

*Full Length Research Paper*

## The extent of groundwater use for domestic and irrigation activities in Thiririka sub-catchment, Gatundu South District, Kiambu County, Kenya

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Population increase in Thiririka sub-catchment is causing high demand of water against limited supply. Currently, only 12,000 households out of 250,000 in the catchment have access to pipe water. Groundwater offers the one of the available options to the limited and irregular supply of pipe water. This study aims to find out the extent to which groundwater as alternative source of water for both domestic and irrigation activities is explored in the Thiririka sub-catchment. To achieve this objective, a field survey was conducted using semi-structured questionnaire to seek the extent to which individuals and households use groundwater. The study indicated a very low and adopted use of groundwater in the catchment. Only 36.7% of the various households visited use groundwater for domestic activities and 13.30% for irrigation purposes. It was found out that residents perception on groundwater to be polluted and therefore not safe for domestic activities, lack of cash availability for individuals who wish to construct wells at their homes and lack of awareness and education on the benefits of groundwater are some of the challenges contributing to the low use of groundwater in the Thiririka sub-catchment. It was therefore, recommended that education on the benefits of groundwater by the Gatundu South Water Services and Sanitation office and other NGOs be intensified to the residents of Thiririka sub-catchment and more community boreholes and wells should be provided to the communities by the government, churches and NGOs, beside the pipe connections.

**Key words:** Groundwater, Groundwater use, Thiririka sub-catchment, Kenya, Millennium Development Goals.

### INTRODUCTION

Water is vital for human welfare and a basic key for enhancing economic development in the world at large. It plays a pivotal role in the achievement of all the

Millennium Development Goals (MDGs). For instance, the MDG 7C outlines the target for halving the proportion of population without sustainable access to safe drinking

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water and basic sanitation by 2015.

Though the MDG 7C has been achieved on global basis, Sub-Saharan Africa is still lagging behind with only an improvement of 16 percentage points from 1990 to 2012 (MDG Report, 2014). Similarly, the World Bank (2015) reports that, 85 and 53% of the urban population and rural population respectively in Sub-Saharan Africa has access to safe drinking water. These figures look promising but far below the world average of 96% for urban population and 82% for rural population (World Bank, 2015).

Kenya is a dry country classified as chronically water scarce because it has a fresh water endowment of only about 650 cubic meters per capita, which according to Wafula (2010), has the potential to drop to 235 cubic meters per year largely due to population growth. According to Marshall (2011), some of the reasons why Kenya face severe water crisis are increase in population, drought, contamination of water bodies, frequent floods, lack of proper water management and deforestation. Thus, the issue of rapid population increase and cost has made potable water supply inadequate to meet the high demand for water by the populace. Groundwater can be a very cheap alternative to scarce water resources. Groundwater is increasingly becoming the source of drinking water for inhabitants of both rural and urban settlements due to intermittent water shortage which has been hitting most parts of cities (Nyarko, 2008). In Kenya, most of the rural population lack access to safe drinking water. According to the World Bank (2015), only about 55% of the rural population in Kenya have access to clean water as while 82% of the urban population have access. In Kajiado North District in Kenya, climate change which has affected water resources in terms of drought, runoff and increased evaporation had communities to rely on groundwater as their main source of water (Mngoli, 2014). Groundwater provides one of the realistic water supply option for meeting rural demand, as alternative water resources can be unreliable and expensive to develop (Foster and Tuinhof, 2000; MacDonald et al., 2005). This is because groundwater is cheaper to access, provides water on demand, easy to develop abstraction systems and face minimal transmissions and storage losses than surface systems (Mumma et al., 2011, Shah et al., 2007).

In Kiambu County in Kenya, 25% of residents use unimproved water sources such as ponds, direct from the rivers, unprotected springs and from water vendors (KNBS and SID, 2013). Groundwater has been an essential source of drinking water for the rural and urban communities (Singh, 2009). Field interview in November 2014 with one officer at the Gatundu South Water Services and Sanitation indicated that the target population of households to which they are to supply pipe born water is 250,000. However, only 12,000 households out of this figure are currently supplied with pipe born

