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WHEN DEMAND EXCEEDS SUPPLY: WATER DEMAND FOR NON-RESIDENT STUDENTS AT THE UNIVERSITY OF KABIANGA, KENYA

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----------ABSTRACT ----------

Approximately one-third of the global population resides in countries experiencing moderate to high water stress. Additionally, Kenya is categorized as a chronically water-scarce country by the United Nations. Further, only 30% of those living in urban areas in Kenya are not connected to the water supply systems that exist. This study therefore sought to determine the water demand as well as the uses of water by non-resident students at the University of Kabianga (UoK). The study relied on an exploratory approach that employed a descriptive survey. Its target population was the non-resident students (673 students) of the UoK, from whom a sample size of 250 students was selected. 53% of the participants were males, while 47% were females. Simple random sampling was used in selecting the participants, while purposive random sampling was utilized to choose the study's private hostels (15 Hostels). The tools for data collection included questionnaires, key informant interviews, and an observation guide. The collected data was analyzed using SPSS to generate descriptive statistics and other statistical outputs presented using tables, pie charts, and graphs. Analysis showed that gender affects water demand since females' average daily water demand is 47.54 lpcd which is higher by 12.4277lpcd than that of men. This difference was mainly attributed to the variation in water usage between male and female students. Moreover, the relationship between daily water usage and the number of students living in a room/housing unit had a high positive and statistically significant Pearson product correlation ($r = .623$, $p<0.05$). Moreover, the relationship between daily water usage and gender had a low positive statistically significant Pearson product correlation ($r = .329$, $p<0.05$). It was further established that students use water mainly for washing, bathing, cooking, drinking, and washing dishes. The relationship between the cost of 20L jerrican of water and daily water usage had a strong positive, statistically significant Pearson product correlation ($r = .516$, $p<0.05$), thus indicating that the cost of water influences daily water usage, thus influencing one`s main uses of water. The findings of this study will provide a basis for the provision of a sustainable water supply of adequate quality to non-resident students` hostels at the University of Kabianga and inform the stakeholders of appropriate measures that should be put in place to ensure adequate water supply to their tenants.----------

INTRODUCTION

Water shortage refers to the lack of adequate resources of water (including those that provide safe drinking water) to meet the demands of a population within a certain region. Therefore, water shortage is population-driven scarcity. On the other hand, water stress refers to the impact of high water demand from the available water sources that results in the deterioration of the quality and quantity of the water that is available. Therefore, water stress is demand-driven scarcity that may occur even with a small population without the potential to cause water shortage (Kummu et al., 2016).

Maintaining human health and well-being requires access to clean and safe water for daily usage. However, people`s access to safe and clean water has been challenging in developed and developing countries despite water occupying the largest portion of earth. Despite occupying a significant portion of the earth, only 2.5% of the water comprises fresh water. Further, people can only access less than 1% of the freshwater for human usage. Additionally, research has shown that approximately 20% of the population lack access to drinking water, while 40% do not have access to proper sanitation facilities (Davis et al., 2017). Moreover, the larger portion of that population come from developing nations (Waziri, 2018). Therefore, this indicates that a significant portion of the global population is not connected to a sustainable water supply system that meets their needs.

Lack of adequate water supply increases the risks of experiencing water-related diseases within a population. This resonates with numerous research studies indicating that nearly 1.1 billion people are subject to a high risk of

water-related deaths and diseases due to poor access to clean and safe drinking water, especially in Africa and Asia. For example, approximately 3.5 million annual deaths due to water-related diseases. Of those case, 84% occur among children. Moreover, nearly 90% of deaths are attributed to diarrheal diseases and occur in the developing world's child population (Davis et al., 2017).

Water stress is driven by many human-related challenges, especially in developing countries like Kenya. Among them is rapid urbanization. For example, nearly 50% of the world's population resides in urban areas. Further, population projections have indicated that Asian and African countries will have a high urban population in the future, thus increasing pressure on the existing water supply systems (Davis et al., 2017). Therefore, proper planning is key to ensuring more water supply systems are put in place to meet the demands of the rapidly rising population in urban areas, especially in developing nations like Kenya.

The challenge of ensuring that people have sustainable access to drinking water of the required quality has grown globally over time. However, this situation may differ in specific local contexts. This has been occasioned by the ever-increasing demand for water from human development-related activities such as agriculture, industrialization, and the rapidly increasing human populations that have piled pressure on the limited available water resources. As a result, this has led to a deterioration in the quality and quantity of the available water for human use. Further, previous studies have shown that nearly a third of the global population lives in areas experiencing moderate to high water-stress areas. Moreover, approximately 75% of the global population will live in regions with water-stressed by 2025 (Barra, 2020). Therefore, the challenge of poor water supply and its resultant effects differ from one region to the other though this problem is most urgent within developing countries.

