Rural Water Supply in the Era of Climate Change in Kenya; the Case of Kapseret Sub County, Uasin Gishu County

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Abstract

There is a perception that water supply in Uasin Gishu County is reliable due to the medium to high annual rainfall amounts received in the region. However, this is not the case as rainfall is not evenly distributed throughout the year. Consequently, many rural households experience water shortage in the dry season. The aim of the study was to assess reliability and evaluate the safety of domestic water sources in Kapseret Sub County. Questionnaires were used to collect data from 404 households selected randomly from four wards in the rural part of Kapseret Sub-County and the data subjected to frequency analysisprocedure. The study established that domestic water sources include; shallow wells (92.2%), rainwater (14.4%), river (8.2%), stream (5.2%), borehole (2.0%), piped water (3.9%), dams (2.0%) and springs (1.0%). An average 44.8% of the households experience seasonal water shortage. Distance to main water sources increases from an average of 22.3 meters in the rainy season to an average of 216 meters in the rainy season. As a result, households have adopted various water conservation strategies in the dry seasons including reusing water, cleaning house and clothes periodically, watering animals and cleaning clothes at the water point, and using little amounts of water for the various activities. About 36.6 % of households use water from unprotected water sources in the rainy season compared to 41.1% in the dry season, and therefore the water is prone to contamination. An average 63.6% of the households' fetch water manually from the source using rope and container, with only 28.7% storing water in tanks. In conclusion, water security is yet to be achieved in the area of study. It was recommended that there is need for sound investment by national and county governments towards reliable water supply in rural areas.

Keywords: Domestic water, augmentation, climate change, water source, water shortage

INTRODUCTION

Water scarcity is one of the global challenges today (Crouch et al. (2021), and is the sixth among the global 2030 Agenda for Sustainable Development (WWAP, 2017). Although the total renewable water resources for the world average 7,453 m^3 per person per year, these resources are distributed quite unevenly geographically (WWAP,2019). Rainfall is also unevenly distributed within the year. Consequently, two thirds of the world's population currently live in areas that experience water scarcity for at least one month a year. About 500 million people live in areas where water consumption exceeds the locally renewable water resources by a factor of two (WWAP, 2017). Today, around four billion people currently experience severe physical water scarcity for at least one month per year, a situation that has been exacerbated by the climate change as documented by WWAP (2020). WWAP (2019) observed that water scarcity on a per capita basis has been increasing and project that it will continue to increase due to population growth and climate change.

WHO/UNICEF (2021) noted that several years into the Sustainable Development Goals (SDGs), the world is not yet on track on SDG 6 on attaining water security. The lack of access to safe drinking water has been attributed to water infrastructure that remains extremely sparse in rural areas, so that millions of women, men and children are not covered by water and sanitation services. In addition, institutional capacity, including domestic resource mobilization and budget allocations has been insufficient to cater for maintenance needs of the installed water infrastructure (WWAP, 2019; WHO/UNICEF, 2021). Hope et al. (2020) concluded that in rural areas, there exists a disconnect, in the approaches which address the social and technical components of rural water supply.

Currently, many parts of Africa experience seasonal water distress. As WHO/UNICEF (2021) noted, Sub-Saharan Africa is experiencing the slowest rate of progress in water supply in the world, with 46% of people lacking access to clean drinking water. WWAP (2019) noted that people living in rural areas account for about 60% of the total population of Sub-Saharan Africa, and many of them remain in poverty. Water supply lags behind particularly in rural areas. Already, parts of Africa experience absolute water scarcity. As population grows and water resources remain more or less constant, many countries are projected to fall below 1000 m^3 per person (WWAP, 2019). It is projected that water scarcity will worsen in the future, due to variety of factors including climate change, rising populations, increasing human activity and urbanization (WHO/UNICEF, 2021; WWAP, 2017; Lim et al, 2011).