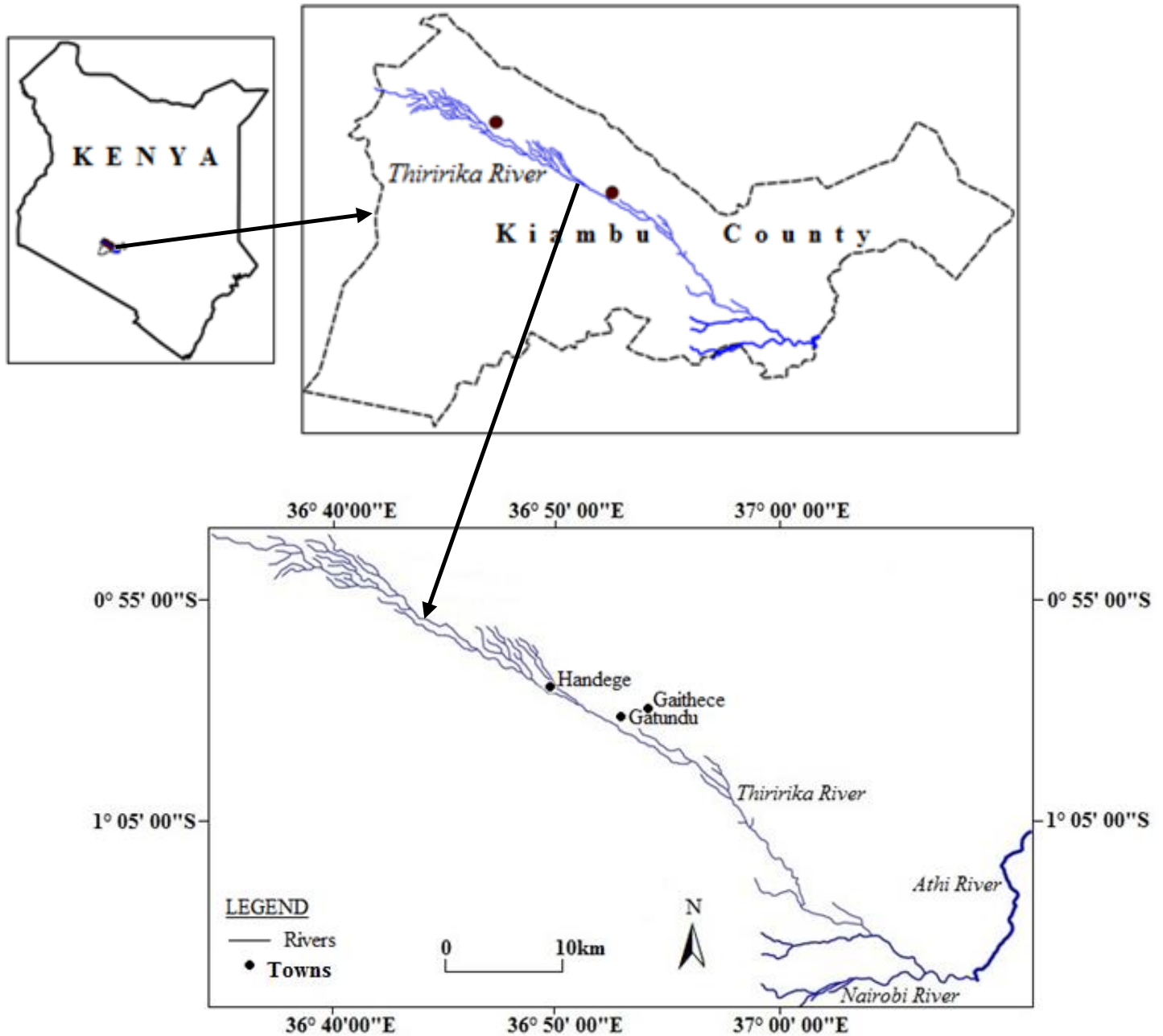
water in the catchment. He therefore, concluded that because of high demand and topography of the area, the people in the catchment do not have regular supply of water at times. Ashun (2014) added that consequently, the inhabitants have had to increasingly rely on groundwater as their sole or supplementary source of water in the Thiririka Sub-catchment to meet the rising demand.

Nevertheless, several studies in the Thiririka sub-catchment in Kiambu County in Kenya had limited themselves to the assessment of water quality. Little work has been done on the extent to which groundwater is prioritised for domestic and irrigation activities in the catchment. It is therefore, against this background that this study sought to find out the extent to which groundwater is used for domestic and irrigation purposes/activities in the Thiririka sub-catchment. Studies of this nature will help advice policy makers in taking precautionary measures against protecting groundwater to safeguard the health of the inhabitants in the Thiririka Sub-catchment who depend on the groundwater for their livelihood. Again, an investigation of groundwater for various domestic and irrigation purposes is important because of the role groundwater resource can play in Kenya context in supplementing the scarce surface polluted water. Firstly, the groundwater resource is in constant demand as an alternative potable water supply and must therefore, be protected, and secondly, it is a subject which is of legislative importance in Kenya context, with the newly enacted Water Acts of 2002, which lays much emphasis on sustainable water resource management. Access to these groundwater sources could be an important part of the peoples' coping strategies when there is a shortage of piped water or when household circumstances change. Therefore, the main aim of this paper is to find out the extent of groundwater use for both domestic and irrigation activities in the Thiririka sub-catchment in the Kiambu County in Kenya.

