



## **PRACTICAL ASPECTS OF SUSTAINABLE WATER MANAGEMENT IN URBAN AREAS**

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### **ABSTRACT**

This paper examines the contemporary challenges faced in urban areas in relation to water supply, including water scarcity, outdated infrastructure, climate change, and population growth. It discusses various mitigation efforts, such as the implementation of water-efficient integrated urban development initiatives, policy interventions, and investment in water infrastructure, and highlights their impact on sustainability. A comprehensive literature review is also provided to gain an understanding of the existing body of knowledge on sustainable water management. It delves into the effectiveness of different interventions, highlighting their strengths and limitations. Survey results reveal that there is notable awareness of sustainable water practices among the population; however, the study uncovers a gap in full community participation, highlighting the need for targeted interventions to bridge this awareness-action division. To bridge this gap, there is a need for innovative community engagement strategies that consider socio-economic dynamics and individual perceptions of impact. While technological and policy means have been effective in mitigating urban water challenges, addressing the behavioral aspect is equally important. Bridging the awareness-action gap requires innovative approaches that resonate with the diverse urban population, fostering a collective commitment to water sustainability.

### **KEYWORDS**

Sustainable water management, Policy, Water-Efficiency, Water scarcity, Population, Urban area, Water supply

## 1. INTRODUCTION

Increasing urbanization has brought several challenges to water management (Lin, et al., 2022). The rising number of people settling in a given area puts a tremendous strain on water resources, and the increasing activities also lead to more water pollution, which has environmental and social consequences (Lin, et al., 2022). Water resource management in urban areas is time-sensitive because it affects current and future generations (Deepak, et al., 2016). In many urban areas, poor water management has led not only to poor water quality but also to water scarcity. Contaminated water has adverse effects on human health (Chocat, 2002).

According to the World Health Organization (2018), more than 55% of the world's population lives in urban areas. As a result, the water demand has increased steadily while freshwater availability has become scarcer due to overexploitation, pollution, and climate change (Boretti & Rosa, 2019). Urban areas are more vulnerable to water scarcity, flooding, and deteriorating water quality, which poses a considerable risk to the environment, human health, and the overall well-being of the population (Yuhan, et al., 2018). Given these challenges, it is crucial to prioritize the development of efficient and long-lasting policies and strategies to manage water in urban settings.

Most current practices focus on short-term solutions, such as increasing water supply or infrastructure expansion or development, with little or no consideration of long-term environmental and social impacts (Vasileios & Nikolaos, 2020). This paper examines current challenges to contribute to a more comprehensive understanding of effective water management strategies. It also highlights the importance of integrating social, environmental, and economic perspectives in ensuring sustainable water management in urban areas. Through a case study, data analysis, and theoretical framework, this paper provides valuable insights for managing our water resources.

## 2. LITERATURE REVIEW

Urban areas worldwide face escalated water scarcity, pollution, and climate change challenges. In response to these challenges, there is a growing emphasis on implementing practical and more sustainable water management strategies of water management. The following literature review explores some key aspects of mitigating the water challenges in urban areas.

### 2.1 Current water management challenges

Urbanization has led to the transformation of landscapes, which has disrupted the hydrological cycle. Impervious materials used in constructing roads and infrastructure contribute to the challenges of runoffs. (UNICEF 2019) reports that the leading causes of these water challenges in urban areas are “major intersecting trends, including population growth, unsustainable water management, poor governance, deteriorating infrastructure, inefficient water use, and increasing competition for water between different sectors.”

Many do not understand the magnitude of infrastructures' impact on the hydrological cycle. The land surface is covered by buildings, concrete pavers, and tarred roads unfavorable for rainwater and snowmelt absorption into the ground. According to Parkinson & Ole (2005), impacts on the hydrological cycle include reduction in infiltration, surface reduction, reduced evaporation, and transpiration rate. In the last few decades, India has seen a massive increase in water demand

triggered by the increase in population, especially in urban areas. The rise influences this demand in food production, domestic water supplies, and industrial growth. These demands have resulted in over-exploited groundwater resources, deteriorated groundwater quality, and surface water pollution (Dinesh & Ballabh, 2000). In Chitungwiza, an urban town in Zimbabwe, more than 40% of the residents experience a water supply cut-off that can last about a day to several days due to poor or lack of financial investment in water supply and infrastructure across Zimbabwe. Most households resort to unprotected and unsafe water sources. Zvobgo (2020) argues that 80.2% rated municipal water supply services unfavorable to two hundred and ninety-eight residents. This was due to the poor water infrastructure maintenance and lack of water investment, resulting in leakages contributing to non-revenue water.

