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AN ASSESSMENT OF ADEQUACY OF WATER SUPPLY FOR CONSUMERS IN URBAN AREAS OF ZIMBABWE

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Abstract

Therefore the aim of this study was to measure the results of current performance in urban water supply during this recovery phase which will enable benchmarking and facilitation of transfer of best practices across urban local authorities. The study included all the 32 urban local authorities in Zimbabwe. Data for the year 2012 was collected using a structured questionnaire administered in person during meetings from January to June 2013. Focus group discussions, key informant interviews and field observations were the tools used in data collection to supplement data from the questionnaire. Data was cleaned and processed in excel to come up with descriptive statistics that are the mean, standard deviation and 75th percentile. The 75th percentile was used to suggest realistic targets during this recovery phase as suggested by various water experts including Tynan and Kingdom. The study found out that local authorities have a number of technical constraints in water supply provision. Per capita supply was the only indicator meeting the international best practice ranging from 1 L/cap.d in Epworth to 654 L/cap.d in Kariba with an average of 241 L/cap.d. Among other indicators was the non revenue water ranging from 10% to

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67 %, continuity ranging from 0.3 to 24 hrs, maintenance coverage ratio from 0 to 24%, pipe bursts from 14 to 388 burst per 100 km and extent of metering from 42% to 100%. The study concluded that adequate water was supplied from the treatments plants as indicated by high per capita supply value above the IBP. However, consumers do not have enough water in their homes due to other factors including high NRW. The study recommended that there is need to put in place dedicated powerlines and stand by generators in case of small towns for raw and clear water pumping. The zonal, bulk and consumer end water meter readings are needed to clearly account for water produced.

Keywords: urban water supply; benchmarking; performance and recovery phase

1.0 Introduction

World population has been reported to have surpassed 7 billion and it is projected to reach 9 billion in 2050 (Greene *et al.*, 2012). Population increase is highest at a rate of 2.5% per annum in poorest and developing countries. In 2010, more people lived in the urban areas than ever before with an estimated 3.5 billion people which is 50.5% of the total population living in urban areas (UNPD, 2011). This rapid urbanisation has posed a lot of technical constraints in the provision of water services in urban areas. Technical constraints including high non revenue (NRW) have resulted in water utilities around the world providing poor water service exposing urban populations to serious health hazards (Banerjee and Morella, 2011).

In Africa, technical challenges including coverage of direct water supply and high NRW have resulted in urban water coverage decreasing from 55% to 47% from 1990 to 2011. This has resulted in 63 million more people using unimproved water sources in 2011 than in 1990 (AMCOW, 2012).

Zimbabwe faced a number of constraints in urban water supply services which reached its peak during the economic meltdown around 2008. Coverage of water in urban areas was 97% in 1990 which decreased to 78% in 2011 (WHO and UNICEF, 2013). This is due to various technical challenges which water supply utilities encounter including high NRW and low direct water coverage. NRW in Zimbabwe is high as indicated by studies in Mutare at 57% (Gumbo and

Zaag, 2002), Bulawayo 35% (Ncube, 2011) and Harare 52% (Nhapi, 2009). This reflects the technical constraints urban water utilities in Zimbabwe face since they are losing more than half water intended for consumers in the distribution system hence the need to evaluate the adequacy water supply to consumers using per capita water supply in urban areas of in Zimbabwe.

1.1 Purpose and significance of the study

The study was conducted to assess the adequacy of water supply to consumers in urban areas in Zimbabwe and also to come up with recommendations for improving water supply per capita in these areas.

2.0 RESEARCH METHODOLOGY

2.1 Description of the study area

2.1.1 Location of study area

The study was conducted in all 32 ULAs in Zimbabwe.. The location of the Urban Local Authorities (ULAs) within Zimbabwe is shown in Fig 2.0.