## METHODOLOGY

### Study area characteristics

The study was carried out in the Thiririka Sub-catchment in Kiambu County in Central Province. The Sub-catchment is about 50 km to the North along the National A2 and C66 from Nairobi off Thika road and along Kenyatta Road. The Thiririka Sub Catchment is in Upper Athi Catchment and its source is in the Southern slopes of the Aberdare Ranges in the Kikuyu Escarpment Forest and flows in a South by East direction to emerge from the forest near to the East of the Karatu Rural Market and joins Ruiru River at Juja farm, which later joins Nairobi river downstream. Geographically, the Thiririka Sub-catchment is bounded by the following coordinates, longitudes 36° 34.6' 0", 37° 9' 0" and latitudes 0° 51' 0" and 1° 13.7' 0". The Sub-catchment extends approximately 2.8 and 2.5 km West of Gatundu town and is bounded by the Kikuyu escarpment to the North and the Kiaora Estate to the South. The Sub-catchment lies within the humid to semi-humid agro-climatic zones of Kenya and



**Figure 1.** Map of the Thiririka Sub-catchment. Source: Geography Unit, Kenyatta University, 2015.

covers approximately 134 km<sup>2</sup> (Ashun, 2014). The map of the study area is presented in Figure 1.

The Thiririka Sub-catchment experiences an annual average rainfall ranging between 800 and 2000 mm which vary along the agro-ecological zones. The Sub-catchment receives a mean annual rainfall of 1160 mm with two distinct peaks in March to May and October to December (Bi-modal pattern). The maximum and minimum rainfall received is 257 and 33.4 mm in April and July. The mean annual temperature in the humid zone varies between 14 to 18°C while in the Sub-Humid to Semi-Humid zones the mean annual temperatures vary between 18 and 22°C. The annual maximum temperatures range from 25.2 to 30.4°C in the months of August and March respectively while the minimum temperatures

range from 9.8 and 15.4°C in the months of February and April, respectively (Gatundu Agricultural office station and Rwabura Irrigation Project, 2013).

The soils in the Thiririka Sub-catchment correspond to the typical Humic Nitisols which are found on the upper part of the Sub-catchment while Rhodic Nitisols are found in the lower parts of the Sub-catchment. These Nitisols have great agricultural potential coupled with the relatively high rainfall regime in this Sub-catchment. Tea production, coffee, tropical fruits, food crops such as maize, beans and potatoes are some of the crops cultivated here.

The main economic activities in the Sub-catchment are subsistence and commercial farming. Most typical type of farming



**Plate 1.** Major types of crops (banana, kales, coffee and maize) grown in the Thiririka sub-catchment. Source: Fieldwork (2014).

practiced in the area is mixed cropping. Livestock rearing is another important activity in the Thiririka Sub-catchment and includes cattle, goats and sheep. Donkeys are an important form of transport, particularly for firewood, water and other goods for the market. The main source of energy for cooking in the homesteads within the catchment is firewood.

#### Sampling design, data collection and data analyses

The study population was all households in Thiririka sub-catchment, Kiambu County, Kenya. The study employed a representative research design using simple random technique to select 30 household heads, 10 from each of the three zones: downstream, middle stream and upper stream. Data collection method included both primary and secondary data sources. Secondary data sources included published and unpublished information on the study area and on groundwater in general. Primary data was collected using questionnaires. Semi-structured questionnaires were administered to respondents to collect information on demographic characteristics and the use of groundwater for domestic and irrigation purposes. The questionnaire involved both open-ended and closed-ended questions. Some of the questions asked included age, household size, educational level, type of groundwater used, distance covered in search of groundwater, source of water used for irrigation, among many others. In addition, recording tools such as camera, eye, pen, and paper were used for recording field observations, especially non-linguistic aspects of human behavior. Some of the field observations recorded were type of groundwater in the various households, general condition of the households, and type of crops grown in the sub-catchment, among others.

The data was analysed using SPSS 17.0 and outputs generated. The data was analysed descriptively to show the type of ground water available, uses of groundwater use, socio-economic characteristics, among others. Descriptive statistics such as frequencies and percentages were used to summarize results. Results were presented using tables, pie charts and bar graphs.

## RESULTS AND DISCUSSION

### Existing situation

All the visited households during the field interviews had their main source of income from either subsistence or commercial agriculture. The main occupation of the respondents within the catchment is farming. The typical type of farming practiced in the catchment is mixed cropping (Plate 1). Types of crops grown mainly include maize, kales, banana, coffee, among others. Dairy cattle are also raised on a minimal scale (Plate 2). The percentage distribution of the respondents' occupation in the sub-catchment is displayed in Figure 2 below. 63% (50% males and 78% females) of the respondents were farmers, 30% (43.8% males and 14.3% females) being salaried workers and 6.7% (6.3% males and 7.1% females) were business persons. None of the respondents in the catchment was unemployed.