## **2.2 Balancing the triad: harmonizing social, environmental, and economic factors**

Water management in urban areas is crucial in maintaining the well-being of city dwellers and the surrounding environment. The inherent complexities of urban water systems necessitate a holistic approach that balances social, environmental, and economic factors—exploring studies and initiatives that have attempted to harmonize these three pillars within the context of water management in urban areas.

### **2.2.1 Social Factors in Urban Water Management:**

The successful implementation of any water management strategy heavily relies on the active participation and support of the urban community. Social factors encompass various aspects such as public perceptions, awareness, and behavior toward water consumption, as well as equity and access to water resources (Jimenez, et al., 2019). Several studies have emphasized the importance of community engagement, education, and the inclusion of marginalized populations in decision-making processes related to water management. Additionally, social factors also involve understanding cultural values and traditions that influence water resource utilization in

### **Environmental Factors**

Urban areas worldwide face growing challenges related to water management due to rapid urbanization and environmental degradation (Heidari & Arabi, 2021). Achieving sustainability in urban water management is critical, with environmental factors playing a central role

### **Economic Factors**

Urban areas face increasing water-related challenges, making sustainable water management crucial. Examining the economic aspects of these practices is essential for long-term viability and cost-effectiveness.

## **3. METHODOLOGY**

This paper uses a methodology that involves conducting a literature review on the challenges and existing practices of sustainable water management in urban areas. The review includes academic papers, published government reports, case studies, and other relevant publications. In addition, a survey will be distributed to key stakeholders involved in urban water management, such as municipal councils, water utilities, environmental agencies, and residents. The surveys will be shared through various platforms, including email, Facebook, WhatsApp, and WeChat. A link to the survey generated by Google Forms will be sent to 100 people from different urban areas around the world. (Malambo, 2016)

#### 4. RESULTS

A survey was conducted among 60 individuals from various parts of the world, most of whom reside in urban areas. The results revealed that 91.7% of the participants live in urban areas, while the remaining 8.3% reside in peri-urban or rural areas. This is a significant number as the survey focuses on urban areas. The survey aimed to determine the water supply situation in urban areas, and Figure 1 illustrates how the participants rated their water supply in their respective towns or cities. Only 18.3% of the respondents rated their water supply as excellent, while 31.7% rated it as good, 33.3% as fair, and 13.3% as poor. Correspondents were also asked to rate the current water supply situation in urban areas, and only 18.3% rated it as excellent, while 31.7% rated it as good, 33.3% as fair, and 13.3% as poor. The remaining 3.4% had a borehole or were disconnected from the main water supply line.

Figure 1 showed that the most significant challenge related to water supply was aging infrastructure, with 40% of the respondents attributing it to this. Lack of awareness about water conservation was attributed by 15% of the respondents, 18.3% attributed it to water scarcity, 6.7% to climate change, and 6.7% listed other reasons.

4. What do you perceive as the most significant challenge related to water supply in your town/city?  
 60 responses

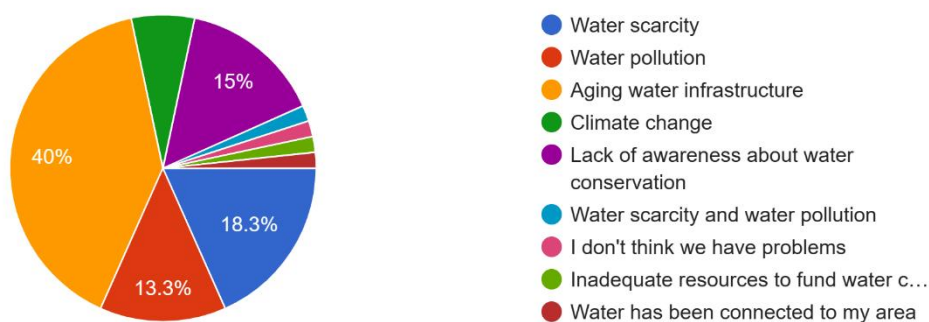


Figure 1 challenges posing a threat to the water supply (Source: Google Forms, 2023)

As the urban population grows, the demand for water supply increases in two ways: through the expansion of water users and the growth of water consumption per resident. This is because the demand for water increases as the population increases, and residents may need more water due to improved living conditions (Wu & Tan, 2012). Figure 2 illustrates the responses of correspondents regarding their perception of water supply in their respective towns/cities over the past five years. Of those surveyed, 35% reported a slight improvement, 30% stated that it remained the same, 15% noted a slight worsening, and only 13.3% thought it had improved significantly. The remaining 6.7% were unsure or had other thoughts.

