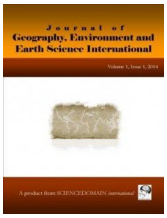

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Urban Water Resource Use and Management: An Assessment of Challenges and Opportunities of Community Water Supply Systems in Wote Town, Makueni County, Kenya

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Authors' contributions

This work was carried out in collaboration between all authors. Author MKK designed the study, wrote the protocol, and wrote the first draft of the manuscript. Authors KMC and KDM managed the literature searches and data analysis while authors LKM and MFM conducted the field surveys. All authors read and approved the final manuscript.

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ABSTRACT

The study assesses challenges and opportunities in urban water resource use and management, drawing from a case study material of community water supply systems in Wote Town, Makueni County. Using a Survey Research Design (SRD) both primary and secondary data were collected by use of questionnaires, interviews, photography, use of GIS, observation and the review of relevant literature in order to (1) identify and spatially locate the existing community water supply systems in Wote Town, (2) investigate the socio-economic characteristics of the residents, (3) examine water demand and supply characteristics in Wote Town, (4) investigate peoples' perception of water quality. First, a reconnaissance survey identified and spatially located the

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community water supply systems and/or points using a GPS. Second, a random selection of respondents from each of the identified water supply point was done. Ultimately, the survey consisted of 80 households. The findings revealed main sources of water for Wote Town are Kaiti River and Water Kiosks served by a borehole. The level of education, type of occupation and level of income of residents have influence on the choice of water source due to cost implication. On average it takes 22 minutes to fetch water from the preferred source located at a mean distance of 0.94 kilometers. Head log (35.8%) and use of bicycles (32.2%) were the most used modes of transport. Others include use of donkeys, water boozers and motorcycles. Besides River Kaiti and Water Kiosks, rain water harvesting (16.2%) was identified as an alternative source of water. More than half of the residents who draw water from River Kaiti used it for selling. The price ranged from US$ 0.10 to US$ 0.26 per 20-liters Jerrican. The residents reported some cases of water borne diseases such as diarrhea (23.1%) and typhoid (15.4%). Most preferred water treatment methods were boiling (23%), use of water guard (13%), and chlorination (3.3%) while majority (76%) did not treat the water before drinking. In light of these findings, the study recommends investment in water supply infrastructure such as piped water distribution as well as promotion and improvement of rain water harvesting technologies. Such interventions will address the critical problem of shortage of clean water that threatens the health and well-being of the urban dwellers.

Keywords: Urban; water; resource use; management; community; Makueni.

1. INTRODUCTION

The rapid urbanization facing developing countries is increasing pressure on public institutions to provide adequate supplies of clean water to populations. Increasing number of people living in urban areas is associated with increasing water demand and difficulties for many people to access adequate supply of clean water [1]. Shortage of plentiful and clean water is a critical problem that threatens the health and well-being of much of the world's urban population. Apart from the dry climatic conditions in many regions of the world being the main driver of water shortage, this problem is also to a large extent aggravated by the unsustainable utilization and management of the available water resources. Given inadequacies in water infrastructure, urban households in many parts of the world incur large time costs associated with gathering water. These costs are disproportionately borne by women and children, who also are most vulnerable to disease and food shortages that arise from a lack of access to safe and sufficient supplies of water [2].

Effective and sustainable management of water resources is vital for ensuring sustainable development. Shakraki [3] emphasizes the need for provision of water resources before the process of planning, designing, and building of a new town and suggests a practical model drawing from a methodological approach of hydraulic flood routing. However, efforts of water resource management seem to demonstrate inappropriate practices, especially when compared to water consumption trends in developing countries in general and Sub-Saharan Africa in particular. Poor water resources management have stimulated and sustained a number of problems related to health, socio-economic and environment, which need to be solved. These problems are accelerated and magnified by the countries', communities' and individuals' struggles for economic and social development as many development initiatives are affected by water availability and vice versa [4]. The unplanned and poorly managed water resource supply systems pose a sanitation inadequacy hence giving room for environmental related health risks and diseases.

The main challenge facing the management of water resources in Sub-Saharan Africa can be attributed to the variable semi-arid climate characterized by precipitation patterns unfavorably distributed in space and time and high evaporation rates reaching up to 100% of the incoming monthly precipitation. In Kenya, every citizen has a right to clean water [5]. The National Water Strategy commits to ensuring that all people are covered by the formal water supply system and that poor Kenyans pay tariffs that they can afford. Kenya initiated the water sector reform by way of enforcing Water Act, 2002. The discussion on the reform has centred on wider relationships among different actors, not restricted to local water users alone, thus leaving relatively unexplored the impact of the institutional change on rural and urban self-help water provision. This matter at the micro level

also needs to be addressed when approaching the issue of financial sustainability in management of water sources [6]. Considerable progress has been made in facilitating access to water since the enactment of the Water Act, 2002. Despite these positive developments, a lot remains to be done. Millions of Kenyans are currently underserved and too many citizens continue to drink unsafe water, or are forced to use minimal quantities of water as distance, waiting times, and cost make water inaccessible. This situation is aggravated by urbanization process.