Kenya, on its part, is classified as a water scarce country with an annual renewable freshwater per capita of 647 m^3 (UNEP, 2008; GOK,2006; Njora et al, 2021). Further, Falkenmark & Widstrand (1992) established benchmarks for water stress of between 1000 and 1700 m^3 per person, water scarcity of between 500 and 1000 m^3 per person, and absolute scarcity of less than 500 m^3 per person. The United Nations' recommends a minimum of 1,000 m^3. The problem of water scarcity is already being felt in Kenya, particularly during the dry seasons. In addition, Njora et al. (2021) opined that the severe crisis in Kenya could be aggravated by multiple causes including drought, deforestation, floods, land pressure from population growth, water contamination, lack of proper water management measures, and ineffective water policies. Incidentally, Strauch et al. (2021) warned that as climate change continues to increase the frequency of extreme events, such as floods and droughts, households will remain vulnerable to water insecurity.

Ironically, in Uasin Gishu County, with an average annual rainfall of >1000 mm, about 42% of the population still lack reliable access to potable water (UGC, 2018; MoALF, 2017). Kapseret Sub-County was selected for this study because massive land fragmentation, deforestation and concomitant development have aggravated the problem of seasonal water shortage due to generation of huge runoff volumes in the rainy season followed by water shortages in the dry season.

METHODOLOGY

Study Area

The study was undertaken in Kapseret sub-county, Uasin Gishu County. Kapseret Sub-County is one of the 6 administrative units in Uasin Gishu County. KSC consists of five wards namely; Kapseret/Simat, Langas, Kipkenyo, Ngeria and Megun. The headquarters of Kapseret Sub-County is Kapseret centre. It is located to the South West of Eldoret Town, along Eldoret-Kisumu road and it is about 10 km from Eldoret Central Business District. The sub-county has an area of 299 km^2 and an average population density of 663 persons per Km^2 (KNBS, 2019). The UGC has a relatively cool climate with mean annual temperatures across the county being predominantly below 21°C, a factor attributed to its location on a plateau that rises gently from 1500m above sea level to 2,700 m above sea level. Rainfall in the county is relatively high with the northern and central parts receiving between 1000 and 1250mm of rainfall annually, the southern parts receiving 1250-1500mm annually and the western tip receiving above 1500mm. Rainfall in the county is reliable throughout the year and even the driest months between November and February receive some rainfall. Soils in the county are red loam soils, red clay soils, brown clay soils and brown loam soils (MoALF, 2017). Figure 1 shows the physical location of Kapseret Sub-County.