5. In your opinion, how has the frequency of water related challenges changed in your town/city over the past 5 years?

60 responses

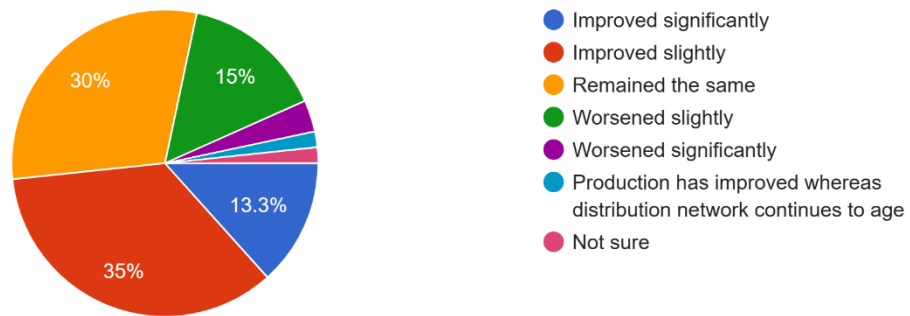


Figure 2 The frequency of water-related challenges has changed in the past five years. (Source: Google Forms, 2023)

6. Are you aware of any water conservation or sustainable water management initiatives in your town/city?

60 responses

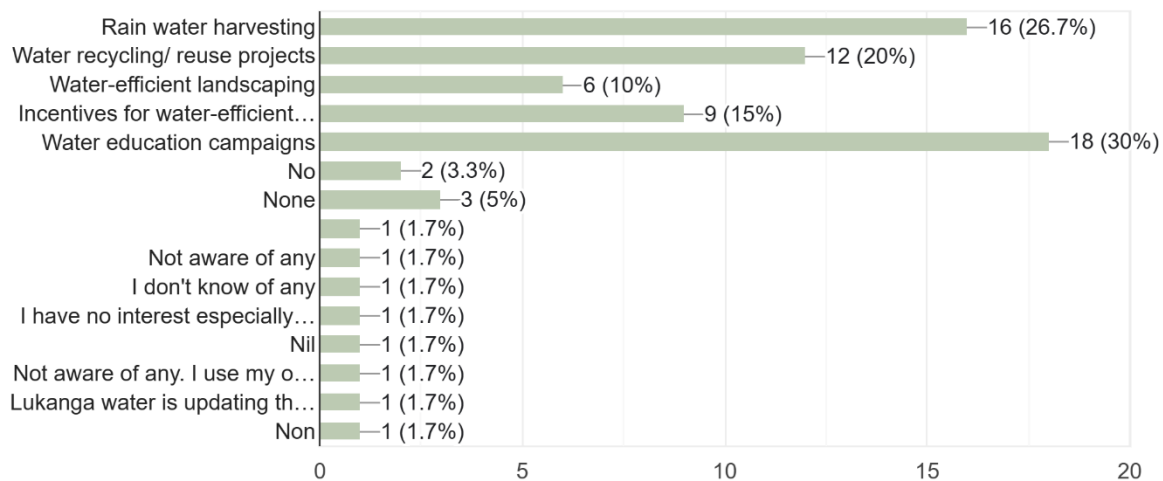


Figure 3. Knowledge of water conservation or sustainable management initiatives in urban areas (Source: Google Forms, 2023)

According to the figure above, many individuals are aware of the initiatives above, which could alleviate some of the water challenges. The figure below shows whether people are personally participating in these initiatives.

### 8. Have you personally participated in any of these initiatives or programs

60 responses

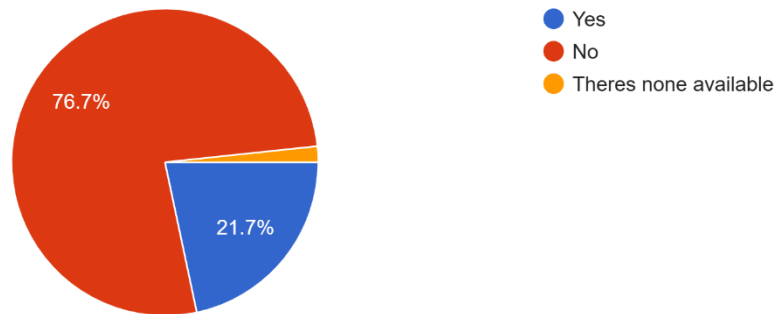


Figure 4. Individual participation in sustainable water management initiatives (Source: Google Forms, 2023)

