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Analysis of Factors Influencing Domestic Water Consumption in Karoi Town, Zimbabwe

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Abstract

The current trends in water resources management underscore management of the resource as an economic good. Consequently, management strategies overlook demographic and social factors that influence domestic water consumption. Adopting water as an economic good conceptual framework, in a case study approach, a total of 120 household heads and two officials from Zimbabwe National Water Supply Authority (ZINWA) were selected in Karoi. While quantitative data were analysed using descriptive (frequency, percentages, etc.) and inferential statistics (t-test, ANOVA etc.), content analysis was used to analyse qualitative data. Findings revealed that while economic factors play a role in influencing domestic water consumption, demographic and social factors play equally the same in determining water consumption at the household level. The study recommends a further study to understand the role of demographic and socio-economic factors which affect water consumption.

Keywords: economic good, household, Karoi, water, Zimbabwe, ZINWA

1. Introduction

Water for domestic uses comprises both indoor and outdoor uses. While indoor water uses encompass drinking, bathing and washing clothes, outdoor water uses, on the other hand, include watering gardens and car washes among others. Noticeable trends in literature are that outdoor water uses are price elastic while indoor uses are price inelastic (Grimble, 1999). This is because most of the indoor uses are essential basic needs and therefore unavoidable (McNeil, 1999). In contrast, consumption for less necessary outdoor uses (gardens, swimming pools) tends to be more responsive to price (Grimble, 1999). Domestic water per capita consumption is the amount of water needed per person for the purpose of meeting domestic needs per day (World Health Organisation (WHO), 2011). Different estimates for minimum daily water consumption per capita has been proposed. While in developed countries a person uses 250 litres of water per day (Gleick, 1996), in developing countries estimates ranges between 7.5-20 litres per capita ((McNeil, 1999). Consequently, migrants from developing countries have water-saving attitudes than their counterparts from the developed world (Nnayi *et al*., 2013). Nevertheless, domestic water consumption is site and case-specific (Rajala & Katko, 2004). For instance, Nyong & Kanaroglou (2001) found that per capita daily domestic water consumption was high (44.9 litres) during the rainy than the dry season (26 litres) in Nigeria. On the other hand, Nnayi *et al* (2013) and Ohmo & Abotutu (2014) found 34.9 litres per capita and 20 litres in two different villages in Nigeria. Based on these findings, an understanding of the factors that influence domestic water consumption is essential to enable water supply authorities crafting policies to regulate domestic water consumption. While several studies were conducted in developing countries, however, their main thrust was on the economics of domestic water consumption. The results of such studies generally regard domestic water as a price inelastic good (Tussupova et *al.,* 2015) as such water can hardly be substituted (Ohmo & Abotutu (2014) and users perceive the resource as being cheap (Taylor *et al*., 2008).

Karoi is one of the most water-scarce small towns in Zimbabwe (Gondo & Kolawole, 2019). Population growth, exacerbated by an influx of tobacco farmers and other immigrants from surrounding agricultural-based areas led to a severe and disproportionate between water supply and water demand (Gondo & Kolawole, 2019). Given the extreme water scarcity in Karoi town (Gondo & Chingombe, 2016), efforts to balance water needs, availability

and economic growth are paramount to secure long term development. Like any other developing countries, traditionally Zimbabwe tries to regulate water demand through adjustments in the water tariffs. Empirical results show no explicit relationship between domestic water consumption and demographic and socio-economic variables. This entails that further research is needed especially under varying conditions. Therefore, the objective of this study was to analyse the demographic and socio-economic variables influencing water consumption in Karoi town in Zimbabwe.

1.1 Water as an Economic Good Conceptual Framework

The conceptual framework adopted for this paper is based on the Integrated Water Resources Management (IWRM) principle 4 which says *[w]ater has an economic value and should be recognised as an economic good, taking into account affordability and equity criteria*. This section starts by clarifying on the concept of water as an economic good and highlights some controversy over the concept. To define water as an economic good means that it is a resource whose price is charged against its value and whose allocation is improved through integrated decision making (Rutherford, 2001). On the other hand, McNeill (1998) defines water as a scarce resource for which there are competing demands, which outweigh its supply. Grimble (1999) regards an economic good as a scarce good, yielding utility which must be allocated either by rationing or by the price mechanism but not a free good. In principle, regarding water as an economic good appears reasonable for two main reasons. Firstly, it is a means to secure the efficient use of water (Rutherford, 2001) and secondly, it offers a basis for cost recovery (Yuling & Lein, 2010). The efficient argument is based on the account that water is a low-priced resource (McNeill (1998) and is wasted due to inefficient use (Yuling & Lein 2010). This scenario leads to water shortages and crises. Some authors erroneously regard water pricing as the best measure to rectify the water shortage situation (Rutherford, 2001; Yuling & Lein, 2010). Nevertheless, Dublin Principle 4 is rather vague and ignites some controversial issues. While some authors (e.g. Grimble, 1999; Petrella, 2001; Yuling & Lein, 2010) believe water differs from other resources due to its non-substitutability and hence it should be treated as a basic right rather than a commodity, others (Savenije & van de Zaag, 2002; McNeil, 1998) argue that water is by nature an economic good thereby making its allocation necessary. But then, there is a disparity as to what this really implies. It is on this premise that the idea of competitive market-based water pricing (to secure optimal water allocation) emerged. However, while the economic value of water is indisputable, it needs not to be treated as an everyday economic good as it has many characteristics which distinguish it from a *normal* economic good. Such water features include it is being scarce, fugitive, non-substitutable, not freely tradable and complex (Grimble, 1999; Savenije, 2002). The concept of water as an economic good thus simply implies that water has value to users who are willing to pay for it. Consequently, like any other good, consumers will use water so long as the benefits from the use of an additional cubic metre exceed the costs so incurred. This is illustrated graphically in Figure 1(a), which shows that the optimal consumption is X*. Figure 1(b) shows that if a consumer is charged a price P^1, which is different from the marginal cost of supply, then the consumer will not consume X* but X^1. The increase in costs (the area under the cost curve) exceeds the increase in benefits (the area under the benefit curve) and there is a corresponding loss of net benefits called deadweight loss (Briscoe, 1996). The implication is that if the water price is exorbitant the poorest residents would reduce the amount of water they draw from the purified grid and substitute the difference with water they draw from rivers, streams or shallow wells. Despite compromising their health residents opt for such water because it is readily available and free. This is the reason why low-income residential areas are the first to suffer from in the event of an outbreak of water-borne diseases. A case in point was the death of people from cholera in high-density suburbs of Harare, Bulawayo and Kadoma during the 2008 cholera outbreak in Zimbabwe (See Remigios, 2011). Thus, water as an economic good needs to be understood in relation to water as a social good in which the minimum water threshold for domestic use is subsidised so that at least each household gets a minimum amount of water for free.