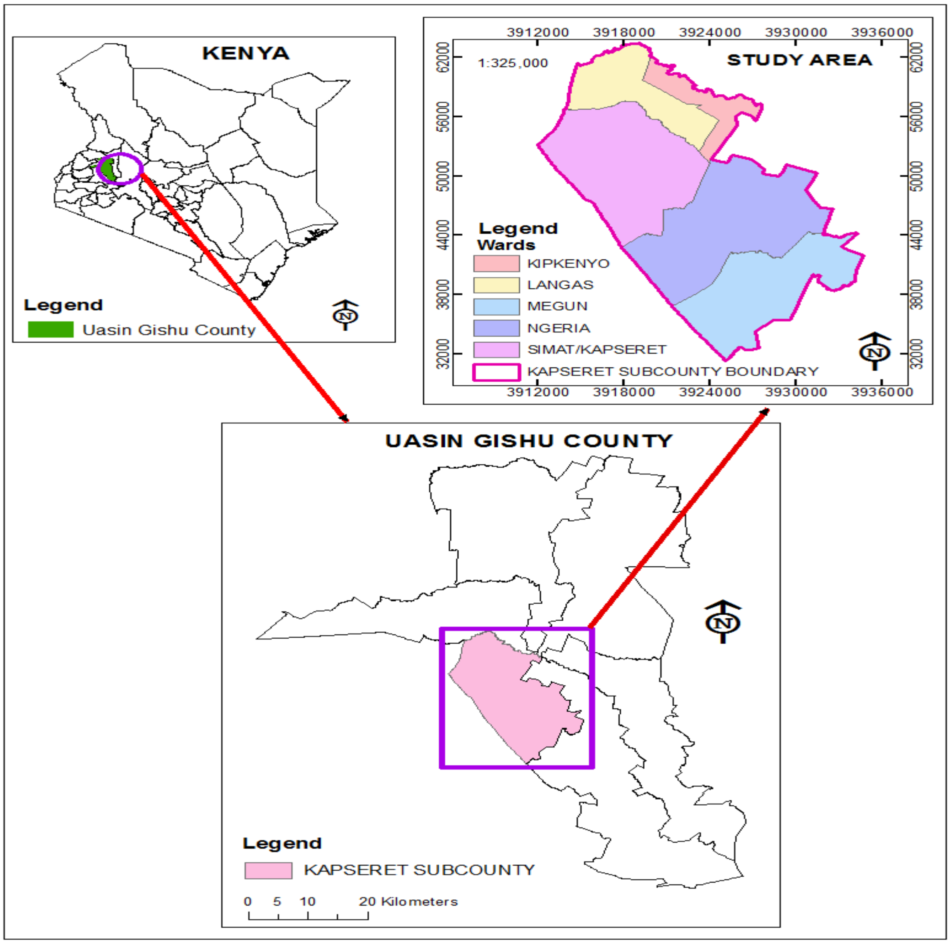

Figure 1: Location of Kapseret Sub-County, Uasin Gishu, Kenya

Sampling Framework

The sample size was determined using Yamane's formula as adopted from Yamane (1967). Using Yamane's sampling formulae, the sample size at 95% significance level will be 399.993 which is approximately 400 households. Random sampling was applied to identify respondents drawn from 4 wards consisting of the rural population namely Simat, Kapseret, Ngeria and Megun. Langas/ Pioneer is entirely an urban settlement.

Sources of data

Both primary and secondary data was utilized. Primary sources include the first-hand information collected by the researcher. They include data on domestic water uses, sources and accessibility to water, price of water, household income levels, level of education of household head, gender of respondent and members of household, nature of settlement, family size and conservation strategies. These were collected from households through questionnaires. Data was analyzed by frequency analysis in SPSS.

Secondary sources of data included rainfall data, which was acquired from the Eldoret Airport Meteorological Department and Kapsoya Meteorological Department. Rainfall analysis was performed to compare monthly averages for 10 years (2010-2019) and 2019.

RESULTS

Rainfall Variability

The area receives rainfall that is concentrated within a rainy season. Precipitation is heaviest between April and October, followed by a dry spell beginning September until March. This can be seen in Figure 2.

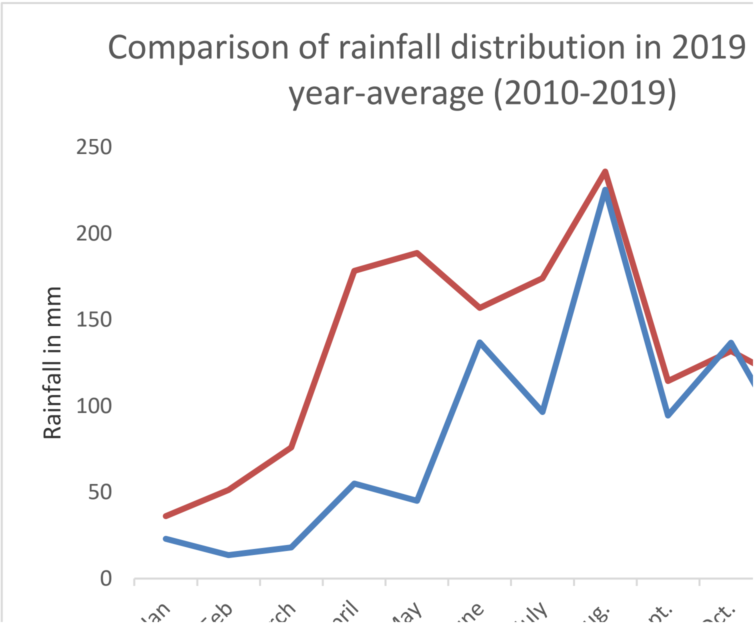

Figure 2: Comparison of rainfall totals in 2019 and average of the last 10 years (2010-2019)

Domestic Water Sources

There are various water sources in Kapseret Sub-County. These include shallow wells, harvested rain water, river, stream, borehole, metered piped water, unmetered piped water, dams and springs. Majority of the households (92.8%) had access to a shallow well. Some households had access to multiple sources of water.

