



## Incorporating an Environmental Management Plan in Water Utilities Management Systems to Reduce Water Loss; Case of Non-Revenue Water in Kisumu City, Kenya

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**ABSTRACT:** One of the biggest issues facing water utilities is the water loss experienced during the distribution process. This study sought to examine water distribution process in Kisumu and formulate an Environmental Management Plan (EMP) to minimize water loss and mitigate their negative environmental impacts. A qualitative research approach and a case study research design were employed where 25 participants from Kisumu Water and Sanitation Company (KIWASCO) were interviewed in a Focus Group Discussion (FGD). Content analysis of the data collected indicated that water quality and quantity were greatly affected by water loss and the problems associated with them included water pollution due to introduction of contaminants when leakages or pipe bursts occur and water scarcity where the water utility was unable to make up for the amount of water lost. Water abstraction technique was also identified as a vital factor that determines how much water is lost even before it gets into the distribution system. Land/soil, socioeconomic and political environment were also some of the factors identified as they form the backbone of a functional EMP. The research concluded that as much as KIWASCO has a strategic plan to minimize these water losses, the goal entirely focuses on doing so for economic gains and not to address the associated negative environmental impacts hence the recommendation that there is need to incorporate an EMP in their management systems that will not only ensure high revenue generation but also guarantee the conservation of the said water resource to achieve environmental excellence.

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Water loss is one of the major challenges facing water utilities around the world and its management therefore requires a comprehensive and integrated approach that takes into account the new and emerging trends in water resource conservation and management (Vermersch and Rizzo, 2007). Vermersch and Rizzo (2007) further explain that the complexities experienced in water resource management are often as a result of misunderstandings and underestimation of the type and dimension of water loss while also citing the need for water utilities to incorporate an EMP in their management. These water losses are categorized into two by the International Water Association; the first being the physical/real losses that occur due to pipe bursts or

leakages in the storage tanks and along distribution systems and the second being the commercial/apparent water losses that occur due to illegal water consumption or consumer water meter irregularities. The American Water Works Association (AWWA, 2019) emphasize on the importance of annual water audit by water utilities in finding the gaps on the distribution networks and establishing the tools and mechanisms that can be used to formulate appropriate measures on water loss reduction. Umutangampundu (2020) further elaborated on the need for water utilities to come up with a good action plan that contains strategies for reducing water losses such as auditing of unbilled water, alert call, search for and repair of leaks,

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changing defective meters together with continuous capacity building to reduce water loss levels. Given that water utilities' problem of increased water loss coupled with the constant weather variation and negative impacts of climate change is making the management of water resource a tedious and complicated process (Kanakoudis and Tsitsifli, 2010), an EMP is therefore required to help in the identification of interdependent environmental components related to water resource management. A report by the Commonwealth of Australia in 2014 noted that most strategies formulated by water utilities lack an Environmental Management Plan (EMP) which they defined as a plan that describes how an action might impact on the natural environment in which it occurs. They further explained that the EMP should also set out clear commitments from the person taking the action on how those impacts will be avoided, minimized and managed so that they are environmentally acceptable. Further description by the commonwealth of Australia (2014) report that a comprehensive EMP should be balanced, objective and concise; it should state any limitations that apply, or should apply and should consist of mitigation measures for each item with each activity to be undertaken as it also helps in complying with various existing environmental regulations. A similar report by Hunter Water (2018) on management and sustainability indicated that an EMP's key benefit is to provide the company/ organization (in this case water utilities) with a means of managing and monitoring their environmental performance and it should therefore include four major elements which are 1) commitment and policy, 2) planning, 3) implementation 4) measurement and evaluation. They argue that this allows water utilities to contribute to improved environmental quality, not to mention cost control on the money that could have been used to mitigate the negative environmental impacts. Hence, the objective of this paper is to evaluate the incorporation of environmental management (EMP) in water utilities management systems to reduce water loss based on the Non-Revenue Water occurrence in Kisumu city, Kenya.

## **MATERIALS AND METHOD**

*Study Area:* The study was conducted at Kisumu Water and Sanitation Company (KIWASCO) in Kisumu, City Kenya which is the major company certified and mandated by the Kenyan government to provide clean and efficient portable water and sanitation services in Kisumu County. The city has a population of 344,874 according to the 2019 Kenyan census and KIWASCO on the other hand has approximately 44,000 active connections within Kisumu city alone as indicated in their 2017-2022

strategic plan. To fulfill their mandate of efficient water provision, KIWASCO has two water treatment plants, one at Dunga beach that extracts a substantial amount of its water from Lake Victoria and the other one at Kajulu water filter which extracts its water from river Kibos. The average level of water loss experienced at KIWASCO is at 39%, also according to KIWASCO's 2017-2022 strategic Plan which is 19% higher than the recommended levels by the Water Services Regulatory Board (WASREB, 2019).

*Data collection:* There were two Focus Group Discussion (FGD) conducted. Each session contained 14 and 11 participants from Kisumu Water and Sanitation Company. The interviews were based on the participants' consent and the discussions lasted no more than one hour. These FGDs were held in a non-intrusive environment to make the participants feel comfortable and confident during the survey.

*Data Analysis:* The data collected was subjected to content analysis using the STATA (17) software where the text mining tool was used to provide an in-depth understanding to help draw conclusions, suggest recommendations and propose the various factors that can be used to construct a functional Environmental Management Plan.