Developed and developing nations experience water access challenges. Primarily, small communities within countries (both developed and developing) experience these challenges due to small customer bases. Small customer bases result in the inadequacy of finances for maintenance and operational costs of water supply systems. As a result, the communities experience numerous water-supply-related challenges, such as rationing and poor drinking-water standards (McFarlane & Harris, 2018). These challenges force households to adopt measures that may increase the risk of water-related diseases within these communities to ensure a constant water supply. Such measures include water storage which increases the risks of contamination due to a lack of water treatment or poor storage. Further, these measures may create breeding places for mosquito vectors that spread malaria, thus leading to poor health among the residents.

Poor access to safe and clean drinking water has forced people to operate small water systems not regulated by the existing laws. As a result, this increases the risk of water contamination, destruction of catchment areas, and deterioration of water sources due to overexploitation. For example, in the United States, people constructed nearly 1000 new small systems annually to increase the water supply in their communities (McFarlane & Harris, 2018). However, some are unregulated under national law, thus increasing the risk of water contamination and deterioration of water sources due to overexploitation.

Lack/poor access to sustainable sources of clean and safe water has resulted in significant challenges, especially among the vulnerable in society. These problems include poor health, increased household expenses, time wastage, and exhaustion among women. Primarily, this can be attributed to inequalities in society and poor governance and policy-making, thus subjecting people experiencing poverty to the risk of traveling for long distance to access water and incurring high costs to meet their water needs (WHO, 2019). In many areas, especially in rural communities, meeting the basic standard of water access is a challenge due to a lack of adequate funding and political will. For example, ensuring that everyone accesses 20 litres per day of safe drinking from an improved source that is within a 30-minute distance from their premises is achievable by almost every government with more funding (WHO/UNICEF, 2010).

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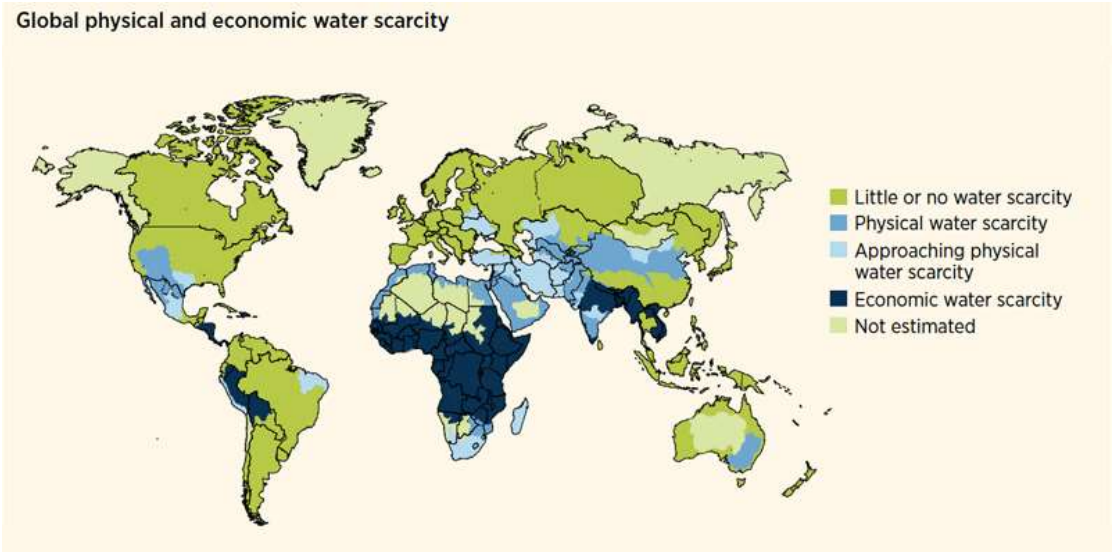

Source: World Water Development Report 4. World Water Assessment Programme , (2012).

In Kenya, the government has implemented measures through the Ministry of Water, Sanitation, and Irrigation to ensure access to adequate and safe water for the public. Moreover, it has partnered with key stakeholders, including private entities, to ensure people's access to safe water through various initiatives like maintaining Water Purification Points (WPPs) and drilling boreholes. For example, in 2020/21, the government drilled approximately 1,401 boreholes. Moreover, it estimated this number to increase to 4,241 in the year 2021/22, with an expectation that 88.9% of the increase would come from private sector initiatives (Economic Survey, 2022).