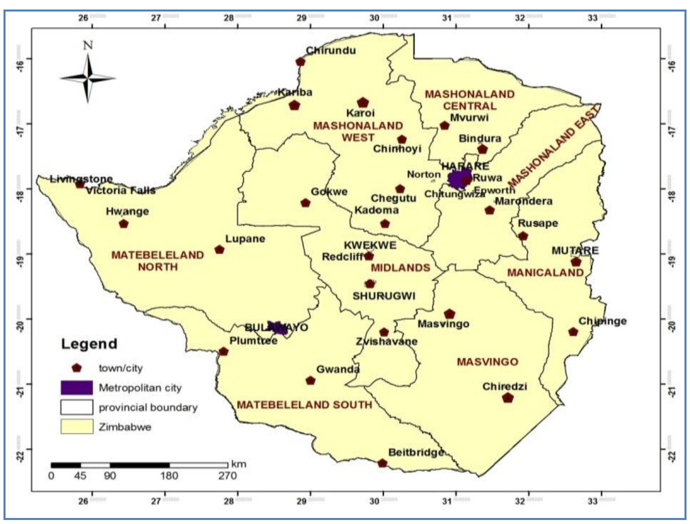
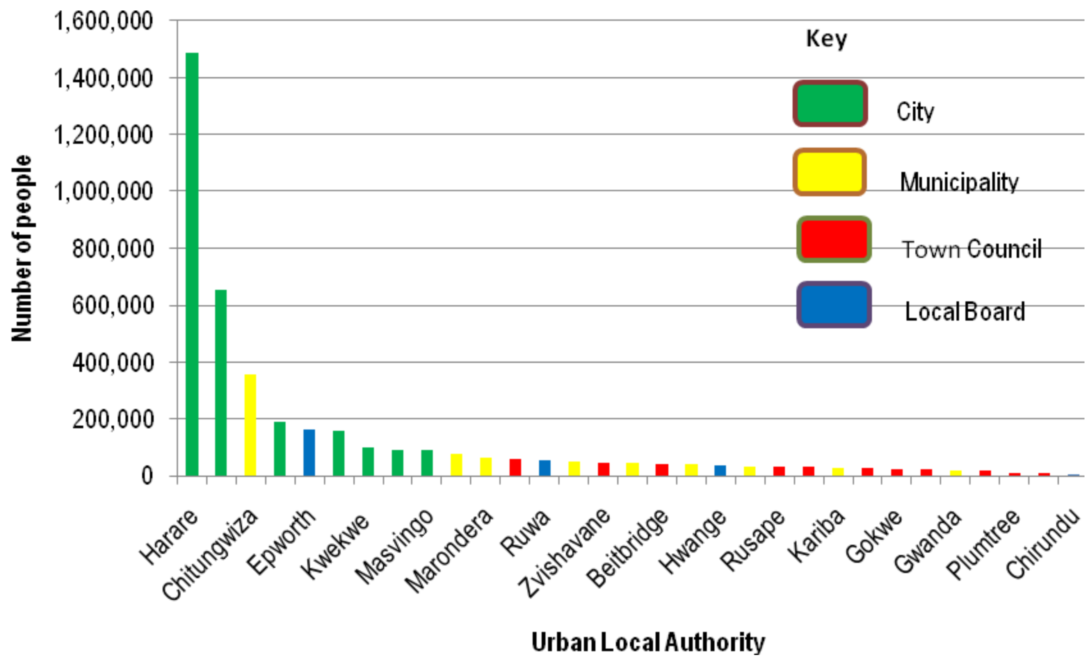


Figure 2.0. Map of Zimbabwe showing the 32 urban local authorities covered under this study



The urban growth rate is reported to be 4% per annum which is highest even in Sub Saharan Africa (GoZ, 2013a). Harare has the highest urban population of 1,582,000 and Lupane the lowest with a total population of 4,000 people. The 32 ULAs have different institutional arrangements for water supply with some under local authorities while some are supplied by the national water utility as shown by Table 3.1. The total population being supplied water by ULAs is 4,058,000.00 which are 97% of the total urban population while Zimbabwe National Water Authority (ZINWA) supplies the remaining population of 113,370 which is 3% of the total urban population.