Wote Town is the headquarters of Makueni County, situated within the vast Arid and Semi-Arid Lands of Kenya. The County is characterized by low rainfall amounts and high temperatures, thus high evaporation rates. Wote Town is located adjacent Kaiti River which acts as the major water source for domestic and commercial operations of the residents. The accessibility to sufficient amount of water for domestic use has proven difficult due to lack of widespread piped/tapped water. The water supply systems in the town have continued to be faced with a number of challenges including; climate change, population increase thus more pressure on the already scarce resource, unreliable power supply systems which often interrupts the pumping of water from boreholes, funding and operational challenges, competing priorities, unsustainable utilization practices among many others. The over- exploitation of Kaiti River which is seasonal and the absence of other water harvesting and storage technologies aggravate the situation in the town.

It is on this basis that the study was designed to make an assessment of the challenges and opportunities in water resource use and management by investigating the existing community water supply systems in the town. The specific research objectives were to: (1) identify and locate the existing community water supply systems in Wote Town, (2) investigate the socio-economic characteristics of the residents as well as water demand and supply characteristics of the community water supply systems, (3) highlight peoples' perception of water safety for the identified categories of community water supply systems, and (4) understand the existing management structures of the community water supply systems.

The results of this study are invaluable to policy and decision makers at both the County and National government level and all other groups (such as the NGOs, Water Resource Users Associations (WRUAs) and the Community) engaged in the use, regulation and management of water resources. To the policy and decision makers, this study is instrumental in revealing the importance of having an effective and fully implemented water policy in place and a strict enforcement mechanism to ensure that the policy is operational. The study also reveals the need for adequate distribution of piped water to households, the impacts emanating from the inadequate supply of the same. The results of this study are instrumental in providing grounds and opportunities for the WRUAs to come up with self-regulatory mechanisms to control exploitation and wholesomeness of the water. From the above, the community will be able to benefit from the regulations created by the government and the WRUAs and there will be an opportunity for the County government to supply household water treatment chemicals. The new regulations will also ensure that the community access safe and clean water for both domestic and commercial use.

Water resources are increasingly under pressure with demands that are growing in volume with different uses and activities affecting their quality and quantity as well as the timelines of their availability [7]. In most cases externalities are often involved where the use of water resources by one group of users lead to reduced quality or quantity of water resource at downstream location. The sustainability or reliability of water systems as Black [8] pointed out is primarily associated with financial aspects of service delivery.

Boone et al. [2] indicated that communities in most of developing countries without access to piped water supply rely on different sources to obtain their water than those with piped supplies. These sources were grouped into four broad categories with differing attributes in terms of accessibility, reliability and quality of water: unimproved sources, improved sources, stand pipes or kiosks, and other paid sources.

According to the WHO and UNICEF Global Water Supply and Sanitation Assessment 2000 Report [9], the water supply and sanitation sector in Africa faces enormous challenges. Presently, the worst levels of coverage are in rural areas, but with urban populations projected to more than double over the next 25 years, the coverage rates are expected to decline in towns and cities.

As a result, approximately 210 million people in urban areas in Africa will need to be provided with access to improved water supply systems. Moreover, most counties are frequently failing to give insights into the dynamics of long-term changes in water use and environmental health, particularly at the local or household level [10]. In fact there is a general dearth of quality information on long-term changes in domestic water supply and use and the factors influencing them. Consequently, the design and implementation of water supply systems and environmental health policies and programmes remains highly problematic.

The major challenges facing domestic water supply and use concern the burden of water collection, cost and how they are related to distance and the distribution within the communities. Several researchers from previous studies have broadly discussed the relationship of time use in water collection and distribution among end users. However, few have focused on available supply systems and their characteristics but alternatively according to Nankhuni and Findeis [11] who found out that having piped water access in the home significantly reduces the time spent searching for such other supply systems. Glick et al. [12] investigated the impacts of water supply systems on time use in Madagascar and Uganda. Ilahi and Grimard [13] used community level variables to examine the impact of available water supply systems and their challenges. Thompson *et al*., [14] looked at labour allocation on water collection from gender and generation perspective with women and children carrying the heavy burden compared to their counterparts.

The most important factor affecting water use in most urban centers is whether or not a household has access to an improved piped system. Reduced access to piped water services not only affects the quantity of water used, it also results in reliance upon alternative sources that are often costly, distant or polluted. As such, it is a basic need and, as with all basic needs, society attaches a value to personal consumption patterns, even in the absence of negative environmental externalities and non-excludability of resource use. Inadequate access to a basic need such as water, which is also potentially degradable and exhaustible, can constrain a household's choices to such an extent that the choice itself can hardly be considered an exercise of freedom in any sense. Clearly, a return to the 'water for all' policies of the past is not an option. Users often do not pay the full cost of services, but neither do they receive reliable supply of adequate drinking water or functioning sanitary facilities. Service hours frequently are erratic and unreliable, and users do not know whether they will get water from the tap and how long they will have to queue [2].

