

CHALLENGES IN DEVELOPING WATER INFRASTRUCTURE IN AFRICA AND THE WAY FORWARD

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ABSTRACT

There is an increased need to build sustainable water infrastructure in Africa to save millions of people from water-related diseases, prevent hunger and even death. As water is a finite resource, available water resources must be efficiently managed and used. This paper investigates and evaluates existing water infrastructure, the developmental goals and key challenges. Identify and analyze the key drivers for implementing efficient and effective water infrastructure in Africa. It was found that dams, surface-water intakes, drinking-water facilities, pipes and aqueducts are inactive and must be revived to provide the basic needs of safe water to people in Africa. There are wide disparities in the water landscape among various countries within Africa, compounding to the already existing challenges in accessing safe drinking water. This study used a secondary research method by reviewing related journals and textbooks.

KEYWORDS: Water, infrastructure, sustainability, development, Africa.

INTRODUCTION

The African continent is known for its rich and vast natural resources, including water. Most of the African countries have sufficient water resources, which, when effectively used, can solve most of the social and economic needs of the continent. However, despite huge water resources, large populations in the African continent still do not have access to safe and clean drinking water. While it seems that Africa has abundant water resources, the World-Wide Fund for Nature (2014) mentions that Africa is the second driest continent after Australia. Poor planning and coordination, lack of water infrastructure development programs, political instabilities, high levels of corruption and lack of will to implement safe and clean access to water has led to water shortages across most African countries throughout the year.

Most of Africa's countries are underdeveloped and poor; this has only added more problems for clean water initiatives. While in some cases, the shortage of water is due to uneven distribution of water, inefficiency in managing water infrastructure, or lack of funds to improve water infrastructure in Africa. In some cases, high water availability levels and low levels of the population make water resources ineffective (Nelson, 2014). For example, the Congo basin has about 30% of Africa's waters, while its availability or accessibility is limited to only 10% of the African continent (WWF, 2014). This mismatch in resource availability and population only compounds the existing problems concerning water infrastructure. While acknowledging such initiatives' importance, undertaking such programs is a very challenging task, especially in Africa, which has many problems such as lack of financial resources, technology and political will. The objectives of this paper are, therefore;



- To identify the existing situations in Africa, in the context of water infrastructure and available resources
- To evaluate the developmental goals and key challenges in building sustainable water infrastructure in Africa
- To identify and analyze the key drivers for implementing efficient and effective water infrastructure in Africa
- To assess and forecast the prospects of having sustainable water infrastructure in Africa.

Water infrastructure is a key area towards building sustainable programs that have a major impact on humans and nature. A critical review of the literature will help in achieving the project aims and objectives. There is a great amount of research work currently being undertaken in building sustainable water infrastructure in Africa. Some well-known global organizations such as WWF, IMF, World Bank, private, public, and governmental organizations are undertaking extensive research to analyze how a sustainable water infrastructure can be implemented in Africa.

A majority of this paper's sources will be from credible organizations, which have data and information at the ground level. Since it will be impractical to collect data from all countries across Africa, secondary sources will help analyze the key challenges and goals in implementing sustainable water infrastructure in Africa. Since the source of information for this paper will be taken from leading global organizations responsible for implementing these initiatives, the paper will present reliable and credible analysis on the proposed topic.

This paper aims not to collect data from the ground level but to identify and analyze the challenges and goals in implementing these initiatives. This study presents analyses and conclusions on the effectiveness of these initiatives.

• PURPOSE OF THE STUDY

- To proffer a solution on how to revive existing water infrastructure
- Developing decentralized water management systems
- Creating a sustainable water life cycle and promoting ecosystems that reduce or eliminates the impacts of climate change.
- We are developing a model for financing water infrastructure projects.
- It is investing in innovative technology for an efficient water management system.