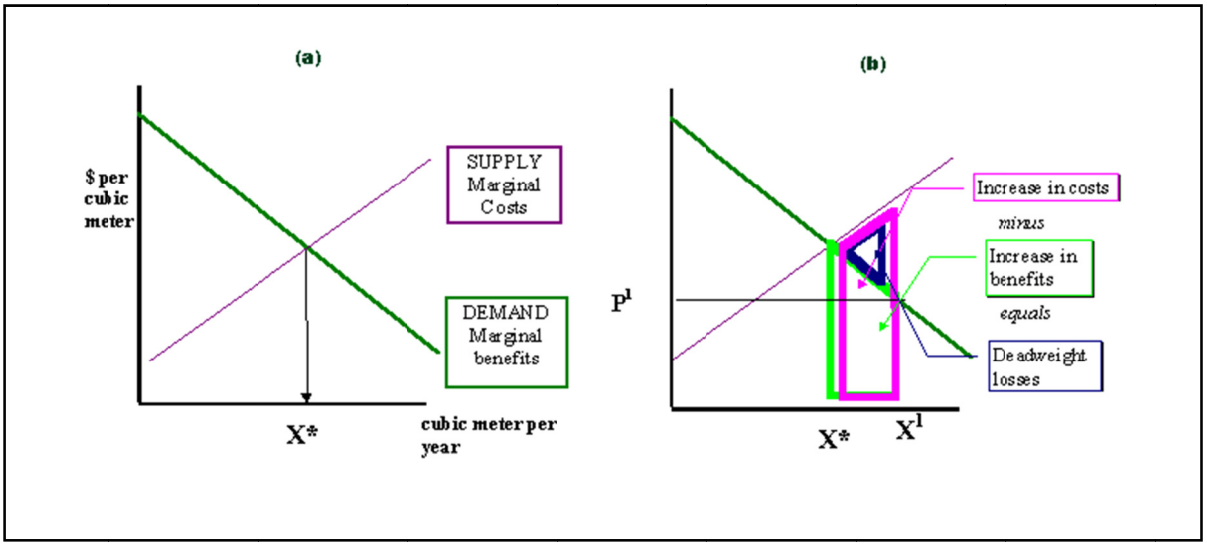

Figure 1. Optimal consumption of water if underpriced

Sources: Briscoe, 1996

2. Methodology

2.1 Study Area

The name Karoi is derived from a local river and the town uses a symbol of a witch clutching onto a sweeping broom. This is because the name Karoi means *little witch.* The town is in Hurungwe district of Mashonaland West Province. It is located in central-northern Zimbabwe, about 85 kilometres from Chinhoyi, the nearest large town. Karoi lies about 288 kilometres, northwest of Harare, along the main Highway (A1), between Harare and Chirundu. Geographically, the town is located on 16°48' South and 29° 42' east of the equator. The surrounding countryside is farmland, where tobacco is the primary cash crop. There are two hotels in namely Karoi Hotel (in the town centre) and Twin River Inn, (about 1.6 kilometres, north, along with the Harare Chirundu highway). The main primary schools are Chikangwe, Tafara, Karoi Junior and Tambawadya and the main secondary schools are Karoi Government, Chikangwe and Chiedza Karoi. The farming growth point of Tengwe lies about 30 kilometres, southwest.

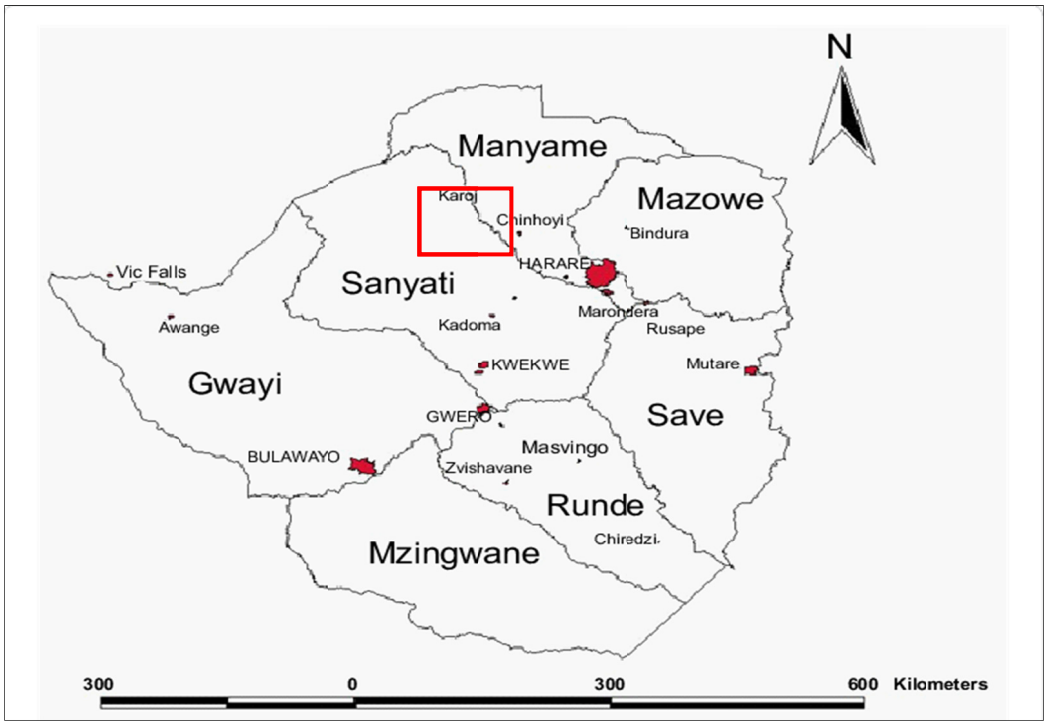

Figure 4. Map of Zimbabwe showing the location of Karoi town

Source: Google maps, 2019

2.2 Sample Size and Data Collection

The research was qualitative in nature and was based on structured interviews, observations and complemented by document analysis. Accordingly, residents of Chiedza D, Claudia and Kubatana were interviewed. ZINWA Karoi was purposively chosen since it is responsible for supplying water directly to residents. This is not the case with other towns and cities in Zimbabwe, where ZINWA supplies town and cities council with raw water and the town or city council will purify water and supply it to residents. Convenience sampling was used to select respondents who were drawn from water-stressed, high-density residential areas such as Chiedza D, Claudia and Kubatana (Gondo & Kolawole, 2019). The residential areas were dominantly characterised by low-income earners, except for Westview, which was inhabited by middle-income earners (ZIMSTAT, 2012). Using convenience sampling, a total of 120 (55 from Chiedza D, 34 from Claudia and 31 from Kubatana) respondents were selected from the three residential areas. Both primary and secondary data were utilised. While primary data were obtained through a questionnaire and observations, secondary data were gathered through a review of existing literature, analysis of journal and newspaper articles. Data, collected between December 2018 and January 2019, were arranged in different themes and analysed through comparative, content analysis techniques as well as descriptive and inferential statistics. Table 1 shows water pricing structure in Karoi town, The table illustrates that from 1-18m^3 of domestic water costs rtgs$30 and the same applies to low-density residential areas. Any water consumption within the 19 m3 and above costs rtgs$40 and it is the same as in the low density. A monthly fixed change of rtgs$8.45 and rggs$17 applies for high and low-density residential areas respectively.