A typical urban household uses water for a broad range of purposes, from the small quantities needed for drinking and cooking to larger volumes used for bathing, cleaning, washing, agriculture [14]. Different levels of water used for consumption i.e., drinking and cooking purposes has been found to be non-discretionary, meaning that it has remained constant for all individuals in all households regardless of the type of water supply system, level of wealth, or other important variables. The mean per capita water used for drinking and cooking has been estimated to be a little over four litres per day.

Hygiene uses include bathing, washing dishes and clothes, cleaning and toilet flushing. The quantity of water used for hygiene purposes by piped households is more than twice that used by un-piped households and this difference is fairly consistent across all categories of hygiene use. Amenity uses include washing cars, watering gardens and swimming pools. Productive uses include consumption by livestock (e.g. cattle, goats, pigs and sheep), making fruit juice, brick making and the construction of homes, and irrigating tree and horticultural crops.

The real fact is that physical factors, such as whether or not a household is located in an urban area and distance to the source, are important in determining levels of water use. Water use seems to become more strongly influenced by economic factors, educational level and wealth. Moreover, households located in urban areas are found to consume more water than those residing in rural areas [15]. At the same time, water use is found to increase comparatively to the proportion of children in the household, the number of household members and cost per litre. Although not statistically significant, water consumption is found to be smaller for households who obtain their water from an improved surface source such as water kiosks. In many cases, households need to rely on secondary and tertiary sources of water to cater for both short and longer-term shortages

and the intermittent failure of their primary piped services in water kiosks.

2. METHODOLOGY

2.1 Research Site

Wote Town is the headquarters of Makueni County (Fig. 1) and lies within Kaiti Sub-watershed (Fig. 2). Kaiti Sub-watershed is characterized by high population and density of 120,116 and 248 persons per square kilometre respectively as compared to the average of 110 persons per square kilometre for the county [16]. According to Muriuki et al. [17], high population has a bearing on the state of the watershed due to the increasing human activities and their effects on the wellbeing of the downstream communities in the county. Soil erosion in the sub-watershed is a major problem due to farming on steep slopes with siltation of manmade reservoirs experienced in the downstream of Kaiti River. It covers an area of 660 km2 and is located between 10º 38 South and 10º 51´ South and 37º14´ East and 37º41´ East.

Kaiti Sub-watershed lies in the fertile upper parts of the county which experience average rainfall of 800 mm-1200 mm. It comprises of Kilungu, Kee, Kalama, Kaiti and Wote divisions. The sub-watershed topography is characterized by mountainous terrain including Kilungu and Mbooni hills. Kaiti River and its numerous tributaries originating from the hills serve the watershed which influence surface water sources and ground water recharge capacity [17].

Unsustainable land management practices exert pressure on natural resources leading to increased soil erosion, increased stream flow, riverbanks erosion, decrease of the amount of water and decline of ground water [17]; and [19]. Kaiti River which is seasonal is the major source of water for the residents of Wote Town. The shallow wells on the river and the water kiosks scattered within Wote Town were the points of data collection. Generally, the town covers an area of 275 Ha and has a population of about 9,875. Urbanization in the County is rapidly increasing [16].

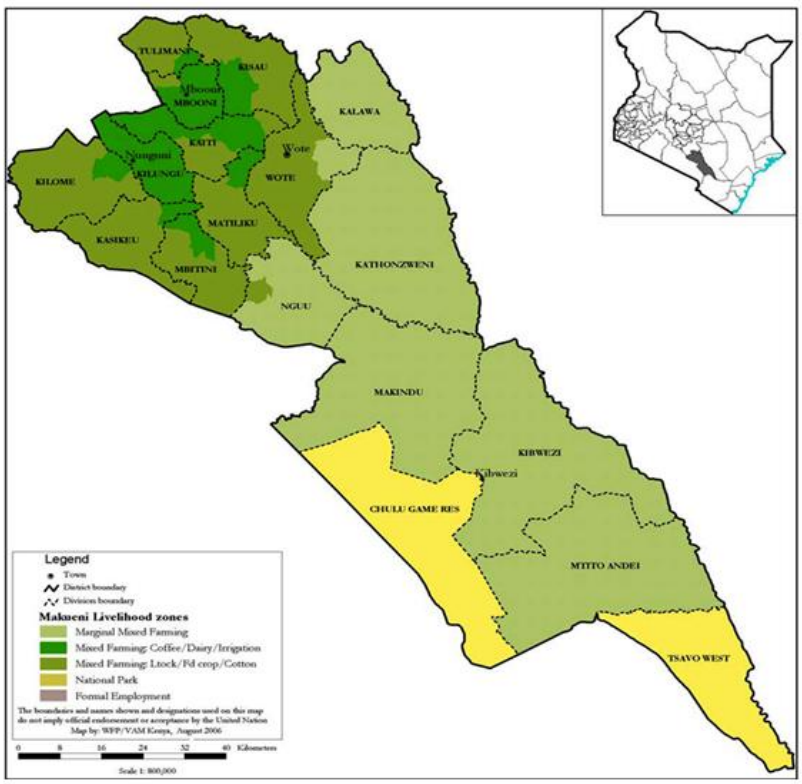

Fig. 1. Location of Wote Town in Makueni County, Kenya
Source: Government of Kenya (GoK), [16]

