State Of Water Storage
In African Cities:
Assessing Constraints
To Urban-Water Harvesting In Sub-Saharan Africa

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ABSTRACT

Africa continent is a host to fastest growing cities in the world expedited by rural-urban migration, improved developmental infrastructure, entrepreneurship opportunities, and better communication networks. However, with this amplified growth of cities in Africa, the state of water storage and harvesting has been compelled. The existing water storage, harvesting, and management systems cannot keep up with this urbanization growth demand. In this paper, we use a theoretical approach to review available scholarly works and secondary data. Our guiding objectives for the study were: evaluate academic findings on the state of water storage and harvesting in Sub-Saharan Africa (SSA) Cities; identify constraints hindering water storage in SSA. From the objectives, we thematically align our review on: population growth trend in SSA; water demand and projections (m$^3$); integrated urban water management (IUWM) grounded on policy and developmental solutions in cities. We draw our conclusion from the findings and recommend the possible root pathways for sustainable water harvesting, storage, and management in Sub-Saharan Africa cities.

Key Words: Water Storage; Sustainability; Urbanization; Cities; Water Harvesting

1. INTRODUCTION

The African continent hosts the fastest growing cities in the world as urbanization growth trend is witnessed across the globe. This growth is expedited by improved developmental infrastructure, rural-urban migrations, better communication networks, and entrepreneurial opportunities. According to Lohnert (2017), Africa is urbanizing fast, growing at 3.9% per year with its population projected to double in the next two decades. Today about 320 million Africans live in urban areas (that is nearly 37% of the African population), increasing urban population index of 1990 (Cities to megacities). By 2030, Africa’s urban population is projected to rise to almost 50% of the population, or some 654m people (UN, 2015; Lufumpa & Yepes, 2017).

This projected population (654m) growth will heighten urban ecological footprint, amplifying pressure on water demand, energy demand and food demand. Urbanized Sub-saharan Africa is engulfed in water stress caused by insufficient developed water storage and harvesting mechanisms that are essential for the development and growth of future African cities (Sanseveno et al., 2017). The existing water storage, harvesting, and management systems cannot keep up with this urbanization growth demand. However, the global agenda 2030, outlines 17 goals that facilitate development and equity to all global citizens. To harness the development of cities and curbing water stress and storage, two sustainable development goals (SDGs) indicators cannot be overlooked. Goal 6: Ensure availability and sustainable management of water and sanitation for all. Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable. Under the Kenyan vision 2030, the social pillar has incorporated these two goals to facilitated the development and realization of its vision.
1.1 POTENTIAL CONSTRAINTS TO WATER STORAGE AND HARVESTING IN SSA CITIES

Water harvesting and storage in major African cities hasn’t fully exploited as the majority of city dwellers depend on piped water (Sullivan, 2017). The vast potential of African cities on buildings, roads, opens grounds and recreation parks if fully developed, they will capture rainwater and surface runoff after a downpour. This however demand for modernized water harvesting and storage techniques – urban water reservoirs, underground water storage tanks linked with gutters from built houses.

Some of the factors that hamper water storage and harvesting in SSA cities include groundwater abstraction (drilling boreholes); dependence and reliance on commercialized piped water; the high initial cost of installation; technology stigmatization; perceptions & attitudes by city dwellers. These can be napped if we utilize the potential rainwater harvesting areas in the urban build-up settings like rooftop rainwater harvesting from buildings, surface runoffs rainwater harvesting along the road, forest water recharge and open groundwater recharge harvesting (Biama and Biama, 2018).

1.2 RAINWATER HARVESTING & MANAGEMENT (RWHM)

Rainwater harvesting is nothing new- this technique has been used for thousands of years in many parts of the globe to capture and store rainwater in the pores of soil or for human use (Campsano et al., 2017). Rainwater harvesting (RWH) is a technology where surface runoff is effectively collected during yielding rain periods. In order to support such technologies, RWH systems should be based on local skills, materials, and equipment. RWH can be through Rooftop RWH (Buildings), Surface runoff RWH (Roads) & Open Ground Water Recharge RWH (Open Spaces). Rapid urbanization, climate change, and amplified water demand, once again have made this ancient technology a viable option for cities – making cities water-wise.

The United Nations survey in African continent indicates that the majority of African nations are facing water shortages (Showers, 2002; Dos Santos et al., 2017). According to Ngare et al. 2017, Africa like other continents is vulnerable from climate variability. This vulnerability trend will affect rainwater harvesting in nations like Kenya, Somalia, and Ethiopia as rainfall patterns will keep changing. Nearly 9 billion people in Africa depend on rainwater, but only a third of this population is dimed to have sustainable rainwater harvesting. Africa water crisis is more of an economic problem that is brought about by poor investment but not an issue of physical scarcity.

