ASSESSMENT OF SUITABILITY OF ADAPTATION STRATEGIES TO WATER SCARCITY IN MAKINDU SUB-COUNTY, KENYA

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ABSTRACT

Water is a fundamental resource in achieving sustainable development in Third World Nations more so in Sub Saharan Africa where Kenya falls. Unfortunately, water scarcity has greatly affected these countries besides increasing human population and poverty levels. The need to examine the suitability of adaptation strategies to water scarcity is therefore important since development is dependent on water availability and usage. This study assessed the suitability of adaptation strategies to water scarcity in Makindu Sub-County of Makueni County. A total of 370 households were selected using simple random sampling. Questionnaires, interview schedules, personal observation, photography were the methods used in obtaining data. The study established that rainwater harvesting and boreholes were the most suitable adaptation strategies to address water scarcity while the least adopted strategies were water tankering and walking for long distances. The study concluded that rural households should harness surface water, Sub-surface water and underground water to address the challenge of water scarcity. The study recommended that policy makers and all stakeholders should put up measures that strengthen the existing most suitable adaptation strategies and cushion the inhabitants against water scarcity by sensitization and educating inhabitants on use of local and innovative water conservation technologies for sustainable development.

Keywords: *water scarcity, suitability, adaptation strategies, sustainable development*

INTRODUCTION

Adaptation is the ability of social and environmental systems to adjust to changes and shocks in order to cope with consequences of change and shocks (Burton, et al, 2002). Adaptation to climate change is no longer a secondary or long term strategy only to be considered the last option. Among the challenges caused by droughts is water scarcity. Current trends indicates that water problems will continue to become more complex, interfering with all sectors of development such as energy, agriculture, mining, transportation and communication, education, environment (Biswas, 2004). According to (UNDP, 2006) around 1.2 billion people live in areas of physical water scarcity, 0.5 billion are approaching the situation and another 1.6 billion face economic water shortage. The need to adapt to water scarcity cannot be overemphasized. Thus its use has to be constrained in terms of availability, quantity, quality (Biswas, 2004). For centuries, communities have devised various strategies to cope with water scarcity. For instance, rainwater harvesting is common in Egypt (Allam et al, 2003) which constitutes a potential source of drinking water (Helmreich and Horn, 2009). Rutten (2005) observes that Maasai pastoralist in Kajiado County, Kenya scoop sand in the dry river beds during dry periods to reach subsurface river flow. Further, in Samburu County

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pastoralists digs shallow wells in the river banks where water accumulate during rainy season for use during drought periods (Lemunyete, 2003). Whereas many water scarcity adaptation strategies have been adopted, the suitability of these strategies has received little attention. This study focused on the suitability of adopted water scarcity adaptation strategies to in Makindu Sub-County of Makueni County in Kenya.

OBJECTIVE OF THE STUDY

The objective of this study was to assess the suitability of adopted water scarcity adaptation strategies in Makindu Sub-County of Makueni County

STUDY AREA AND METHODOLOGY

Makindu sub-county is located in south eastern Kenya covering an area of 2075.6km2. It lies at latitude 2^0 10^1 and 2^0 South and longitude 37^0 40^1 and 37^0 55^1 east. It has four administrative locations namely Makindu, Kiboko, Nguumo and Twaandu (Figure 1). It has a population of 42,094 people living in 9,907 households (National Census, 2009). The sub-county is served mainly by Rivers Kiboko, Maangi-uvungu which are permanent and Rivers Kyumbi, Makindu, Kikuu, Muooni which are seasonal. Other sources of water sources in the area of study include communal dams, private dams, roof catchment, boreholes and Kwavombo spring. The climate arid and semi-arid land and often characterized by prolonged drought. Rainfall has a bi modal distribution with long rains in March-May (MAM) and short rains in October-December (OND) (Makueni CIDP, 2013). Data on the adaptation strategies to water scarcity was obtained from 370 households in Makindu Sub-County mainly through the use of questionnaires. Other methods included: Interviews to key informants, personal observation and photography.