Main water source in the dry season

The main source of water for a majority of households in the dry season was shallow well, which accounted for 82.4% of the respondents. Rivers were a source of water for 10.6% of the households, while metered and unmetered piped water supplied 2% and 1.5% of the households respectively. Dams were a source of water for only 1% of the households. The smallest percentage of households accessed their water from borehole, harvested rain water and springs, each accounting for 0.5%. This can be seen in Table 2.

Table 2: Main source of water for domestic use in the dry season

Main source of water in the dry season	Frequency	Percentage
Shallow well	334	82.7
River	43	10.6
Metered piped water	8	2.0
Unmetered piped water	6	1.5
Dam	4	1.0
Stream	3	0.7
Borehole	2	0.5
Harvested rain water	2	0.5
Spring	2	0.5
Total	404	100.0

Main Water Source in the Rainy Season

Majority of the households (74.5%) used water from shallow wells in the rainy season. 16.3% harvested rainwater, 4.5% used water from the river, 1.7% accessed their water from the stream, 1.5% used metered piped water, 1% used unmetered piped water, while 0.2% accessed water from dams and springs each. This can be seen in Table 3.

Table 3: Sources of water in the rainy season

S/No.	Main source of water in the rainy season	Frequency	Percentage
1	Shallow well	301	74.5
2	Harvested rain water	66	16.3
3	River	18	4.5
4	Stream	7	1.7
5	Metered piped water	6	1.5
6	Unmetered piped water	4	1.0
7	Dam	1	0.2
8	Spring	1	0.2
	Total	404	100

Safety of Domestic Water Sources

It was established that slightly 34.7% of the respondents used water from unprotected water sources including shallow well, river, stream, dam and unprotected springs, which are prone to contamination as shown Table 4.

Table 4: Proportion of Residents Accessing Water from Protected Water Sources

S/No.	Nature of water source	Frequency	Percentage
1	Unprotected	140	34.7
2	Protected	264	65.3
	Total	404	100

Consequently, households have devised various ways to purify their drinking water. The majority of the households boiled their drinking water, 20.3% treated water using chemicals, 2% drank bottled water while 1.2% sourced water from Eldoret Water and Sanitation Company (ELDOWAS). Only 3% consumed water without any form of treatment, as can be seen Table 5.

Table 5: Water purification options

S/No.	Water purification option	Frequency	Percentage
	Boiling	362	89.6
	Using chemicals	82	20.3
	Already treated	5	1.24
	Buying bottled water	8	1.98
	We don’t treat	12	2.97

Seasonal Water Shortages

During the dry season, 44.8% of the households experienced water scarcity as can be seen in Table 6.

Table 6: Households that experienced water shortage in the dry season

S/No.	Water scarcity experienced in the dry season	Frequency	Percentage
1.	Yes	181	44.8
2.	No	223	55.2

The distance to main water source was longer in the dry season compared to the rainy season, as seen in Table 7.

Table 7: Average distance to the main water source in the dry and rainy seasons

	Average distance to main water source in the dry season	Average distance to water source in the rainy season
Mean	215.96	22.34
Sample size	404	404
Std. Deviation	902.07	73.69

As a result of the water shortage experienced in the dry season, households conserved water in various ways.An average 41.3% of the respondents practiced water reuse, 37.9% cleaned their houses occasionally, 29% cleaned clothes occasionally, 28.9% used minimum amount possible for various activities, 24.8% watered animals at the water point, for instance river, and 29.7% cleaned clothes at the water point. This can be seen in Figure 3.

Domestic Water Collection and Storage

Majority of the households (63.6%) fetched water manually using a rope and container from the water source while 27.5% pumped water to a tank using electricity. An average 3.9% fetched water using a pulley and only 2% used a manual pump. A paltry 3% had access to piped water, as shown in Figure 4.

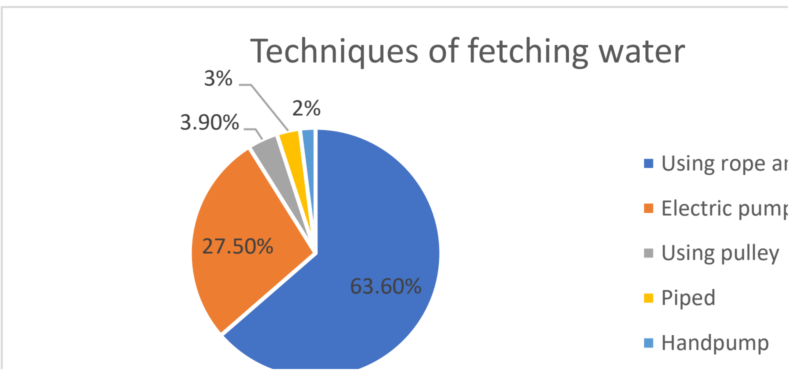

Figure 4: Various techniques of fetching water in the study area.