Kenya's government is committed to ensuring adequate water supply by funding various initiatives. These initiatives include water development, training of staff, irrigation development, national water harvesting and storage, and rural water supply. For example, between the 2020/21 financial year and 2021/22, the government`s total expenditure on rural water supplies development was expected to increase from Ksh 2.4 Billion to Ksh 3.5 Billion. Additionally, the budgetary allocation for Irrigation Development was increased from Ksh 0.5 Billion to Ksh 1.4 Billion between the 2020/21 financial year and 2021/22, while the allocation of National Irrigation Authority was increased from Ksh 8.5 Billion to Ksh 10.7 Billion (Economic Survey, 2022). Therefore this shows the government`s efforts in ensuring adequate water supply to all Kenyans regardless of their status.

Despite the measures that the government has put in place to ensure adequate water supply for all, studies have shown a huge difference in water supply coverage between urban areas (71.7%) and rural areas (28.3%). While most of the urban population rely on piped water as their primary source of water, most of the rural population rely oN streams/rivers. As a result, the urban population uses more water (two times more) than the rural dwellers due to their convenience of accessing their water source.

The water supply situation in rural areas differs with that of urban areas. All the water service providers in urban areas are regulated by Water Services Regulation Authority (WASREB). As a result, the water supply coverage is substantial and reliable since the Water Service Providers can meet their operational and maintenance costs. However, provison of water in informal settlements is challenging due to planning issues as a result of dense unplanned structures. As a result, people rely on water kiosks as their only source of safe water for their uses (Chepyegon & Kamiya, 2018). Conversely, rural dwellers rely on unimproved water sources, thus forcing them to use homemade solutions like boiling to treat their drinking water. Moreover, most of the rural areas lack piped water systems since their settlements are sparsely populated, thus rendering investment on such systems very expensive. Moreover, water projects that have been installed are managed by community groups, whereby a managing committee is tasked with their maintenance. However, delivering their mandate is challenging due to lack of adequate finance since they only rely on the amount consumers pay for operation and maintenance (Chepyegon & Kamiya, 2018).

The lack of piped water systems in rural areas have resulted in water shortages, especially in areas where satellite campuses or charted universities have been established in Kenya. As a result, off-campus students have been

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forced to rely on water vendors as their water source during the dry seasons and rainwater during the wet seasons. Moreover, some landlords have dug shallow wells or boreholes to ensure that their tenants (off-campus students) access water. As a result, students have been forced to use water of unknown qualities, thus subjecting them to the risks of waterborne diseases like typhoid. This study therefore sought to determine the water demand as well as the uses of water by non-resident students at the University of Kabianga.

MATERIALS AND METHODS

Study Area

The study was conducted at Kabianga University Town. According to the Urban Areas and Cities Act Part II, Section (1), the county governor may, in consultation with the committee constituted under Section 8(2), confer the status of a town on an area that meets the criteria set out in subsection (2). The criteria under subsection (2) state that the area under question must have; a population of at least ten thousand residents according to the final gazetted results of the latest population census carried out by an institution authorized under any written law preceding the grant; the existence of an integrated development plan under the Act; the capacity to effectively and efficiently deliver essential services to its residents as provided in the First Schedule; and sufficient space for expansion (Urban Areas and Cities Act, 2011). Kabianga University Town was conferred as a town since an integrated plan was done in 2015 and approved in 2018. Moreover, it had a population of 17,000 residents per the census of 2009 and had sufficient space for expansion.

The study focused on non-resident students residing in private hostels within Kabianga University Town. Being a public university town, it will provide a good representation of public university students' experience in private hostels. The main reason for preferring this area is the increase in students residing in private student accommodation hostels and the increased construction of low-standard private hostels within the town.

Table 1: Student stay status from 2018/19 to 2021/22

Academic Year	*Resident Students*	*Non-Resident Students*	*Total*
2018/19	899	506	1405
2019/20	915	554	1469
2020/21	1569	424	1993
2021/22	1577	673	2250

Moreover, despite the numerous hostels that have been built, the area lacks a well-laid water distribution system for providing water. As a result, students rely mostly on private vendors and rainwater for use. Additionally, some hostels have shallow wells, while very few draw water from boreholes. Finally, the weather patterns keeps on changing over time from wet to dry seasons thus affecting the water supply especially in the month of January and February where there are no rains hence a low water supply.