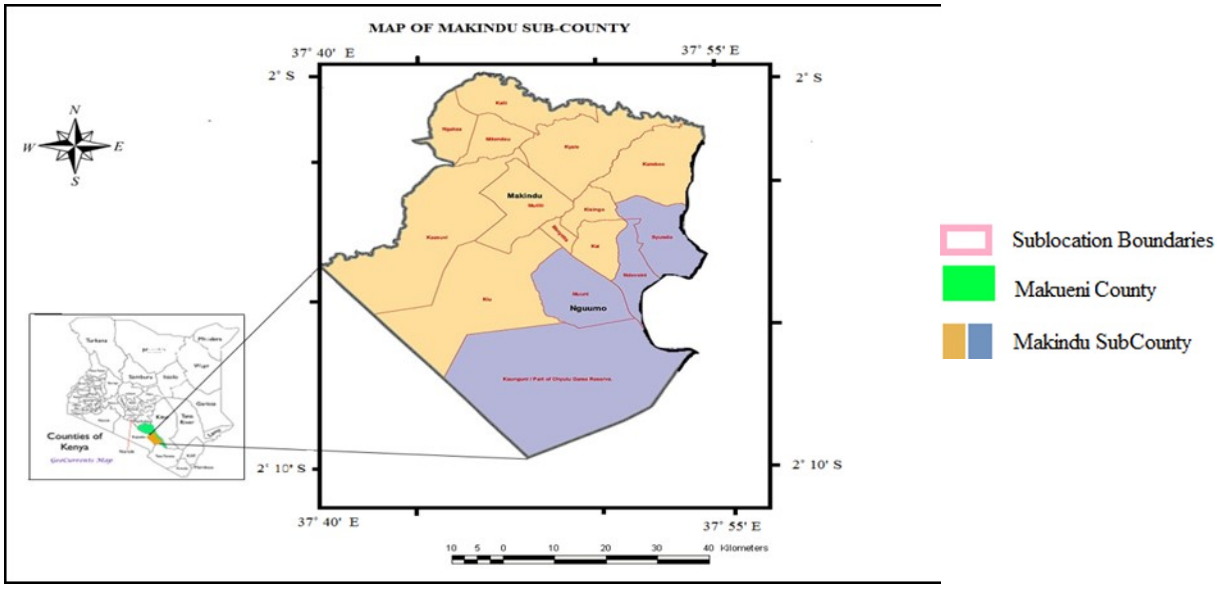

Figure 1. Location of Study Area in Makueni County

RESULTS AND DISCUSSIONS

Water Scarcity Adaptation Strategies

Households in Makindu Sub-county used various water scarcity adaptation strategies. This included: rain water harvesting (33.5% of the households), boreholes (22.4%), piped water (14.6%), shallow wells (8.6%) and walking long distances, water tankering, sand and earth-dams water tinkering (20.9%) (Table 1)

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Table 1. Adaptation Strategies to Water Scarcity (Source: Field Data, 2015)

Adaptation strategy	No. of Rural Households	Percentages (%)
Boreholes	83	22.4
Rainwater harvesting	124	33.5
Piped water	54	14.6
Shallow wells	32	8.6
Walking for long distances, water tankering, sand and earth-dams water tinkering	77	20.9
Total	370	100

Rain water harvesting was the most preferred adaptation strategy. Households attributed this to nearness of harnessed water and low startup and maintenance cost. Most of the harnessed water was from roof catchment. Ngima (2015) observes that most households' adapt to erratic water supply by buying water containers for storage purposes once the water is harvested. Shallow wells were least adopted at household levels because of the startup cost involved.

Suitability of Adaptation Strategies to Water Scarcity

Suitability of the strategies was examined through the following parameters: durability, affordability, reliability, and accessibility.

Durability

Durability in this study referred to the duration in which the adopted adaptation strategies provided water to the households. Boreholes were the most durable sources of water while shallow wells were the least durable.

