|---|
| | **Website:** www.watconman.org | **DOI:** 10.26480/wcm.02.2025.249.256 |

Cite The Article: Idrissa Kaboré (2025). Managing Urban Water Bodies For Sustainable Development In Rapidly Urbanizing West African Cities: Insights From Burkina Faso. *Water Conservation & Management, 9(2): 249-256.*

factors like rapid population growth, unstable institution and climate change constitute complex issues for many West African countries such as Burkina Faso, which often experiences institutional adjustment and policy restructuring. Additionally, the failures of urbanizational planning process and deficiency of canals drainages systems are increasing the risks of floods, sanitation and water pollution problems. Also, the climate change is exacerbating the vulnerability of urban areas, and affect local level of governance, the most proximate level to address water quality problems. However, these critical issues of urban water quality are very poorly documented and unknown by the citizens. Therefore, this study aims to establish ecological awareness of urban water bodies sanitation and address perspectives for effective and suitable management of underdeveloped urban cities. The key objectives are to review the potential threats of urban water bodies and to address holistic approaches for successful integrated water body management for the welfare of citizens.

## 2. The Approaches And Methods

With a population estimated at approximately 381 million people, West Africa covers around 6.14 million *km*2. According to Economic Community of West African States (ECOWAS), 15 countries belong to West african geographical area (Fig. 1). All these countries deal with similar challenges, such as low economic development, fast growing population particularly in big cities, less education level of the population, low social conditions in terms of accommodation, sanitation and health issues (Türke, 2022). Located in the centre of West Africa, Burkina Faso is a Sahelian country characterized by sub-Saharan dry climate, and has to cope with episodes of severe drought and unpredictable intense rain exacerbated by climate change. It is bordered by Niger in the East, Mali in the North and North/West, Côte d'Ivoire in the South/West, Ghana, Togo and Benin in the South. In Burkina Faso the rapid population growth, lower policy capacity management, increasing human pressures and climate variability, negatively affect urban cities and the citizen's life quality. In Burkina Faso, the main cities are accustomed to rapid geographical expansion, spontaneous and informal settlements due to natural growth and to rural urban migration (Dos Santos et al., 2019).

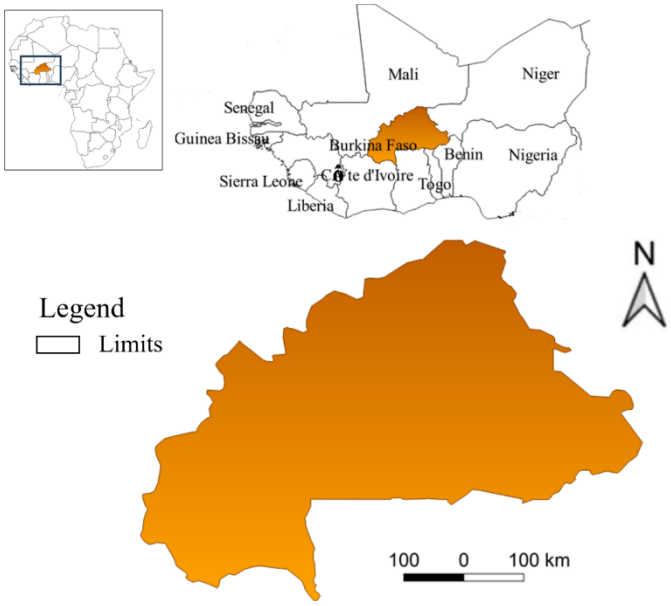


**Figure 1:** Map of West Africa showing Burkina Faso location

Wise steps were used to address the central question of surface water quality in the rapid growing cities. Firsly, the narrative literature review includes recent selected papers dealing with specific keywords, such as, threats of urban water bodies associated with cities management and policy deficiency, as well as, an overview on external factors such as climate change were tackled using Google Scholar, ResearchGate, Academia.edu, ScienceDirect, Scopus, and institutional websites. Secondly, main indicators of literature researches are those investigated for a pollution profile impact to conceptualise different perspectives of urban water quality policy implementation. Finally, for consistence with literature assessment, field observation were undertaken in Ouagadougou, main city and capital of Burkina Faso. In addition, to strengthen the discussion, relevant recent publications from other continents were used, but very few old articles and grey literatures were taken into account. More than 90 publications were read, and deemed to be relevant for the present study. From the climate data gathered from the National Meteorological Agency of Burkina Faso, temperatures are significantly increasing (Fig. 2). According to Huang et al. (2021), Sawadogo et al. (2024) these high temperatures lead to massive losses of water due to high evapotranspiration rates, and increasing flood invents that pose serious threats for urban inhabitants in Burkina Faso, consequently impacting the poor designed cities with bad quality of water infrastructure.

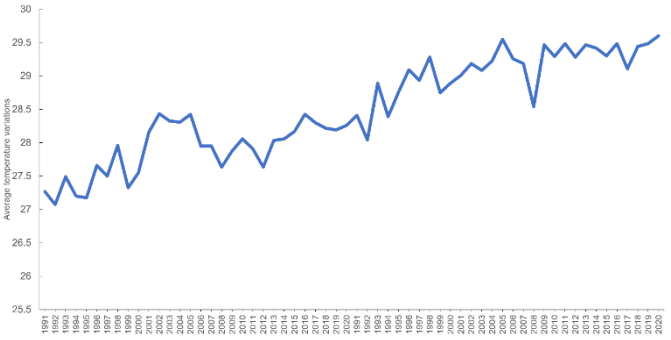


**Figure 2:** Evolution of average temperatures in the Ouagadougou station from 1991 to 2020

## 3. Effects Of Uncontrolled Urbanizations

The inadequate expansion of urban areas due to rapid population growth has led to the destruction of original drainage. Many suburban areas are increasing without any effective canal systems, leading to high risks of flooding. For example, in September 2009, Ouagadougou, the capital of Burkina Faso, was mostly flooded, leading to catastrophes for infrastructure and loss of life, because of the failure of the urbanisation planning process involving poor design and quality of water infrastructure (Dos Santos et al., 2019; Miller et al., 2022). For more details, flood extent was mapped by MapAction (2016; https://maps.mapaction.org/dataset/186-1695), and others authors (De Risi et al., 2018 ; Dos Santos et al., 2019). Indeed, the uncomom annual rainfall >850mm fell on the city of Ouagadougou in 2009 between 1992 and 2011, and daily rainfall of 329 mm reported in Ouagadougou in september, 1st, 2009 in short time. This represents 86% of the total monthly precipitation in 2009, and often intense rainfall is observed in Ouagadougou (Figure 3a, 3b), and forecasted to increase in the future according to experts, as demonstrated by several studies, among others (Tazen et al., 2018 ; Hang et al., 2021 ; Miller et al., 2022 ; Yanogo and Yaméogo, 2023 ; Sawadogo et al., 2024). This is expected in many West African countries, including Côte d'Ivoire, Nigeria, and Ghana, as analysed by severals authors among others (Cobbinah et al., 2017 ; Ogbonna et al., 2021 ; Abass et al., 2022 ; Naah et al., 2025). Indeed, the existing sewers and drains were constantly overcharged by citizen's misbehaviours ; the poorly constructed infrastructures are not capable of handling the heavy rainfall intensity. For example, domestic wastes (e.g. biologicals and plastics), garbage, and storm water are released into the small water storages and bridges that are built across the drainage system. Here, some evidences of field observation were shown (Fig. 4). The chemical leaching from plastics, nutrient overload from organic waste can cause water quality problems associated with water eutrophication (Kaboré et al., 2018). The urban waters are impaired practically by a variety of uses, including intense irrigated agriculture using pesticides and fertilizers who have demonstrated that inappropriate land development exerts direct pressure on surrounding ecosystems, causing variations in the micro-topography of the city (Kaboré et al., 2022). In addition, in the context of cities, engineers constructing projects do not obey the law and regulatory standards because of corruption, and unregulated settlements that are widely spread in most of West African big cities. Construction projects are more vulnerables to floods events as previously argued by several authors (Collord et al., 2021; Thompson and George-Ibikiri, 2024).