LITERATURE REVIEW

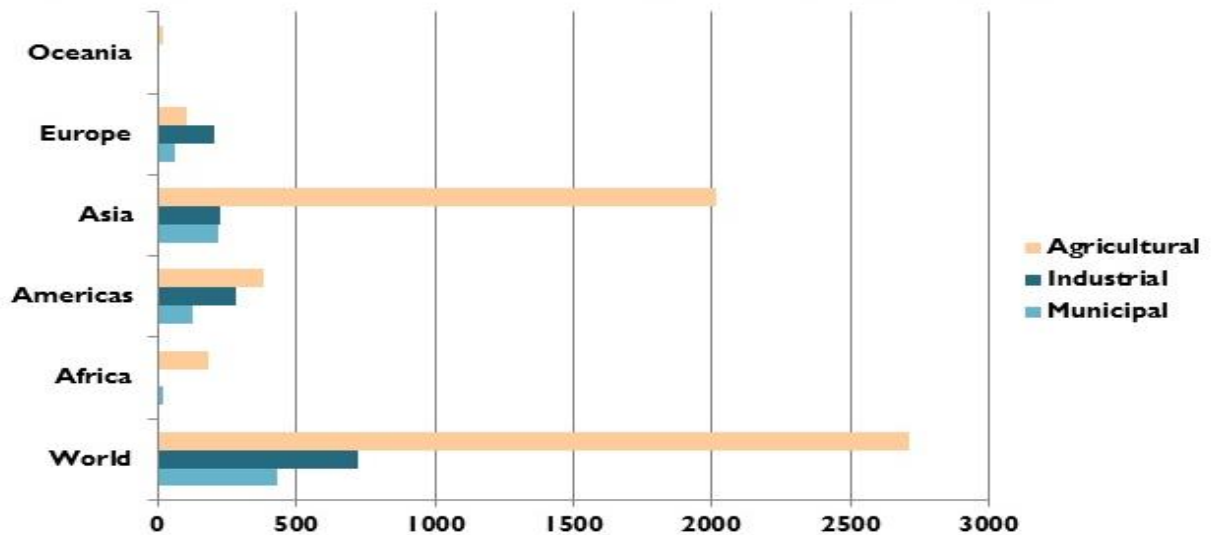
There is huge water stress in many African countries; it is forecasted that more than 50% of the African countries will face a severe water crisis by 2025. Scarcity of drinking water will be the major concern for Africa's 1.1 billion population (United Nations Environment Programme, 2012). Today, the sub-Saharan part of Africa, one of the world's poorest regions and has a population of about 300 million people, does not have access to even minimal needs such as the supply of safe water.

Most of the freshwater, lakes, and rivers flow between different countries, and for these countries, coordination and management of water resources is a challenging task. Moreover, some large water infrastructure projects undertaken by individual countries are only exacerbating the impact caused by



floods and droughts. Apart from causing severe water problems for the local population, these issues threaten their very basic livelihood. Some countries, such as South Africa, a relatively rich and advanced country compared to other African countries, have some good water laws and initiatives such as "Working for Water" (African Development Bank Group, 2015). This unique program introduced by the South African helped alleviate water scarcity by managing water resources and nature efficiently. However, in Africa's remaining parts, water scarcity remains the single biggest problem and threat to the people.

Figure 1: Total Water Withdrawal by Sector (Km³/per year)



Source: UN FAO AQUASTAT, 2013

The above figure indicates the level of water withdrawal from agricultural, industrial, and municipal sectors across all continents. It can be observed that the African continent has the lowest level of water withdrawal in each sector; this indicates the extent to which Africa is facing water problems.

While water is used for many purposes such as agriculture and irrigation, in some cases, the water that is supposed for human consumption is diverted to agriculture, mainly because of the lack of proper water infrastructure. Even in this case, the agricultural developments and goals are yet to yield the desired benefits (WWF, 2014). The African continent is home to the majority of the poorest of the poor people. Although there are some variances in development and infrastructure in different African countries, the Sub-Saharan region, East Africa, and North Africa face severe water-related problems. Water is a necessity for survival; even the smallest problems related to water scarcity and unsafe drinking water can affect humans' Quality of life.

More than 50% of the population in Africa suffer from water-related diseases. Diarrhea, Malaria, Schistosomiasis and other water related diseases are more prevalent in Africa than any other part of world (World Health Organization, 2015). Most developing countries in other continents are quickly

progressing towards creating good water infrastructure; however, many African countries show negative trends in creating provisions for safe drinking water.