### Types of Groundwater in Various Homes in Thiririka Sub-catchment

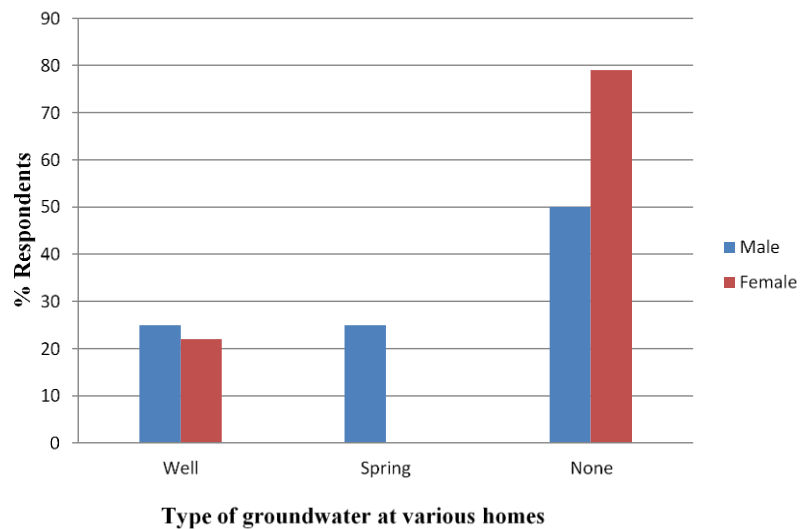
From Figure 3, 23.3% (25 % males and 21.4 % females) had and use wells, 13.3% (25 % males only) had and use springs in their homes. None of the homes had boreholes present. 63.3% (50% males and 78.6 % females) had and use no groundwater. These results also agree with Mngoli (2014) who reported that only 33.7% households use and depend on groundwater (mainly boreholes) in Kajiado North District in Kenya, though that is the major source of water use in this area. Those with groundwater



**Plate 2.** Cattle keeping carried out as part of crop farming in the sub-catchment. Source: Fieldwork (2014).



**Figure 2.** Percentage distribution of respondents' occupation by sex in the sub-catchment. Source: Fieldwork (2014).



**Figure 3.** Types of groundwater in various homes in Gatundu district, Thiririka sub-catchment. Source: Fieldwork (2014).



**Plate 3:** Groundwater (well) in one of the homes in Thiririka sub-catchment, which the owner uses to irrigate her farmland. Source: Fieldwork (2014).



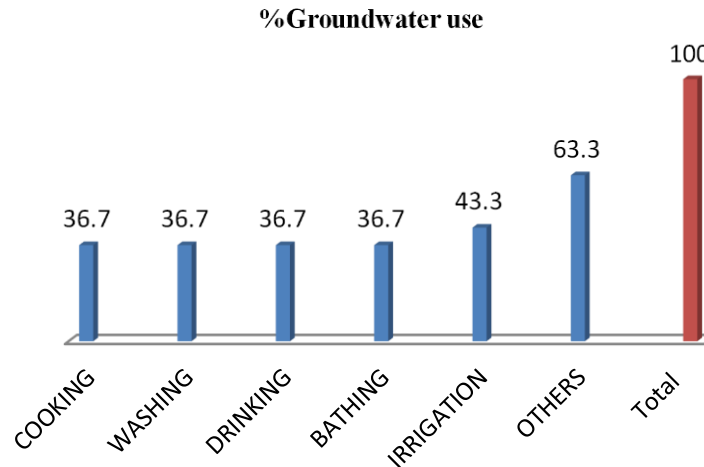
**Plate 4:** Crops grown under green house, where the owner uses the water from the well to irrigate the crops. Source: Fieldwork (2014).



**Plate 5.** Groundwater (well) under construction in one of the homes in Thiririka sub-catchment, where the owner considers it for her dairy farming. Source: Fieldwork (2014).

in their homes only consider it solely for irrigation purposes (their croplands and dairy farming). Plate 3 shows one well where the owner uses for irrigating her

farmland and crops grown under green house (Plate 4). Plate 5 also shows one well, which is under construction, where the owner considers using it for her dairy farming.



**Figure 4.** Use of groundwater for domestic activities by respondents in the Thiririka sub-catchment. Source: Fieldwork (2014).



**Plate 6.** Thiririka River as the main source of water supply in the Thiririka sub-catchment. Source: Fieldwork (2014).

### Level of groundwater use for domestic activities in the Thiririka Sub-catchment

From figure 4, groundwater use for domestic activities such as cooking, washing, drinking and bathing is minimal. 36.7% of the respondents use groundwater for cooking, washing, drinking and bathing. 43.3% of the respondents use groundwater for irrigation activities and 63.3% considered using groundwater for other activities such as expanding the size of their farmlands. The main reason for low usage of groundwater is attributed to the fact that, 80% of households have access to pipe water connections. In addition, most households perceive groundwater to be polluted with chemicals and thus unsafe for domestic activities especially drinking and cooking. These observations agree with findings by Philip and Stevens (2013), who reported low groundwater use for domestic purposes in four communities in Kisumu,

Kenya, at 9 to 29% because the households perceived groundwater to be polluted with chemicals and thus unsafe for their domestic activities. People in the catchment will rather prefer using water from the Thiririka River (Plate 6) and its tributaries in dry seasons and when there is irregular water supply from taps to using groundwater.