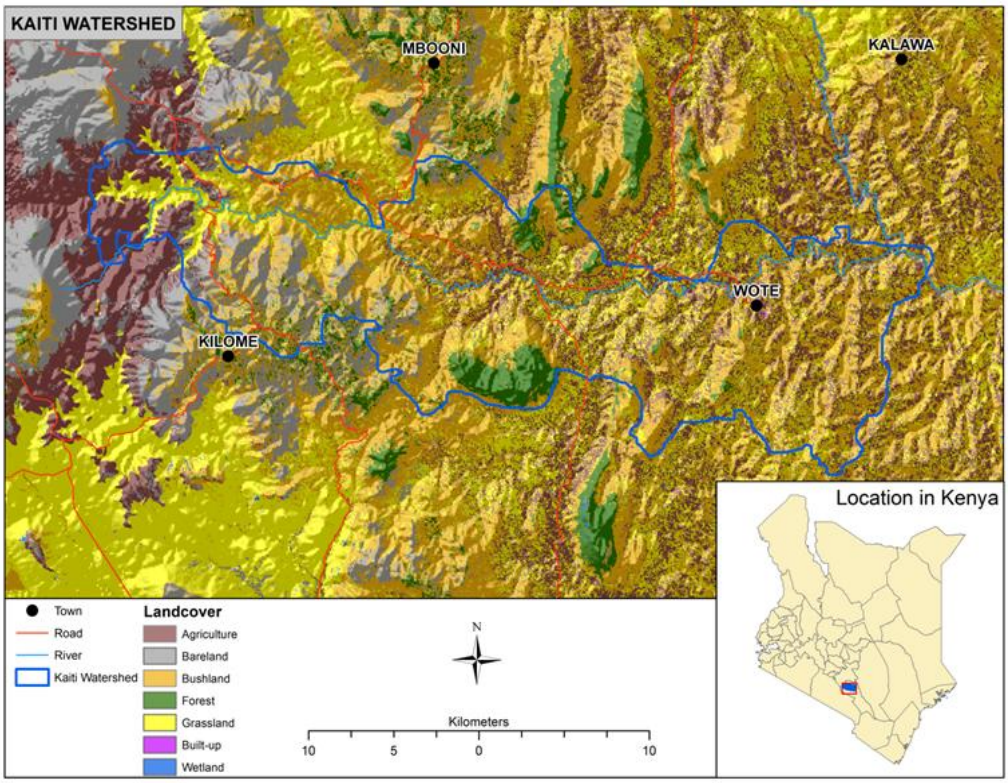

Fig. 2. Location of Kaiti Sub-watershed within Major watershed in Makueni County
Source: Modified from Preserve Africa Initiative (PAFRI), [18]

2.2 Data Collection and Empirical Specification

The study employed a Survey Research Design. The procedure followed was as follows: First, a reconnaissance survey was done to identify and spatially locate the community water supply systems and/or points using a GPS. Second, a random selection of respondents from each of the identified water supply point was done. Ultimately, the survey consisted of 80 households, for which detailed data was collected on the socio-economic characteristics of the households, information on water demand and supply characteristics associated with the community water supply systems, as well as respondents' perception of water quality in the community water supply systems. The study used variety of methods to collect both quantitative and qualitative data and information. These included participant observation and photography, key-informant interviewing, administration of standard questionnaires, and use of secondary sources of data.

3. RESULTS AND DISCUSSION

3.1 Identification and Spatial Location of Community Water Supply Systems

An identification and spatial location of existing community water supply systems using a GPS was done and a map generated as shown in Table 1 and Fig. 3. The survey located three main water source points for residents of Wote Town, namely Kaiti A (next to the bridge), Kaiti B (near the Makueni County-funded sand dam) and Water Kiosks (situated within the town and residential areas). Both Kaiti A and Kaiti B comprised of open surface water wells located along the part of River Kaiti adjacent the town, while the Water Kiosks relied on water from a borehole managed by Wote Water and Sewerage Company (WOWASCO).

3.2 Socio- economic Characteristics of Respondents

Table 2 shows general respondents' socio-economic attributes with regards to water

acquisition. It is evident that majority of the respondents have basic education with a total average of 9.13 years of education implying that majority have gone to secondary school level. The Kenya's education system is 8:4:4 i.e., 8 year of primary education, 4 of secondary and 4 in the university.