It is a known fact that water is a finite resource; any stress or increased demands on water accessibility will add undue pressure on other sectors such as agriculture and industries (Banerjee & Morella, 2011). While the importance of a fresh and safe water supply for human consumption cannot be undermined in any way, undue water stress can affect many other spheres of life for humans and other living beings and destroys the natural environment of the planet.

There is an increased need to build sustainable water infrastructure in Africa, save millions of people from water related diseases, and prevent hunger and even death. As water is a finite resource, available water resources must be efficiently managed and used. The best way to do this is to undertake sustainable water infrastructure developmental program across Africa.

There is no one specific method to build a sustainable water infrastructure. Rather, based on existing factors and circumstances and availability of resources at a local level, innovative water infrastructure programs must be developed. Global agencies such as World Health Organization, World Bank, International Monetary Federation, African Development Bank, World Wide Fund for Nature and other similar financial, health and environmental agencies must contribute in building sustainable water and sanitation infrastructure in Africa.

This project aims to identify, evaluate, and analyze the importance, goals, and key challenges in improving Africa's water infrastructure. Africa is home to millions of people in poverty, and who do not have access to safe and clean drinking water. Water scarcity is one of the most serious and dangerous issue that impacts human health and survival. It is important to take adequate measures to build sustainable water infrastructure in Africa, so as to prevent water related diseases, improve the Quality of human life and bring about changes in social, economic and environmental aspects of the African people.

METHODOLOGY

This study employed secondary research method under qualitative research approach. According to Bhandari, 2020 qualitative research involves collecting and analyzing non-numerical data (e.g., text, video, or audio) to understand concepts, opinions, or experiences. It can also be used to gather in-depth insights into a problem or generate new ideas for research. Adi Bhat 2018, opined that secondary research or desk research is a research method that involves using existing data; existing data is summarized and collated to increase the overall effectiveness of research.

Key Drivers/Issues/Challenges/Implementation

Developmental Goals for Sustainable Water and Sanitation Infrastructure

The implications of having access to clean and safe water and adequate sanitation cannot be overstated. Water-related diseases can have serious repercussions on public health and the economy. Sustainable water infrastructure promotes healthy living and contributes to the development of other spheres in life. The Millennium Development Goal (MDG) states that access to safe water alone can contribute US 3.1 billion dollars' worth of economic benefits to Africa (Banerjee & Morella, 2011). These benefits arise

because of time savings and health benefits of having access to safe water. Safe water provides a range of social, economic and environmental benefits to the people.

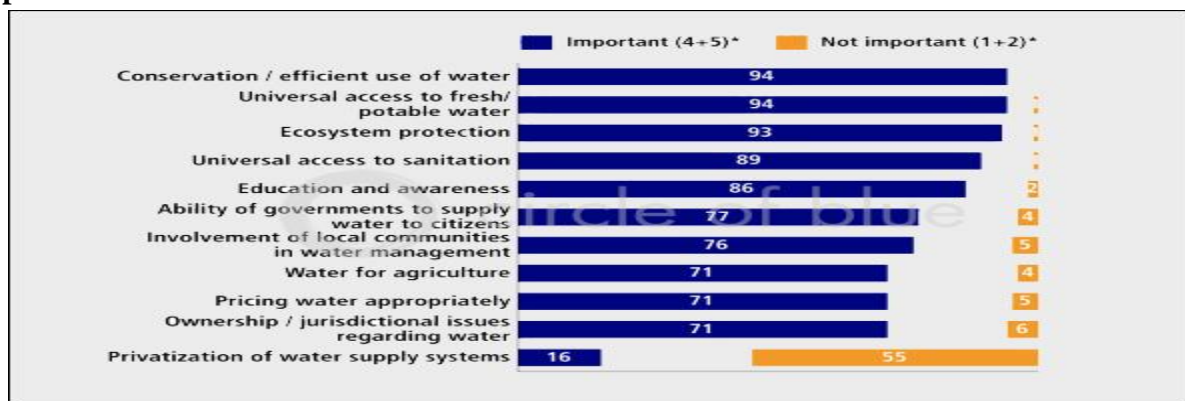
Following are some important developmental goals for sustainable water and sanitation infrastructure

