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WATER DEMAND MANAGEMENT OPTIONS IN MASVINGO CITY, ZIMBABWE

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Abstract:
With most cities around the world, especially in less economically developed countries, facing a growing challenge in meeting rapidly escalating demand for water, water demand management has emerged as a potentially powerful instrument with which to enhance socio-economic development amidst limited water supplies. The study sought to assess water demand management strategies in the City of Masvingo in south-eastern Zimbabwe, and suggests some options towards a more effective demand management regime. The need for water demand management in Masvingo City arises due to water supply challenges that have further been compounded by rapidly growing demand. A household questionnaire, structured interviews and observation were the tools used in collecting data for the study. Descriptive statistics were used in analysing quantitative data gathered through the questionnaire, while qualitative data were analysed thematically. Among the water demand management strategies in Masvingo City identified by the study include water pricing, water rationing and prohibited/restricted water use for certain activities. Water pricing as a demand management strategy was, however, being hindered by political interference which has seen government occasionally coercing municipalities across the country, including Masvingo City, to cancel outstanding bills of residents, and especially when elections are around the corner. Such politically motivated moves render water supply services ineffective by depriving them of much needed revenue. Through the study, it was also noted that a lot of the restricted or prohibited water uses such as the use of horse pipes for watering, were not being heeded by most of the residents of Masvingo City. High non-revenue water loss through leakages in the reticulation network has also made water demand management in Masvingo City to be ineffective. The study recommends that water users should pay for the water they would have used, which will force them

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to use water wisely. The populist and politically motivated interference by government in the affairs of municipalities, such as the coercive cancellation of outstanding water bills of residents, should therefore stop. Masvingo City Council should take measures aimed at reducing non-revenue water loss due to leakages in the reticulation network. Last, but not least, the City of Masvingo should expand its current water supply infrastructure so that it reflects the reality of a rapidly growing water demand.

Keywords: water demand management, water scarcity, urban water supply, Masvingo City

1. Introduction

Water promises to be to the 21st century what oil was to the 20th century: the precious commodity that determines the wealth of nations (Tully, 2000). Indeed, water is now recognised as the most fundamental and indispensable of all natural resources (Gleick, 1999). Almost every country on earth faces a growing challenge to meet the rapidly escalating demand for water. As water supplies continue to dwindle due to depletion, pollution and climate change, on the other hand, demand for water is rapidly rising as population grows, coupled with rapid industrialisation, mechanisation and urbanisation (Biswas, 1998; Catley-Carlson, 1993; Manzungu et al, 2016). The situation is particularly acute, and will worsen more rapidly, in the arid regions of the world where water scarcity and associated increases in water pollution limit socio-economic development and are often closely linked to poverty, hunger and disease (Biswas, 1998).It is estimated that over a billion people, mainly in the developing world, lack access to safe drinking water. In Zimbabwe, as in many other countries across the world, water supply challenges are more acute in the urban areas where service provision has been dwarfed by rapidly increasing populations. It is worth noting that by 2030, more than 55% of Zimbabwe's population will be living in urban areas (Chenje et al, 1998).

Water demand management has emerged as a potentially powerful instrument with which to enhance socio-economic development amidst limited water quantities (Arlosoroff, 2004). Water demand management seeks to increase the efficiency of water use through increasing the benefits to society arising from a unit volume of water (Dube and van der Zaag, 2003; Arlosoroff, 2004). The increasingly popular, and apparently convincing, argument propounded by the concept of water demand management is that, in the face of water scarcity, solutions should not be limited to supply-side options only, but demand-side options such as minimising water losses, and influencing demand to more desirable levels, should also be considered (Gumbo and van der Zaag, 2002). In most cases, the solution to water scarcity will be to increase water availability through developing new sources of water. However, in the face of a rapidly growing urban population, or in the absence of financial resources with which to develop new water supplies, supply-side options may be too expensive hence, the increasing popularity of demand-side measures to water scarcity (Gumbo and van der Zaag, 2002).