Table 1. Identified community water supply systems and points of data collection

Kaiti A (Near the Bridge)
Open Surface Water Well No. 1
Open Surface Water Well No. 2
Open Surface Water Well No. 3
Open Surface Water Well No. 4
Kaiti B (Near the Sand Dam)
Open Surface Water Well No. 5
Open Surface Water Well No. 6
Open Surface Water Well No. 7
Water Kiosks
1. Maji (Shimo)
2. WWSC Kiosk No. 1 (Kalawa)
3. WWSC Kiosk No. 2 (Kichinjioni)
4. WWSC Kiosk No. 3 (Shimo)
5. Kentank (Shimo)
6. Makueni CDF Water Kiosk

The level of education has influence in the choice of water source as can be seen from the findings. Drawing water from water kiosks is preferred by the most highly learned portion of the water drawers (12.57) as compared to Kaiti A (8.05) and Kaiti B (6.77). This is because; the water sourced from Water Kiosks is sold and of a better quality as compared to that drawn from River Kaiti in open-access wells and for free. This finding is supported by the analysis on occupation of the respondent's which reveals that majority of those employed draw their water from Water Kiosks (56.67%) and therefore can afford to buy the water.

It was deemed important to find out the occupation of the respondents since this displays their financial ability to pay for water supply services and therefore influence the choice of water source. Should most of the respondents be unemployed, this would mean weak financial base and inability to pay for the water supply services, most of them being left with no option apart from going to Kaiti river where they can fetch the water free of charge. Overall findings from the survey indicate that most of the respondents are self-employed (62.25) in small businesses and water selling activities. However, employment characteristics differ across the water sources with Water Kiosks having the highest number of formally employed (56.67) and Kaiti A having the lowest number of formal employment. Self-employment is highest in Kaiti A (91.89) because majority, who are less educated (8.05) have involved themselves in the water selling activities as a form of self-employment using own bicycles. On the other hand, Kaiti B has the highest levels of unemployment. This is attributed to the low levels of education (6.77). Here, majority cannot afford water from Water Kiosks and have to fetch the water themselves from the river for free using head-log as discussed later under the section on mode of transport.

Table 2. Socio- economic characteristics of respondents (N=80)

Characteristic	Community Water Supply			
	River Kaiti A	River Kaiti B	Water Kiosks	Grand Average
Years of education (Mean)	8.05	6.77	12.57	9.13
Level of education (%)				
1. None	0.00	23.08	0.00	7.69
2. Primary	64.86	30.77	6.67	34.10
3. Secondary	32.43	46.15	50.00	42.86
4. Post-Secondary	0.07	0.00	43.33	14.47
Occupation in (%)				
1. Employed	5.41	23.08	56.67	28.39
2. Self employed*	91.89	61.54	33.33	62.25
3. Unemployed	2.70	15.38	10	9.36
House rent (Monthly) US$ (Mean)[+]	16.08	15.93	24.32	18.78
Household (family) Size (Mean)	4.51	5.08	3.10	4.23
Distance to water point (Kms) (Mean)	1.56	1.09	0.163	0.94
Distance to water point (Minutes) (Mean)	30.14	30.77	5.3	22.07

**Small business enterprises and water selling activities, [+]The exchange rate was Kshs: 98 = US$ 1 in July 2015*

Fig. 3. Spatial location of community water supply systems in Wote Town

House rent is used as a proxy indicator of level of income and economic status of respondents in order to examine how it influences the choice of water source, thus signifying ability to pay for water supply services. The findings show that respondents whose source of water is Water Kiosk pay the highest monthly rent of US$ 24.32. On the other hand, the monthly rent for the respondents who draw water from Kaiti A and Kaiti B does not vary significantly (US$ 16.08 and UD$ 15.93 respectively). The results indicate that the water drawers from Water Kiosks are of a higher economic status and can afford to buy the water, a confirmation of the earlier finding that majority are in formal employment and therefore, can afford to buy water from the Kiosks.

Household (family) size influences water consumption rates and varies from household to household. It was therefore used as a variable in the study to examine its effect on water source choice. The study indicates that the largest household size is in Kaiti B (5.08) followed by Kaiti A (4.51) while households drawing water from the Water Kiosks are the smallest (3.10).

Distance travelled and time spent to the preferred water source is deemed to be important determinants of choice of water source. As shown in Table 2, on average it takes residents of Wote Town 22 minutes to travel to their water source of choice located at an average distance of 0.94 kilometers. This implies that a lot of time is spent in water collection activities that would otherwise be spent in other productive activities. It is also important to note that the average distance travelled and time spent to the preferred water source vary from one source to another with Kaiti B having the highest mean time of 30.77 and Water Kiosks having the lowest mean of 5.3. This state of affairs can be explained by the fact that most Water Kiosks are located in residential areas and therefore, less time is spent to fetch water from them. In Kaiti A, even though the average distance is higher than in Kaiti B (1.56 for Kaiti A and 1.09 for Kaiti B), the time spent (30.14 in Kaiti A) is lower than in Kaiti B (30.77) because bicycle, a faster mode of transport is the most preferred as opposed to head log and donkey in Kaiti B. This issue is further examined and validated by data in a later part of this article under mode of transportation.