- Keeping more rainwater on the ground and getting evaporated water into the atmosphere will help create more clouds and a consistent saturated water cycle (Royan, 2012). This will solve most problems associated with water scarcity, and it also helps the planet to be cool, thus preventing the harmful effects of global warming
- Maintaining consistent and sustainable water delivery systems, wastewater disposal systems and flood control mechanisms to promote and maintain safe and clean water for consumption
- Integration of drinking water, waste water and storm water management activities, so as to have a cohesive plan to utilize multiple water resources effectively
- Involving both the public and private sector participation in building sustainable water and sanitation infrastructure in Africa
- Promoting innovation and technology in designing better water management and sanitation systems
- Providing more sources of funds and financing for water and sanitation projects that are not only sustainable but are also ecofriendly and helpful in preventing climate change

Challenges in building sustainable water and sanitation infrastructure

The water landscape is very diverse and varied in Africa, some countries have more water resources than other countries, while some countries have better water management systems. In contrast, some countries do not have any recognizable and credible water policies at all. Many of the challenges in improving water infrastructure arise from existing local situations, hence there is no one unique solution for building sustainable water and sanitation infrastructure. Even in a single country, the water management systems are very different at different levels such as –urban settlements and rural settlements. This makes it very challenging to improve water management systems.

Figure 2: List of factors contributing for sustainable water infrastructure by rating and their level of importance



(Source: Survey results on Sustainable Water Infrastructure by GlobeScan, 2010)

The above figure indicates that many factors contribute to building sustainable infrastructure. Similarly, for each factor, there is equal measure of challenge in making sustainable water infrastructure possible and producing the desired social, economic, and environmental benefits.

Following are some of the most important challenges in building sustainable water infrastructure in Africa

- Reviving existing water infrastructure
- Developing decentralized water management systems
- Creating sustainable water life cycle and promoting ecosystems which reduces or eliminates the impacts of climate change
- Financing sustainable water infrastructure projects
- Investing in innovative technologies for efficient water management systems

Reviving Existing Water Infrastructure

Wells and boreholes are the key sources for water storage. A small percentage of African population receives water through pipes and stand posts, and as such most of the people are still dependent on surface water. Piped water supply varies largely from country to country, for example only 2% of the population receives water through pipes, where as in South Africa it is 60% (African Development Bank Group, 2015). These variances make it difficult to take a uniform approach in building sustainable water infrastructure. Moreover, water supply is even worse in rural areas when compared to urban areas. Wells and boreholes are very important to store water, however even the water stored in these are not protected from dust, pollution and other wastes. This leads in additional costs in purification and transportation. Piped water, stand posts, wells and boreholes must be preserved properly and effectively, only basic water protection levels are not sufficient to make the water clean and safe. Inadequate water management systems not only compound existing problems of water scarcity, but they also increase the costs for additional maintenance works (Banerjee & Morella, 2011). Municipal water systems are already facing great deal of challenges in operating and renewing of pipes regularly, there is an urgent need to replace old and technically weak pipes with newer, better quality water pipes, where there is an opportunity to do so.

Decentralized water management systems

Water is the most mismanaged natural resource across the world, and in the case of Africa, any mismanagement or inefficient use of the available water resources can have drastic consequences. Centralized water treatment plants in most parts of Africa are out of date, operating above capacity, contain chemicals which are very unsafe for consumption (Water Environment Research Foundation, 2015). Decentralized water systems contribute a lot towards building water infrastructure, these benefits include energy savings, restoration of aquifers, habitat, streams and wetlands.

Decentralized water systems also help in improving air quality and creating green space. However, in most developed countries and some developing countries are following decentralized water management systems to meet sustainable water infrastructure needs, it seems a long way for many African countries.