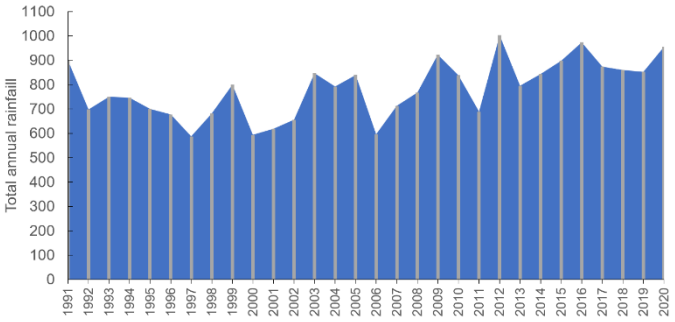


**Figure 3a:** Evolution of the annual rainfall totals in the Ouagadougou station from 1991 to 2020

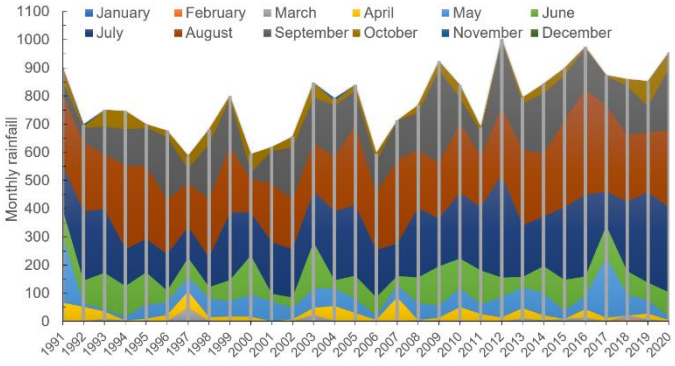


**Figure 3b:** Evolution of the monthly rainfall in the Ouagadougou station from 1991 to 2020


**Figure 4:** Showing water courses in very bad conditions. a) indicates garbage's in river bed and (b) degraded water photographed by I. Kaboré.

## 4. Ongoing Pollution Of Urban Aquatic Ecosystems

Urban water pollution is a major issue in Burkina Faso, as it is the case in many other West African countries. Many studies have demonstrated that in the absence of comprehensive solutions, urban water bodies will continue to be heavily deteriorated (Ferreira et al., 2018; Mishra et al., 2021). Urban aquatic ecosystems are crucial for the greening of nature, mitigating temperature in very warm countries such as dryland areas (e.g., Burkina Faso), and biodiversity conservation (Li et al., 2017; Olatunji et al., 2024; Martín-Muñoz et al., 2024). By improving the landscape quality of the city, the presence of good water may create a micro-habitat/climate dominated by vegetation that may help to prevent erosion and the filtration of pollutants released from agriculture and industries (Ribbe et al., 2024). In most low-income countries, such as Burkina Faso, urban water bodies are threatened by an array of anthropogenic pressures mainly driven by municipalities wastes, including wastewater and sewage containing solid materials, food waste, faecal matter, urine, and soaps that are disposed from informal settlements without any sanitary infrastructure (Bashir et al., 2020; Dueñas-Moreno et al., 2024). According to Fayiga et al. (2018) and Tyagi et al. (2024), domestic discharges of feces including other pathogenic organisms, dumped into surface water represent acute pollution and constitute a public health risk. For example, in a suburban area of the main city of Ouagadougou, we observed the evidence of fecal discharges and slaughterhouse wastes due to citizens' misbehavior. In previous studies, reported a higher concentration of microbiological contamination in vegetables and water columns, including total coliforms (44744.33 CFU/ 100 ml), Escherichia coli (13567 CFU/ 100 ml) and Streptococci (13746 CFU/ 100 ml), as well as, Pseudomonas, Salmonella that largely exceeded the standards of the World Health Organization (WHO) (Dao et al., 2018; Kaboré et al., 2023; Traoré et al., 2023). Unfortunately, because of runoff, the contamination of receiving waters contributes severely to lower water quality. In addition, discharges of untreated industrial effluents are increasing the concentration levels of toxic pollutants in water such as, heavy metals, organic/inorganic compounds and plastics material, as demonstrated by many authors (Bashir et al., 2020; Ouattara et al., 2023; Colls et al., 2024). For the urban aquatic ecosystems, these ongoing pollutions lead to the loss of habitat and water quality, and hence, have the potential to worsen freshwater fauna by decreasing biodiversity as demonstrated in recent studies across the main cities of Burkina Faso (Kaboré et al., 2016; 2022; 2023), they also cause the disruption of food chains and toxics substances bioamplification in food webs and may cause sicknesses and diseases among the citizens (Lehel, and Murphy, 2021. Zaynab et al., 2022; Kumar and Vats, 2024). Some additional sources of pollution resulting from hospitals wastes, biomedical substances and pharmaceutical industries, as well as, traffic-related pollutants are becoming serious problems aggravating the water pollution in tropical developing countries (Sharma et al., 2021; Järlskog et al., 2021; Ajima et al., 2022; Janik-Karpinska et al., 2023; Gorgaslidze et al., 2024). In Burkina Faso, this situation is worsened because of lack of adapted incinerators. The authors argued that several chemical substances, such as antibiotic and formol among others, are released into the environment, and may often enter the water cycle, causing health hazards for urban dwellers (Wang et al., 2021; Maghsodian et al., 2022; Hanna et al., 2023; Zeng et al., 2024). Furthermore, the urban agriculture and livestock are still ecological challenges, particularly in cities of Burkina Faso, because of intense use of chemicals in fertilizers that cause water quality problems, and the exposure of surface waters to pesticides, and domestic livestock wastes (Kaboré et al., 2018). The non eco-friendly vegetable farming practices in urban areas using chemical fertilizers increase nutrient contents in waters, leading to the eutrophication of water in urban areas, as demonstrated in previous studies (Fetahi, 2019; Bonsdorff, 2021; Dumitran et al., 2024). Many authors have shown that the additional inputs of nutrients are associated with algal and macrophyte blooms, reflecting very poor ecosystem health (Zhu et al., 2020; Lihepanyama et al., 2022; Schneider et al., 2024). The interconnected associations used to visualize the impacts of urban alteration detected in Burkina Faso are shown in the conceptual diagram. In figure 5, the model includes indirect prevailing new factors such as insecurity crises and conflicts, as well as extreme climate events and climate change that act as a significant threat impacting cities and increase the vulnerability of fragile cities in West Africa, particularly in Burkina Faso. Cities have to cope with recurrent droughts, flood risks, and additional investment uncertainty, which are detrimental to policy makers and local population (Hove et al., 2013; Ofoezie et al., 2022). This diagram synthesizes evidence of causes and effects in environmental systems to inform policy makers and managers.