Water demand management is a relatively new concept that features prominently in the Southern Africa Vision for Water, Life and the Environment adopted by the SADC Heads of State in Arusha, Tanzania, in 2000 (Gumbo and van der Zaag, 2002). Several initiatives for implementing water demand management have been undertaken in the SADC region and such initiatives have seen some cities embracing and adopting a variety of demand management strategies (Gumbo and van der Zaag, 2002). While various cities in the region have adopted water demand management strategies, there have not been follow-up studies in many of them to find out how these strategies are helping in easing water scarcity.

This research uses the City of Masvingo as a case study to explore water demand management initiatives in Zimbabwe's urban areas. The three specific objectives which guided this study were:

- To establish the need for water demand management in Masvingo City;
- To assess the various water demand management strategies put in place in the study area;
- To come up with demand management options to further enhance water use efficiency in Masvingo City;

In pursuing the above specific objectives, the following research questions acted as useful guides:

- Why the need for water demand management in Masvingo City?
- What are the various water demand management strategies that have been put in place by Masvingo City Council, and with what measure of success?
- What demand management options can be adopted to further enhance efficient water use in Masvingo City?

Only one studyon water demand management in the study area (Dube and van der Zaag, 2003) haspreviously been undertaken. Approximately two decades have lapsed with no further assessments of current scenariosyet demand for water continues to rise in the city, while the water supply infrastructure remains the same. The need for new studies to assess current realities pertaining water demand management in Masvingo City, therefore, becomes apparent hence, the current study. While the study by Dube and van der Zaag mainly focused on water use patterns in Masvingo City, this study specifically focuses on water demand management in the same study area.

2. Methodology

2.1 Study site

The City of Masvingo is situated in the southern part of Zimbabwe (Figure 1) 292km to the south of Harare, the capital, and is the oldest urban centre in Zimbabwe. The city has grown to become a major distributive and communicative centre as it is strategically located equidistant from Zimbabwe's major urban centres of Harare, Bulawayo, Mutare, Beitbridge and Gweru. Masvingo is a growing city with a rapidly expanding suburbia comprising high-income, middle-income and low-income residential areas. According to the Central Statistical Office (2012), the City of Masvingo

had a population of 88554 people in the 2012 national census, the latest population count in Zimbabwe.