Table 1. Water pricing structure in Karoi town

Water use band		High Density	Low density
(a) Domestic			
(i)	1-18 m^3	rtgs$30	rtgs$30
(ii)	19 m^3 and above	rtgs$40	rtgs$40
(iii)	Fixed Charge	rtgs$8.45	rtgs$17
(b) Commercial			
(i)	1-24 m^3	rtgs$50	
(ii)	25 m^3 and above	rtgs$50	
(iii)	Fixed charge	rtgs$33.89	

Source: Fieldwork December 2018-January 2019

For commercial activities, water consumption in Karoi costs rtgs$50 for every 1-24$m^3$. Any 25$m^3$ and above water consumption costs rtgs$60 and a fixed monthly charge of rtgs$33.89 is charged every month for any commercial activities. Table 2 illustrate average monthly household water consumption in six residential areas in Karoi. The results show that the highest (686) household number of litres of water were consumed per in Westview and that the least (200) litres were consumed in Chiedza D.

Table 2. Descriptive statistics of household monthly water consumption in Karoi

Residential Area	Mean	Mode
Chiedza A	442	196
Chiedza B	535	107
Chiedza D	200	250
Westview	686	533
Claudia	350	375
Chikangwe	489	224

While Chiedza D consumes 442 litres of water on average per month with a mode of 250 litres, Chiedza B needs 535 litres of water per household per month with a mode of 355 litres on average. A household in Claudia consumes 350 litres of water with a mode of 375 on a monthly basis.

2.3 Place of Residence and Dwelling Type in Karoi

The dwellings were classified according to the number of rooms each dwelling had (See table 3). The results indicate that 38.8% of the dwellings had 1-2 rooms and the majority (44.2%) lived in 3-4 roomed houses. The least (25%) had dwellings with over five rooms. The mean number of rooms in the study area was 3 with a standard deviation of 2.

Table 3. Dwelling type according to the number of rooms

Variable	Frequency	%	n = 120
Type of dwelling			
1- 2 roomed house	37	30.8	
3-4 roomed house	53	44.2	M = 3
5 + roomed house	30	25	SD = 2

Source: Field survey, December 2018-January 2019

Figure 2 shows the three residential areas which constituted this study. The results of this study show that 20.9%

of the respondents were drawn from Westview and the majority (53.3%) of the respondents resided in Chiedza. Chikangwe had 25.8 % of the respondents in this study.

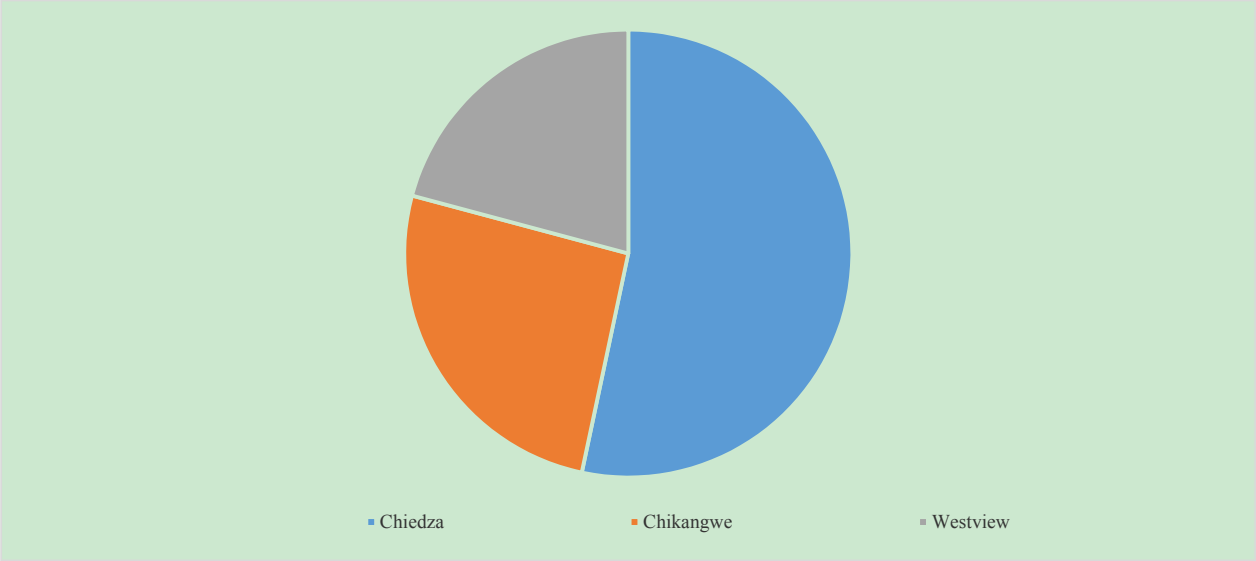

Figure 2. Residential areas studied in Karoi

Source: Fieldwork, 2019

2.4 Gender and Water Consumption in Karoi

Figure 3 shows that the majority (58%) of HHs were males and the remainder were females. The fact that 42% of the respondents were women may reflect the impact of culture in Karoi town. As put forward by one key informant who says *"[c]ulture dictates that women are subordinates to men. They are not allowed to speak in public or in the presence of men"*. This could explain why women in Karoi could not effectively participate in this study. During a focus group discussion, only men were seen asking questions. The sentiments raised by the key informant buttresses Taylor *et al*. (2008) who argue that although it is widely acknowledged that women play a key role in the collection and safeguarding of water for domestic use, nevertheless, women are less instrumental than men in key areas like decision-making processes related to water resources management. Oftentimes, the marginalised role of women in water resources management is traced to a social and cultural tradition which also vary between societies (Briscoe, 1996).