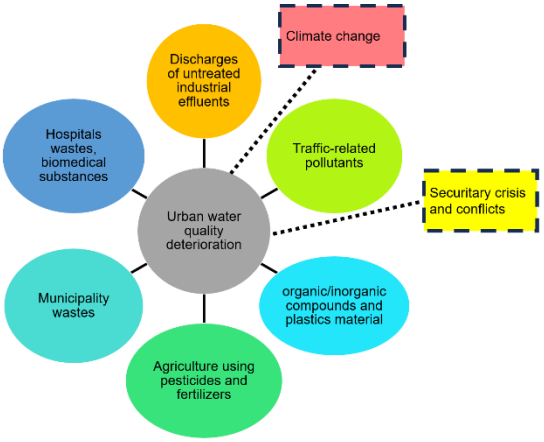


**Figure 5:** Prevailing factors that affecting urban surface water health including indirect onces

## 5. Inconsistency Of Policies And Strategies

For the capacity to plan and implement proper and effective approaches to urban environmental planning and management, it is essential to understand and specify the factors that perpetuate the lack of appropriate preventive and curative environmental actions (Capolongo et al., 2018; Sheoran et al., 2024; Plowright et al., 2024; Rahma et al., 2024). To a large extent, urban environmental problems can be attributed to institutional deficiencies, inadequate policies, or inaction by public and private actors. Some authors have demonstrated that weak institutional capacity hampers most efforts to improve environmental conditions in cities, for example, decentralisation is an effective tool for building suitable development, including environmental sustainability, in many West

African countries, but in most cases, it is characterized by "governance", which refers to the exercise and sharing of power (Ziervogel et al., 2019; Odume et al., 2022). These confusing institutional regulations constitute a main constraint to effective urban environmental management in sub-Saharan countries, as proven by several authors (Estache et al., 2019; Moore et al., 2021; Haldar et al., 2021; Odume et al., 2022; Manzungu, 2024). In the past decades, most West African cities have been built with disregard for environmental considerations, and the inadequate regulatory policies have led to anarchical topographies of urban areas and planning. The complexity of the urban area crisis is mainly caused by the failure of urbanization policies such as, conflicting land use policies, insufficient enforcement of waste management laws, or fragmented responsibilities between different government agencies. In the absence of clear effective policy interventions, spontaneous habitations appear to affect the natural drainage system, leading to water-related disasters when it rains intensively and for several hours. Many big cities in west Africa are in crisis due to inadequate governance, inadequate regulatory and economic policies, and insufficient knowledge and information, for example, in the recent years in Burkina Faso, the urban area management have been devoted to the private sector, without rigorous policy enforcement and clear management plan (Obeng-Odoom, 2013; Hove et al., 2013; Ofoezie et al., 2022). This led to anarchical cities geograhic expansion, land grabbing and speculation, and the increase of spontaneous habitation areas. Unfortunatlely, the policy discourses do not consider polluting activities and water quality improving measures, but focus more on resolving problems of lands crisis, tensions between citizens generated, creating a considerable gap in urban environmental governance and urban sustainability. The well-being of the urban population is related to the sanitation status which is a basis for the long-term and suitable development of countries, but the non-ecofriendly anthropogenic activities are leading to the proliferation of vectors found in polluted water bodies and small hazardous man-made water storages. Consequently, waterborne diseases and neglected diseases continue to be a great concern for public health, especially in urban areas, where these diseases contribute to high percentage of illnesses and deaths every year (Ashbolt, 2004; Yang et al., 2012; Tulchinsky and Snow, 2018; Kouamé et al., 2022; Kazadi et al., 2023). Polluted waters and bad wastewater drainage systems are responsible for the emergence of the dengue epidemic caused by vector mosquitoes of the genera Culex in recent years in Burkina Faso with the high dengue risk in the population (Ridde et al., 2016; Sondo et al., 2021; Okoro et al., 2023). We found evidence of overlapping of human settlements and small industries in Ouagadougou and Bobo-Dioulaso, coupled with discharges from households and industries due to inefficiency of legislation and/or none respect of laws or neglect of the national government. Also, in most cities, managers and decision makers have a lower capacity in terms of urban surface water management because of lack of technical background, also they lack financial support leading to failures of interconnective capacity of cities governance. The abundance of illegal housing areas due to fast growing population particularly in big cities combined with poor education and poverty aggravate the precarious complex situation. The governance enforcement of all key actors in water management through the application of rules is still missing to prevent water pollution due to the absence of clear normative framework in waste management dominated by informal sectors.