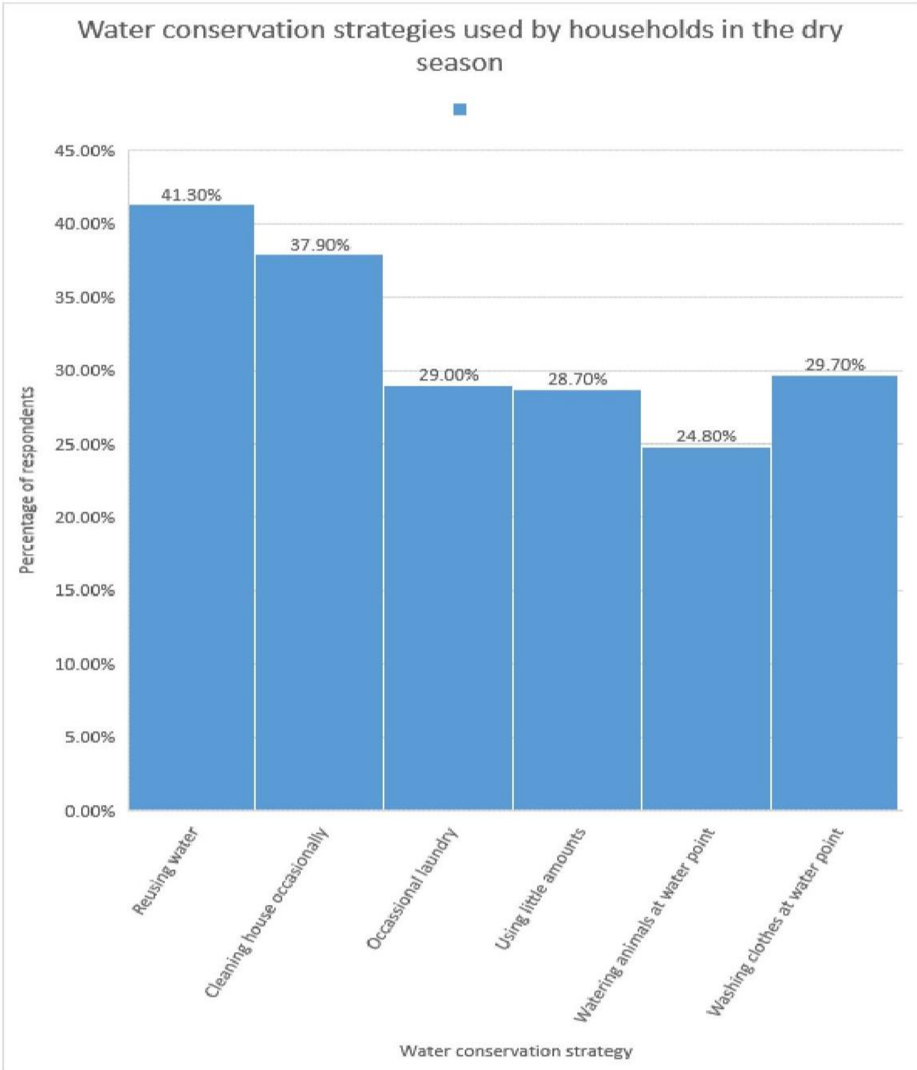

Figure 3: Water conservation strategies in the dry season

Majority of the households (71.3%) stored water in 10- or 20-litre jerricans, while 7% store their water in tanks as shown in Table 8.

Table 8: Domestic water storage facilities

S/No.	Medium of storage	Frequency	Percentage
1.	10/20 liter jerricans	288	71.3
2.	Tank/s	116	28.7

There was a high correlation between ownership of a tank and monthly income and main housing type, as can be seen in Table 9.