Creating sustainable water life cycle and climate change

Water needs to be given back to environment's natural water cycle, however most African countries, like in developing countries are over-taxing it by inefficient water management systems (Ademiluyi & Odugbesan, 2008). The African continent is one of the worst victims of climate change. The average temperatures in Africa are increasing gradually over many years compared to other parts of the world. This is a direct result of global warming or climate change.

The natural water cycle needs to be restored to its originality, which is affected by climate changes, acidification of oceans and other water bodies and over exploitation of water resources. Sustainable water infrastructure can reduce or mitigate the ill effects of climate change by reducing carbon emissions. This can be done by creating alternative water supply and storage systems, increasing water management systems' efficiency, using green technologies for construction and integration of water infrastructure.

Financing sustainable water infrastructure projects

Most water treatment plants in Africa need a complete overhaul, which requires huge financial investments. While most countries in Africa are relatively economically weak, countries with some financial resources are also not utilizing the funds judiciously to revamp water treatment plants. For effective water and sanitation infrastructure, political will is necessary, however for many decades, water management has been ignored or not given due attention by respective governments across many African countries (The Johnson Foundation, 2012). Global organizations such as World Bank, IMF and other regional developmental banks, environmental agencies and other nations must contribute generously in building sustainable water infrastructure. Any kind of sustainable water infrastructure project undertaken across any part of the world, will benefit the world.

Investments in innovative technologies

Aging water infrastructure, depleting water resources and inefficient planning are the major challenges for overcoming water crisis. Water management must be a major initiative for decision makers, irrespective of African countries' financial standing. Most of the urban settlements in Africa have piped water supply to some extent, however most of them follow a centralized water system framework, this makes it difficult to manage even a small issue, and even a small issue requires to be passed through a long list of bureaucracy (Tortajada, 2014). In most parts of Africa, development of waterborne sewerage networks lags far behind the piped water networks technology, this completely disintegrates, what must be an integrative system (Koehler, et al., 2015).

Only a handful of countries are making steady progress in improving water infrastructure since the last two decades. Lack of funding, non-availability of newer and sustainable water management technologies is some of the major challenges faced by many countries in Africa (Swilling, 2006). Apart from few countries, most countries face severe water related issues, and the existing water infrastructure is very poor compared to what is being done in developing countries. This huge disparity in development is due to many factors, and poses many challenges, which must be handled carefully by proven policy implementations.

Key Drivers for Sustainable Water Infrastructure in Africa

Most water sector systems in Africa are working hard to move towards greater water infrastructure sustainability, however the level of investments or commitments needed for building sustainable water infrastructure is not keeping up pace with ground realities of water scarcity and water mismanagement. It is important to identify the key drivers in building sustainable water infrastructure, to reduce the gap between investments required and pace at which sustainable water infrastructure must be achieved. Following are the three categories of key drivers which enables sustainable water infrastructure in Africa

- International Agencies
- Environment Protection Agencies
- Business and Financial Agencies
- Social and Economical
- Rapid urbanization and Population growth
- Water quality and Public health
- Water supply requirements
- Environmental
- Water droughts
- Storm water management
- Carbon footprint

Sustainable water infrastructure provides a framework to address many social, economic and environmental challenges in the context of climate change. Water is a finite resource, and its must be put to better use, right water infrastructure helps in solving many of the problems associated with water mismanagement and water scarcity(Swilling, 2006). Financing water and sanitation infrastructure requires substantial amount of money. Even though some countries are not financially self-sufficient, many private, public and global organizations and individuals contribute financial resources for better water management and sanitation.

The social and economic problems associated with water scarcity also creates a necessity to build sustainable water infrastructure. Rising population demands more water resources, this can lead to water scarcity, hence alternative water supply and storage systems must be created to manage water resources in a better way. Similarly floods and storms cause huge damages to water resources, moreover it aggravates severe water related diseases, and can even contribute for increase in carbon emissions, if not managed efficiently, and hence it is important to take up timely initiatives for building sustainable water infrastructure.