## 6. New Paradigm For Urban Welfare

In West Africa, many efforts and investments are oriented towards the development of transportation infrastructure and the expansion of urban settlements, but urban water management is completely abandoned or neglected. However, to build sustainable cities that benefit human society, objectives-based approaches to urban environmental planning and management are urgently needed to mitigate and prevent the future catastrophe of growing urban areas. By prioritizing multi-level governance approaches and giving strong engagement of water governance processes could help to strengthen governance system. For example, Burkina Faso is divided hierarchically into different levels from regions to rural communes, with specificity in terms of urban problems, management needs, and what kind of governance model should be adapted to whole regions, provinces and municipal/local scale. From case studies (e.g., research on appropriate policy responses, land-use plans development, reinforcing capacity building, conducting local inventories etc.), and granting appropriate solutions solutions is crucial for implementing excellent cities management. Indeed, for effective and integrative water management, the effect on local communities are important prerequisites because aquatic ecosystems and the population living around them are intricately linked with urban environment. Some authors have demonstrated that the transfer of authority and responsibility to lower levels of organisation including non-state actors through public-private partnerships can yield suitable responses in water resources and urban environment management, and may lead to a wide range of perspectives and knowledge (Odume et al., 2022). Despite the fact that decentralisation still remains a theory in many West African countries, it still is a central key to sustainable development, including environmental management. As argued by previous authors, true decentralisation, including the transfer of power, participation, cooperation, and democratisation of institutions, can help strengthen governance and institutional processes for adequately and governing water urban resources (Ziervogel et al., 2019; Odume et al., 2022; Ofoezie et al., 2022). Although sub-saharan countries, such as Burkina Faso, are still struggling with participatory democracy, the debates on decentralization remains the main core to connect diverse communities in resource governance, maintain equity, resources management and the balance of political systems (Dunn et al., 2014; Withanachchi et al., 2018; Franco et al., 2019; Atisa et al., 2021). Factors, such as, government capacity, lack of funding, or bureaucratic inertia, and the fear to lose the power, among others, remain the challenges to implement decentralization in Burkina Faso causing the poor performance of local governments' functions. In Burkina Faso, maximizing the capacity of human populations at the ground level, such as, public education campaigns, local governance initiatives, or science programs for public including new technologies in water quality monitoring (using startups, smartphones etc.) can help them to take leadership role in water and cities management. Water is vital resource for all communities, and all models of management must reflect community-based approaches that integrate local decision-making and flexibility (Hardoy et al., 2013; Dyer et al., 2014; Ziervogel et al., 2019). Some examples are given here to upgrade urban water management approaches, such as, enforcing government officials as well as polluters to improve environmental conditions, educating citizens about local environmental quality, the effects of existing environmental management practices, and reinforcing the capacity of environmental professionals such as architects, urban planners, estate managers, builders, and engineers (Daramola and Ibem, 2010). In addition, raising public awareness of the environmental problems, reinforcing local capacity building, and involving science-based information for sound policy formulation and appropriate practice development on the ground. On the other hand, the urban stormwater treatment ponds, wetland designs, green entertainment spaces, as well as industrial effluent and sewage treatment plant installations in urban areas can play a significant role in the prevention of water contamination, the improvement of a livable macro-climate, and the aesthetic of urban water landscapes (Hughes et al., 2014; Godfrey et al., 2019). In addition, controlling solid, biological, and liquid wastes by adopting strict and standardized protocols for solid waste management may help facilitate waste recycling and may sustain local economic development (Das et al., 2019; Mor and Ravindra, 2023; Husain, 2023; Singh et al., 2024). Here, figure 6 shows the mapping model's "public-stakeholder" actions for reliable integrated urban planning and water management. The political and institutional stabilities in Burkina Faso are key steps for successful implementation of integrated water management and urban planning, but from top-down or bottom-up, the communication tools and approaches must be more flexible to avoid dilemmas regarding inclusive local community-based knowledge inputs in the sustainable management of urban areas. For example, the local governments can promote the local planning and participation by co-creating consistent citizens framework and guidelines about water quality including diversity of pollutants and their toxicity and impacts may help to increase local community environmental awareness, and contribute to long-term sustainability of cites. Urban water quality problems are still poorly documented and not given a deserved priority by concerned policy-makers. Thus, the present study calls for an urgent revolution in urban water management and sanitation for the wellbeing of local population in constantly expanding cities (e.g. revising cities policy and regulations, and including flood risks, periodic assessments plan). With regard to climate change and high population growth, the national government must contextualize nature-based solutions aligned with the Sustainable Development Goals for more resilence, as demonstrated by (Omisore, 2018; Addaney and Cobbinah, 2019). Therefore, in dealing with urban water management in Burkina Faso, there is a crucial need for holistic approach and full engagement of all stakeholders including politicians, public-private partnerships and universities in water-related issues in urban area aligned with Sustainable Development Goals (SDGs), such as, sanitation (SDG 6) and sustainable cities (SDG 11) which present opportunities in catalysing actions, and properly address successful development in sub-Saharan Africa cities. Practically, Burkina Faso has to face more challenging tasks in governance to achieve the absolute targets of these two goals, but starting to implement solutions by building a solid bridge between research-legislation-community-city to drive the SDGs agenda, as previously argued will help by (Annan-Aggrey et al., 2021). In addition, reliable national data and international cooperations are also needed to address environnemental problems of vulnerable and fragile

cities, and meet international standards. The effective and efficiency management of urban cities in West African region can lead to peace, stability, security, healthy lives of people and development rooting, and enhancing local economies, or reducing vulnerability to climate-related disasters as demonstrated by some authors (Vaidya and Chatterji, 2020; Milan, 2017; Delanka-Pedige et al., 2020 ; Torres et al., 2020).

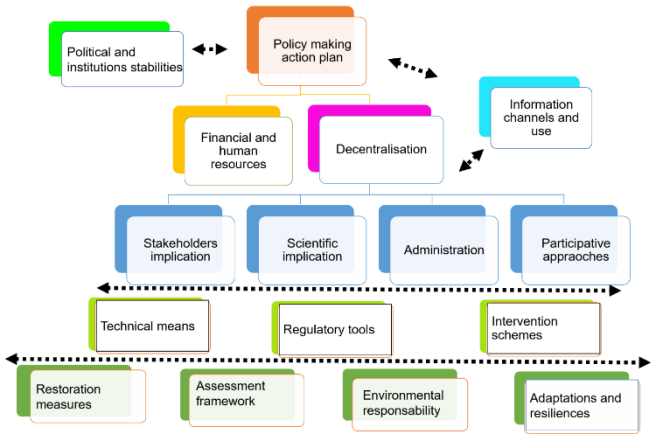


**Figure 6:** mapping the models and implication to facilitate implementation and practice in cities surface water management.

## 7. Conclusion

Summarily from our findings, many lessons are learnt which include these points:

- The threats of urban surface water, and risks citizens face resultantly are clearly highlighted in the study area, but the quantification of direct and indirect pressures on urban water bodies are still needed to perfect our results,
- Climate change affect the urban areas and increase the risks of disasters in the absence of urban planning process, the integration of urban surface water management and flood risks into the urban planning process (effective canals drainage systems, wastes water treatment systems) is crucial,
- Delegation of power, financial and technical supports to local level are urgently needed to improve urban surface water management challenges,
- Co-creation of knowledge by all stakeholders is crucial for successful urban water management and sanitation (e.g. water management framework and guidelines),
- Implementation of communication tools (e.g. promoting locals' languages) and usage of innovative platform may help increase environmental awareness,
- The dissemination of science-based knowledge and promotion of scientific research is crucial to urban cities development and planning process,
- Policies, legislations reformulation and institutions stabilities are necessary for adequate governance and sustainable management of cities and urban waters,
- The international collaborations in terms of technical and financial support are necessary for urban areas managers capacity building

Funding: This research did not receive any specific grant, from funding agencies in the public, commercial, or not-for-profit sectors

## Acknowledgments

We are thankful to Dr Tampo Lallébila, Dr Bancé Victor for their supports in fruitful discussion that help to improve the paper, and to Dr Olusegun Olatunji (university of Lagos) and Dr Christian Larbi Ayisi (university of Accra) for English proof read. We are also grateful to local cities hall for sharing informations that helped us to rise the quality of the present work, and the anonymous reviewers for their valuable comments on earlier versions of this paper

## References

Abass, K., 2022. Rising incidence of urban floods: Understanding the causes for flood risk reduction in Kumasi, Ghana. GeoJournal, 87(2), 1367-1384.

Addaney, M., and Cobbinah, P.B., 2019. Climate Change, Urban Planning and Sustainable Development in Africa: The Difference Worth Appreciating. In: Cobbinah, P.B., Addaney, M. (eds) The Geography of Climate Change Adaptation in Urban Africa. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-04873-0_1

Ajima, M. N., and Pandey, P. K., 2022. Effects of Pharmaceutical Waste in Aquatic Life. In Advances in Fisheries Biotechnology, Pp. 441-452. Singapore : Springer Nature Singapore. https://doi.org/10.1007/978-981-16-3215-0_25

Annan-Aggrey, E., Bandauko, E., and Arku, G., 2021. Localising the Sustainable Development Goals in Africa : implementation challenges and opportunities. Commonwealth Journal of Local Governance, (24), Pp. 4-23.