Table 9: Correlation between ownership of a tank and other variables

Variable		Ownership of a tank	Monthly income	Main housing type
Ownership of a tank	Pearson Correlation	1	0.487	0.523
Monthly income	Pearson Correlation	0.487	1	0.475
Main housing type	Pearson Correlation	0.523	0.475	1

DISCUSSION

Households in rural settlements of Kapseret Sub- County had access to multiple sources of water including; shallow wells, harvested rain water, river, stream, borehole, metered piped water, unmetered piped water, dams and springs. Shallow well was the most common source of water for domestic use. Majority of the households (92.9%) had access to a shallow well. This finding agrees with that of Wagner et al. (2019) who noted the wide use of shallow wells in rural Meru. A majority, 74.5% of the households used water from shallow well in the rainy season while in the dry season, the percentage was higher (82.7%). This can be attributed to the fact that in the rainy season, 16.3% of the household's harvested rainwater. Rainwater is a valuable resource and is used in rural areas to augment domestic water sources as observed by Biwott (2017). However, the collected rain water did not last to the dry season for most households because of limited storage capacity of the tanks, closely related to low incomes. In the dry season, only 0.5% of the households with sufficient storage used harvested rainwater as their main source of water. This agrees with the finding of Kimani et al. (2015) who observed that households with higher incomes were more likely to own larger tanks to secure themselves against water shortage.

Water shortage is prevalent in the area of study, particularly in dry season for 44.8% of the household experienced water shortage in the dry season. This finding concurs with that of WHO/UNICEF (2021), that the rate of progress of water supply has not met the existing demand, hence water shortages are still being experienced in the dry season. This is because many shallow wells usually dry up in the dry season, forcing people to travel for longer distances looking for water in shallow wells further from their homes. In fact, distance to the water source was longer in the dry season (215.96 meters) compared to 22.34 meters in the rainy season. This is in line with the finding of Kimani et al. (2015) who observed that in the dry season in Makueni, people walk for long distances, up to 2 km, to find water for household use.

Consequently, households that experienced water shortages adopt various strategies to conserve water. The most useful strategy was water reuse, accounting for 41.4% of the households. Another 28.7% of the households used the minimum amount of water possible for various activities by avoiding wastage. The water sources in the study area were not entirely safe, as 34.7% of the households use water from unprotected sources. Utilization of such water exposes their members to waterborne ailments. This relates to the finding of WHO/UNICEF (2021) that about 46% of people in Sub-Saharan Africa lack access to clean drinking water. These unprotected sources are at risk of contamination, especially in the rainy season when there is surface runoff. These include shallow wells, streams, rivers, dams and springs. However, most households purify their drinking water at home. Majority of the households (89.6%) boiled their drinking water, 20.3% used water treatment chemicals, and 2.0% used bottled water while 1.2% sourced drinkingwater from ELDOWAS. Only 3.0% of the households perceived no danger in drinking water directly from the source without prior treatment. This finding agrees with that of WWAP (2019) and Hope et al. (2020), who noted that millions of households in this century continue fetching water from unprotected sources from long distances.

Like many other Kenyan rural settlements, majority of the households (63.6%) fetched water manually using a rope and container while 27.5% pumped water to a tank using electricity. The manual nature of water collection and transportation exposes people, especially women and children to health problems, particularly backache and fatigue. Although plenty of water is available in the rainy season, financial capacity to harvest and store rainwater is limited. Only 28.7% of the households had invested in a tank, while the majority, (71.3%) stored water in 10 and 20 liter- jerricans. The presence of a tank had a positive Pearson correlation coefficient of 0.487 with income. This implies that ownership of a tank is related with high income, because of the cost implication of buying and installing a tank. There was also a Pearson correlation coefficient of 0.523 between ownership of a tank and housing type. This means that households with permanent houses were more likely to invest in a tank so as to secure water supply.