## **RESULTS AND DISCUSSION**

The current KIWASCO's strategic plan (2017- 2022) recognizes its mandate in ensuring clean and efficient provision of water to Kisumu residents. It does not however provide mechanisms to handle the environmental aspect of this critical situation. There are various environmental management plans developed in countries such as the Australian Environmental Management Plan (EMP) (2014) but they do not address the environmental aspect of water loss neither do they propose how such cases may be handled. This proposed EMP aims at reducing the amount of water loss and the associated negative impacts. In developing the EMP for NRW in Kisumu, six interdependent factors that collectively constituted a functional EMP were considered as elaborated Table 1.

The first factor the study explored was water quality because it is adversely affected by water loss. The quality of water is compromised when there is leakages or pipe bursts that provide avenues for contaminants to get into the distribution system thereby compromising the quality of water distributed to the consumers. The problems associated with water quality include; water pollution due to introduction of contaminants and other toxic substances and when consumers ingest this water they are exposed to infections by water borne diseases such as Bilharzia

and Cholera. In the case of KIWASCO, it manages water quality by ensuring that the water distributed to the consumers is fit for consumption. This is done through frequent analysis of water quality parameters before the water is distributed. It also ensures that after repairing pipe bursts/ leakages, the water in the system

of the affected area is drained to get all the contaminated water out. However, there is also need to ensure that once in a while the water that reaches the final consumer is analyzed to ensure it did not get into contact with any contaminants/ toxic substances during the distribution process.

**Table 1:** Proposed Environmental Management Plan

S/N	Factor	Associated problem	Proposed Mitigation Measures
1.	Water Quality	Water pollution Health implications	Frequent analysis of water Non-corrosive distribution material Efficient pressure management
2.	Water Quantity	Water shortage/scarcity Declining water volumes Intermittent water supply	Active leakage control Replacement of outdated equipment Proper planning and Implementation
3.	Water Abstraction technique	Water loss Pollution of water at source	Environmentally sound equipment Clear conservation measures Clear guidelines for extracting water
4.	Land/ Soil	Soil erosion/sedimentation Increased water logging Water catchment destruction	Policies on water loss reduction Interdepartmental liaison Proper installation of the distribution lines
5.	Socio-economic	Unskilled personnel Inadequate funds Stakeholder engagement	Regular staff training Government funding/support Community involvement
6.	Political/ Policies	Legal requirements Environmental policies	Trans-boundary Management Implementing existing policies Operating within legal bounds

The water provider also needs to invest in new infrastructure and replace the old and worn out pipes that are corrosive and prone to bursts/ leakages that provides leeway for contaminants to get into the distribution system. Controlling the distribution pressure is also an important aspect of reducing contamination of water noting that foreign substances can get into the distribution system both when the pressure is high or low. Another factor considered was the issue of water quantity because too much water in the system can cause pipe bursts leading to water loss and also over abstraction can lead to decline in the volume of water at the source.

The challenges that reduced water quantity impose are intermittent water supply and overall water scarcity for utilities that cannot make up for the lost water. There is need for KIWASCO to identify the types of water loss (prioritizing the most rampant ones) and also properly calculate the amount of water lost instead of working with approximations. Other measures include fixing active leakages and application of optimum pumping pressure to avoid pipe bursts due to high pressure. It is also vital to regularly service old and worn out pipes that are prone to pipe bursts or investing in new infrastructure.

The third factor was the technique or mechanisms used for water abstraction by KIWASCO as this may cause water loss before it even gets into the distribution system. Aside from that also, use of efficient water abstraction instruments ensures efficient use of energy

and protection of the water catchment areas to enhance sustainability. Land and soil management were also examined as the fourth factor because they directly interact with the physical water losses. The impact of water loss interaction with land and soil will result into soil erosion, increased water logging, increased sedimentation and reduced aesthetic value of the urban centers due to the formation of articial wetlands.

Therefore, controlling the distribution pressure, implementing policies on water loss reduction, community participation and proper installation of the distribution network are some of the mitigation measures that can help reduce the challenges cause by water loss on both land and soil. The fifth factor was socioeconomic environment because this will influence the type of mitigation measures as well as attitudes and practices of managing water loss. This factor is often influenced by unskilled personnel, inadequate funds, inadequate infrastructure and lack of community involvement.

The sixth and last factor identified was the political & environmental policies because all Environmental Management Plans operate within certain set legal bounds and are influenced by political situations and policy governance. In the case of Kenya, such laws are domiciled in the constitution of Kenya 2010 and are reflected in the vision 2030 whose aim is to reduce water loss to acceptable levels of below 25%. These legal instruments help keep the water service providers on toes as they work towards achieving set targets

thereby reducing the levels of water loss across the country. This can be mitigated by ensuring each water utility is in compliance with the existing environmental laws, policies, strategies or agreements and by also ensuring that frequent reports are provided for the same. Further, the study established that environmental and natural resources laws and policies (of which water resource is one of them) are applicable regionally and globally to minimize trans-boundary conflict of interest.

For instance, article 111, 112 and 114 of the East African Community Treaty provides for partner states to take a joint effort in strengthening the resilience and sustainable management of biologically significant trans-boundary freshwater ecosystems such as Lake Victoria which is the main source of water for the three East African countries. It is important to note that all these mitigation strategies require financial investment, a designated time frame and various persons responsible which is unique to each water utility in all the countries around the world; these aside from enhancing the water resource management also provide an avenue for evaluation and monitoring of the goals achieved.

*Conclusion:* Environmental Management plans exist for various projects, however, there is none that has been developed to help in the reduction of water loss and management of water as a natural resource based business which is an everyday activity. Developing an EMP will therefore help in understanding the inter connectivity of various factors related to water loss and the threat they pose to human and environmental health as well as helping water utilities to properly plan depending on the available resources. The study recommends the need for incorporating this Environmental Management Plan as a holistic approach towards the management of water and its related resources.

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