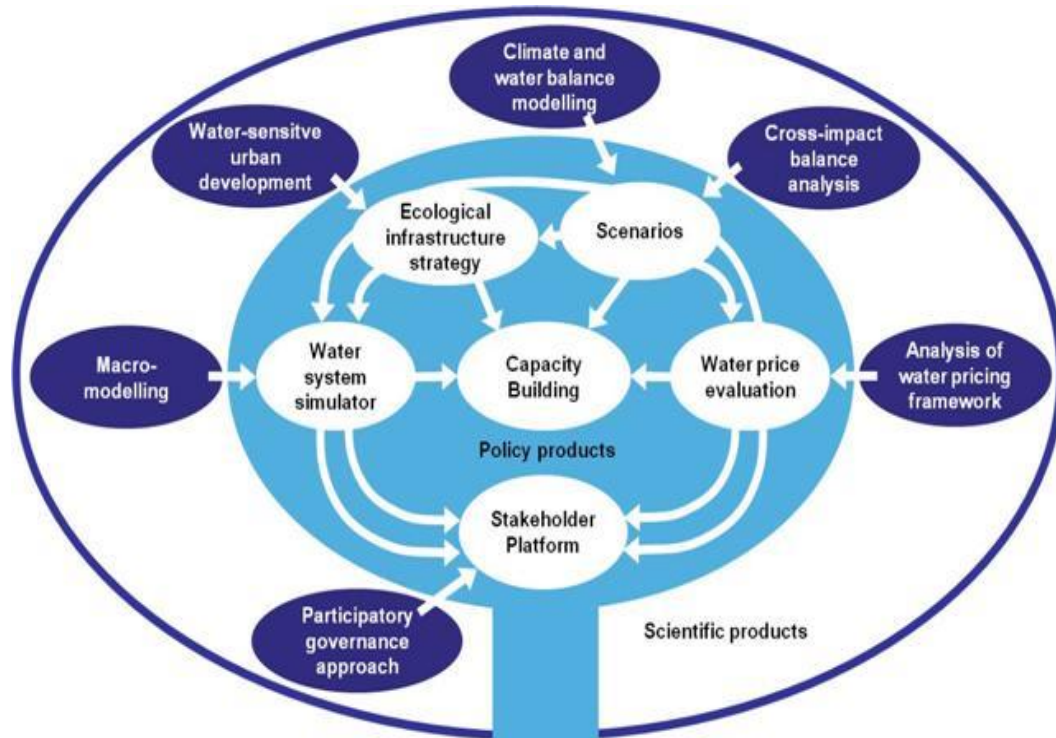


Figure 3: Sustainable Water Infrastructure Planning and Network
(Source: Federal Ministry of Education and Research, 2013)

The above figure indicates the partners' network required in planning and implementation stages for building sustainable water infrastructure. It can be observed that there is a requirement for many partners and coordinated efforts to achieve sustainable water infrastructure. Planning and implementing sustainability are based on many factors and require an in-depth analysis of existing local conditions and available global solutions.

RESULTS/DISCUSSION

Implementation strategies for building sustainable water infrastructure in Africa

Following are the key implementation strategies for building sustainable water infrastructure in Africa

Improving Asset Management

Water infrastructures are the most valuable part of public infrastructure, municipalities are entrusted with the responsibility of managing and expanding them for current and future generations. Infrastructures inexorable age and degrade, while society places increasing demands for service levels, risk management and sustainability. Asset management of water infrastructures is the set processes that utilities need to have in place to ensure that infrastructure performance corresponds to service targets over time, that risks are adequately managed, and that the corresponding costs, in a lifetime cost perspective, are as low as possible.

Increasing Water and Energy Efficiency

Water and energy efficiency provide a wide range of benefits for utilities, consumers, businesses, and the community. According to United state environmental protection agency (EPA, 2017), using less water means moving less water, reducing the strain on water supplies and drinking water and waste water infrastructure. If water and waste water utilities could reduce energy by just 10 percent using demand management and cost-effective and energy efficiency investments, it would save a lot in annual budget.