Table 1 shows the distance to groundwater by respondents who used groundwater in the Thiririka sub-catchment. From the table, 42.9% covers less than 0.5 km distance to fetch groundwater, 7.1% covers within 0.5 to 1 km distance to go fetch groundwater and 50% had groundwater made in their home premises.

Table 2 shows the distance respondents spend or cover to fetch tap water. From the table above, 17.2% covers less than 0.5 km to go fetch tap water, 3.4% covers within 0.5 to 1 km to go fetch tap water and 79.3% use or fetch tap water from pipes made in their homes.

**Table 1.** Distance to groundwater of respondents who use groundwater in the Thiririka sub-catchment.

| <b>Background Characteristics</b> | <b>&lt;0.5</b> | <b>0.5 – 1 km</b> | <b>On premises</b> | <b>No. of respondents</b> |
|-----------------------------------|----------------|-------------------|--------------------|---------------------------|
| <b>Sex of Respondent</b>          |                |                   |                    |                           |
| Male                              | 37.5           | 12.5              | 50                 | <b>16</b>                 |
| Female                            | 50             | 0                 | 50                 | <b>14</b>                 |
| <b>Age of Respondent</b>          |                |                   |                    |                           |
| 19-25 years                       | 100            | 0                 | 0                  | <b>6</b>                  |
| 26 - 45                           | 14.3           | 0                 | 85.7               | <b>15</b>                 |
| 45 and above                      | 0              | 50                | 50                 | <b>9</b>                  |
| <b>Level of Education</b>         |                |                   |                    |                           |
| Primary                           | 25             | 0                 | 75                 | <b>17</b>                 |
| Secondary                         | 16.7           | 16.7              | 66.7               | <b>8</b>                  |
| College / University              | 100            | 0                 | 0                  | <b>5</b>                  |
| Never Enrolled                    | 0              | 0                 | 0                  | <b>0</b>                  |
| <b>Overall Total</b>              | <b>42.9</b>    | <b>7.1</b>        | <b>50</b>          | <b>30</b>                 |

Source: Field data (2014).

**Table 2.** Distance to tap water of respondents in the Thiririka sub-catchment.

| <b>Background characteristics</b> | <b>&lt;0.5</b> | <b>0.5 – 1 km</b> | <b>On premises</b> | <b>No. of respondents</b> |
|-----------------------------------|----------------|-------------------|--------------------|---------------------------|
| <b>Sex of Respondent</b>          |                |                   |                    |                           |
| Male                              | 25             | 0                 | 75                 | <b>16</b>                 |
| Female                            | 7.7            | 7.7               | 84.6               | <b>14</b>                 |
| <b>Age of Respondent</b>          |                |                   |                    |                           |
| 19-25 years                       | 16.7           | 0                 | 83.3               | <b>6</b>                  |
| 26 - 45                           | 21.4           | 0                 | 11                 | <b>15</b>                 |
| 45 and above                      | 11.1           | 11.1              | 77.8               | <b>9</b>                  |
| <b>Level of Education</b>         |                |                   |                    |                           |
| Primary                           | 31.3           | 6.3               | 62.5               | <b>17</b>                 |
| Secondary                         | 0              | 0                 | 100                | <b>8</b>                  |
| College / University              | 0              | 0                 | 100                | <b>5</b>                  |
| Never Enrolled                    | 0              | 0                 | 0                  | <b>0</b>                  |
| <b>Overall Total</b>              | <b>17.2</b>    | <b>7.1</b>        | <b>79.3</b>        | <b>30</b>                 |

Source: Fieldwork (2014).

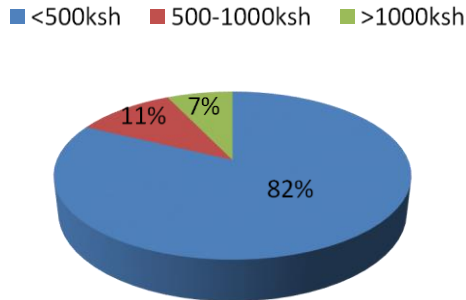
These figures compared to same distances residents travel to go fetch groundwater further explain the reasons why groundwater use in the sub-catchment is minimal. In short, tap water is made easily accessible and available within reach more than groundwater.