Table 2. Durability of adaptation strategies to water scarcity

Adaptation strategy	No. of households'	Percentages (%)
Boreholes	156	42.2
Masonry tanks and sand dams	33	8.9
Rainwater harvesting	90	24.3
Shallow wells	20	5.4
Use of earth dams	36	9.7
Piped water	35	9.5
Total	370	100.0

Source: Field data (2015)

The durability of boreholes was not in question. For instance, Kisingo and Syumile boreholes those were sunk by colonial government in 1952 and were still in use. Other boreholes that were still in use included: Katangini, Kwakyambi, Ndalani and Kwanzioka (sunk in 2007) and Kyeni Kya Ngakaa (sunk year 2008), Kalakalya and Ngomano boreholes (sunk in 2009 and 2011) respectively. The duration of use of water harvested through rainwater harvesting techniques dependent on capacity of storage. Households indicated that the harvested water lasted for up to between 2 to 4 months depending on the capacity of storage structures. According to Ministry of Water and Irrigation-MWI (2015), rainwater harvesting presents opportunities to address water scarcity in ASALs during periodic dry spells. The study established that the household had both masonry tanks (Plate 1) which had a higher lifespan

and plastic tanks (Plate2) which were prone to breakage due to exposure to prolonged spells of high temperatures in the area

Plate 1: Masonry water tank

Plate 2: Plastic water tank

Households indicated that only two out of the five earth-dams held water throughout the year. These were Kwa-Luma which had water since it was constructed in 2010 and Sekeleni which had served households since 2009. On the other hand, Kwa-Kasina, Miangeni and Kwa – Munyalo earth dams dried up during the prolonged droughts due to siltation and high evaporation rates. They lasted for an average of 1.5 years before drying up. Similar observations were made by Munyao(2014) and most of the earth dams do not survive entire period of drought due to high rate of evaporation, leaching and sedimentation. Households who lived far from Earth dams,used piped water. The study established that piped water was continuously available for six months (May –October). This period coincided with rainy season in the study area, a period in which Kwa-Vombo spring which was the main source of piped water was fully recharged. However, the supply of water was rationed in Kalii and Kyale Sub-Locations which were far from the spring. Kisingo sand dam (along River Kiumbi) and Muooni sand dams (along River Muooni) provided water for three months after rainfall session. A study in Sakai in Mbooni in Makueni County by IISD (2009) established that earth dams provided water to 382 households and 1,146 cattle from four villages during droughts. Shallow wells which included Mathayoni, Kalakalya and Mumbuni provided water for less than 2 months during drought.

Affordability

Affordability of water scarcity adaptation strategies was measured based on travelling cost to water sources, construction and maintenance of the strategies adopted. Rainwater harvesting was the most affordable as indicated in Figure 2.

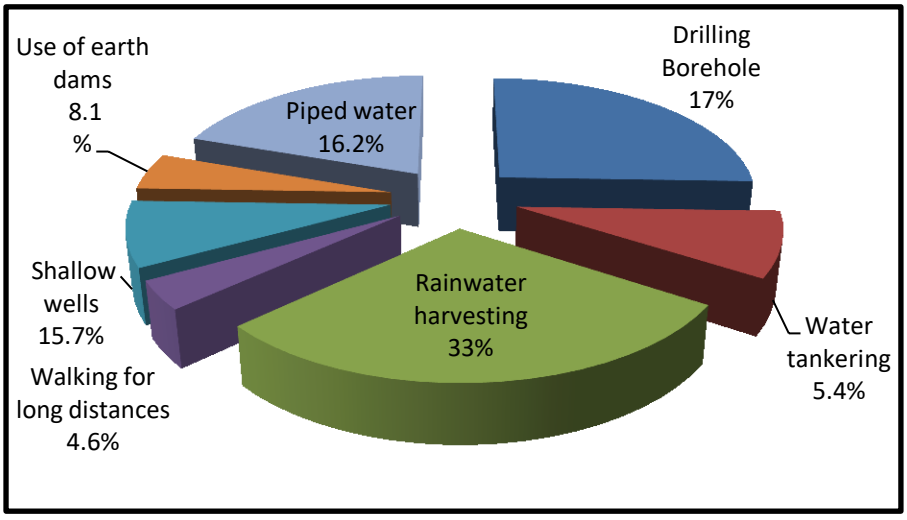

Figure 2. Affordability of adaptation strategy to water scarcity.