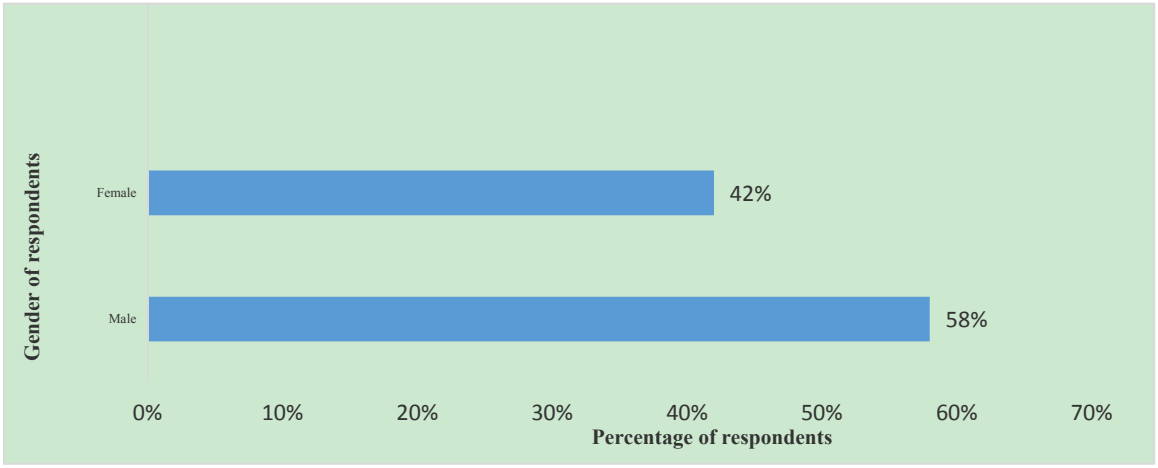

Figure 3. Gender and water consumption in Karoi

Source: Fieldwork, 2019

There is a large and growing literature on gender and water consumption (see Harris *et al.,* 2017; Barnes, 2013; Buechler & Hanson, 2015). While the case studies that comprise this literature are diverse, the major issue which emanates from them suggests that women consume more water at the household level and that women are denied major decision making roles for water supply at both local and national levels. Accordingly, gender plays a prominent role in water management discourses. Overall, literature has shown that men in rural areas are less involved in water collection and similarly, rural women are more often sorely responsible for water collection. However, literature has found that men are oftentimes involved in water collection when the distance to a water source is far and the technological requirements to collect water are high. However, a study on gender and water in Mongolia conducted by Hawkins & Seager (2010) found that although men and women share responsibility for water collection in rural areas, however, men were the majority in water collection. Men represent the majority of water collection across all forms of water collection but prominently collection by vehicles and by animals. Rural survey findings in Mongolia indicate that 100% of rural residents collect water from outside the home and that most rural households use multiple collection methods. Overall, the rural survey results indicate in households that collect water by vehicle, men are sorely responsible for 48% of water collection. According to the survey, rural women dominate in water collection when done by hand. In general, water collection appeared to be more equally shared between men and women in the rural survey results compared to the urban survey. Results also indicate that women who are not involved in water collection themselves are responsible for directing others in the household to collect water. Conversely, men who make a decision about when to collect water only make a decision about their own collection routines and never decide when other household members should collect water. Overall then the study indicates that although women decide when men should collect water, men never make these decisions for women. As water use varies significantly between people of different sexes (Jordán-Cuebas *et al.*, 2018), gender then becomes a vital variable in decision making for water management at the household level (Van Koppen, 2018). Females are perceived to use more water than males because they carry out more water-related activities than their male counterparts in a traditional society at the household level (Jordán-Cuebas *et al.*, 2018). While a study by Jordán-Cuebas *et al.* (2018) shows that females take long showers than males, another study by Fink (2011) on gender roles indicated that females have a high level of knowledge on water conservation than males who are less frequently engaged in water conservation particularly at the household level.

2.5 Age and Water Consumption in Karoi

The distribution of respondents by their age group (see Table 2) indicates that 18.3% of the respondents were aged 20-30 and 33.4% of them were age 31-40 years. The results show that the majority (37.5%) of the respondents were aged 41-50 and the least (18.8) were 50 years and above. The average age of the respondents was 38.9 years with a standard deviation of [SD] of 14.5. A one way between groups analysis of variance (ANOVA) was employed to explore the impact of age on the amount of water used in litres. HHs were divided into four groups according to their age [Group 1: 20-30 years; group 2: 31-40 years; group 3: 41-40 years and group 4: 50 and above years]. There was a statistically significant difference ($F = 0.17$, $p = 0.002$, at $p = 0.05$) in the amount of water used per age group. Therefore, we concluded that old people consume more water than young people. Literature has shown that there are two opposing arguments on the relationship between age and domestic water consumption (Billings & Day, 1989; Schleich & Hillenbrand (2009).

Table 4. Respondents' age group

Variable	Frequency	%	Descriptive statistic
Age group			
20-30	22	18.3	M = 38.9
31-40	40	33.4	SD = 14.5
41-50	45	37.5	
50+	13	10.8	

Source: Fieldwork, 2019

One argument proposes that as people age, they consume more water (Billings & Day, 1989). Schleich & Hillenbrand (2009), who analyse water consumption in over 600 water supply areas in Germany using regression analysis, found that per capita water consumption increased by 1.8 litres per day with a one-year increase in the

average age. This may have been because many retired people in the developed world spend more time at home and consequently, have more chances to use water, such as watering their gardens and bathing (Billings & Day, 1989). However, this finding contradicts Manzungu & Machiridza's (2005) study in Zimbabwe in which they observe that old people in the city of Harare use less amount of water as compared to young people even though a majority of them spend most of their time at home. Therefore, age has a negative relationship with water consumption (Nauges & Thomas, 2000) just as Makki *et al.* (2013) who examine the factors engendering water consumption for showering in Australia note that households with children consume more water in a shower than households without children. The contradictions between these empirical findings are attributable to the differences in social context examined or to differences in the study periods (winter or summer) or geographical location (rural or urban). Buttressing this finding, literature from (Aminzadeh *et al.,* 2000; Gitlin, 2001). Western countries have shown that many elderly people tend to use their bathroom more often due to health concerns, indeed concurring with Billings & Day's (1989) observation in Germany. The age structure of a given population is another relevant driver of domestic water consumption (Murdock et al. 1991). Though there are not many studies on ageing and resource consumption in Karoi, it seems that old people tend to spend less water per capita than young people. Moreover, families with children or teenagers can be expected to use more water, principally related to outdoor uses, as elements of the built environment such as swimming pools are largely targeted for them. Nauges and Thomas (2000) suggest that old people show more saving attitudes and the young use water less carefully, have more showers, and demand more frequent laundering. Shove (2003) and Binet *et al*. 2006), similarly, argue that elderly people are not generally used to the comfort conditions of the 21st century. Finally, due to the generally lower incomes of elderly, Nauges and Reynaud (2001) argue that they are more vulnerable to water price mechanisms. Yet another argument is that elderly people tend to live in old houses with dilapidated water reticulation infrastructure which tends to have any leakages. Therefore, high water consumption is attributed to the fact that some water is lost through leakages rather than having been consumed by the residents. Another explanation is linked to economies of scale. As elderly people are mostly leaving alone or two, it implies that the economies of scale usually associated with the high number of people within a household are absent in elderly people's apartments.