76.7% of the correspondents indicated that they are not currently participating in water conservation or sustainable water management practices, only 21.7% said they are not, and 1.6% were unaware. According to Figure 5, when individuals were asked about their opinion on the effectiveness of water conservation or sustainable water management measures, 40% reported that they had no impact. 25% found them effective, while 20% considered them ineffective. 6.7% found them very effective, and 8.3% had different views.

### 7. In your view, how effective have these initiatives or programs?

60 responses

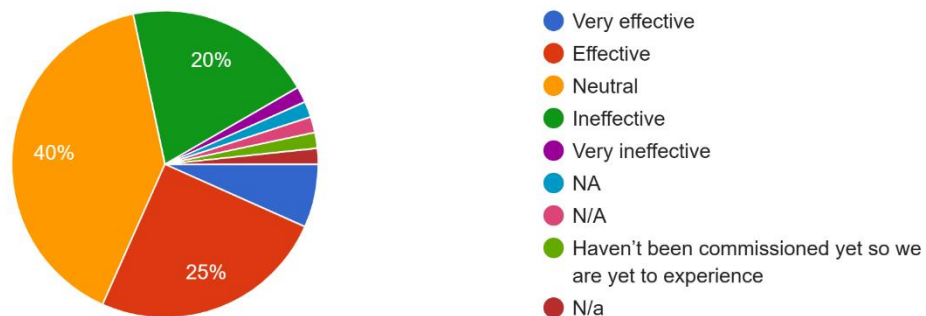


Figure 5. Views on the effectiveness of water management initiatives (Source: Google Forms, 2023)

Some recommendations for sustainable water management include:

1. Promoting tree planting as part of an integrated approach to sustainable water management.
2. Educating communities, especially those in rural areas, on best practices for sustainable water management.
3. Implementing integrated urban planning to prevent developments that may harm water resources.

4. Taking initiatives towards sustainable water management is essential in addressing the global water crisis and promoting environmental resilience. This includes various strategies to conserve and responsibly use freshwater resources.
5. Efficient water use is a key aspect of sustainable water management. Advanced irrigation techniques, such as drip irrigation and precision agriculture, can minimize water waste in agriculture, the largest water consumer globally. Improving urban water infrastructure through leak detection and efficient water treatment can also reduce losses and ensure equitable distribution of water resources.
6. Conservation practices, such as watershed protection and reforestation, are crucial for maintaining water quality and mitigating the effects of climate change. Sustainable water initiatives prioritize restoring and protecting aquatic ecosystems, recognizing their vital role in maintaining water balance and biodiversity.
7. Creating awareness about water conservation is vital for the success of any water-saving initiatives.

## 5. DISCUSSIONS

The main emphasis of this paper is to identify water challenges in urban areas and further highlight practical aspects to help mitigate these challenges. Urban areas face different challenges; this survey highlights common water-related challenges in different countries.

According to the survey in Figure 1, many water-related issues in urban areas are linked to the aging of water infrastructure. It is believed that old pipes and treatment facilities may become corroded and leak, resulting in water loss and potential contamination. To ensure the safety and reliability of water supply systems, it is essential to invest in adequate maintenance and overhaul of these infrastructures (Ramos-Salgado, et al., 2022). Figure 1 also highlights water scarcity and pollution as common challenges in growing urban cities. Such cities put additional strain on existing infrastructure, initially designed for a smaller population. Upgrading these systems to accommodate evolving needs and investing in alternative water supply methods, such as rainwater harvesting and borehole drilling, can alleviate current stresses. Environmental changes or climate change often cause water scarcity, leading to extreme weather events that impact the availability and quality of water sources (UNICEF, 2023).

Based on Figure 2, when individuals were asked if there was an improvement in the water supply over five years, the goal was to determine if the projects and initiatives to address water challenges had produced measurable results. Unfortunately, most respondents reported seeing little to no improvement in the water supply. This suggests that despite investments in water supply, management, and conservation initiatives worldwide, progress has been minimal due to inadequate funding. Additionally, a lack of political will may also be a contributing factor, as policymakers and authorities may not prioritize these initiatives, resulting in a lack of necessary support (ADB, 2021).