Data in Figure 2 reveals that over one third of the household viewed water harvesting was the most suitable adapted strategy. Although the indicated that the initial cost of constructing the masonry tanks or purchasing the plastic tanks was high, no more costs was incurred. In addition, even household without the high cost storage tanks were able to harvest water in 20-litre jerricans and other cheap containers. This observation agrees with Munyao (2014) assertion that rain water harvesting is very effective and inexpensive and suitable for ASALs. Walking for long distances in search of water the least affordable adopted strategy due to time required to travel to the water source vis-a-vis tat amount of water obtained. Although boreholes were the most durable, the cost of drilling and maintaining them was very high. On average, the cost of drilling boreholes in Makindu Sub-county was USD 24,167. For example Ngakaa borehole was sunk at a cost of about USD 27,500 in 2008/2009 while Kwa-Kyambi and Ndalani were sunk at a cost of about USD 25,000 each in 2007. Ngomano borehole was sunk at a cost of about USD 20,000. Even for hand-dug borehole, the cost was still high for most of the households averaging at 150/$m^{3.}$ However, during acute water shortage, borehole water was retailed at USD 0.05 for every 20-litre jerrican. Shallow wells were sunk at a cost of about between USD 1000- 1500. Kwa-nzioki shallow well for instance was sunk by an N.G.O (PASS-AFRICA) at a cost of about USD 1500. Due to high maintenance cost, a 20-litre jerrican of shallow well water was retailed at USD 0.1. Provision of water through tinkering was a monopoly of KIMAWASCO. Due to the tinkering costs involved e.g. fuel, tanker maintenance and payment of the driver, a 20-litre jerrican was retailed at USD 0.6. This strategy was used during severe droughts and particularly for communities living away from other water sources. Water tinkering was common in Kalii Sub-Location where most household depended on seasonal River Kikuu. According to Mati et al., (2005) who stated that water tankering is quite expensive and unsustainable.

Reliability

Reliability referred to how households depended on the strategies adopted and how they trusted them in terms of provision of water during dry spells in the area. Table 3 shows household response with regards to reliability of the adopted strategies.

Table 3. Reliability of Water Scarcity Adaptation Strategy

Reliability of water scarcity adaptation strategy	No. of households'	Percentage (%)
Borehole	97	26.2
Water tankering	16	4.3
Rainwater harvesting	72	19.5
Walking for long distances	23	6.2
Shallow wells	53	14.3
Earth dams	37	10.0
Piped water	72	19.5
Total	370	100.0

Boreholes were the most reliable source of water while the least reliable source was water tankering (Table 3). Analysis showed that boreholes were most reliable water scarcity adaptation strategy because they held water throughout the year even though the levels reduced during prolonged droughts. For instance, Syumile and Kisingo boreholes supplies water since they were sunk by colonial government in 1952. This statement corroborates with US-Geological Survey (1993) assertion that in arid or dry regions people rely on ground water (Boreholes) to meet their needs.In Isiolo County, boreholes are the mostly reliable sources of water during dry spells (Mati et al., 2005. The permanent nature of Kwa-Vombo Spring has made piped water reliable. Reliability of rainwater harvesting was attributed to