2.1.3 Classification of ULAs in Zimbabwe

The Urban Council Act Chapter 29:15 provides for the administration of towns and cities in Zimbabwe. There are four classes in Zimbabwe which towns and cities are classified or ranked. The highest ranking is a city status followed by municipality, town councils and local boards. The following are considered according to the SI 50 (1997) containing [Urban Councils (Town Status) Regulations 1997] which is used in the classification of towns.

- size and population of town
- extent to which a town provides employment opportunities
- total valuation of property

- centre for state services
- standard of marketing and shopping facilities and the range of specialist, professional banking and other services

Table 2.0:. Classification and Institutional Arrangements for Water Supply (Adapted from GoZ, 2013b)

Cities	***Population***	***Classification***	***Water supply institution***
Harare	1,582,000	City	ULA
Bulawayo	656,000	City	ULA
Chitungwiza	355.000	Municipality	ULA
Mutare	189,000	City	ULA
Epworth	162,000	Local Board	ULA
Gweru	159,000	City	ULA
Kwekwe	101,000	City	ULA
Kadoma	91,000	City	ULA
Masvingo	89,000	City	ULA
Chinhoyi	80,000	Municipality	ULA
Marondera	63,000	Municipality	ULA
Norton	59,000	Town Council	ULA
Ruwa	57,000	Local Board	ULA
Chegutu	50,000	Municipality	ULA
Zvishavane	46,000	Town Council	ULA
Bindura	46,000	Municipality	ULA
Beitbridge	43,000	Town Council	ULA
Redcliff	36,000	Municipality	ULA
Hwange	35,000	Local Board	ZINWA
Victoria Falls	34,000	Municipality	ULA
Rusape	31,000	Town Council	ULA
Chiredzi	31,000	Town Council	ULA
Kariba	27,000	Municipality	ULA
Chipinge	26,000	Town Council	ULA

Gokwe	25,000	Town Council	ZINWA
Shurugwi	23,000	Town Council	ULA
Gwanda	21,000	Municipality	ULA
Karoi	19,000	Town Council	ZINWA
Plumtree	12,000	Town Council	ZINWA
Mvurwi	11,000	Town Council	ZINWA
Chirundu	4,075	Local Board	ZINWA
Lupane	4,000	Local Board	ZINWA

- extent of use of the local board/ growth point as a district centre for commercial, industrial, mining, agricultural, financial and administrative purposes
  - road network
  - postal and telecommunications
  - tourism
- growth rate

City councils and municipalities are headed by town clerks while town councils and local boards employ town secretaries to head their administrations. In Zimbabwe there are 32 ULAs with are ranked as shown in Table 2.0 (GoZ, 2013b).

This classification raises a lot of questions since it seems expectation of the ULAs might not be met by the classification which is currently there. The classification is based on ratable property and sometimes appears political. This is not clear for example if ratable property was used, then Redcliff should have been a city for example but it is a municipality. The method used for rating the property is not even clear. Therefore results presentation was based on population size since the classification which there currently is not clear.

2.1.2 Population

The population of towns which include Bindura, Gweru, Chinhoyi and Mutare were adjusted as universities were closed when the census was done in August 2012 since they are catered for by the corresponding ULAs. The population is shown by Fig2.2 from the town with the highest population to the one with the least and the classification as well. The difference in terms of population size also highlight that these ULAs face different challenges in terms of water supply provision. The population of Zimbabwe was 11,600,000 in 2002 and 12,973,808 in 2012 indicating a national growth rate of 1.1% (Zimstat, 2012). The urban population in the 32 urban local authorities was 4,171,370 people (Zimstat, 2012). This represents 32% of the total population of 12,973,808 people in Zimbabwe.