#### **Amount of money spent on tap water monthly and price affordability of tap water**

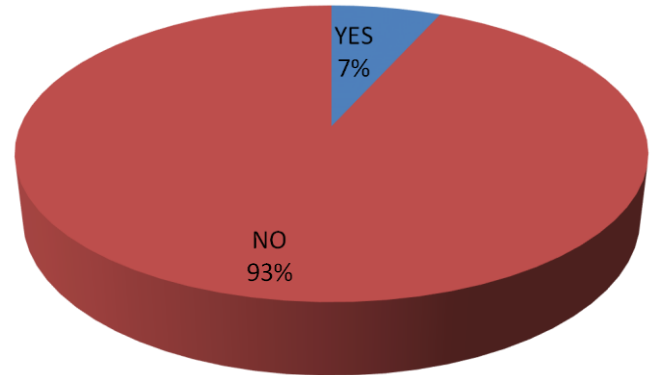
Figure 5 shows the amount of money respondents spend on paying for tap water in Kenyan shillings (ksh) and

compared to see if groundwater is an alternative to respondents. 90 ksh presently exchanges for 1 United States dollar (USD). It could be seen from the figure 5 that 82% of the respondents spend less than 500 ksh on tap water monthly, 11% spends between 500 to 1000 ksh and 7% spends more than 1000 ksh monthly on paying for tap water. These figures further explain that tap water is more affordable to the respondents and further explains the less use of groundwater water in the study area. These results confirm a similar study by Ashun (2012) in the Thiririka sub-catchment, who found that

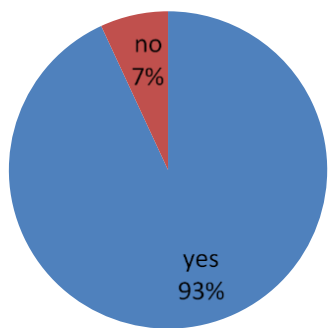




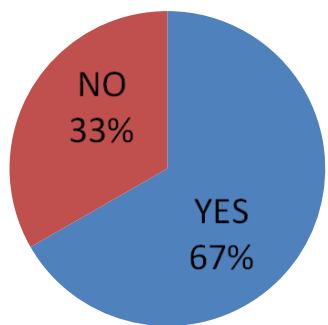
**Figure 5.** Amount spent on tap water by residents in the Thiririka sub-catchment. Source: Fieldwork (2014).



**Figure 8.** Percentage of respondents to regularity of supply of tap water. Source: Fieldwork (2014).



**Figure 6.** Price affordability of tap water by residents in Thiririka sub-catchment. Source: Fieldwork (2014).



**Figure 7.** Percentage of respondents who consider groundwater as an alternative for domestic activities, if they cannot afford the price of tap water. Source: Fieldwork (2014).

75% of the people spend less than 500 Kshs per month for buying water. Price affordability of water to the respondents is explained more in figure 6. In terms of whether respondents are able to afford the price of tap water, 93% said “yes” they can afford and 7% of the respondents said “no”. This further explains the reason

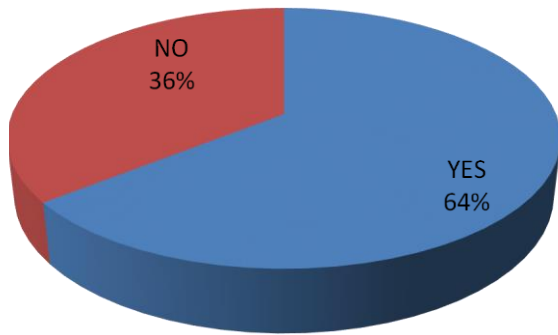
why majority of the households do not use groundwater especially for their domestic activities in the sub-catchment.

**Groundwater as an alternative supply of water for domestic activities**

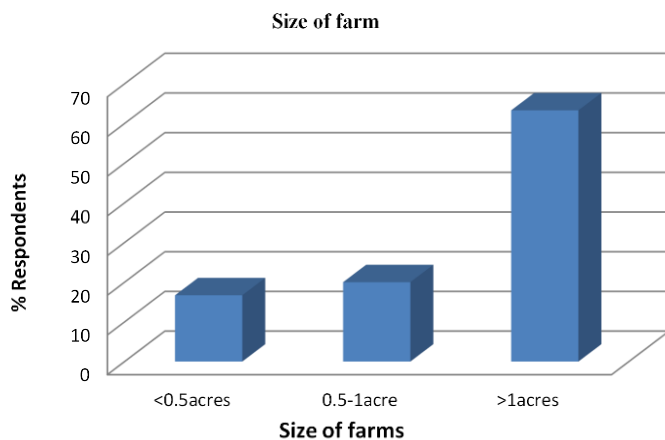
The households of Thiririka sub-catchment will consider groundwater as an alternative supply of water for domestic activities if they cannot afford the price of tap water. In terms of whether households consider groundwater as an alternative supply of water for their domestic activities 67% responded ‘yes’ and 33% responded ‘no’ (Figure 7). Also, out of these, all the females (100%) responded ‘yes’ to considering groundwater as an alternative because the supply of water from the taps is irregular and unreliable within the week, it will help them to have enough water to irrigate their farmlands and only if they have enough money to dig the well. Philip and Stevens (2013) reported of improved household livelihoods in terms of family income levels, increased farm productivity and food security of women who depended on groundwater use for their farming activities in Kisumu, Kenya.