Ashbolt, N. J., 2004. Microbial contamination of drinking water and disease outcomes in developing regions. Toxicology 198(1-3), Pp.229-238.

Atisa, G., Zemrani, A., and Weiss, M., Decentralized governments: local empowerment and sustainable development challenges in Africa. Environment, Development and Sustainability 23, Pp.3349–3367. https://doi.org/10.1007/s10668-020-00722-0

Bashir, I., Lone, F. A., Bhat, R. A., Mir, S. A., Dar, Z. A., and Dar, S. A., 2020. Concerns and threats of contamination on aquatic ecosystems. In : Hakeem, K., Bhat, R., Qadri, H. (eds) Bioremediation and Biotechnology: sustainable approaches to pollution degradation (1-26). https://doi.org/10.1007/978-3-030-35691-0_1

Beißler, M. R., and Hack, J., 2019. A combined field and remote-sensing based methodology to assess the ecosystem service potential of urban rivers in developing countries. Remote Sensing 11(14), Pp. 1697.

Bhonde, U., Choudhury, B., and Sachdeva, R., 2024. Urban river management : scope and spectrum. In Managing Urban Rivers, Pp. 25-39. Elsevier. https://doi.org/10.1016/ B978-0-323-85703-1.00015-8.

Bonsdorff, E., 2021. Eutrophication : Early warning signals, ecosystem-level and societal responses, and ways forward: This article belongs to Ambio's 50th Anniversary Collection. Theme: Eutrophication. Ambio 50(4), Pp.753-758.

Capolongo, S., Rebecchi, A., Dettori, M., Appolloni, L., Azara, A., Buffoli, M., Capasso, L., Casuccio, A., Conti, G., O., D'Amico, A., Ferrante, M., Moscato, U., Oberti, I., Paglione, L., Restivo, V., and D'Alessandro, D., 2018. Healthy design and urban planning strategies, actions, and policy to achieve salutogenic cities. International Journal of Environmental Research and Public Health 15(12), Pp. 2698.

Capps, K. A., Bentsen, C. N., and Ramírez, A., 2016. Poverty, urbanization, and environmental degradation: urban streams in the developing world. Freshwater Science 35(1), Pp. 429-435.

Cobbinah, P. B., Poku-Boansi, M., and Peprah, C., 2017. Urban environmental problems in Ghana. Environmental Development 23, Pp. 33-46.

Collier, C.A., Almeida Neto, M.S., Aretakis, G.M., Santos, R.E., de Oliviera T.H., Mourão, J.S., Severi, W. and El-Dier., 2015. Integrated approach to the understanding of the degradation of an urban river : local perceptions, environmental parameters and geoprocessing. J Ethnobiology Ethnomedicine 11, 69. https://doi.org/10.1186/s13002-015-0054-y

Collord, M., Goodfellow, T., and Asante, L. A., 2021. Uneven development, politics and governance in urban Africa: An analytical literature review.

Colls, M., Viza, A., Zufiarre, A., Camacho Santamans, A., Laini, A., González Ferreras, A. M., and al., 2024. Impacts of diffuse urban stressors on stream benthic communities and ecosystem functioning: A review. ACRC Working Paper 2021- 02. Manchester : The University of Manchester. Available online: www.african-cities.org

Dao, J., Stenchly, K., Traoré, O., Amoah, P., and Buerkert, A., 2018. Effects of water quality and post-harvest handling on microbiological contamination of lettuce at urban and peri-urban locations of

Ouagadougou, Burkina Faso. Foods *7*(12), Pp.206.

Daramola, A. and Ibem, E. O., 2010. Urban environmental problems in Nigeria : Implications for sustainable development. Journal of sustainable development in Africa 12(1), Pp. 124-145.

Das, S., Lee, S. H., Kumar, P., Kim, K. H., Lee, S. S. and Bhattacharya, S. S., 2019. Solid waste management : Scope and the challenge of sustainability. Journal of cleaner production 228, Pp. 658-678.

De Risi, R., Jalayer, F., De Paola, F. and Lindley, S., 2018. Delineation of flooding risk hotspots based on digital elevation model, calculated and historical flooding extents: the case of Ouagadougou. Stochastic Environmental Research and Risk Assessment 32, Pp. 1545–1559. https://doi.org/10.1007/s00477-017-1450-8

Delanka-Pedige, H. M. K., Munasinghe-Arachchige, S. P., Abeysiriwardana-Arachchige, I. S. A., and Nirmalakhandan, N., 2020. Wastewater infrastructure for sustainable cities: assessment based on UN sustainable development goals (SDGs). International Journal of Sustainable Development and World Ecology, 28(3), Pp. 203–209. doi.org/10.1080/ 13504509.2020.1795006

Dos Santos, S., Peumi, J. P., and Soura, A., 2019. Risk factors of becoming a disaster victim. The flood of September 1st, 2009, in Ouagadougou (Burkina Faso). Habitat International 86, 81-90. https://doi.org/10.1016/j.habitatint.2019.03.005

Dueñas-Moreno, J., Vázquez-Tapia, I., Mora, A., Cervantes-Avilés, P., Mahlknecht, J., Capparelli, M. V., Kumar, M. and Wang, C., 2024. Occurrence, ecological and health risk assessment of phthalates in a polluted urban river used for agricultural land irrigation in central Mexico. Environmental Research 240, 117454.

Dumitran, G. E., Vuta, L. I. and Popa, B., 2024. Overview of the Eutrophication in Romanian Lakes and Reservoirs. Limnological Review 24(1), Pp. 76-104.

Dunn, G., Bakker, K. and Harris, L., 2014. Drinking Water Quality Guidelines across Canadian Provinces and Territories: Jurisdictional Variation in the Context of Decentralized Water Governance. International Journal of Environmental Research and Public Health 11, Pp. 4634-4651. doi:10.3390/ijerph110504634

Dyer, J., Stringer, L.C., Dougill, A.J., Leventon, J., Nshimb, M., Chama, F., Kafwifwi, S., Muledi, J.I., Kaumbu, J.M.K., Falcao. M., Muhorro, S., Munyemba, F., Kalaba, G.M. and Syampungan, I. S., 2014. Assessing participatory practices in community-based natural resource management : experiences in community engagement from southern Africa. J Environ Manag 137, Pp.137–145. https://doi.org/10.1016/j.jenvman. 2013.11.057

Estache, A., 2019. Africa: Successes and Failures of Water and Sanitation Governance Choices in Sub-Saharan Africa (1990–2017). Facing the Challenges of Water Governance, 223-257.

Everard, M., and Moggridge, H.L., 2012. Rediscovering the value of urban rivers. Urban Ecosyst 15, Pp. 293–314. https://doi.org/10.1007/s11252-011-0174-7

Fayiga, A.O., Ipinmoroti, M.O. and Chirenje, T., 2018. Environmental pollution in Africa. Environ Dev Sustain 20, 41–73. https://doi.org/10.1007/s10668-016-9894-4

Ferreira, C. S., Walsh, R. P. and Ferreira, A. J., 2018. Degradation in urban areas. *Current* Opinion in Environmental Science & Health 5, 19-25.