Developing Alternative Technologies

Planning or implementing any kind of water infrastructure must be taken on short term and long-term basis to quantify economic and social costs with the benefits they provide in the short term and long term (USEPA, 2015). This strategy helps in eliminating unnecessary spending or wasting of resources and helps in improving the process itself. Both public and private organizations must actively participate in building efficient water management systems. This helps minimize the cost and adds value by bringing in different and innovative technologies into sustainable water infrastructure. A road map for sustainable water infrastructure must be based on strong planning and executing best practices in the water systems sectors. Asset Management – Governments must invest in right kinds of assets, to build sustainable water infrastructure within reasonable financial estimates, this helps in acquiring the most useful and productive assets in building sustainable water infrastructure

Sustainable technologies, processes and frameworks must support water and Energy Efficiency-Water management systems. These systems' efficiency and reliability are increased, which greatly reduces costs and addresses future challenges concerning water preservation and climate change. Africa is one of the worst victims of climate change, and having efficient water management systems greatly helps in reducing the negative effects of climate change

Alternative Technologies – Since most African countries are poor and have insufficient financial and technological resources, developed and developing countries and global agencies must provide innovative solutions and technologies (Russo, et al., 2014). These investments can be greatly helpful in building sustainable water and sanitation infrastructure in Africa.

Most of the advanced sustainable water treatment solutions are deployed in the developed world and some extent in developing countries. However, few water treatment solutions require less investments and are equally effective in storing, treating, and transporting safe water to African households. Some water treatment solutions that can help in building sustainable water infrastructure that can be used in Africa are

- Biogas generation from waste water treatment
- Water reuse and recycling systems market
- Smart water solutions to decarbonize water services

Implementing efficient water management systems is the first step towards building sustainable water infrastructure, however the level of reinvestments and fresh investments in water sectors is not in pace with the basic needs of large population in Africa (African Development Bank Group, 2015). As an implementation strategy, reducing this gap between investments required to build sustainable water



infrastructure and the issues that can be solved by achieving sustainable water infrastructure must be given priority.

Strategies for building sustainable water infrastructure in Africa

- Establishing sustainable water infrastructure developmental goals that reflect local aspirations and utilities
- Establish objectives for each of the sustainable water infrastructure developmental goal
- Analyze range of alternatives based on prevailing water infrastructure systems across Africa
- Ensure that investments into sustainable water infrastructure projects are sufficiently funded, maintained and replaced over time
- Develop new and innovative technologies which support sustainability consistently

Key Performance Indicators

- Improvement in water accessibility and Quality of water
- Increased reliability and serviceability in proposed sustainable water infrastructure
- Reduction in Greenhouse emission as a direct consequence of sustainable water infrastructure
- Improvement in Quality of life and other social indicators
- Reduction in energy consumption and increase in energy efficiency
- Return on Investments in terms of quantifiable economic, social and environmental aspects

CONCLUSION

Water management systems in most parts of the Africa are outdated and are ineffective in dealing with many problems of water related issues. It was found that existing water and infrastructure in Africa is in a very bad shape and must be revived to provide the basic needs of safe water to people in Africa. There are wide disparities in water landscape among various countries within Africa, compounding to the already existing challenges in accessing safe drinking water. Despite advances in water treatment solutions in the international and African markets, most countries are still using surface water and fragmented waterborne sewerage systems for their water needs.

Since most African countries do not have enough finances to support sustainable water, efficient water management systems must be addressed based on local and prevailing conditions in different countries or regions in Africa. Further research is needed in developing predictive modelling to create low cost water infrastructure technologies. Similarly innovate approaches need to be applied to reduce or eliminate aging water infrastructure. To address climate change in the context of sustainable water infrastructure, improvements in design and green infrastructure effectiveness must be developed based on region specific conditions.

RECOMMENDATION

- ✓ The level of reinvestments and fresh investments in water sectors should be increased to meet the basic needs of a large population in Africa.

- ✓ Water reuse and recycling systems should be encouraged so that the effects of climate change across sub-Saharan can be greatly reduced.
- ✓ Biogas generation from waste water treatment should be used as the sources of energy; this will reduce greenhouse emission as a direct consequence of sustainable water infrastructure.
- ✓ Planning and implementing any kind of water infrastructure should be taken on short term and long-term basis, to quantify economic and social costs with the benefits they provide in short term and long term

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