**Regularity of water supply in the Thiririka sub-catchment and groundwater as an alternative**

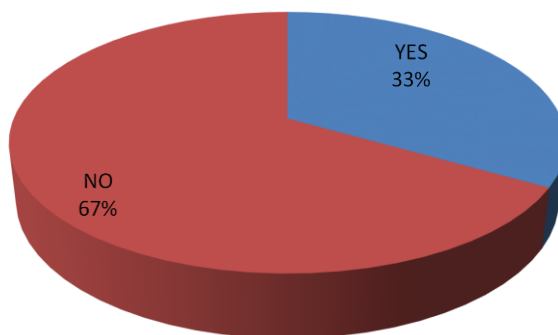
Regular flow of tap water in pipes in various homes in the Thiririka sub-catchment is a problem. Households reported that tap water flows about three times a week. This means water from the taps is not reliable, though about 80% of the households had pipes connected in their homes. Figure 8 shows the regularity of tap water in the sub-catchment. From the figure, 93% of the respondents receive irregular water supply in pipes and 7% receive regular flow of water in pipes. These results



**Figure 9.** Percentage of respondents who will consider Groundwater as an alternative to irregular tap water supply in the sub-catchment. Source: Fieldwork (2014)

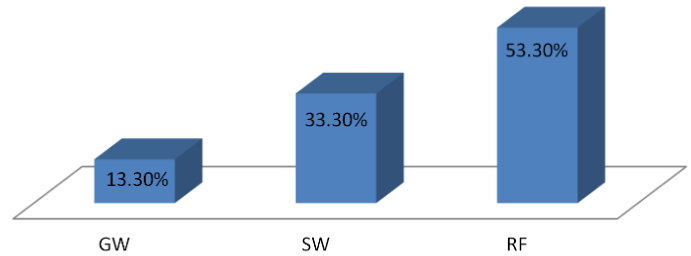


**Figure 10.** Percentage size of farms of respondents in the Thiririka sub-catchment. Source: Fieldwork (2014).



**Figure 11.** Percentage of irrigation use in the Thiririka sub-catchment. Source: Fieldwork (2014).

confirms similar findings by Philip and Stevens (2013) who found out that the supply of piped water is unreliable with frequent water shortages in four informal communities in Kisumu, Kenya. Also, Figure 9 shows whether households consider groundwater as an



**Figure 12.** Percentage of groundwater use for irrigation in the Thiririka sub-catchment. Source: Fieldwork (2014).

alternative coping measure to the irregular tap water supply. From Figure 9, 64% respondents said 'yes' they consider ground water and 36% respondents said 'no' they do not consider groundwater as an alternative coping strategy to the irregular supply of tap water in the sub-catchment.

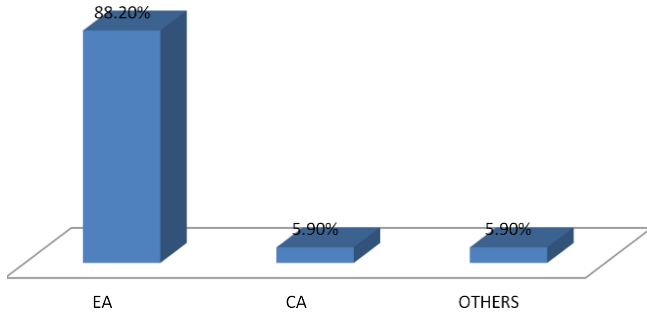
### Use of groundwater for irrigation in the Thiririka sub-catchment

The main occupation of the respondents in the sub-catchment is farming (crop farming and animal rearing). Households mostly farm at the subsistence scale ranging between 0.5 acres to more than 1 acre. The Figure 10 below shows the percentage of farm sizes of respondents in the catchment. From the figure, 16.7% have farms of less than 0.5 acres, 20% have farm sizes between 0.5 to 1 acre and 63.3% have farm sizes of more than 1 but less than 3 acres.