1.3 INTEGRATED URBAN WATER MANAGEMENT – TOWARDS URBAN WATER SECURITY

Integrated Urban Water Management (IUWM) refers to the practice of managing freshwater, wastewater, and stormwater as links within the resource management structure, using an urban area as the unit of management. IUWM offers a set of principles that underpin better coordinated, responsive and sustainable resource management practices in Cities (Bahri, 2012; Freeman et al., 2013). IUWM is important in SSA water harvesting because of the following reason:

- Utilization of alternative water sources, including rainwater, and reclaimed and treated water
- Improvement of water storage, supply and consumption efficiency
- Establishment and implementation of policies and strategies to facilitate water storage and harvesting.
- Engages urban communities to reflect their needs and knowledge for water management

Some of the advantages of urban water harvesting include:
- It augments water from piped supplies.
- Does reduces the over-abstraction of groundwater.
- It reduces excessive flooding of streets, houses, and other infrastructure.
- Stabilizes groundwater storage, hence improving river flows from nearby streams.
- Create better awareness and participation of all stakeholders.

2. METHODOLOGY

A desktop study approach was used to review the available literature on water harvesting and management in urban areas. Available data was mined from published papers and reports that were authentic to the study. The guiding objectives to the study were: to project urbanization population growth trend in SSA cities (1950-2050); to evaluate the state of water storage and harvesting in SSA cities; to identify constraints hindering water storage and harvesting in SSA cities and to extract existing secondary data on Urbanization and water demand in SSA Cities.

3. RESULTS AND DISCUSSIONS

3.1 URBANIZATION TREND IN AFRICA

United Nations Department of Economic and Social Affairs (UNDESA, 2012) report attributes that Africa’s urban population growth trend index in the past 50 years has been growing steadily and faster than the rural population. By 2055, the urban population growth rate will overtake the rural community. Nearly half of the African population will live cities in the next two decades. Econometric studies repeatedly have shown a strong correlation between urbanization and gross domestic product (GDP), & between urban growth and economic growth. No country has achieved middle-income status without urbanizing. In Africa, urban household income is twice as high as rural household income (Annez and Buckley, 2009). This fast urbanization has heightened water demand in the urban households. Table 1, shows the state of water harvesting in ten African Cities. Their probable rainwater harvesting potential has been indicated.

<table>
<thead>
<tr>
<th>CITY</th>
<th>UNIT</th>
<th>BUILDING</th>
<th>ROADS</th>
<th>OPEN GROUND</th>
<th>FOREST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaborone</td>
<td>Area (m³)</td>
<td>3,416,889</td>
<td>2,984,939</td>
<td>18,545,852</td>
<td>59,873</td>
</tr>
<tr>
<td></td>
<td>Volume (m³)</td>
<td>1,330,194</td>
<td>956,971</td>
<td>2,123,500</td>
<td>4,113</td>
</tr>
<tr>
<td>Lilongwe</td>
<td>Area (m³)</td>
<td>2,393,250</td>
<td>1,361,337</td>
<td>19,361,813</td>
<td>1,758,679</td>
</tr>
</tbody>
</table>
Possible water harvesting units with African cities were analyzed. Ten targeted Sub-Saharan Africa cities were assessed. Their area in square meters against the rainwater capacity potential in cubic meters. Buildings, roads, open grounds and forests within the cities were used to account water harvesting potential capacity. Addis Ababa was the city with the leading building rainwater harvesting potential with $11,436,523 \text{ m}^3$ with Gaborone recording the least potential of $1,330,194 \text{ m}^3$.

### 3.2 WATER DEMAND COMPARISON BETWEEN SSA AND OTHER PARTS OF THE WORLD

The World Bank studies (2012) indicate an overtime water demand in Western Africa and Eastern Africa that make the larger SSA from the 16th century and a projection to the end of the 21st century. Since the 20th century, water demand in Sub-Saharan Africa has increased and will continue to the 21st century. A combined Western Africa and Eastern Africa water demand have surpassed Western Europe and China. It is projected this demand will be at par with India in the middle of the 21st century.

### 3.3 PUTTING SOCIAL THEORY INTO PRACTICE TO SUSTAINABLE URBAN WATER MANAGEMENT (SUWM)

Social theory is an analytical framework or paradigm used to examine social phenomena. The term ‘social theory’ encompasses ideas about ‘how societies change and develop (Harrington, 2005). It has been acknowledged across the global scale that existing urban water systems and management lead to unsustainable outcomes (Bos & Brown, 2012). If a change towards sustainable urban water management (SUWM) practices
is to occur, a transformation of our established social-technical configuration that shapes the behavior and decision making of actors is needed. Social theory in research is increasingly being recognized in responding to the challenges associated with evolving sustainable form of urban water management.

Nairobi presents a classic case of how the gap between water supply and demand might grow over time among the SSA cities. Nairobi faces significant uncertainties in assessing the difference between future water demand and supply. Its water demand has increased exponentially expedited by doubled population growth. Since 1985, its population had approximately grown from 1.2M in 1985 to 3.2 million in 2010. Over the same period, H₂O demand grew slightly faster, from 203,000 m³/d to 579,000 m³/d (AWSB, 2012)

4. CONCLUSION

There are insufficient datasets associated with the multiple objectives of Rain Water Harvesting notably: water saving & stormwater management in urbanized SSA. Commercialized or industrial scale RWA harvesting to be prioritized to ease water stress burden in SSA cities.

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5. REFERENCES