Fetahi, T., 2019. Eutrophication of Ethiopian water bodies : a serious threat to water quality, biodiversity and public health. African Journal of Aquatic Science 44(4), 303-312.

Franco, I. B., and Tracey, J., 2019. Community capacity-building for sustainable development: Effectively striving towards achieving local community sustainability targets. International Journal of Sustainability in Higher Education 20(4), 691–725.

Godfrey, L., Ahmed, M. T., Gebremedhin, K. G., Katima, J. H., Oelofse, S., Osibanjo, O., Richter, U.H. and Yonli, A. H., 2019. Solid waste management in Africa: Governance failure or development opportunity. Regional development in Africa, 235(10.5772). Pinto, U., Dickens, C., Babel, M., and Maheshwari, B., 2024. Urban river health assessment and management. Managing Urban Rivers, Pp. 283-299.

Gorgaslidze, N., Sulashvili, N., Gabunia, L., Pruidze-Liparteliani, N. and Giorgobiani, M., 2024. The Impact of Pharmaceuticals on the Ecology and Human Health. World of Medicine*:* Journal of Biomedical Sciences 1(4), Pp. 65-89.

Haarstrick, A. and Sharma, L., 2024. Urban river pollution control. In Managing Urban Rivers Pp. 131-159. Elsevier.

Haldar, K., Kujawa-Roeleveld, K., Schoenmakers, M., Datta, D. K., Rijnaarts, H. and Vos, J., 2021. Institutional challenges and stakeholder perception towards planned water reuse in peri-urban agriculture of the Bengal delta. Journal of Environmental Management 283, 111974.

Hanna, N., Tamhankar, A. J. and Lundborg, C. S., 2023. The development of an integrated environment-human risk approach for the prioritisation of antibiotics for policy decisions. Science of the Total Environment 880, 163301.

Hardoy, J. E., Mitlin, D. and Satterthwaite, D., 2013. Environmental problems in an urbanizing world : finding solutions in cities in Africa, Asia and Latin America. Routledge, 464. https://doi.org/10.4324/9781315071732

Hove, M., Ngwerume, E. T., and Muchemwa, C., 2013. The urban crisis in Sub-Saharan Africa: A threat to human security and sustainable development. Stability 2(1), Pp.1-14 DOI: http://dx.doi.org/10.5334/sta.ap

Huang, W. K., Monahan, A. H., and Zwiers, F.W., 2021. Estimating concurrent climate extremes: A conditional approach. Weather and Climate Extremes 33, 100332

Hughes, R. M., Dunham, S., Maas-Hebner, K. G., Yeakley, J. A., Schreck, C., Harte, M., Molina, N., Shock, C.C., Kaczynski V.W. and Schaeffer, J., 2014. A review of urban water body challenges and approaches:(1) rehabilitation and remediation. Fisheries 39(1), Pp. 18-29.

Husain, A., 2023. Management and Disposal of Solid Waste : Practices and Legislations in Different Countries. In Management of Wastewater and Sludge, Pp. 271-295. CRC Press.

Janik-Karpinska, E., Brancaleoni, R., Niemcewicz, M., Wojtas, W., Foco, M., Podogrocki, M. and Bijak, M., 2023. Healthcare waste a serious problem for global health. In Healthcare 11(2), Pp.242.

Järlskog, I., Strömvall, A.M., Magnussond, K., Galfi, H., Björklund, K., Polukarova, M., Rita Garção, R., Markiewicz, A., Maria Aronsson, M., Gustafsson, M., Nori, M., Blom, L. and Andersson-Sköld, Y., 2021. Traffic-related microplastic particles, metals, and organic pollutants in an urban area under reconstruction. Science of the Total Environment 774, Pp.145503.

Kaboré, I., Bancé, V., Zangré, T. D. R. and Ouéda, A., 2023. Influence des rejets municipaux sur la qualité physico-chimique et biologique des écosystèmes aquatiques urbains : Cas de la rivière Massili (Burkina Faso, Afrique de l'Ouest). International Journal of Innovation and Applied Studies 40(4), Pp. 1281-1291.

Kaboré, I., Moog, O., Melcher, A. L. P., Guenda, W., Koblinger, T., Mano, K., Ouéda, A., Ouédraogo, R., Trauner, D. and Melcher, A. H., 2016. Using macroinvertebrates for ecosystem health assessment in semi-arid streams of Burkina Faso. Hydrobiologia 766, Pp. 57–74.

Kaboré, I., Moog, O., Ouéda, A., Sendzimir, J., Ouédraogo, R., Guenda, W. and Melcher, A. H., 2018. Developing reference criteria for the ecological status of West African rivers. Environ Monit Assess 190, Pp.2.

Kaboré, I., Ouéda, A., Moog, O., Meulenbroek, P., Tampo, L., Bancé, V. and Melcher, A. H., 2022. A Benthic invertebrates-based biotic index to assess the ecological status of West African Sahel rivers, Burkina Faso. J. Environ. Manage. 307 (16), 114503.

Kaboré, I., Sawadogo, L., Bancé, V., Tampo, L., Sanogo, S., Ouéda, A., Moog, O. and Melcher, A., 2024. Development of new assessment approach: a macroinvertebrates-based biotic scoring system to assess the health of riverine ecosystems in the Sahel area in Burkina Faso (West Africa). African Journal of Aquatic Science 49(1), Pp.40–51. doi.org/ 10.2989/16085914 . 2023.2292122

Kazadi, K. T., Beya, T. B., Ilunga, T. F., Tshikez, K. D., Mbuyi, T. J. C., Kazadi, T. J. and Luboya, K. J., 2023. Determinants of the Endemicity of Waterborne Infectious Diseases in Luputa in the Province of Lomami in the DRC. Open Access Library Journal 10(10), Pp. 1-14.

Kouamé, P. K., Dongo, K., Fokou, G., Apkatou, B., Ouattara, A. F., and Bassirou, B., 2022. Assessing transmission patterns of flood-related waterborne diseases in two urban municipalities of Côte d'Ivoire.

10.21203/rs.3.rs-2048605/v1

Kumar, S., and Vats, S. V. 2024. Ecological threats of biomagnification : insights from recent studies. World Journal of Pharmaceutical Research 13 (15), Pp.761-771.

Lehel, J., and Murphy, S., 2021. Microplastics in the food chain: food safety and environmental aspects. Reviews of Environmental Contamination and Toxicology Volume 259, Pp.1-49.

Li, F., Liu, X., Zhang, X., Zhao, D., Liu, H., Zhou, C., and Wang, R., 2017. Urban ecological infrastructure : an integrated network for ecosystem services and sustainable urban systems. Journal of Cleaner Production 163, Pp.12-18.

Lihepanyama, D. L., Ndakidemi, P. A., and Treydte, A. C., 2022. Spatio–Temporal Water Quality Determines Algal Bloom Occurrence and Possibly Lesser Flamingo (Phoeniconaias minor) Presence in Momella Lakes, Tanzania. Water 14(21), Pp.3532.

Maghsodian, Z., Sanati, A. M., Mashifana, T., Sillanpää, M., Feng, S., Nhat, T. and Ramavandi, B., 2022. Occurrence and distribution of antibiotics in the water, sediment, and biota of freshwater and marine environments: a review. Antibiotics 11(11), Pp. 1461.