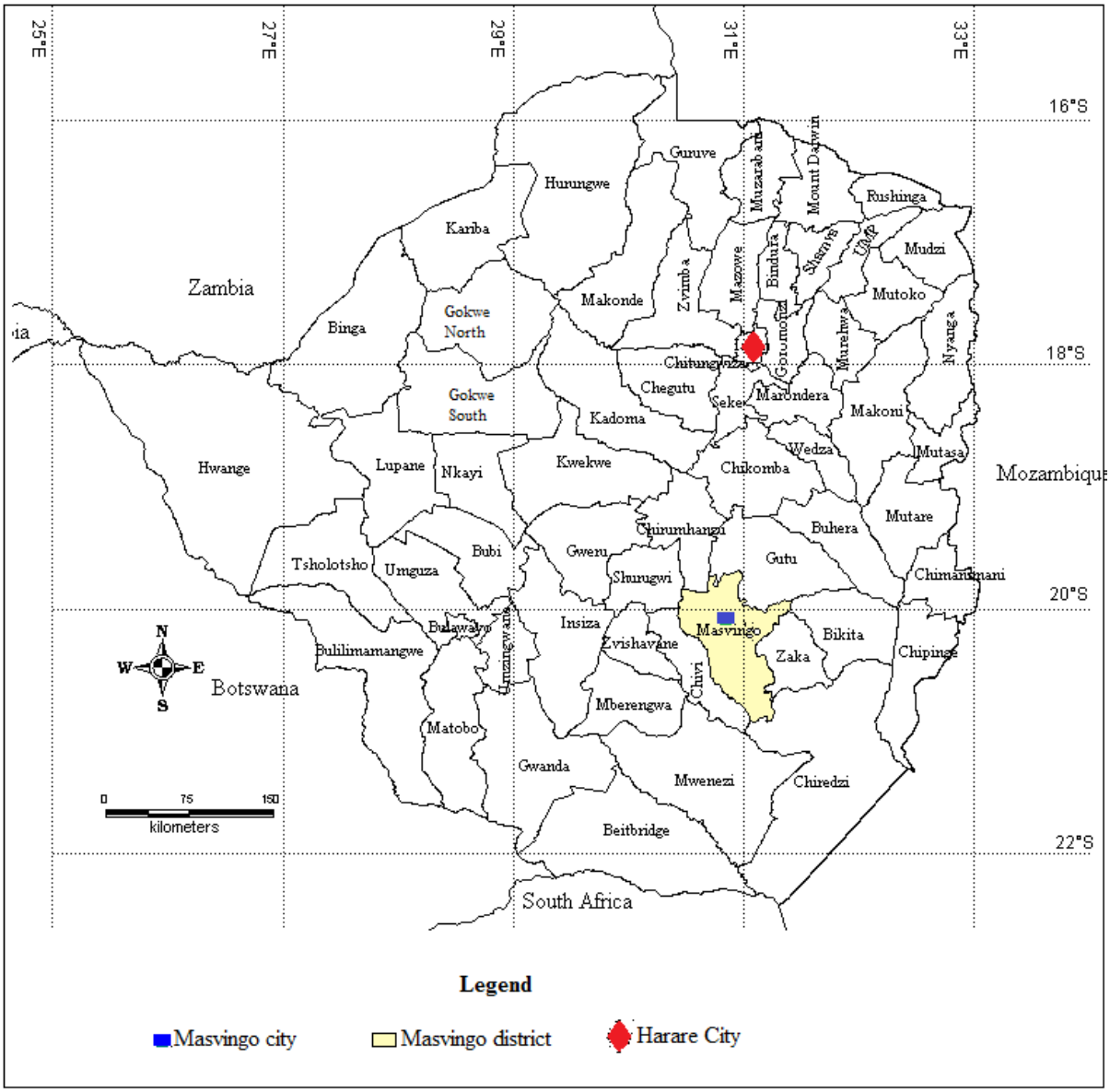

Figure 1: District map of Zimbabwe showing location of Masvingo City

The City of Masvingo is situated in a drought prone area of agro-ecological zones IV and V, with an average rainfall of 600mm per annum. The raw water source for Masvingo City is Lake Mutirikwi, Zimbabwe's second largest inland lake. Apart from providing water to the City of Masvingo, Lake Mutirikwi also supports large sugarcane irrigation schemes in Triangle and Hippo Valley in the south-east lowveld. Water use in Masvingo has increased over the years from 2.4 million m^3 per annum in 1977 to 6.8 million m^3 per annum in 2001 (Dube and van der Zaag, 2003). The current water treatment works were upgraded in 1982 to their current capacity of producing 24000m^3 per day of treated water, and may produce a maximum of 28000m^3 per day under severely stressed conditions (Dube and van der Zaag, 2003). The capacity of the water

treatment plant is not enough to meet current demand. The consumptive uses of water in Masvingo City range from domestic, institutional, municipal and industrial needs.

2.2 Data collection and analysis

The study employed the descriptive survey design to assess water demand management strategies in Masvingo City. A questionnaire was used to collect data from residents in the high-income and low-income suburbs of Masvingo City, with the former including Rhodene, Clipsham and ZIMRE Park, while the latter comprises Mucheke, Rujeko and Victoria Range. A total of 120 questionnaire respondents were selected for interviews, 60 from the high-income suburbs and another 60 from the low-income suburbs. Stratified random sampling was employed in selecting questionnaire respondents, with houses used as sampling units. The high-income and low-income suburbs were the two demarcated study strata. Lists of the house numbers of the various suburbs in the two study strata were used to randomly pick households for interviews. The questionnaire solicited for information from respondents on, among other issues, water demand management strategies in place in Masvingo City, and the effectiveness of such strategies.