3.3 Research Design

The study used an exploratory approach employing a descriptive survey design because it was effective in describing the current phenomenon without manipulating variables. A descriptive survey design seeks to explore a phenomenon in detail without manipulating it. Akhtar further observes that descriptive survey design is very effective in gathering information, summarizing, presenting, and interpreting data in preliminary and explorative studies (Akhtar, 2016).

Target Population

The target population for this study was the University of Kabianga undergraduate non-resident students in private hostels within Kabianga University town. Accordingly, the population included all the non-resident students residing within the Kabianga market center, Kapmaso market center, and Chepnyogaa market center.

Table 2: Distribution of the target population.

Location	*No. of Students*
Kapmaso	106
Chepnyogaa	28
Kabianga	116
Total	250

However, the population did not encompass other residents who were not students from the University of Kabianga. Therefore, non-resident students of the University of Kabianga residing outside the boundaries of Kabianga University town were not part of the study. This aided the researcher in ensuring that their hostels were easily accessible for the study.

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3.5 Sample and Sampling Procedures.
Oribhabor and Anyanwu (2019) assert that a sample from a large population can be calculated using the formula below;
$n = N/ [1+N (e)^2]$
Where
n = the sample size
N = total population (673)
e = tolerance of desired confidence level (0.05%) at 95% confidence level
Hence the sample size is 251 students.

Simple random sampling was used to categorize students into various subgroups (gender). This method aimed at achieving desired representation from various subgroups, thus ensuring gender differentiation (Taherdoost, 2016). Grouping the respondents into different genders was essential to determine if different factors influence water use between both genders. However, simple random sampling was used to select the students to ensure that all the students had an equal chance of inclusion in the study.

Purposive random sampling was used to select private student accommodation hostels (15 Hostels). The researcher focused on hostels that contain a large population of students, unlike those that are mostly populated by individuals who are not students. As a result, this allowed a researcher to use cases with the required information concerning this study (Taherdoost, 2016).

3.6 Data Collection Instruments
This study used four research instruments, questionnaires, a key informant interview, an observation guide, and a camera.

Questionnaire for Students
Questionnaires were preferred for data collection from the non-resident students because they are appropriate in descriptive surveys with many respondents. Moreover, the questionnaires allowed the respondents to express their views and make suggestions freely. Therefore, this tool was critical in collecting relevant data for determining water demand. Such data included the amount of water used daily by respondents, the cost of buying water, and sources of water during dry and wet seasons, among others. Overall, questionnaires were critical in collecting data for carrying out descriptive and inferential analysis to determine the demand for water.

Interview
The researcher used interviews to gather information from the key informants, such as Hostel Department Officers at the University and Landlords. Interviews are more effective than questionnaires when collecting information from a small sample since one can gather more data from respondents because the questionnaires tend to limit more data. Therefore, this was critical in collecting data on the available sources of water within the hostels, and the uses various uses of water among students.

Validity of Instruments
The researcher assessed content validity using professionals who included my university supervisors and other lecturers within the department. This was achieved through a content validity survey whereby every item was evaluated through a three-point scale (not necessary, useful, but not essential and essential). Additionally, the total number of panelists who conducted the study's content validity was five.

RESULTS AND DISCUSSION

Gender of Respondents
According to the findings, 53% of the respondents were males, while 47% were females (N=250). The percentage of male non-resident students was higher mainly due to male students' desire for privacy. This resonates with the study`s finding that most of the housing units (75%) comprised one student. Part of the students claimed that the campus hostels had strict rules that limited their freedom. Those who lived together gave reasons like cost sharing to manage the high household expenses like rent.

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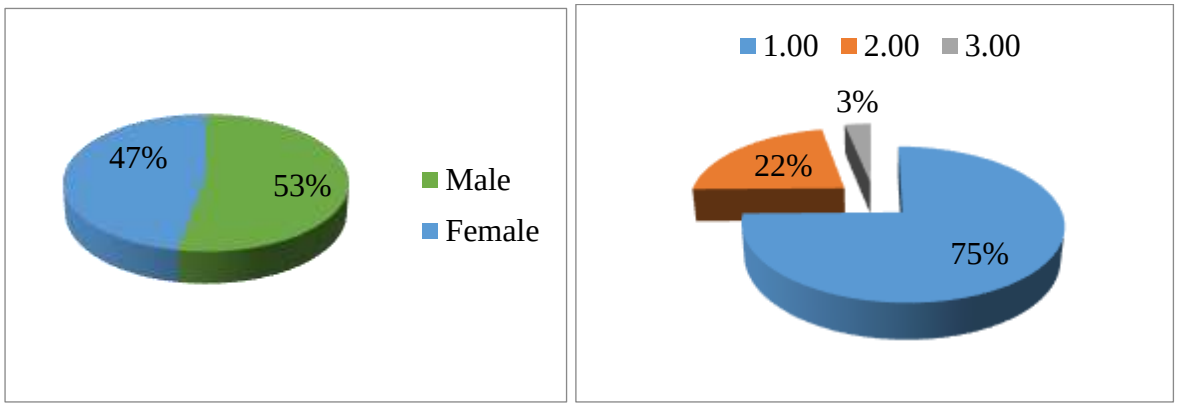