2.2 Data Collection

2.2.1 Research Design

The research was based on the technical challenges in ULAs. That is to investigate first whether ULAs are supplying enough water. Then if they are supplying water whether eonough or not, is everyone receiving the water? Then what is the fate or where is the water going since consumers do not have water in their homes. Lastly is there adequate maintenance provision to keep infrastructure in a serviceable state.

The 32 ULAs were involved in this study since performance measurement for the intention of inter utility comparison data requires that every local authority to participate. The ULAs have different challenges in terms of water supply hence there was need to consider all the 32 ULAs in this exercise of measuring performance during recovery phase. This study was the baseline survey for benchmarking operations of ULAs in Zimbabwe hence data was gathered for each and every local authority with a team comprising of officials from the former Ministry of Water Resource Development and Management (MWRDM), Ministry of Local Government Public Works and National Housing (MLGPW &NH), National Action Committee (NAC), Urban Councils Association of Zimbabwe (UCAZ) and the World Bank.

2.2.2Data collection technique

Field visits were done to collect the data in person thorough administering the questionnaire in person and check on the information provided in the questionnaire. Field visits to water treatment plants were also done after the meeting to check the problems which ULAs face in water supply provision in Zimbabwe. Focus group discussions were done in the Kadoma workshop in July consisting of town engineers, town treasurers and health officials from all the 32 ULAs in Zimbabwe.

2.2.3 Reliability Score

Accuracy of data was checked and indicated during the data collection. A reliability score was given for data on main indicators depending on the source of the data. The reliability score indicates the accuracy of the data and what need to be done in terms of data management so as to provide accurate data when it is required. The highest preferred reliability for each indicator was a score of 1 and any score beside 1 would show some gaps in terms of the data management. This would results in recommendations being given so that the score can be 1. This is illustrated using the extent of metering of water connection indicator. The highest preferred reliability indicates that all water connections should be metered and meters should be read consistently so as to charge consumers based on consumption. Reliability of data colours used is shown in Fig 2.2 and was indicated on summary of results.

Key	
Colour	**Reliability score**
	1
	2
	3
	4
	Not scored

Figure 2.2: Reliability colours used to show reliability of data per ULA

2.2.4 Methods of Data Analysis and Interpretation

Data cleaning was done before processing. Focus group discussions with members of the infrastructural development group (AfDB, UNICEF, GIZ, and AusAID) were done to further verify and validate the data. Mop up visits were done to Marondera, Rusape, Chipinge, Chiredzi, Zvishavane, Harare, Manyame Catchment, Gwai Catchment, Mzingwane Catchment, Hwange, Kwekwe and Redcliff were done to further clean up the data on these towns which were critical. Relative performance of urban of the ULAs was based on the public policy for private water provision (Tynan and Kingdom, 2002). The findings were supported by data gathered during key informant interviews, focus group discussions and field visits. The results were presented scientifically in the forms of graphs and tables.

The following formulae were used to calculate the main indicators used in the study;
Per capita supply of water is the total amount of water supplied to customers expressed as percentage of population served per day (GoI, 2008; Mugabi and Castro, 2009) and was calculated as follows;

Per capita water supplied (L/cap.d) = $^{a}/_{c} \times {}^{b}/_{1000}$ ***Equation 2.1***

Where;
a is water supplied to the domestic distribution system
b is Population served
c is the number of days in the year

2.2.5 Statistical methods and purpose

A database was created and processing was done in excel using descriptive statistics which included the mean, standard deviation and percentile were calculated from the data. Percentiles were used to suggest a realistic target during the recovery phase. This method was adopted from Tynan and Kingdom (2002) and Mugabe and Castro (2009). Standard deviation was used to assess difference in level of performance between local authorities. The mean was used to compare the data to international best practices as these international best practices were suggested from averages. The Pearson Product Moment Correlation (r) which is also called correlation coefficient was used to check for correlations between indicators. This was done using SPSS. The interpretation of the correlations was done according to Rumsey (2011) and Stockburger (1996) as shown in Table 3.2.