Structured interviews were also conducted with purposively selected key informants. These included a representative from the Engineering Department responsible for water provision, and a representative each from industrial, commercial, institutional and domestic water users in Masvingo City. The aim of the structured interviews was to get in-depth information on water demand management strategies in Masvingo City, information which the questionnaire is usually incapable of collecting.

Observation was also very instrumental in gathering data for the study, whereby physically observable aspects of water demand management could be visually noted and assessed across the city. Some of the hindrances to sustainable water demand management in Masvingo City were also highlighted through observation.

Descriptive statistics were employed in analysing quantitative data obtained through the questionnaire. Qualitative data from interviews and observation were analysed through a combination of thematic and narrative analysis guided by the research objectives. The information generated from the analysis of the data was then corroborated so as to facilitate the drawing of sound inferences and conclusions.

3. Results and discussion

All questionnaire respondents (100%) in the high-income and low-income suburbs highlighted that there was need for water demand management in Masvingo City. When further asked why there was need for water demand management in the city, again, all the questionnaire respondents (100%) in the two suburb categories indicated that the water being supplied by the city's reticulation network was well below demand, hence the need to manage the demand for the scarce water supply.

An interview with a representative from the Engineering Department revealed that Masvingo City requires about 45000m^3 of water per day. The current daily

production capacity of the city's Bushmead Water Treatment Plant is only 28000m^3. This translates into an unmet daily water requirement of 17000m^3 for the City of Masvingo. Interviews with representatives from the city's commercial, industrial, institutional and domestic water users also unanimously highlighted that water demand in Masvingo City far surpasses current supply capacity.

In 2002, Masvingo City had a population of 69490 inhabitants (Central Statistical Office, 2002). The 2012 national census confirmed that the city's population had increased to 88554 people, giving an intercensal increase of 19064 or 27% in ten years. Besides population growth through natural increase, Masvingo City, as the capital of Masvingo Province, also has a number of pull factors promoting rural-urban migration. The rapid growth of population being experienced in Masvingo City is certainly not being matched up with parallel improvements in the water supply infrastructure, hence the huge water deficit highlighted above. In 2002, there were two relatively small high density suburbs in the city, Mucheke and Rujeko, and these have rapidly expanded over the years, while a new high density suburb, Victoria Range, has also been developed. In the same time period, one more low density suburb was developed, ZIMRE Park. With such a rapidly growing water demand in Masvingo City, the need for water demand management is evidently apparent. It is no surprise, therefore, that all the study respondents unanimously highlighted a need for water demand management in the city. The results of the study echo current literature highlighting rapid population growth, especially in developing countries, to be one of the key drivers of urban water scarcity (Manzungu et al, 2016).

With the need for water demand management in Masvingo City established. The study went on to assess water demand management strategies in the city. The various study respondents showed that they were knowledgeable of the different water demand management strategies that have been put in place by Masvingo City Council. One of the identified water demand management strategies in Masvingo City was water pricing. Masvingo City Council's Engineering Department has ensured that all water use in the city is connected with a water meter of an approved quality standard. Since there are numerous water meters of various standards on the market, the Engineering Department ensures that every water connection is approved and executed by council employees. In addition to the above, Council has also come up with a water pricing structure reflecting the differences in water use in the various water-use sectors of the city (Table 1).