2.6 Education Level and Water Consumption in Karoi

The findings of this study reveal that the majority (53.3%) of the respondents had primary education and that they consumed on average 20-30 litres of water per capita per day (see Fig. 4). Furthermore, the results show that 25.8 percent of the respondents had attained secondary education and that they consumed 31-50 litres of water per capita per day. The least (20.9%) of the respondents had attained tertiary education and they consumed 51- 60 litres of water per capita per day. Findings reveal that the minimum amount of water used in the study area was 20 litres and the maximum was 160 litres for bigger households. The mean number of litres used per household (HH) was 45.8 with a standard deviation of 32.3. An independent sample t-test was used to compare the amount of water in litres used by males and females. There was no significant difference in the amount of water used between males and females ($t = 0.46$, $p = 0.65$). However, the results of this study concur with the results of a study done by Clarke & Brown (2006) in Melbourne and that of Navascues & Alfredo (2018) carried out in Spanish Mediterranean coastline municipalities and that of Fan *et al*. (2013) conducted in Yangling district in China all of which were investigating the influence of socio-demographic and economic factors on domestic water consumption. The findings for all the three studies in different parts of the world and for this study all reveal that a high level of education results in the high propensity of domestic water consumption. Nevertheless, mixed results were found for education in different studies conducted globally as some researchers found low levels of water consumption among people with high levels of education (Clarke &Finley 2007; Vannavong *et al,* 2017) and another group of researchers found empirical evidence for the opposite (Oliver 2003; Gregory & Di Leo, 2003). The explanation for this contradictory evidence emanates from the fact that high levels of education always lead to a better understanding of the scarcity problem through a high level of income associated with high levels of education makes those with high education high consumers of domestic water. This has been linked to the availability of both indoors and outdoors water-consuming infrastructure and gadgets. Thus, the results of this study concur with Mete *et al.* (2016) who argue that mixed results were found for education as a high degree of education always leads to a better understanding of the scarcity challenge. In turn, education often is confounded with income as a high education often leads to a high income.

Furthermore, other authors are of the opinion that consumer behaviour oriented towards water serving influence domestic water consumption. Whereas some studies correlate education level with the degree of environmental awareness, which can be manifested through various activities such as the acquisition of water-saving appliances or the choice of garden typology with low water requirements, education also has an equivocal relationship with

water consumption. Some studies show that those with high education are more conscientious on water conservation hence monitor their consumption. However, there is no consensus on the issues of education as a factor which reduces or increases consumption of domestic water in Karoi and globally.

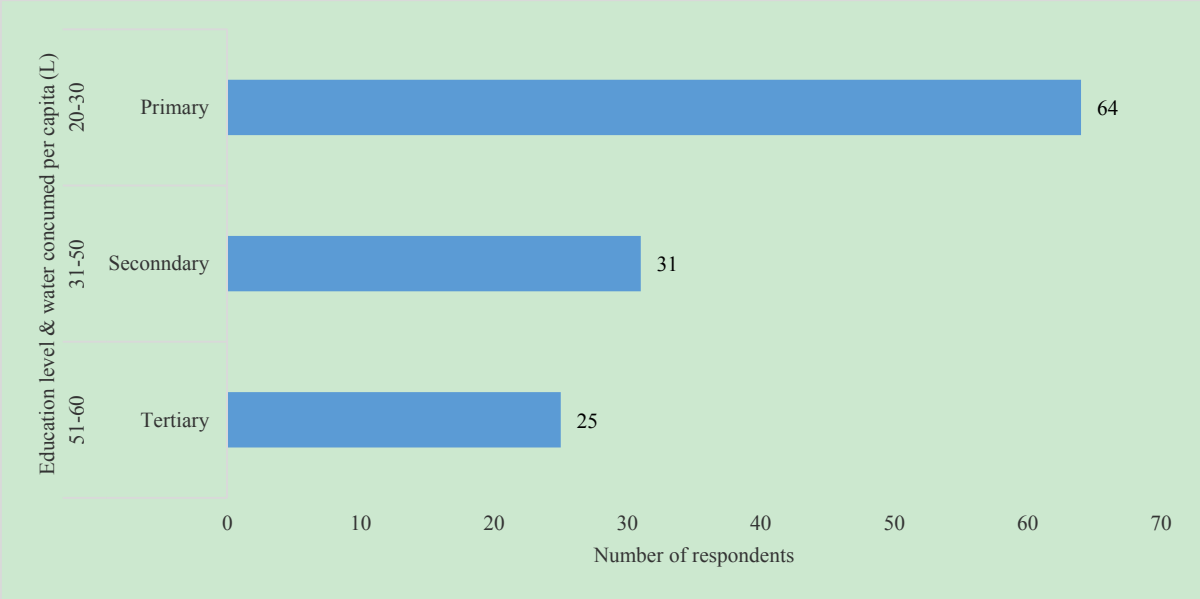

Figure 4. Level of education and amount of water consumed per capita

2.7 Water Price and Domestic Water Consumption in Karoi

The desire to include the price in the factors influencing domestic water consumption in Karoi was informed by the erroneous assumption that high price for domestic water leads to its low consumption. While literature show that price is one of the most studied factor influencing domestic water consumption across the globe (Corbella & Pujol, 2009; Howe & Linaweaver, 1967; Arbues et al., 2004, Campbell *et al.,* 2004), however, it is concluded in most of the studies that its increase does not significantly reduce the amount of domestic water consumed. However, such studies all point to the fact that an increase in water price drastically reduce non-indispensable water uses such as outdoor uses like gardening among others. Figure 5 shows the average amount of money paid for water consumption in 30 of the 120 households in the three residential areas of Chikangwe, Chiedza and Westview in Karoi town. On average households in block number 1 for the three residential areas pay rtgs$19, rtgs$20 and rtgs$105 for Chikangwe, Chiedza and Westview respectively. Those in block 2 show that the highest (rtgs$105 (Note 1)) amount of money was paid by consumers in Westview and the least (rtgs$19) was paid by residents of Chikangwe and those in Chiedza pay rtgs$20. Whereas the least (rtgs$15) of money was paid by residents of Chiedza, the highest (rtgs$180) was paid by households in Westview for those households in block 3. For those in block 4, the least (rtgs$15) amount was paid by Chikangwe households and the highest (rtgs$130) was paid by Westview residents and those in Chiedza pay on average rtgs$102 per month. In block 5, the least (rtgs$16) amount was paid by households in Chikangwe and the highest (rtgs$45) was paid by the households in Westview. The results show that the highest (rtgs$202) amount of money in Westview was paid by households within block 8 and the least (rtgs$45) was paid by household in block 4. In Chiedza, the highest amount of money paid for consuming water per month was rtgs$102 and the least was rtgs$11. In Chikangwe, the least amount of money paid for water was rtgs$11 and the highest was rtgs$80. Generally, the results of this study have shown that households in Westview (a high-income residential area) consume more water as shown by the fact that in each case they pay more in terms of water charges than those in any of the two other residential areas of Chikangwe and Chiedza. The mean monthly water charges for domestic water use was rtgs$27.5 in Chikangwe with a standard deviation of 22.66 while for Chiedza was rtgs$31.7 with a standard deviation of 26.7 and for Westview, the average was rtgs$117 with a standard deviation of 51.05. A one way between groups ANOVA was conducted to explore the effect of place of residence on the cost of water in rtgs$. Residential areas were divided into three groups according to population density (group 1: Chiedza; group 2: Chikangwe group 3: Westview). The results demonstrate that there was a statistically significant difference at $p < 0.05$ in the amount of money paid per month for water use in the three residential areas ($F = 1.6$, $p = 0.004$). The effect size,