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duration of usage and fresh water harvested during rainy season. Households stated that rainwater could take about 2 - 4 months once it was harvested ensuring availability of water during dry months in the study area. This statement is line with Enfors (2009) that water harvesting and storage would be vital to ensure water availability especially during prolonged dry season and droughts. According to Kimani et al., (2015) rainwater harvesting has shown a high degree of reliability especially to households who have invested in high capacity rainwater storage tanks. Water tankering was also relied upon. However, those who relied on this strategy were financially able earning monthly income of over USD 200. This was the least reliable strategy because of its cost. Thus, it is not a common adopted strategy in Kenyan ASALs and is mostly used in extreme drought events. Other least reliable adaptation strategies were shallow wells and earth dams because they were exposed to indiscriminate solid waste disposal and high contamination due to their openness and high rate of evaporation in the area. This statement corroborates with Kimani et al., (2015) who stated that high evaporation rates, frequent drought events have resulted to unreliability of earth-dams.

Accessibility

Accessibility referred to nearness or proximity of adopted water scarcity strategies to households in terms of average distance. Rainwater harvesting was the most accessible strategy while water tankering was the least accessible (Figure 3).

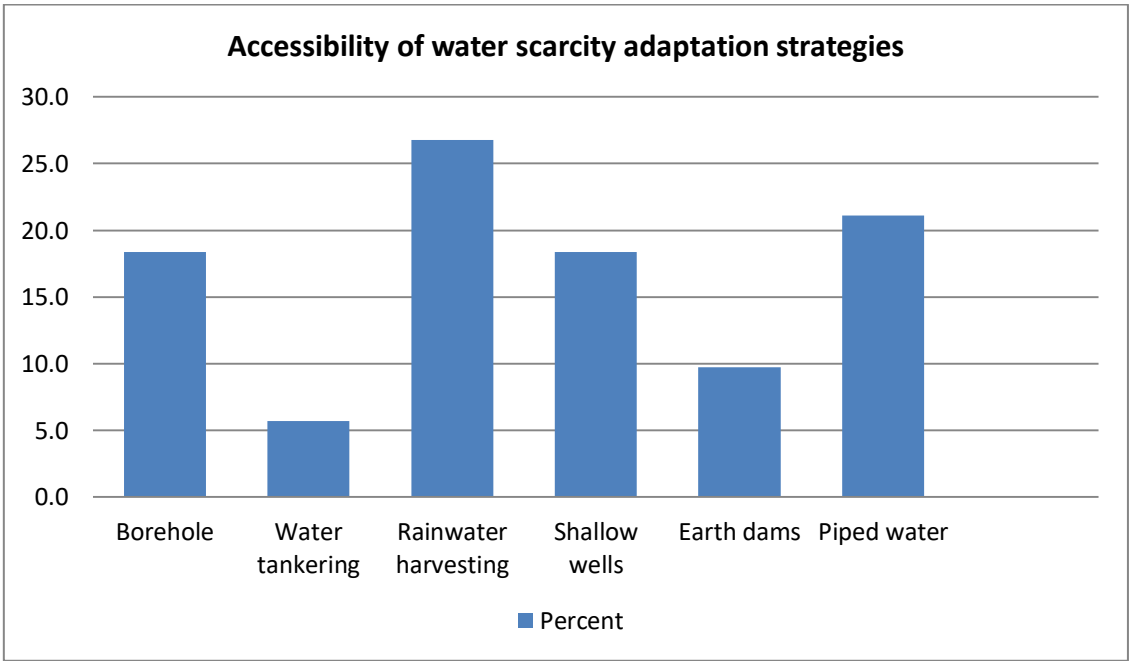

Figure 3. Bar graph showing accessibility of water scarcity adaptation strategy

Accessibility of rainwater harvesting was attributed to the distance to the storage tanks in the homesteads which was in range of metres. In addition, households indicated that technologies to harness the water were locally available and once water was harvested, it was easy to access it. Households from Kiu Sub-Location indicated that they had access to piped water in addition to rainwater harvesting. This was because the distance from the source of connections (Kwa-vombo Spring) was short about 5 – 10 km on average making accessibility easier. Piped connections minimized the distance taken by households to other water sources making water accessible to them. The study established that 21.1 percent of the households in the study area had access to piped water. These results are slightly below the 28.5 percent of