Table 1: Water pricing structure for Masvingo City

	Water prices in various use categories			
	Domestic: low-income	**Domestic: high-income**	**Commercial/ Institutional**	**Industrial**
Water-use bands per sector				
Domestic				
$1m^3$ – $18m^3$	$0.30/m^3	$0.30/m^3	-	-
$19m^3$ and above	$0.40/m^3	$0.40/m^3	-	-
Commercial/industrial/instl.				
$1m^3$ – $24m^3$	-			
$25m^3$ and above	-	-	$0.50/m^3	$0.50/m^3
		-	$0.60/m^3	$0.60/m^3
Fixed water charge	$8.45/month	$17/month	$33.89/month	$52.41/month

For the domestic sector, residents pay $0.30 per cubic metre within the range of 1 cubic metre to 18 cubic metres of water used. From 19 cubic metres upwards, the water users in the domestic sector will now be paying $0.40 per cubic metre. Theincreasing block tariff structure being used by Masvingo City has the effect of discouraging water users from using unnecessarily too much water, especially those in the high-income residential areas who often use more water through swimming pools, car washing, and lawn watering among other water uses associated with affluence. In addition, residents of high-income suburbs pay a fixed monthly water charge of $17compared to $8.45in the low-income suburbs.

The water pricing structure for the commercial (including institutional) and industrial sectors is different from that for the domestic sector noted above, though it is also based on the increasing block tariff structure as in the domestic sector. Commercial and industrial water users pay$0.50per cubic metre within the range of 1 cubic metre to 24 cubic metres. From 25 cubic metres and above, they pay $0.60per cubic metre. In addition, commercial water users pay a fixed water charge of $33.89per month, while industrial water users pay $52.41as fixed water charge. The higher water charges for the commercial and industrial sectors are reflective of the high water consumption associated with these sectors, and more particularly the latter.

Masvingo City Council also disconnects water supply to users with outstanding bills. Such water users will then be required to settle their bills before a reconnection of water supply can be effected, in addition to paying a reconnection fee. The disconnection of water supply for unpaid water bills, therefore, is another water demand management strategy by Council, as water users will now be forced to use only the water they can afford to pay for at the end of the month, hence reducing water wastage by users. However, political interference by government in the affairs of municipalities across the country is increasingly affecting the effectiveness of water pricing as a water demand management strategy in many urban areas in Zimbabwe. For example, councils across the country, including Masvingo City Council, have often been coerced by government to cancel outstanding water bills of residents, especially during elections, as a campaign move. It is important to note that, due to the harsh

current economic environment in Zimbabwe, most domestic water users are struggling to settle their water bills. As such, many municipalities are owed millions of dollars by residents, thereby further undermining the capacities of already overwhelmed water supply entities. Another hindrance to effective water demand management through water metering and pricing revealed from the questionnaire and structured interviews was that of malfunctional and/or non-functional water meters. Sixty percent (60%) of the questionnaire respondents highlighted that a lot of domestic water meters were either no longer functional or were not properly functioning. The above response from the questionnaire respondents was further confirmed through an interview with the representative from the Engineering Department who acknowledged that approximately 30% of water meters in the city were no longer properly functioning. Water meters require constant maintenance and eventual replacement (Chigonda and Chazireni, 2017).

Another water demand management strategy employed by Masvingo City Council is that of water rationing. As a recap, Masvingo City has a daily water deficit of 17000m^3. This has forced Council to institute water rationing, whereby water supply to the reticulation network is cut off from 3 o'clock pm up to 4 o'clock am the following morning. Water rationing helps Council in managing the distribution of a scarce resource, and also simultaneously checks on water use by the various water users in the city. However, during the hours when water is available, residents often fill containers, which may negate the effectiveness of rationing as a demand management strategy. In this case, water rationing might actually result in more water use, as residents fill up more containers than is really necessary.

Masvingo City Council also prohibits or restricts certain water uses in the city. For example, the city prohibits the use of horse pipes for watering gardens or lawns. Instead, residents are encouraged to use buckets when watering their gardens or lawns. Residents are also encouraged to avoid watering during the day when evapotranspiration will be high, and to restrict watering to the cooler hours of the late afternoon and early evening. The move is meant to reduce excessive water consumption and wastage. However, it was observed that very few residents were adhering to this regulation as most of them use horse pipes for watering, and at times even during the day. Seventy five percent (75%) of questionnaire respondents indicated that they used horse pipes for watering their gardens or lawns. The construction of swimming pools is also strongly discouraged by Masvingo City Council, as this involves the use of a lot of water. For this reason, very few houses in the high-income suburbs of the city have swimming pools, with most of these pools being non-operational.