When asked about being aware of some of the water conservation and sustainable water management initiatives according to Figure 3, respondents are aware of initiatives such as; Rain water harvesting, Water recycling/ reuse projects, water-efficient landscaping, incentives on

water-efficient appliances, and water education campaigns however when asked if they have personally participated in these programs or projects over 70% said no—indicating a huge gap between knowledge and implementation. Assuming that sensitization and education are being done with limited understanding despite the awareness, most individuals may prioritize immediate concerns over long-term environmental issues, especially if they perceive other urgent matters in their lives (Jimenez, et al., 2019). Developing targeted and clear communication campaigns that emphasize the impact of individuals' actions, such as harvesting rainwater for domestic use or recycling water used for watering using various channels for dissemination. As mentioned earlier, political will could influence pricing mechanisms, promoting water efficiency and restricting water-intensive activities. (Jimenez, et al., 2019)

When asked if they thought the mentioned and other water conservation and sustainable water management initiatives, according to Figure 5, 60% thought they were either neutral or ineffective. This could be why most individuals are not participating in implementing the initiatives despite being aware. Using behavioral science techniques to influence positive behaviors, such as providing feedback on water usage, can significantly impact individual choices. (Koop, et al., 2019)

## 6. CONCLUSION

This paper explores the common water-related challenges faced by urban areas worldwide caused by several issues, including population growth, aging water infrastructure, and climate change. Despite various projects and programs aimed at mitigating these issues, a survey conducted in this paper revealed minimal or no impact. Sustainable water management practices are essential for the environment and ensure efficient, equitable, and resilient water use for all. By implementing innovative initiatives and technologies, encouraging community participation, and adapting policies, we can create urban environments that coexist harmoniously with water resources, ultimately securing a more sustainable future for future generations.

## 7. RECOMMENDATIONS

Achieving efficient, equitable, and resilient water use for everyone requires a multifaceted approach. Here are eight steps we can take to achieve this goal:

1. Educate residents on sustainable water use practices, including reducing water consumption and harvesting rainwater to ease the strain on local water resources.
2. Implement integrated urban development initiatives that use water-efficient technologies and green infrastructure to promote rainwater harvesting, permeable pavements that allow groundwater recharge, and more.
3. Practice efficient water use as a practical approach to sustainable water management, such as water recycling.
4. Invest in water infrastructure by upgrading and expanding systems to enhance efficiency, reduce leaks, and ensure sustainable water supply. This includes modernizing water treatment plants and implementing smart water meters for accurate monitoring.
5. Practice conservation by protecting watersheds, reforestation, and intentional protection of aquatic ecosystems to mitigate the effects of climate change.



6. Implement behavioral change programs and training to encourage residents to take ownership of these practices.
7. Introduce incentives for using water-efficient products, encouraging people to purchase them at affordable prices.
8. Establish sustainable water management policies prioritizing responsible water use, conservation, and protection of water resources. This may include setting industrial and agricultural water usage standards and enforcing water quality.

## **8. PRACTICAL IMPLICATIONS OF THE PAPER**

1. Educating and sensitizing communities about sustainable water practices can create a water-conscious culture, reducing water wastage. Empowering individuals to make informed decisions promotes the adoption of water-efficient technologies and enhances community collaboration for effective water conservation.
2. Implementing integrated urban development initiatives can yield benefits such as optimized land use, reduced runoff, improved stormwater management, and enhanced water efficiency through features like green roofs, permeable surfaces, and efficient drainage systems. It also contributes to minimizing flood risks and improving water quality.
3. Water recycling alleviates the demand for freshwater resources, mitigating water scarcity and ensuring a more resilient water supply. By treating and reusing wastewater, communities can lower environmental impact, decrease pollution, and create a closed-loop system that conserves water resources.
4. Investments in water infrastructure can improve the reliability and efficiency of water supply systems. Upgrading infrastructure can reduce water losses, enhance distribution networks, and prevent leakages. This investment would also support the implementation of advanced water treatment and monitoring technologies.
5. Practicing conservation through the protection of watersheds, reforestation, and intentional preservation of aquatic ecosystems has benefits such as safeguarding the quality and quantity of water resources. This approach helps prevent soil erosion, maintains natural filtration processes, and regulates water flow, improving water quality.
6. Additionally, it enhances urban resilience by reducing the risk of floods and droughts, and it provides recreational and aesthetic benefits.

Overall, such efforts are vital to ensuring the long-term sustainability of urban water resources and ecosystems.

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