Figure 2: (A) summary of the respondent's gender (B) number of students in a housing unit.

Average Number of Students in a Housing Unit

Most of the housing units (75%) comprised one student. This was due to the respondents' desire for privacy though others claimed that the campus hostels had strict rules that limited their freedom. However, those who lived together gave reasons like cost sharing to manage the high household expenses like rent. Figure 2 B shows the household sizes of the respondents.

Water Demand for Non-resident Students of the University of Kabianga

The study's second objective of the study was to determine water demand for non-resident students at the University of Kabianga. In establishing the average daily (per capita household water consumption for the non-resident students at the University of Kabianga, it was considered critical to determine their water demand. Table 3 shows per capita water consumption based on the gender of respondents and the sample size's overall per capita water consumption.

Table 3: Per Capita Water Consumption

Gender	Mean	N	Std. Deviation
Male	35.1154	130	21.21745
Female	47.5431	116	13.09656
Total	40.9756	246	18.87292

According to the study, male respondents' per capita water consumption was 35.1154 lpcd (sd=21.21745), while females' per capita water consumption was 47.543 lpcd (sd= 13.09656). However, the average daily per capita water consumption was 40.9756lpcd (sd= 18.87292). Therefore, this shows that gender affects water demand since females' average daily water demand is 47.54lpcd which is higher by 12.4277lpcd than that of men. This difference was mainly attributed to the variation in water usage between male and female students. For example, female students used more water while doing their laundry and other house chores compared to male students. Therefore, an increase in the number of female students will increase the water demand for non-resident students of the University of Kabianga.

Analysis of the factors that affect water demand was also considered critical in establishing the water demand for non-resident students of the University of Kabianga. The table 4 shows a correlation analysis of the factors that affect water demand among non-resident students.

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Table 4: Factors Affecting Water Demand

		Gender	Daily water usage in litres	Amount of time for accessing water	Famliy size
Gender	Pearson Correlation	1	.329**	.047	.101
	Sig. (2-tailed)		.000	.462	.113
	N	250	246	249	250
Daily water usage in litres	Pearson Correlation	.329**	1	.015	.623**
	Sig. (2-tailed)	.000		.812	.000
	N	246	246	246	246
Amount of time for accessing water	Pearson Correlation	.047	.015	1	-.025
	Sig. (2-tailed)	.462	.812		.700
	N	249	246	249	249
Famliy size	Pearson Correlation	.101	.623**	-.025	1
	Sig. (2-tailed)	.113	.000	.700	
	N	250	246	249	250

**. Correlation is significant at the 0.01 level (2-tailed).

According to the findings, the relationship between daily water usage and the number of students in a room/house unit had a high positive and statistically significant Pearson product correlation($r = .623$, $p<0.05$). Therefore, an increase in number of students occupying a room increases daily household water usage, thus increasing the water demand. Moreover, the relationship between daily water usage and gender had a moderately positive, statistically significant Pearson product correlation ($r = .329$, $p<0.05$). This shows that gender influences daily water usage, as highlighted in by means of the daily water usage for males and females in Table 3.

According to the study, an increase in the number of students living in a housing unit increases the respondents' per capita water consumption. Moreover, gender influences per capita water consumption since females' per capita water consumption was 12.4277lpcd higher. Romano (2014) states that people`s lifestyles influence their per capita water consumption. Women are more likely to do laundry, use more water while washing dishes, and prefer high sanitation standards over men. As a result, the per capita water consumption of women is likely to be higher, thus leading to an increase in water demand (Dagnew, 2012). This is consistent with this studies finding since females' per capita water consumption was 12.4277lpcd higher. Therefore, an increase in females among the non-resident students would increase the water demand. However, an increase in males would lead to reduced water demand due to their per capita water consumption.