One of the hallmarks of modern effective water demand management includes the minimisation of non-revenue water loss due to leakages in the reticulation network (Chigonda and Chazireni, 2017). The representative from the Engineering Department estimated that an average of 25% of treated water fed into the city's reticulation network was being lost through leakages. A study by Dube and van der Zaag in 2003 estimated non-revenue water loss in Masvingo City at 15%. This highlights an increase in non-revenue water loss in the city over the years, probably due to ageing water

reticulation infrastructure. Forty five percent (45%) of questionnaire respondents highlighted the occurrence of frequent pipe bursts in the city. Considering the huge water supply deficit for Masvingo City highlighted earlier, the pipe bursts represent a simultaneous loss of a scarce commodity and also revenue.

Toilet flashing was identified as one of the major domestic uses of water by all (100%) questionnaire respondents in the study area. The above notwithstanding, 58% of the questionnaire respondents, mostly located in the older suburbs, noted that the capacities of their cisterns for toilet flashing ranged from 7.1 to 10 litres. This highlights a wastage of large quantities of water through toilet flashing, which renders water demand management in Masvingo City to be less effective. The flashing of these toilets could still be effectively performed using far much less water, thereby saving a scarce commodity for more productive uses.

4. Conclusion and Recommendations

The study has revealed a huge need for water demand management in Masvingo City. This conclusion rests upon the premise that the city's water treatment and pumping infrastructure is way below the daily water demand for the study area as highlighted by a daily water supply deficit of 17000m^3. While various water demand management strategies by Masvingo City Council were identified, these have also been found to be ineffective in a number of ways. The study therefore ends by suggesting some recommendations so as to make water demand management in Masvingo City more effective. To begin with, the Engineering Department must ensure that all water meter connections are properly functioning. All premises whose water meters will no longer be functional should, therefore, have their water connections cut off until new water meters are purchased by the consumers. Government should desist from coercing municipalities into reluctantly cancelling outstanding water bills of residents, as such populist political manoeuvres will only result in the incapacitation of already struggling water supply entities in the country's urban areas. It would be much more sustainable for flexible payment arrangements to be devised for those residents struggling to settle their water bills, than to have the bills cancelled outright.

There is a glaring need for Masvingo City Council to reduce the high non-revenue water loss due to leakages in the reticulation network. For this to be effectively done, Council should install modern computerised leak detection and surveillance systems that quickly detect and report pipe bursts at any point in the entire reticulation network. Other urban centres in the country have successfully installed such leak detection systems, resulting in marked reductions in non-revenue water loss.

All houses in the old suburbs of Masvingo City, such as Rhodene and the Chesvingo section in Mucheke suburb fitted with unnecessarily large toilet flashing cisterns, should be retrofitted with modern smaller cisterns that can effectively flash the toilet using much less water. There are now some three-litre or even smaller cisterns using high-pressure flashing mechanisms.

In yet another "*thirst in the midst of the twin lakes*" (Chigonda, 2011) scenario as with the town of Norton near Harare experiencing acute water shortages and yet surrounded by the third and fourth largest inland water bodies in Zimbabwe, Masvingo City is also located near the largest (Tokwe Mukosi) and second largest (Mutirikwi) inland impoundments. Endowed with such huge raw water sources, the City of Masvingo should therefore not be experiencing any water supply challenges. Masvingo City Council hence needs to upgrade its water treatment and pumping infrastructure. The study has revealed that water demand in the city has grown rapidly over the years without a corresponding expansion in water supply infrastructure. For this reason, most of the new suburbs coming up in the city, such as Victoria Range (or new sections within existing suburbs) are not connected to the city's water reticulation network, yet people are already residing in these areas. This poses various water-related health risks to the residents.

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