Manzungu, E., 2024. Are 'second generation'water regulators the catalyst for sustainable water outcomes and an integrated water sector in sub-Saharan Africa? Insights from Zimbabwe. Physics and Chemistry of the Earth, Parts A/B/C, 103579.

Map Action, 2016. 18 datasets found for "Burkina faso, september 2009". Updated. https://maps.mapaction.org/dataset?q=Burkina+faso%2C+september+2009&sort=score+desc%2C+metadata_modified+desc

Martín-Muñoz, S., Schoelynck, J., Tetzlaff, D., Debbaut, R., Warter, M. and Staes, J., 2024. Assessing biodiversity and regulatory ecosystem services in urban water bodies which serve as aqua-Nature-based Solutions. Frontiers in environmental Science 11, 1304347. doi: 10.3389/fenvs.2023.1304347

Mehta, G., and Jade, D., 2024. Nine steps towards rehabilitation and restoration of degraded urban rivers. In Managing Urban Rivers, Pp. 241-259. Elsevier.

Milan, B.F., 2017. Clean water and sanitation for all : interactions with other sustainable development goals. Sustainable Water Resources Management 3, Pp. 479–489. doi.org/10. 1007/s40899-017-0117-4

Miller, J., Taylor, C., Guichard, F., Peyrillé, P., Vischel, T., Fowe, T., Panthou, G., Visman, E., BologoM., Traore K., Coulibaly, G., Chapelon, N.,Beucher, F., Rowell, D.P., and Parker, D. J., 2022. High-impact weather and urban flooding in the West African Sahel–A multidisciplinary case study of the 2009 event in Ouagadougou. Weather and Climate Extremes 36, Pp.100462.

Mishra, B. K., Kumar, P., Saraswat, C., Chakraborty, S. and Gautam, A., 2021. Water security in a changing environment: Concept, challenges and solutions. Water 13(4), Pp.490.

Mishra, R. R. and Saxena, S., 2024. Cities and rivers: a symbiotic relationship. In Managing Urban Rivers, Pp. 3-24. Elsevier.

Moore, L., Steynor, A., Waagsaether, K. L., Spires, M. and Marie, A., 2021. Exploring the opportunities and constraints to the development of locally applicable water management technology in three sub-Saharan African cities. Environmental Science and Policy 120, Pp. 108-117.

Mor, S. and Ravindra, K., 2023. Municipal solid waste landfills in lower-and middle-income countries : Environmental impacts, challenges and sustainable management practices. Process Safety and Environmental Protection.

Naah, B., Pervarah, M., Yiridomoh, G.Y., and Derbile, E.K., 2025. Perennial flood incidence in Ghana's Wa municipality: planning deficiency or human attitude?. Discover Sustainability 6, 126. https://doi.org/10.1007/s43621-025-00890-x

Obeng-Odoom, F., 2013. Governance for pro-poor urban development: Lessons from Ghana. Routledge.

Odume, O. N., Onyima, B. N., Nnadozie, C.F., Omovoh, G.O., Mmachaka, T., Omovoh, B.O., Uku, J. E., Akamagwuna F.C. and Arimoro F.O., 2022. Governance and Institutional Drivers of Ecological Degradation in Urban River Ecosystems: Insights from Case Studies in African Cities. Sustainability 14(21), 14147. https://www.mdpi.com/2071-1050/14/21/14147

Ofoezie, E. I., Eludoyin, A. O., Udeh, E. B., Onanuga, M. Y., Salami, O. O. and Adebayo, A. A., 2022. Climate, urbanization and environmental pollution in West Africa. Sustainability, 14(23), Pp.15602.

Ogbonna, D. N., and Udotong, I. R., 2021. An Appraisal of the Waste Crisis, Urban Floods and municipal Solid Waste Management in Port Harcourt City, Nigeria. Open Access Journal of Waste Management & Xenobiotics, 4(1), Pp. 1-14.

Okafor, O. C., and Obaze, W. O., 2025. Assessment of Heavy Metal Contents of Surface Water Around Waste Dumpsites in Ebonyi, Enugu and Anambra States, Southeastern Nigeria. Environmental Forensics, Pp.1-18.

Okoro, O. J., Deme, G. G., Okoye, C. O., Eze, S. C., Odii, E. C., Gbadegesin, J. T., Okeke, E. S., Oyejobi, G.K., Nyaruaba, R., and Ebido, C. C., 2023. Understanding key vectors and vector-borne diseases associated with freshwater ecosystem across Africa: Implications for public health. Science of The Total Environment 862, 160732.

Olatunji, E.O., Elakhame, L. A., Osimen, E.C., Tampo, L., and Edegbene, A. O., 2024. Responses of macrobenthos invertebrates' diversity to environmental factors in a tropical freshwater river in Edo State, Nigeria. *Biologia* 12, Pp. 1-12.

Olatunji, E.O., Isola,O. B., and Fakeye, O.D., 2019. Characterization and identification of Bacterial Isolates from different Drinking Water sources in Uromi, Edo State, Nigeria. SAU Science-Tech Journal 4(1), Pp.37-52.

Omisore, A.G., 2018. Attaining Sustainable Development Goals in sub-Saharan Africa; The need to address environmental challenges, Environmental Development 25, Pp. 138-145. https://doi.org/10.1016/j.envdev.2017.09.002

Osawe, A. I., and Ojeifo, M. O., 2019. Unregulated Urbanization and challenge of environmental security in Africa.World Journal of Innovative Research *6(*4), Pp.1-0.

Ouattara, Z. A., Kabo-Bah, A. T., Dongo, K., and Akpoti, K., 2023. A Review of sewerage and drainage systems typologies with case study in Abidjan, Côte d'Ivoire: failures, policy and management techniques perspectives. Cogent Engineering 10(1), Pp. 2178125.

Plowright, R. K., Ahmed, A. N., Coulson, T., Crowther, T. W., Ejotre, I., Faust, C. L., Frick, W.F., Hudson, P.J., Kingston, T., Nameer, P. O., O'Mara, M.T., Peel, A.J., Possingham, H., Razgour, O., Reeder, DA.M., Ruiz-Aravena,M., Simmons,N.B., Srinivas, P.N., Tabor, G.M., Tanshi, I., Thompson,I.G., Vanak, A.T., Vora, N.M., Willison C.E. and Keeley, A. T., 2024. Ecological countermeasures to prevent pathogen spillover and subsequent pandemics. Nature Communications 15(1), Pp. 2577.

Rahma, A., Mardiatno, D. and Hizbaron, D. R., 2024. Developing a theoretical framework: school ecosystem-based disaster risk education. International Research in Geographical and Environmental Education 33(1), Pp.6-23.

Ribbe, L., Dekker, G., and Thapak, G., 2024. Urban wetlands and water bodies. In Managing Urban Rivers, Pp. 91-107. Elsevier.

Richardson, M., and Soloviev, M., 2021. The Urban River Syndrome : Achieving sustainability against a backdrop of accelerating change. International Journal of Environmental Research and Public Health 18(12), Pp. 6406.