calculated using eta squared, was 0.06. A posthoc comparison using the Tukey HSD test indicate that the mean monthly water charges in Chikangwe (M = rtgs$27.5; SD =22.66), Chiedza (M = rtgs31.7; SD = 51.05) and Westview (M = rtgs$117.7; SD = 51.05) differ significantly between low and high-income households. The results of this study resonate well with those of Bich-Ngoc & Teller (2018) in which in their study on residential water consumption determinant they concluded that water demand differ significantly between low and high income and that an increase in water prices does not result in a significant reduction in water consumption for both low and high-income groups.

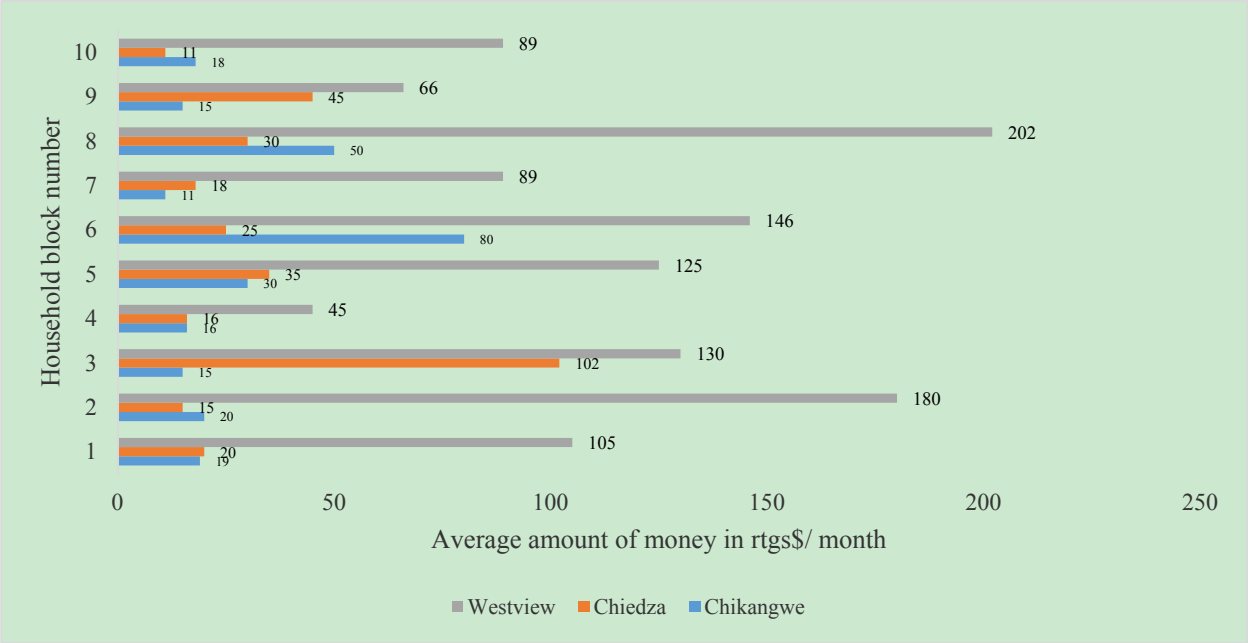

Figure 5. Average amount of money paid per household in each block per residential area per month

Based on Bich-Ngoc &Teller (2008) the assumption that an increase in water prices will also lead to a decrease in water consumption would only be true if and only if water behaves like any other normal economic good. Consequently, that being said, water is not like any other normal economic good. For instance, Savenije (2002) posit that since most water uses are essential and irreplaceable, the market theory cannot be simply applied for domestic water consumption. Empirical evidence generally supports the fact that domestic water consumption is price inelastic that is, a large increase in water price generally leads to insignificant low or no change in domestic water consumption (Espey *et al*., 1997; Nauges & Reynand, 2001). However, it is noteworthy that the price elasticity of water demand varies among different end uses. Whereas price mechanisms cannot make great differences in domestic water consumption, it significantly influences water uses related to outdoor activities such as leisure activities, gardening or filling swimming pools (Corbella & Pujol, 2019). Available evidence suggests that in the study of price variable as a factor influencing domestic water consumption, there exist a demand threshold which is the essential amount of water for basic needs. It is argued that when the threshold is reached, increment in price really affects water consumption (Martinez-Espineira & Nanges, 2004). Furthermore, the influence of price on domestic water consumption also differs among people of different socio-demographic groups. Literature has shown that domestic water consumption is low in low-income households since water in such households is just only for basic needs and as such cannot be reduced even with high water prices (Bich Ngoc & Teller, 2018; Inman & Jeffery, 2006) However, studies have also demonstrate that there is also evidence that very little or no effect of price to domestic water consumption on high-income households (Renwick & Archibald, 1998) since price signal is not strong enough to curb their consumption (Renwick & Green, 2000). Some studies point to the fact that water consumption is more responsive to price changes in summer than in winter. Consequently, such understanding is critical for setting price schemes which can target savings in high consumption groups whilst not posing the conservation burden on indispensable uses.

2.8 Sources of Domestic Water in Karoi

The results of this study show that the main sources of domestic water in Karoi comprise in-house piped water, communal borehole and streams/rivers. The distribution of respondents by their main sources of domestic water

(see Figure 6) indicate that the majority (86%) of the respondents receive water from pipes installed in their houses and the least (6%) fetch water from directly unprotected sources such as rivers and streams. Only 8% of the respondents relied on public boreholes and unprotected wells for domestic water. The results, furthermore, show that piped water was not reliable as people reported that oftentimes they spend 3-5 days with dry taps. There were reports that residents of some residential areas (Chiedza and Chikangwe) spend 3 to 4 months without water coming out of their taps. During such periods the alternative source of water was said to be the borehole, which was also reported to be unreliable. Accordingly, based on the key informant domestic water consumption in the study area was influenced by water scarcity situation in the town. The key informant had this to say:

We are now moving into the water rationing mode. We have to use some austere measures in terms of water supply. This means that people have to reduce the amount of water that they are using and the as water supply authority we will also reduce the amount of water that we pump.

Accordingly, the amount of domestic water consumed by the residents in Karoi was also affected by water scarcity which comes as a result of seasonal water fluctuations in the town and its vicinity. As the main water sources get drier the supplier reduces supply per day thus residents are also required to reduce their domestic water consumption levels.