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World Health Organization (WHO) recommends that a person uses approximately an average daily water consumption of 50Litres of water to ensure that most of their essential needs and health concerns are met. Moreover, one should use an average of approximately 30Litres daily for personal hygiene. Consequently, any amount below this measure may be attributed to an inadequate water supply that forces them to minimize the amount of water they use for their hygiene (WHO, 2013). According to the study, the per capita household water consumption is 40.9756lpcd (sd= 18.87292), thus indicating water inadequacy since one should use an average amount of 50L per day (WHO). Therefore, this shows that the available water sources provided inadequate water hence the need for reliable alternative water sources.

Uses of Water by Non-resident Students of the University of Kabianga

The study revealed that most respondents (57%) confirmed using the available water for indoor purposes such as drinking, cooking, and washing dishes. However, 29% noted that they use water for bathing, while 14% used it for doing laundry. Figure 3 shows the uses of water;

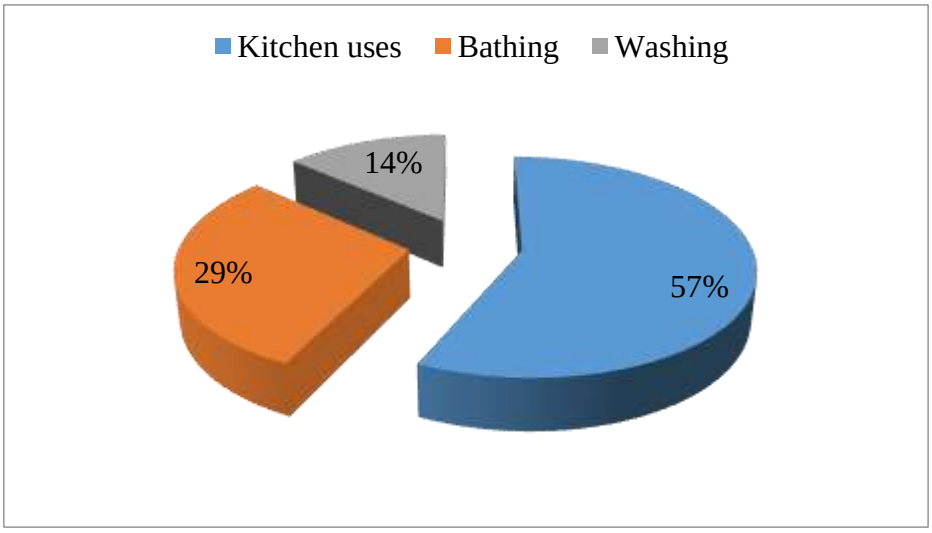

Figure 3: Main uses of Water

Further analysis, as shown in the table below, indicated that the relationship between the cost of 20L jerrican of water and daily water usage had a strong positive, statistically significant Pearson product correlation (r= .516, p<0.05). This shows that the cost per 20L jerrican of water influences daily water usage, thus influencing one`s main uses of water to avoid the high costs of buying water daily.

Table 5: Other factors affecting water demand

		Gender	Main water use	Cost per 20L	Access time	Daily usage (L)
Gender	Pearson Correlation	1	.050	-.025	.047	.329**
	Sig. (2-tailed)		.435	.742	.462	.000
	N	250	244	173	249	246
Main water use	Pearson Correlation	.050	1	.144	.071	-.011
	Sig. (2-tailed)	.435		.063	.271	.863
	N	244	244	168	244	242
Cost per 20L	Pearson Correlation	-.025	.144	1	.516**	.087
	Sig. (2-tailed)	.742	.063		.000	.257
	N	173	168	173	172	170
Access time	Pearson Correlation	.047	.071	.516**	1	.015
	Sig. (2-tailed)	.462	.271	.000		.812

	N	249	244	172	249	246
Daily usage (L)	Pearson Correlation	.329**	-.011	.087	.015	1
	Sig. (2-tailed)	.000	.863	.257	.812	
	N	246	242	170	246	246
**. Correlation is significant at the 0.01 level (2-tailed).						

CONCLUSION

Taken together, the study shows that the water demand is high hence the need for reliable alternative water sources. An increase in the number of students in a housing unit increases daily water usage, thus increasing the water demand since the relationship between daily water usage and the number of students in a room had a high positive and statistically significant Pearson product correlation. In the study, most respondents stayed alone though 25% of the housing units were composed of two or more students. Therefore, an increase in the percentage of those who wish to remain together would increase the demand for water hence the need for reliable water sources among the students.

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