Table 2.1:. Interpretation of correlation coefficient (Adapted from Stockburger,1996 and Rumsey 2011)

Range	Interpretation
0 to 0.29	Weak positive correlation
0.3 to 0.69	Moderate positive correlation
0.7 to 0.99	Strong positive correlation
1	Perfect positive correlation
0 to -0.29	Weak negative correlation
-0.3 to -0.69	Moderate negative correlation
-0.7 to -0.99	Strong negative correlation
-1	Perfect negative correlation

3.0 RESULTS AND DISCUSSION

Adequacy of water supplied is evaluated using per capita water supply in urban water supply (Tynan and Kingdom, 2002; Mugabi and Castro, 2009). In this study, per capita supply of water is defined as the total amount of water supplied to consumers expressed in terms of the total population served per day within the service jurisdiction (Tynan and Kingdom, 2002; GoI, 2008; PWWA, 2011). According to the same authors, for water to be considered adequate the minimum water supply should be 135L/cap.d with any amount below being considered inadequate. Quantitative data from the questionnaire collected during meetings with key people in the management of ULAs was used to calculate this value based on the definition from Tynan and Kingdom 2002. Qualitative data collected during meetings, filed observations and focus group discussions was used to explain the results obtained. The 75th percentile was used to determine realistic targets from the current performance at the Kadoma workshop consisting of town engineers, town treasures and health officers from all the 32 ULAs. This method is used in determining realistic performance targets in water supply whereby a realistic target is one in which the performance target set is equal to the 75th percentile or less in water supply.

3.1.1. Per capita supply of water

The average per capita supply of water in ULAs was 241±128 L/cap.d and 56% of the ULAs were below the average. Satellite towns being supplied by Harare that is Ruwa, Epworth, Chitungwiza and Norton had the lowest per capita of 122 L/cap.d, 0.31 L/cap.d, 79 L/cap.d and 101.7 L/cap.d respectively. Information gathered during data collection meeting indicated that city of Harare was supplying little water to the surrounding towns. This was confirmed during focus group discussion at the Kadoma workshop comprising town engineers, town treasures and health officers for all the ULAs.

Rapid urbanization has been reported to be a challenge to water utilities in the provision of safe water (UNICEF and WHO, 2012). The population of greater Harare for which the city of Harare was responsible for water service delivery represented 53% of the total urban population in Zimbabwe. This may mean that the population increase is beyond what the city planners had anticipated in terms of water supply hence the water shortages. Epworth had the lowest per capita due to the fact most of the residents were not connected. The observation during field visits confirmed information gathered during the meeting. The town is comprised mostly of informal settlements hence they are not recognised in the water supply service planning and provision. The challenges in amount of water received in greater Harare also was compounded by the fact that the residents did not have schedules of when they will receive water. This may affect consumption patterns since sometimes there will be no one at home to fetch water when water supply resumes in a suburb. Fig 4.1 shows the performance of the ULAs in terms of per capita supply of water.