CONCLUSION

There are multiple sources of water for domestic use in the area of study including shallow wells, harvested rain water, river, stream, borehole, metered piped water, unmetered piped water, dams and springs, with majority of the households (92.8%) having access to a shallow well. 34.7% of the households use water from unprotected water sources, with a significant portion of the population (44.8%) facing recurring water shortage every dry season. As a result, households have adopted various water conservation strategies in the dry seasons including reusing water, cleaning house and clothes occasionally, watering animals and cleaning clothes at the water point, and using little amounts of water for the various activities. Since majority of the households do not have access to potable water, 89.6% boil their drinking water. 63.6% of the households' fetch water manually from the source using rope and container, with only 28.7% storing water in tanks. Distance to main water source increases from an average of 22.3 meters in the rainy season to an average of 216 meters in the rainy season. This is because in the dry season, some shallow wells dry up and at the same time harvested rain water is not available. Thus, in the dry season, people travel for longer distances up to 1000 meters, looking for water. There is need for more investment in water supply in rural areas.

RECOMMENDATIONS

First, there is need for government to heavily invest in rural water supply, hence enhance water security. This will ensure households have access to safe water within reasonable distance. This can be done through adoption of Public Private Patnerships between Uasin Gishu government, private investors, local communities and other stakeholders.

In addition, rainwater harvesting has a huge untapped potential to provide domestic water. Local communities, NGOs, county governments and other stakeholders could partner to facilitate development of rainwater harvesting infrastructure.

Finally, water conservation must be enhanced as a strategy of reducing water demand by reducing water inefficient practices. Communities need to be trained on the various ways of conserving water as an approach of managing water demand.

REFERENCES

Biwott, G. C. (2017). Rain water harvesting as a sustainable water provision strategy in urban areas. International Journal of Advanced Scientific Research 2(3), 30-33.

Crouch, M. L., Jacobs, H. E., & Speight, V. L. (2021). Defining domestic water consumption based on personal water use activities. *Journal of Water Supply: Research and Technology-Aqua*, *70*(7), 1002-1011.

Falkenmark M, Widstrand C. (1992) Population and Water Resources: A Delicate Balance. *Popul Bull. 47* (3), 1–36.

Government of Kenya, GOK (2006). Disaster Risk Reduction Strategy for Kenya 2006 – 2016: A Resilient and Safer Nation. Government Printer. Nairobi, Kenya.
Hope, R., Thomson P., Koehler J., Foster T., (2020) Rethinking the economics of rural water in Africa, *Oxford Review of Economic Policy*. *36*(1), 171–190.
Kimani, M., Gitau A.N., Ndunge, D. (2015) Rainwater Harvesting Technologies in Makueni County, Kenya. *International Journal of Engineering and Science 5* (2), 39-49.
Lim, M.H. & Leong, Y.H. & Tiew, K.N. & Seah, H. (2011). Urban stormwater harvesting: A valuable water resource of Singapore. *Water Practice and Technology*. *6*(4).
Njora, B, Yılmaz, H (2021). Evaluation of Water Accessibility, Distribution, Water Use Policies and Management in Kenya. *International Journal of Water Management and Diplomacy: 1*(3), 5-16.
Strauch, A. M., Kalumbwa, E., & Almedom, A. M. (2021). Spatial analysis of domestic water uses and rural livelihoods in a semi-arid African highland. *Journal of Arid Environments*, *194*(8), 104608.
Uasin Gishu County (2018) County Integrated Development Plan (2018–2022) www.uasingishu.go.ke
UN World Water Assessment Programme (2017) The United Nations World Water Development Report 2017. Wastewater: The Untapped Resource. UNESCO. Paris, France
UN World Water Assessment Programme (2020). The United Nations world water development report 2020: water and climate change. Paris, UNESCO.
UNEP (2008). Vital water graphics. an overview of the state of the world’s fresh and marine water (2nd ed). http://www.unep.org/dewa/vitalwater/article116.html
Wagner, J., Cook, J., & Kimuyu, P. (2019). Household Demand for Water in Rural Kenya. *Environmental and Resource Economics*. 74, 1563-1584.
World Health Organization (WHO) and the United Nations Children’s Fund (UNICEF) (2021). Progress on household drinking water, sanitation and hygiene 2000-2020: Five years into the SDGs. Geneva.
World Water Assessment Programme (2019) The United Nations World Water Development Report 2019: Leaving No One Behind. UNESCO. Paris, France
Yamane, Taro (1967). Statistics, An Introductory Analysis, 2nd Ed., New York: Harper and Row