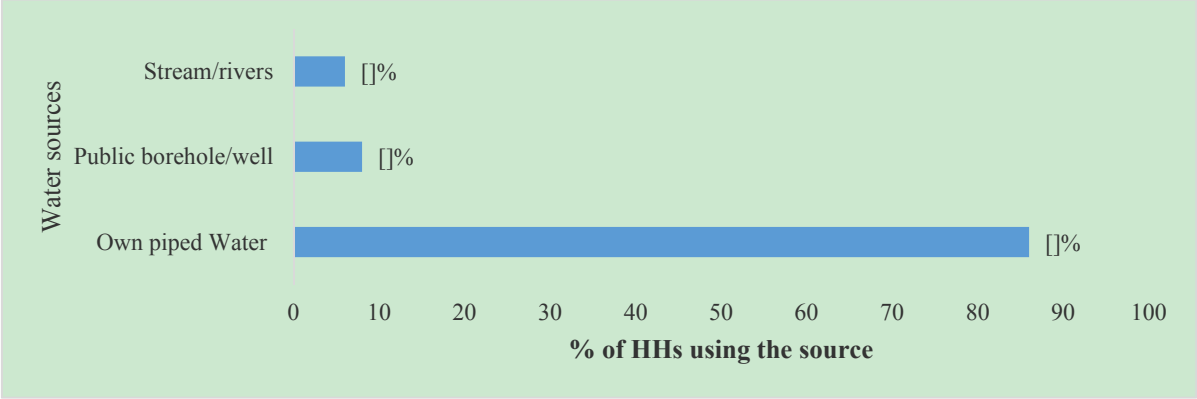

Figure 1. Main sources of water

Source: Fieldwork December 2018-January 2019

On the issue of water shortage one resident had to say:

Daily, I need an average of ten 20-litre buckets. If I do not wake up on time, it means we would have to go for the whole day without water to use for cooking, bathing, doing laundry or flushing the toilet.

The residents' toil in the study area resonates well with the results of other studies in Zimbabwean cities which argue that water scarcity leads a reduction in water consumption and the generality of township dwellers tend to *moonlight* to get the precious liquid (Dandadzi *et al.,* 2019; Mashizha & Dzvimbo; 2018; Nhapi, 2009; Muzah, 2015). Based on residents of Chikangwe, Chiedza and Westview water taps dry up as early as 4 in the morning, forcing residents to find alternative, but unsafe water bodies, such as shallow dug out wells and streams. The most affected areas were the sprawling high-density residential areas such as Garikai, Chiedza, Chikangwe and Petergroot. Residents interviewed by the researcher castigated ZINWA for failing to prioritise water provision, arguing the local water supply authority had to buy water bowsers to service locations, especially those situated on high ground, where supplies do not reach the areas such as Chiedza D.

2.9 Distances and Domestic Water Consumption in Karoi

While borehole, wells and pipe were major water sources in the study area, there were also alternative water sources which were mainly used when there was no water at the main sources. The distribution of respondents by their distance from alternative sources of water is shown in table 3. Whereas the highest (60%) of the residents of Westview travel less than 100 metres to fetch domestic water from alternative sources, 30% and 10% obtain water within the same distance in Chikangwe and Chiedza respectively. The majority (40%) of the residents of Chikangwe fetch water from a distance of 100 – 500 metres. In the same distance category, 30% were in Westview and 20% in Chiedza.

Table 5. Distance to alternative water sources in Karoi

Distance (ms)	Chiedza	Chikangwe	Westview
> 100	10	30	60
100 - < 500	20	40	30
500 - < 1000	50	25	7
> 1000	20	5	3

Source: Fieldwork 2019

While the majority (50%) of the residents of Chiedza fetch water from alternative water sources within 500 metres to about 1000 metres, 25% of Chikangwe residents obtain it from within the same distance. However, only 7% of the residents of Westview obtain water within 500-100 metres. The furthest distance where residents obtain water was more than one kilometre. The results of this study reveal that the highest (20%) of the residents fetch alternative to water in a distance of over a kilometre were in Chiedza and the least was in Westview. For Chikangwe, only 5% of the residents obtain water from a distance of over a kilometres. The mean distance to the nearest water source was 156 metres with a standard deviation of 0.705. The distance to the alternative water source affects water consumption as well as the socio-economic status of the households. Longer distances to the nearest water source imply longer hours spent on fetching water. The time spent on collecting water could be more productively used elsewhere. On average, 80 percent of the respondents spent a minimum of 25 minutes and a maximum of 3 hours while fetching water. The mean time is 1 hour 8 minutes with a standard deviation of 0.9 hours. The weight of the water also affects the health status of the people involved in fetching water who are coincidentally mostly women and children. Some residents are tempted to carry water on their own to save money on water expenditure. The residents can resort to alternative water sources like wells which may be polluted if the piped sources are far.

Although domestic water is available to the residents of Karoi from the various sources at differ rent times of the year, this survey shows that households had preferences for water from particular sources. Authors of this study were interested in identifying the characteristics of sources that make them attractive. It appears that the salient factor was the proximity of the water sources to the home, as cited by 81 percent of the respondents. Only 10% of the respondents used particular water sources because they were well-kept and maintained, while 5% of the respondents preferred particular sources because fewer people used them. Surprisingly, only about 4% of the respondents considered the quality of the water as a major factor in their choice of alternative domestic water. People were three times more likely to use a particular source of poor quality water that was closer to their residential areas than one that had good quality water but was some distance from their homes. People who live farther away from any water source settle for the water of lower quality than those who live close. To confirm this finding, respondents were also asked why they did not use certain water sources for most of their domestic water. About 66% said it was because those sources were far from their homes. Some stated that, after spending a long and hard day on the in street trading, they were not willing to walk long distances to fetch water for their domestic activities. About 23% of the respondent's avoided certain sources because of poor water equality.

2.10 Household Size and Domestic Water Consumption in Karoi

A household refers to a person or group of persons who make common provisions for food, shelter and other essentials for a living (Bongaarts, 2001) and its size is essentially the number of persons which constitute that household. The size of a household is a very cruel demographic variable to consider when studying factors affecting domestic water consumption within a household. In the study area (see Table 4), the majority (36.7%) of the households had 2 to 5 members. The least (14.2%) had 1 member. It is also noteworthy that 25 5% of the households in the study area had 6 to 9 members and the largest (9 members and above) comprise 24.1% of the households. The mean household size was 5 with a standard deviation of 2. Literature has shown that the higher the number of people living in a household, the lower the amount of domestic water consumed. This is linked to economies of scale regarding the optimization of water use. Consequently, economies of scale are generally absent in smaller households (Arbués *et al*. 2000). In addition, Arbués *et al*. (2003) argue that there is an optimum household size and that beyond this threshold these economies of scale tend to vanish. On the other hand, the increasing number of smaller households intensifies the effect of inefficient water use in small households (Hummel and Lux 2007; Lux 2008). A study by Kanda *et al.* (2017) in Zimbabwe on the adaption of household water use in rural areas and another by Vannavong *et al.* (2017) on the effects of socio-demographic characteristics and household water management in rural villages in Thailand buttress the argument that the

bigger the household size the relatively lower the domestic water consumption within the household as both of these studies come to the same conclusion.