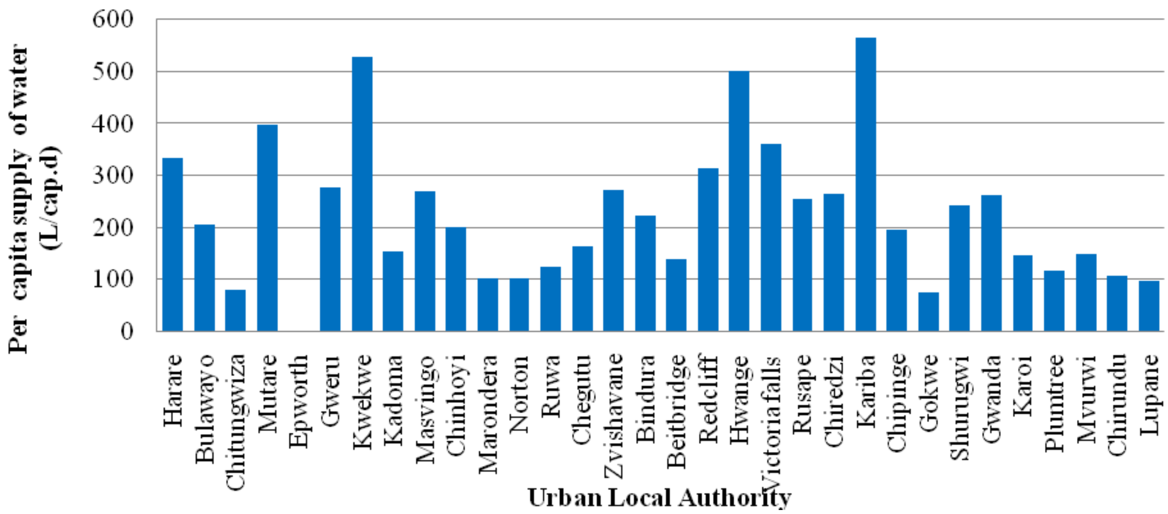


Figure 3.1. Per capita supply of water in ULAs

The International Best Practice (IBP) is 135 L/cap.d (GoB, 2007; GoI, 2008; PWWA, 2011). The average for the ULAs of 241 L/cap.d was above the IBP of 135 L/cap.d and 72% reached the

IBP value. The 75^{th} percentile was 276 L/cap.d therefore the target set for Zimbabwe at the Kadoma workshop of 150 L/cap.d is realistic. ULAs for example Victoria Falls, Shurugwi and Karoi have dedicated power lines for their water pumping stations hence they are able to pump enough water to their residents. The average of 241 L/cap.d in Zimbabwe was greater than the average reported in West Africa which is 62 L/cap.d. It is also above the range of average reported in East and Southern Africa of 87 to 102 L/cap.d (Banerjee *et al.*, 2008). ULAs for example Chirundu do not have standby pump for raw water abstraction which affect the amount of water pumped in case of a breakdown. It is therefore recommended that the ULAs should put in place enough pumping equipment.

There was a challenge in ULAs to accurately quantify the amount of water put into the transmission and distribution system. The bulk meters are not working most of them hence ULAs rely on pump performance curves to estimate amount of water being put into the transmission and distribution system which may affect accuracy of results. Therefore it is recommended that ULAs should replace non-functional bulk water meters and have a bulk water meter replacement policy to avoid under registration of water produced with time. The amount of water being pumped at water treatment plants was therefore adequate according to the average which is above IBP. However the water reaching the consumers is not enough due to other issues including high NRW.

4.1.2 Current capacity utilisation

Fig 4.2 and 4.3 shows current capacity utilisation across ULAs. The data was presented seperately for Harare and Bulawayo than the rest of ULAs because the values for Harare and Bulawayo are high hence they affect the scale for ULAs with low values.