3.3 Water Demand and Supply Characteristics of the Community Water Supply Systems

3.3.1 Type of water use

The study revealed seven types of water uses (Table 3). Overall, drinking (78.5%) and cooking (74.1%) ranks the highest followed by washing (61.5%) among all the listed water uses. On the other end, water use for livestock (12.2%) and

crop (12.1%) was comparatively less implying that there are few agricultural activities in Wote town. Kaiti A ranks the highest (75.7%) in water fetched for selling as compared to Kaiti B (60.8%) and Water Kiosks which has no water selling related activities. Kaiti B is located closer to a farming community and thus ranks highest (30.8% for crops and 23.1% for livestock) in water drawn for agricultural activities. Also, the construction industry sources most of its water from Kaiti B (30.8%). This is because it is located in part of River Kaiti where there is always a pool of water throughout the year and it's accessible by the water boozers. Most of the water drawn in Water Kiosks is used for cooking and drinking (both 100%) as shown in Table 3.

3.3.2 Mode of water transportation

The study indicated that the mode of water transport is determined by type of water use, the distance to the water source and the economic status of the residents. Table 4 shows the percentage preference of modes of water transportation across the community water supply sources. Overall, most of the people use head log (35.8%) to carry water. This preference can be attributed to the fact that most of the residents are low class individuals who are not earning sufficient income hence this mode of transport is cost free. The other reason is that most Water Kiosks are located in residential areas and also due to the fact that some respondents live within the proximity of Kaiti River and thus the residents prefer carrying the water themselves rather than paying for water supply services. This can also be attributed to the fact that water drawing is a responsibility of house helps.

The number of people using bicycles to carry water is relatively high (32.2%) since; bicycles are multipurpose hence can be used for multiple tasks therefore have been acquired in some homes. Carrying water with a bicycle is not quite tiresome, is a faster means of transporting water and one can carry several Jericans of water per trip. Use of donkey (20.5%) ranks third as they are mostly used to supply water to middle income earners. Most people earn their income by using donkeys to fetch water for middle income earners and selling the water at a relatively cheaper price as compared to other modes of transport. The relatively lower usage of donkeys as a mode of transport is attributed to the fact that it is expensive to purchase a donkey. The use of water boozer, motorcycle and Tuk-tuk comes in among the very last as a very low number of people have access to them owing to the fact that they are expensive to buy, maintain and they require fuel. This makes it more expensive but to the people using them they enjoy the advantage of being able to carry more water per trip and it takes lesser time per trip.

Table 3. Type of water use versus community water source

Type of water use	Community water supply source (%)			
	River Kaiti A	River Kaiti B	Water Kiosks	Average
1. Drinking	43.24	92.31	100	78.52
2. Washing	43.24	84.62	56.67	61.51
3. Cooking	40.54	84.62	100	74.05
4. Crops	5.41	30.77	0	12.06
5. Livestock	13.51	23.08	0	12.19
6. Construction	16.22	30.77	0	15.66
7. Selling	75.68	60.77	0	45.48

Table 4. Mode of water transport versus community water source

Mode of transport		Community water supply source (%)			
		River Kaiti A	River Kaiti B	Water Kiosks	Average
1.	Donkey	16.22	38.46	6.67	20.45
2.	Bicycle	75.68	7.69	13.33	32.23
3.	Head-log	2.41	38.46	66.67	35.84
4.	Boozer	2.70	15.38	0	6.02
5.	Motorcycle	7.56	0	10	5.85
6.	Tuk-tuk*	4.75	0	3.33	2.69

** A three-wheel motorcycle*

Comparatively speaking, the preferred mode of water transportation varies from one community water supply source to another. At Water Kiosks, the most preferred mode of transport is head log (66.7%) while at Kaiti A is use of bicycles (75.7%) and Kaiti B is head log and donkey (each at 38.5%) for the reasons stated above.

3.3.3 Water drawing characteristics

Water drawing characteristics vary from one community water supply source to another as shown in Table 5. The most salient feature of the results is that the largest amount of water is drawn from Kaiti B (17,090.2Ltrs) as compared to Kaiti A (3,888.8Ltrs) and water drawn from Water Kiosks is the least (175.4Ltrs). This can be explained from the findings in Table 4 which revealed that the most common modes of water transportation in Kaiti B are Head log (38.5%) (due to proximity to residential areas) and use of donkey (38.5%) and Water boozers (15.4%) which draw large amounts of water. The portion of the river also has a large pool of water used mainly for construction purposes. Although the findings confirm households with more members are likely to consume more water as compared to households with few members, this study could not be conclusive in this endeavor since as noted earlier the study revealed seven types of water uses which are not directly related to household water consumption.