Table 6. Household size in the study area

Variable	Frequency	%	Descriptive statistics
Household Size			
Only one person	17	14.2	
Between 2 and 5	44	36.7	
Between 6 and 9	30	25	M = 5
Above 9 members	29	24.1	SD = 2

Source: Fieldwork 2019

Following Keshavarzi *et al.* (2006) and Froukh (2001), both household size and composition affect water use. Households with more female members may have more litres of water fetched in a day for their use as opposed to those with more male members. This is because women consume more water than males (Harris *et al.,* 2017; Barnes, 2013; Buechler & Hanson, 2015). The amount of water used per household is mainly determined by the number of people in it. Large families use more water at the end of the day than smaller families even though economies of scale play a role. What this means is that the large households will need to source for more water, even if it is from different sources so as to meet their daily water demand. More so household size has been found to be the most important factor affecting water consumption. For instance, Totoum (2012) posits that a household's size has a significant positive effect on a household's choice of private tap and a negative impact on a household's choice of coping sources.

2.11 Time Is Taken to Collect Domestic Water in Karoi

With regard to hours of water supply service, the majority (42%) of those with in-house connections receive water once a week. The average number of hours they receive water per week is 3 with a standard deviation of 0.85. Access to water has been very poor and considerably below the average in Chiedza D and at times in Claudia. None of the residential areas received water for 24 hours of continuous supply. This concurred with a key informant who reiterated that "*We are now guaranteed of reliable water supplies even if it is not for the whole day but at least there is water twice in the morning and evening".* Data analysis shows that while 22 percent of the respondents received water once a day for less than 2 hours, 24 percent received water for 3-4 hours a day and only 24 percent of the households received water twice a day. The study found that only 2 per cent of HHs received water supply once in 2-3 days. About 10 percent of the HHs never received water despite connections to the main water supply grid. Thus, 10 percent of the HHs depend on water from rivers and streams for their domestic needs in Karoi town. Consequently, some residents had this to say during the interview "*Hatichabhadhari mvura yeZINWA isu hazvibatsiri kubhadhara iyo isingabudi* literally translated to English as "*We decided to stop paying for water altogether. It just didn't make sense".*

The time taken to walk to a water source and then queuing to fetch the water and getting the water to the household is really critical when analysing factors influencing domestic water consumption within a household. In some cases, literature has shown that many hours are spent to collect very few litres of water because either the water points are many kilometres away from the homesteads or they are in a location where a lot of effort and time is required to access them (Kithinji, 2015). This is a time that could be used in more productive work that would help in improving the lives of a household. UNFPA (2002) report estimated that women in many developing countries walk for an average of about 6 kilometres each day to collect water. The report further states that water collection for domestic purposes is generally the responsibility of women and children. Women interviewed in the Chikangwe, Chiedza and Westview reported that they have to walk for 2 km to get to an open well or a total of four hours a day to fetch 40 litres of water. Based on UN (2000) report, the water collection times for villages in Kenya average just over 4 hours per day during the dry season and 2 hours per day during the wet season. The data also indicate times in the range of 4 to 6 hours per day in Botswana, Burkina Faso and Ivory Coast. Inadequate water infrastructure can create multiplier risks in rural areas. Several hours are wasted when women and children spend more time to fetch water for domestic use in walking for long distances to water points. As a result, domestic water use in the mentioned countries especially in rural households has been adversely affected as women and girls spend lots of time walking long distances or queuing to fetch water for

use at home. Many times the water is not affordable affecting the domestic water use. This has adversely affected the girl child education and the woman's ability to engage in other income-generating activities, cultural and political involvement, rest and recreation. Mu *et al.* (1990) using data collected by in-depth personal interviews from 69 households in Ukunda –Kenya found out that household's decisions on where to source their drinking water are influenced by the time it takes to collect water from different sources, the price of water and the number of women in a household. Madanat and Humplick (1993) on extending the work of Mu *et al.* (1990) by first looking at water usage and secondly analysing households' choice of water sources and connection decisions found out that the distance from the household to the water source impacts negatively on water source choice. Hindman (2002) conducted a study on household water choice in Philipines on 769 households of Cebu. He analyzed the effects of water prices, taste and household size on the probability to choose a specific water supply source and the results indicate that the time taken to collect water from different sources has a statistically significant effect. A study by Howard *et al* (2003) reveals that distance is a crucial factor in determining water consumption at the household level. The further away the source of water is to a household, the lesser the amount of water consumed. For instance, in areas where people walk for more than one kilometre or spend more than 30 minutes for water collection, the per capita water use drops to about five to ten litres per day (Osman and Khan (2011). Bosch *et al.* (2008) point out that in the urban areas, a major deterrent factor is not necessarily the distance to the water source but rather the time is taken to get water. More people are most likely to reduce consumption of water if they have to walk shorter distances but have to queue for long hours to draw the water. Osman and Khan (2011) note that the amount of time involved in getting water is probably more important than the distance covered to the water source as a determinant of access to water. This is due to the fact that some areas are so severely hit by the scarcity of the vital resource (water), that it actually takes a long time before an individual fetches water than the distance covered to the water source. In a study conducted in Mueda, Mozambique for instance, women spend about two hours to get to a water source and spend about three hours queuing as they wait for their turn to fetch water due to the relative scarcity of available water for the people. In a study by Mercado and Kjellstorm (2008) to determine the social determinants of health equity in urban settings, it is revealed that the burden of the inadequacy of water and sanitation is borne by women and children.

3. Conclusion

The paper set out to analyse the demographic and socio-economic factors influencing domestic water consumption in Karoi town in Zimbabwe. The results indicated that most of the times there was no water in the town. During the period when taps were dry residents' access to water from alternate sources among them being unprotected sources like streams. Distances to alternative sources of water were more than the United Nations recommended 1000 m mark. Furthermore, it has been revealed that water comes only at certain times of the day and for a very short time. The study has shown that gender affects water consumption. Consequently, women consume more water even though, they are denied major decision making roles at household levels. The study has also shown that there is a significant difference in water consumption by age within households. The general trend was that demographic and socio-economic factors play a significant role in understanding factors influencing domestic water consumption at the household level. The study recommended a further study in the factors affecting domestic water consumption in small towns in developing countries.

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Note

Note 1. rtgs$1 was presumed to be equivalent to US$1 even though on the black market the scenario was different