Ridde, V., Agier, I., Bonnet, E., Carabali, M., Dabiré, K. R., Fournet, F., Ly, A., Meda, I. B. and Parra, B., 2016. Presence of three dengue serotypes in Ouagadougou (Burkina Faso) : research and public health implications. Infectious Diseases of Poverty 5, Pp. 1-13.

Sado-Inamura, Y., and Fukushi, K., 2018. Considering water quality of urban rivers from the perspectives of unpleasant odor. Sustainability 10(3), Pp. 650.

Schneider, S. C., Coetzee, J. A., Galvanese, E. F., Harpenslager, S. F., Hilt, S., Immerzeel, B., and Vermaat, J. E., 2024. Causes of macrophyte mass development and management recommendations. Science of The Total Environment 931, Pp.172960.

Sharma, K., and Kaushik, G., 2021. Urbanization and pharmaceutical waste: an upcoming environmental challenge. An Upcoming Environmental Challenge. In : Kateja, A., Jain, R. (eds) Urban Growth and Environmental Issues in India, Pp 287-300, Springer, Singapore. https://doi.org/10.1007/978-981-16-4273-9_18

Sheoran, M., and Das Gupta, D., 2024. International best practices for e-waste take back and policy interventions for India. Facilities 42(3/4), Pp.376-404.

Singh, K., Kumari, V., Kumar, R. and Gupta, A., 2024. Recent Trends and Strategies in Waste Management : A Comprehensive Analysis of India's Waste Scenario. In Integrated Waste Management : A Sustainable Approach from Waste to Wealth, Pp. 13-35. Singapore : Springer Nature Singapore.

Sondo, A. K., Diendéré, E. A., Meda, B. I., Diallo, I., Zoungrana, J., Poda, A., Manga, N.M., Bicaba, B., Gnamou, A., Kagoné, C. J., Sawadogo, G., Yaméogo, I., Benzekri, N.A., Tarnagda, Z., Kouanda, S., Ouédraogo-Traoré, R., Ouédraogo, M.S. and Seydi, M., 2021. Severe dengue in adults and children, Ouagadougou (Burkina Faso), West Africa, October 2015–January 2017. IJID regions 1, Pp. 53-59.

Tampo, L., Kaboré, I., Alhassan, H. E., Ouéda, A., Bawa, M. L., and Boundjou, G. D., 2021. Benthic macroinvertebrates as ecological indicators: Their sensitivity to the water quality and human disturbances in a tropical river. Front. Water 3, 662765. doi: 10.3389/frwa.2021.662765

Tazen, F., Diarra, A., Kabore, R. F., Ibrahim, B., Bologo/Traoré, M., Traoré, K., and Karambiri, H., 2019. Trends in flood events and their relationship to extreme rainfall in an urban area of Sahelian West Africa: The case study of Ouagadougou, Burkina Faso. Journal of Flood Risk Management 12, e12507.

Thompson, J. E., and George-Ibikiri, S., 2024. Evaluation Of Challenges In The Enforcement Of Planning And Development Laws In Land Development In Nigeria.Unizik Law Journal, 20(1).

Torres, M.L.L., Uribeondo, P.B., and Yago, F.J.M., 2020. Citizen and Educational Initiatives to Support Sustainable Development Goal 6 : Clean Water and Sanitation for All. Sustainability 12, 2073. doi:10.3390/su12052073

Tulchinsky, T.H., and Snow, J., 2018. Cholera, the Broad Street Pump; Waterborne Diseases Then and Now. Case Studies in Public Health. 2018 : Pp. 77-99. doi: 10.1016/B978-0-12-804571-8.00017-2. Epub 2018 Mar 30. PMCID : PMC7150208.

Türke, A. I., 2022. The ECOWAS (Economic Community of West African States) in Focus of West African Integration Efforts. Journal of Central and Eastern European African Studies *2*(2), Pp. 168-188.

Tyagi, I., Kumar, V., and Tyagi, K., 2024. Water pollution-sources and health implications of the environmental contaminants on the aquatic ecosystem and humans: approach toward sustainable development goals. In Water, the Environment and the Sustainable Development Goals, Pp. 35-66. Elsevier.

Vaidya, H., and Chatterji, T., 2020. SDG 11 Sustainable Cities and Communities. In: Franco, I., Chatterji, T., Derbyshire, E., Tracey, J. (eds) Actioning the Global Goals for Local Impact. Science for Sustainable Societies. Springer, Singapore. https://doi.org/10.1007/978-981-32-9927-6_12

Wang, C., Zhao, Y., Liu, S., Xiao, Q., Liang, W., and Song, Y., 2021. Contamination, distribution, and risk assessment of antibiotics in the urban surface water of the Pearl River in Guangzhou, South China. Environmental Monitoring and Assessment 193, Pp. 1-14.

WHO., 2006. Guidelines for the Safe Use of Wastewater, Excreta and Greywater, Volume 2 Wastewater Use in Agriculture ; World Health Organization: Geneva, Switzerland,; ISBN 92-4-154683-2.

Withanachchi, S. S. Ghambashidze, G., Kunchulia , I., Urushadze, T., and Ploeger, A., 2018. A Paradigm Shift in Water Quality Governance in a Transitional Context: A Critical Study about the Empowerment of Local Governance in Georgi. Water 10, Pp.98; doi:10.3390/w10020098

Xia, J., Zhai, X., Zeng, S., and Zhang, Y., 2014. Systematic solutions and modeling on eco-water and its allocation applied to urban river restoration: case study in Beijing, China. Ecohydrology & Hydrobiology 14(1), Pp. 39-54.

Yang, K., LeJeune, J., Alsdorf, D., Lu, B., Shum, C. K., and Liang, S., 2012. Global distribution of outbreaks of water-associated infectious diseases. PLoS neglected tropical diseases 6(2), e1483.

Yanogo, I. P., and Yaméogo, J., 2023. Recent rainfall trends between 1990 and 2020 : Contrasting characteristics between two climate zones in Burkina Faso (West Africa). Glasnik Srpskog Geografskog Drustva 103 (1), Pp.87. 106. ff10.2298/gsgd2301087yff. ffhal-04154388

Zaynab, M., Al-Yahyai, R., Ameen, A., Sharif, Y., Ali, L., Fatima, M., Khan , K.S., and Li, S., 2022. Health and environmental effects of heavy metals. Journal of King Saud University-Science, 34(1), Pp. 101653.

Zeng, Y., Duan, L., Xu, T., Hou, P., Xu, J., Li, H., and Zhang, H., 2024. Occurrence and Risk Assessment of Antibiotics in Urban River–Wetland–Lake Systems in Southwest China. Water 16(8), Pp. 1124.

Zhu, K., Wu, Y., Li, C., Xu, J., and Zhang, M., 2020. Ecosystem-based restoration to mitigate eutrophication : A case study in a shallow lake. Water 12(8), 2141.

Ziervogel, G., Satyal, P., Basu, R., Mensah, A., Singh, C., Hegga, S., and Abu, T. Z., 2019. Vertical integration for climate change adaptation in the water sector: lessons from decentralisation in Africa and India. Regional Environmental Change 19, Pp. 2729-2743.