3.3.4 Alternative sources of water supply

Most people (42.7%) use Kaiti River as their alternative water source since no cost is incurred in acquiring the water. Furthermore, it spans a large section of Wote hence it is more accessible to many people. Another reason as to why Kaiti

Table 5. Water drawing characteristics versus community water source (Mean)

Consumption characteristics	Community water supply source		
	River Kaiti A	River Kaiti B	Water Kiosks
1. Number of 20 litre Jeri-cans fetched	4.65	43.69	1.33
2. Number of times per day	7.16	3.85	1.8
3. Number of days per week	5.84	5.08	3.67
4. Amount of water fetched per day (Ltrs)	33.29	168.21	2.39
5. Amount of water fetched per week (Ltrs)	194.44	854.51	8.77
6. Total amount fetched/week/respondent	3,888.80	17,090.2	175.40
7. Household (family) Size (Mean)	4.51	5.08	3.10

Table 6. Alternative source of water supply

Alternative Source	Main use	Distance (Kms) from Home	Distance (Mins) from Home	% of preference
Piped water	Drinking Cooking	0.5	6.25	3.7
Bore hole	Selling Washing	4.0	10	6.2
Water kiosk	Drinking Cooking Washing	0.163	5.3	31.2
River Kaiti A	Washing Selling Cooking Drinking	1.56	30.14	42.7
River Kaiti B	Washing Selling Cooking Drinking Livestock Construction	1.09	30.77	42.7
Rain H_2O harv	Drinking Washing Cooking	0	0	16.2

River is the most preferred alternative water source is because Wote town is prone to frequent and long periods of power outages which renders water pumping from boreholes irregular.

An interview with the attendants of Mwaani borehole which is the main source of piped water in Wote Town, confirmed that the standby generator normally lacks fuels. Water kiosks come in as the second most popular alternative source (31.2%) owing to their distribution across the town and accessibility since they are located near residential areas. Rain water is the third alternative (16.2%) whereby most people collect water using gutters on roofs into plastic tanks and underground tanks. Even though the rainwater is readily clean to use, it only becomes available during the rainy season. Some people (6.2%) use borehole water as an alternative during the dry season when the river water becomes scarce and also during rainy seasons when the turbidity of the River water is high.

3.3.5 Opportunities in community water supply systems in Wote Town

The analysis on type of water use (Table 3) indicated more than half of the respondents, especially those drawing water from Kaiti River, were fetching for selling purposes. These categories of water drawers use bicycles, donkeys, motorbikes and boozers as modes of transportation. The price at which they sell the water to the residents vary from one mode of transport to another (Figure 4) with the highest price (US$ 0.25) per 20Ltr. Jerican being recorded by the motorbike users. This can be attributed to the high fuel and maintenance cost. On the other hand, the water drawers using bicycles sell the water at US$ 0.20 per 20Ltr. Jerican while those using donkeys sell US$ 0.10 per 20Ltr. Jerican.

The trips to the river also vary from respondent to another with the highest approximate number of trips being recorded by the bicycle users with a mean of 6.7 trips per day while the donkey users had a mean of 5.8 trips a day. The number of Jericans carried per trip also differed from one mode to the other. The bicycle users have a mean of 4.3 Jericans per trip while the donkey users have a mean of 9.9 Jericans per trip. The number of days per week in which the water drawers are involved in the water selling activities also vary with the bicycle users recording the highest mean of 5.7 and the water boozers the lowest mean at 2.3 as shown in the Table 7.

From the foregoing, it is evident that there is tremendous opportunity for income generation from community water supply systems in Wote town. This is because the calculations translate to a bicycle user earning approximately US$ 4.89 per day while a donkey user earning approximately US$ 3.67 per day per donkey. When this is calculated with the mean of seven days a week, the income for both bicycle and donkey users is sufficient enough to sustain their livelihoods and meet their day- to -day needs. Thus, there is great opportunity for income generation for the unemployed youths. They can venture into the water selling activities and earn income to improve their livelihoods. This will also reduce the number of idlers in the town which in turn reduces the crime rates emanating from the idling.

3.4 Community Perception Regarding Water Quality

The choice of water source for the residents is influenced by their perception about the quality of water from the source. An attempt was made to investigate residents' experiences with regards to incidences and/or occurrence of common water borne diseases (Fig. 5).

Table 7. Household water consumption versus mode of transport

Household consumption	Mode of Transport					
	Bicycle	Donkey	Head-Log	Motorbike	Boozer	Tuk-tuk
1. No. of 20 Ltr Jeri-cans fetched	4.3	9.8	1.3	4.2	220	2.4
2. No. of times per day	6.7	5.8	2.1	3.0	1.0	2.5
3. No. of days per week	5.7	5.1	2.5	3.2	2.3	4
4. Amount of water fetched per day	24.5	56.8	2.7	12.6	220	6
5. Amount of water fetched per week	138.9	288.7	6.8	40.3	512.6	24