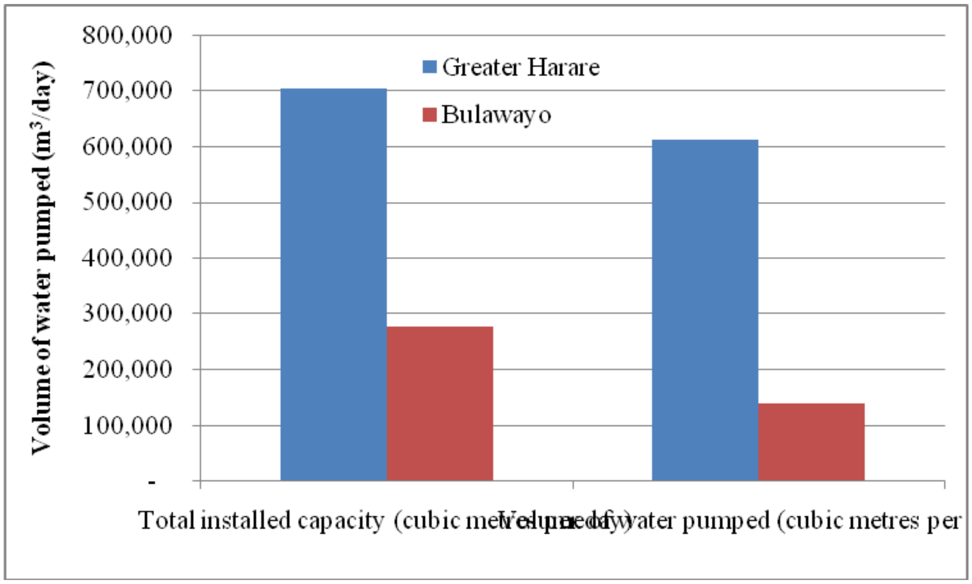


Figure 3.2: Capacity utilisation in Harare and Bulawayo

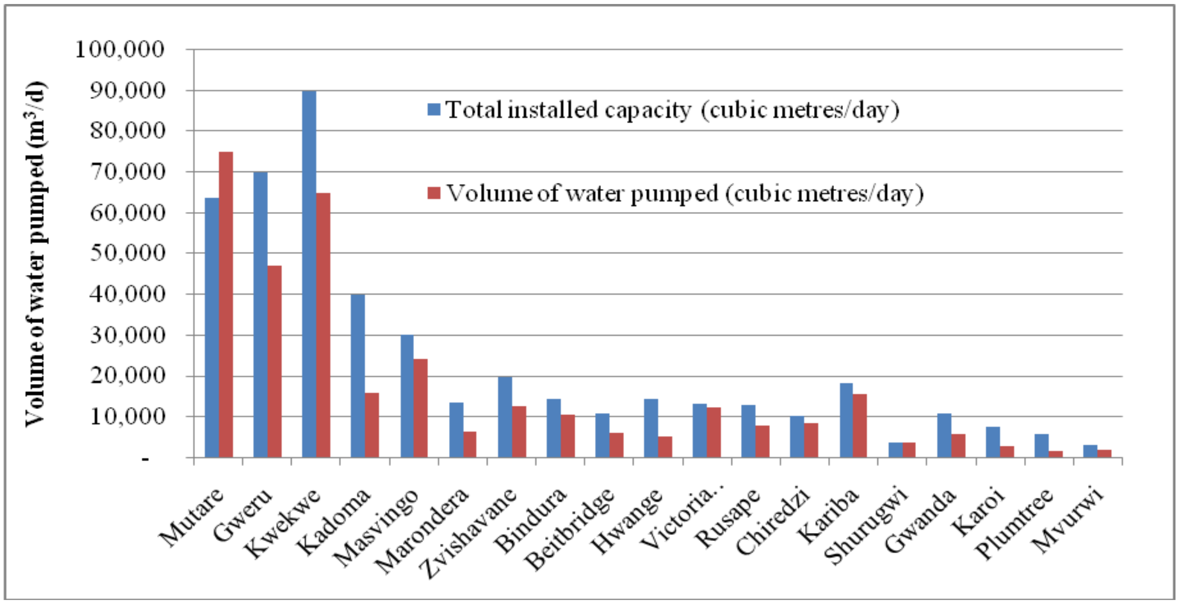


Figure 3.3:. Capacity utilisation in ULAs excluding Harare and Bulawayo

The consumers do not have enough water but most ULAs were failing to operate at design capacities. The average installed design capacity was 68,229 m^3/d and the average pumped volume of water per day was 51,279 m^3/d. The main challenge was due to frequent power cuts and lack of pumping capacity as highlighted during key informant interviews and focus group discussions at the Kadoma workshop. Therefore there is need to adjust pumping regimes in order to pump enough water during the time which electricity is available. ZINWA has a design pumping time of 14 hours but very few cities and towns in Zimbabwe have electricity available for an average of 14 hours.