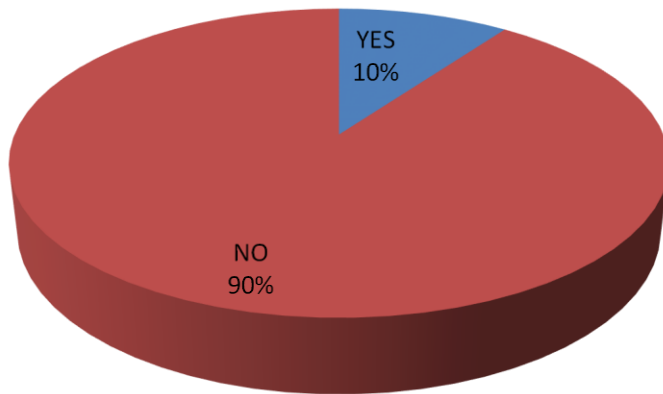
Figure 11 shows the percentage of irrigation use of respondents in the sub-catchment. From the figure, 33 % use irrigation on their farms and 67% do not use irrigation on their farms. This is because most of the farmers in the catchment operate at the subsistence level and usually rely on natural rain to water their farms.

### Groundwater use for irrigation

From Figure 12, households in the catchment do not use groundwater (GW) for irrigation. Households usually rely on rainwater to irrigate their farms. It could be deduced from the Figure 12 that 53.3% of the respondents rely on natural rain (RF) to grow their crops, 33.3% rely on surface water (SW) such as tap water and water from the river to irrigate their farms. Only 13.3% use GW to irrigate their farms. This is because many of the respondents believe groundwater is polluted with chemicals and that it is not suitable for irrigation. However, the few (13.3%) who use groundwater to irrigate their farms, all of them, testifies that groundwater is more reliable for them than tap water from the pipes, which are usually irregular in supply and that they had realized benefits of relying on GW for irrigating their farms such as increased crop yields, increased number of times they harvest in a



**Figure 13.** Factors influencing GW use over TW by respondents in the Thiririka sub-catchment. Source: Fieldwork (2014).



**Figure 14.** Percentage of education on benefits of GW use by respondents in the Thiririka sub-catchment. Source: Fieldwork (2014).

growing season, increased enrollment of their children at school, able to pay for their house rents, electricity bills and water bills as well as improvement in their household income levels. It is commonly noted that access to groundwater is reliable, available on demand, improves household incomes and ensures food security (Philip and Stevens, 2013; Mumma et al., 2011; Shah et al., 2007).

**Factors influencing peoples’ use of GW over TW**

From Figure 13, 88.2% of respondents use groundwater (GW) because it is easily accessible (EA), 5.9% responded they will use GW if they have the cash available (CA) to dig a well and 5.9% said they will GW based on other reasons such as for supplementing irrigation of their farms and increasing their crop production, if they cannot afford the price of tap water, if water supply from taps is not regular, if it is the only one available and because they cannot trust the readings from the water meters at times. One respondent had this to say:

*“Me, myself, I like farming and all I need is water. If I can get enough cash, I will build my own well and I will do wonders. I will feel comfortable, extend my family size and can do farming on a large scale. I really need to dig one right now.”*

**Education on benefits of GW**

From Figure 14, respondents’ use of GW is low partly due to little education they receive about the many benefits GW offers. From the figure, only 10% of the respondents receive education on GW benefits and 90% do not receive education on GW and its benefits.

**Conclusion**

The study assessed the extent of groundwater use for domestic and irrigation activities in the Thiririka Sub-catchment, Kiambu County, Kenya. Findings from the study indicated that groundwater use for domestic and irrigation activities is very low and not adopted in the catchment. This is because about 80% of the various households visited during the survey had connections to pipe born water, the fact that residents perceive groundwater to be polluted and therefore not safe for domestic activities and lack of cash availability for individuals who wish to construct one at their homes. As a result, most of the households use and depend more on tap water and Thiririka River for their domestic activities. Similarly, most households depend more on natural rainfall to irrigate their farms, which are usually at the subsistent level, followed by surface water such as tap water and river water.

However, respondents prefer using groundwater for irrigation activities to boost their crop production than to use it for domestic activities such as cooking, drinking, washing and bathing. Moreover, households consider the use of groundwater when they cannot afford the price of tap water, when the supply of tap water is not regular and when they need more water to expand their farm size. Finally, education on benefits of groundwater was very low in the sub-catchment. As a result, the Gatundu South Water Services and Sanitation office and other non-governmental organizations need to provide and intensify education on benefits of groundwater in the sub-catchment.

**Recommendations**

Based on the results of the study, the following recommendations are made:

- i) There is the need for education to the households of Thiririka on the benefits of groundwater by the Gatundu South Water Services and Sanitation office and other non-governmental organizations in the District;

ii) More groundwater especially community boreholes and wells should be provided to the communities by the government, churches and NGOs, beside the pipe connections. This will help provide all year round water for the households especially in times of dry seasons;

iii) Finally, individuals who wish to construct their own wells at their homes in order to expand their farm size could be supported by the government to do so. This will make them increase food production through irrigation and thereby increase household income to make them more sustainable.

### Conflict of Interest

The author(s) did not declare any conflict of interest.

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