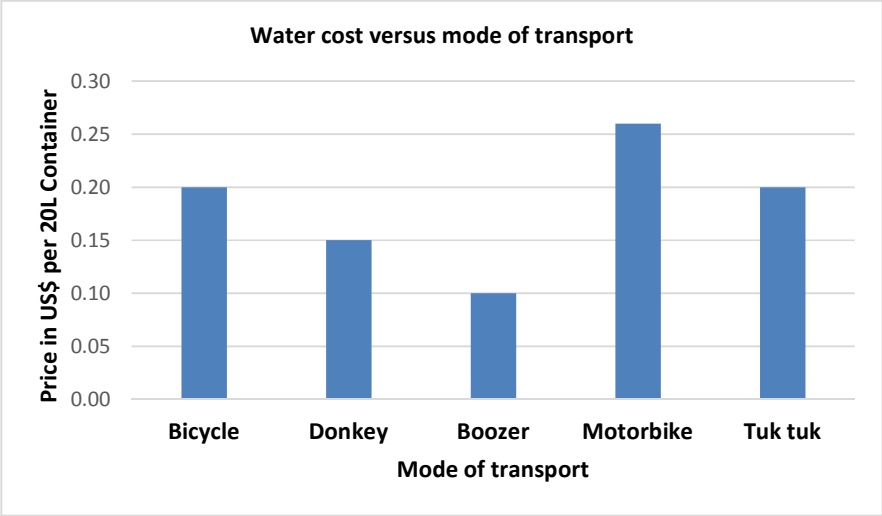

Fig. 4. Water cost versus transportation mode

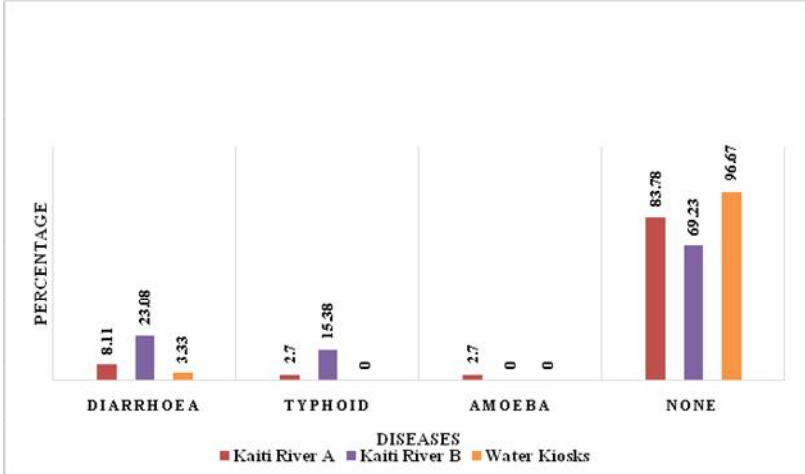

Fig. 5. Incidences of water borne diseases

It is evident that majority of the residents of Wote Town had not experienced any incidences of water borne diseases, which supports their belief that the water is safe for consumption. Some of the respondents recorded to have experienced cases of water borne diseases with Kaiti B having the highest incidences for both Diarrhea (23.1%) and Typhoid (15.4%). This is attributed to the poor sanitary conditions emanating from the nearby residential settlements as well as pollution resulting from urine and excreta of donkeys which are the main transportation mode. This explains why respondents sourcing water from Kaiti B lead in water treatment as shown in Table 8.

Majority of the respondents use some form of water treatment which seems to contradict their perception that the water is safe for consumption. This could be an indicator of high sensitization on sanitation issues due to the proximity to the County Headquarters and Public Health Officials. The most preferred water treatment method is use of Water guard which is cheap and readily available and not classified as a poison like Chlorine. Chlorination as a method of water treatment is very rare in Wote Town with only one respondent recording the use of this method. This is because of its' complicated acquisition and application procedures. Water treatment cases are high among the respondents fetching water from Kaiti B confirming higher incidences of water borne disease prevalence as shown in Fig. 4.

Table 8. Water treatment methods

Treatment method	Community water supply source		
	Kaiti River A	Kaiti River B	Water Kiosks
1. Boiling	16.21	38.46	23.33
2. Water guard	62.16	61.54	13.33
3. Chlorination	0	0	3.33
4. No treatment	37.34	15.38	76.67

4. CONCLUSION

The results of this study revealed that the main sources of community water supply in Wote Town are River Kaiti and Mwaani Borehole managed by Wote Water and Sewerage Company (owned by the County Government of Makueni) and which supplies water through Water Kiosks. Rain water harvesting was also identified as an alternative source of water. The level of education, type of occupation and level of income of residents have strong explanatory power on the choice of water source due to cost implication. Water gathering is associated with large time and financial costs as a result of inadequacies in water infrastructure in the urban centre. There are wide range of water uses and demand in the town such as drinking, cooking and washing. Other uses include; agriculture, selling and construction. This state of affairs has attracted many water vendors in the town. The most common mode of water transportation was found to be head log, use of bicycles and donkeys. Other modes of water transportation are use of Tuk Tuks, boozers and motorbikes. Although majority of the residents of Wote Town believe that the water from available sources is safe for use, there are cases of water borne diseases.

In view of these findings, the study broadly recommends investment in water supply infrastructure such as piped water distribution as well as promotion and improvement of rain water harvesting technologies. Such interventions will address the critical problem of shortage of clean water that threatens the health and well-being of the urban dwellers. Further research to be carried out to assess the conflict between conservation of the Kaiti riparian ecosystem and the ecological foot print of the adjacent and rapidly urbanizing Wote Town.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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