There was capacity underutilisation among ULAs due to frequent power cuts and lack of pumping capacity. The current installed capacities if fully utilised, may ease water shortages to urban populations across ULAs.

4.0 LIMITATIONS

The population size which was used for the purpose of this study, that is 32 urban…, can not be used to generalise the results of the whole country of Zimbabwe. There is also threat of respondents being not sincere during interviews and responses from questionnaire even though participants in the research were assured that their identities will be kept confidential and that the study is purely for academic purposes.

5.0 CONCLUSION

The study concluded that adequate water was supplied from the treatments plants as indicated by high per capita supply value above the IBP. However consumers do not have enough water in their homes due to other factors including high NRW.

6.0 Recommendations

There is need to put in place dedicated powerlines and stand by generators in case of small towns forraw and clear water pumping. The zonal, bulk and consumer end water meter readings are needed to clearly account for water produced.

There is need to enforce development control requirements for water supply. This will enable coverage of direct water supplies to be 100% since there will be no occupation of a property without water connection.

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QUESTIONNAIRRE TO STUDENTS

Appendix 1: Water Supply Structured Questionnaire

Ref	Data Item	Comment	Unit	Response	Reliability Score	Frequency of measurement
1.1	**Per capita supply of water**					
	Definition: Total water supplied to consumers expressed in terms of population served per day.		**L/cap. d**			
1.1.1	a. Water produced and supplied to the distribution network	The daily quantities must be measured through metering, and records should be maintained. The total must be based on averages from daily quantities produced. Only treated produced from the water treatments plants should be measured. If water is distributed from multiple points, the aggregate of that quantity should be considered. Water purchased directly from other sources (e.g. neighbouring councils) and put into the distribution system should be included. Water supplied in bulk to large water intensive industries/industrial estates must not be included. The quantity should not include bulk water transmission and distribution losses. In the absence of a reliable estimate of losses, a factor of at least 25% should be used for calculation purposes. Urban local authorities are encouraged to carry out a water audit to assess the losses to their realistic level.	m^3/yr			
1.1.2	b. Population served	Number of people within the service area.	#			
1.1.3	c. Number of days in the year	The number of days within the specific year.	#			

	Per capita water supplied = [(a/c) /b]*1000		**L/cap. d**			
	Additional information					
1.1.4	d. Water supplied at the production level	The daily quantity supplied at the production level (ex-treatment) should also be recorded. The total supply for the month should be based on an aggregate of the daily quantum.	m^3/month			
1.1.5	e. Population receiving water at a rate less than **50 L/cap.d** may also be reported	Number of people living within the service jurisdiction area. The quantity of water supplied to these areas should be measured through bulk meters or pumping records.	#			
1.1.6	f. Water supplied in bulk to large water intensive industries/industrial estates		m3/d			
1.1.7	g. Bulk water transmission and distribution losses.		m3/d			
1.2	**Additional Information not related to indicator**					
	Water Production Capacity					
1.2.1	Installed Capacity of Treatment Plants for Surface Water Sources		m^3/d			

1.2.2	Volume of water produced through Surface Water Sources		m^3/d			
1.2.3	Installed Capacity of Treatment Plants for Ground Water Sources		m^3/d			
1.2.4	Volume of water produced through Ground water (power pumps)		m^3/d			
1.2.5	Volume of water produced through any other sources		m^3/d			
1.2.6	Total Installed Capacity		m^3/d			
1.2.7	Total Volume of water produced		m^3/d			

GUIDING INTERVIEW QUESTIONS TO URBAN LOCAL AUTHORITIES SENIOR MANAGEMENT

1. Do you have your own water treatment plant or you get bulk water from other local authorities?
2. Do you use installed bulk water meter or estimates based on pumping capacity and efficiency to estimate water produced?
3. Are there any separate bulk water meters for industries and residential areas?
4. Do you carryout population surveys or you rely on census data for estimating the population you are serving in your area of jurisdiction?
5. Does the raw water sources have capacity to supply drinking water to the population you are serving?