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the people who have access to piped water in Eastern and 30 percent of the households in Kenya (GoK, 2010). Households also indicated that they were able to access water from boreholes since they were permanent sources of water. Households from Twaandu Location easily accessed water from Ngakaa, Kwanzioka and Ngomano boreholes which were on average about 5km. It was difficult to access water from earth dams because of the distance. For instance households from Kalii Sub-Location could travel a distance of about 15km to get water for their livestock in Kwa-Luma earth dam while households from Kaunguni Sub-Location travelled an average distance of about 10-15km to Sekeleni earth dams. This finding is in line with Munyao (2014) who stated that one of the challenges of accessing water from earth-dams is long distances covered. The least accessible adaptation strategy was water tankering. This was because water was supplied by KIMAWASCO alone and therefore could not be accessible easily when needed. This finding agrees with Mati et al., (2015) who argued that people in Isiolo County could not access water from water tankering because it was not practiced in large scale and the cost involved was huge

AVERAGE ASSESSMENT OF PARAMETERS OF SUITABILITY

When all suitability parameters were combined, the study established that boreholes were the most suitable strategy while water tankering was the least.

Table 4. Average assessment of parameters of suitability

Adaptation strategy	Durability	Affordability	Accessibility	Reliability	Total %	Average %
Borehole	42.2	17	18.4	26.2	103.8	25.95
Rainwater Harvesting	24.3	33	26.7	19.5	103.5	25.87
Water tankering	8.9	5.4	5.7	4.3	24.3	6.07
Walking for long distances	0	4.6	0	6.2	10.8	2.70
Earth dams	9.7	8.1	9.7	10	37.5	9.38
Piped water	9.5	16.2	21.1	19.5	66.3	16.58
Shallow wells	5.4	15.7	18.4	14.3	53.8	13.45
Total	100 %	100 %	100 %	100 %	400 %	100 %

Source: Authors compilation from field data (2015)

From Table 4 above boreholes were the most suitable strategy on average of assessment. Rainwater harvesting was the second best. Majority of the households indicated that water from boreholes was available throughout the year even though the cost of sinking was too high. Households who could not afford opted for walking for long distances which was the least adopted adaptation strategy in the area.

CONCLUSIONS

From the findings, the study concludes that the households should embrace rainwater harvesting techniques because of its affordability and accessibility. Despite the cost of sinking and maintaining boreholes, they were the most suitable adaptation strategy in the sub-county. In all aspects, walking long distances in search of water was the least suitable. It was exhausting and time consuming.

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RECOMMENDATIONS

The study result has demonstrated that households are affected greatly by water shortage in Makindu Sub-County. The research findings has revealed that adaptive capacities of households have been constrained by increased poverty levels, increased drought intensities, poor management of water resources, low uptake and resistance by the community in engaging in addressing water scarcity, unreliable water resources, and unreliable rainfall in Makindu Sub County. Therefore this study makes the following recommendations:

1. Engagement of the community in sinking and maintaining boreholes, crucial in enabling accessibility of water. These will further be of importance since it will addressed at local level hence develop more technologies for adapting to water scarcity and saving water resources for the future.
2. Interventions to enhance opportunities for local rainwater harvesting technologies, provision of awareness on the importance of harvesting water, providing access to information on drought and climate change, encouraging N.G.O s investing in provision of water tanks for households in Makindu Sub County, practical oriented adaptation strategies to drought related water scarcity should be put in place both politically and economically so as to reinforce the already existing adaptation strategies
3. The County government should be engaged in maintaining water projects constructed by N.G.O.s for instances, boreholes, water kiosks and masonry tanks. This will motivate them and encourage them to continue with similar projects for the benefit of the rural Inhabitants.
4. The County government should allocate funds towards construction of farm ponds, sand dams, drilling of mega boreholes so as to supplement the adaptation strategies used by households to address the water scarcity issues. Further, the government should give loans to households for them to buy tanks with large storage capacities. This will enable them to harvest much water during rainy season.

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