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Water Scarcity Influenced Water Use Coping Mechanisms in Selected Sites of Makueni County, Kenya

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Authors' contributions

This work was carried out in collaboration between both authors. Author AKN designed the study, wrote the protocol, analyzed data and managed the literature searches. Author JMK coordinated the study, organized the first draft of the manuscript and led in all manuscript editorial corrections. Both authors read and approved the final manuscript.

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ABSTRACT

Water constitutes a vital element of household food security for humans and livestock. Therefore, the general objective of this study was to establish the ease of water access, water scarcity and coping strategies used by rural communities in selected study sites of Makueni (Kilili sub-location in Makueni sub-county and Kyanguli sub-location in Kibwezi East sub-county), all located in Makueni County. The study involved a total of 70 households which were selected using cluster and simple random approach to gather quantitative data using household surveys. The data were collected using a structured questionnaire and in-depth interviews with key informants. The collected data was coded and analysed using the Statistical Package for Social Sciences (SPSS). Results from the analysed data were presented using tables. Results obtained revealed that majority of the households obtained water from rivers (78%), followed by shallow wells (31%), boreholes (28%), sand dams (24%) and springs (11%). However, most respondents at Kyanguli obtained water from rivers (94%) compared to Kilili (62%). Further, at Kilili sub-location, majority of

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the households got water within less than 1 km (46%) while at Kyanguli most respondents got water within 1-3 km (48%). Five major water access problems were documented in the study sites included increasing distance to water sources, high cost of water, dirty water, water scarcity and conflict with neighboring communities. In overall water scarcity was the commonest problem in both study sites (77%), followed by dirty water (62%), increasing distance to water sources (45%), high cost of water (44%) and conflict with neighboring communities (43%). Water use coping mechanisms identified in the study included use of water harvesting structures, soil conservation techniques, diversification of crop types and varieties, irrigation, water reuse, reducing number of livestock and reduced water use. In overall the commonly used water copying mechanisms included soil conservation (85%), water reuse (71%), reduced livestock (64%), reduced water use (55%) and crop diversification (54%). We concluded that water scarcity, dirty water, increasing distance to water sources, high cost of water and conflict with neighboring communities were the main challenges which led the households to develop water coping mechanisms in the selected sites of Makueni County. We recommend the results of this study to be used by policy makers in water development projects in Makueni to improve water availability and access in the selected study sites.

Keywords: Climate change; coping mechanisms; cost of water; soil conservation; water scarcity; water sources.

1. INTRODUCTION

There is a consensus that over the coming decades human influenced climate change will cause dramatic transformations in the biophysical systems that will affect human settlements, ecosystem services, water resources and food production; all of which are closely linked to human livelihoods [1,2,3]. These transformations are likely to have widespread implications on individuals, communities, regions and nations. According to [4] the poor, natural resource-dependent rural households will bear the greatest burden of the adverse impacts. This is because rural livelihoods are subject to multiple shocks and stresses that can increase household vulnerability. Climate variability is one of the pervasive stresses that individuals and communities in rural areas have to cope with. However, seasonal climate forecasts provide an indication of how variable the rainfall might be compared to past years and is therefore considered as information that could help to prepare for and adapt to climate variability.

Rural community are particularly vulnerable to changes in the climate that reduce productivity and negatively affect their weather-dependent livelihood systems. For instance, in Malawi, frequent droughts and floods have eroded assets leaving people more vulnerable to disasters [5] such as water and food insecurity, diseases and land degradation. Evidence strongly suggests that increased droughts and floods may be exacerbating poverty levels, leaving many rural communities trapped in a cycle of poverty and vulnerability to diminishing resources [6].

Water scarcity is already a major problem in arid and semi-arid areas of Sub-Saharan Africa (SSA) [7]. This is most probably because African countries are particularly susceptible to climate change due to the desertification process, declining run-off from water catchments, declining soil fertility, dependency on subsistence agriculture, the prevalence of HIV and AIDS and vector-borne diseases, inadequate government mechanisms and rapid population growth [8]. High reliance on climate-sensitive renewable natural resources sectors such as water and agriculture in Africa will worsen the negative impacts of climate change on African countries [9].

The availability of water resources in Kenya has been decreasing over time as a result of persistent droughts and land-use patterns. The climate scenarios show that rainfall variability and increased evaporation due to higher temperatures will lead to further decreases in the available water. Already there are dramatic reductions in the snow and glaciers of Mount Kenya, believed to be associated with global warming. These glaciers could vanish in the next 15 years. The disappearance of the glaciers will affect agricultural activities, the availability of water for both rural and urban populations, hydroelectric production and tourist activities [10].

Adaptation to climate change is one of the most important issues facing Kenya today as there are

indications that rural Kenyans' livelihoods are already affected by a changing climate, [11].The growing evidence of global environmental change and increased climate variability demands that adaptation options, adaptive capacity and ways to reduce risk should be prioritized [12]. However, catchment degradation is undermining the limited sustainable water resources base in the country [13]. Degradation of both surface and ground water resources through over-abstraction and illegal abstraction, among other factors has led to serious degradation of the water catchments in terms of quantity and quality [14]. This study therefore sought to document the current water sources, problems associated with water access and adaptation mechanisms used by rural communities in selected sites of Makueni and Kibwezi East sub-counties in Makueni County, Kenya.

2. METHODOLOGY

2.1 Physiographic Conditions and Choice of the Study Sites

The area is generally arid and semi-arid with annual temperature ranging between 27℃ and 34℃ the area has two rain seasons. The long rain season is between March and April and the short rains between November and December. The rainfall pattern is erratic and ranges between 400-1000 mm per year. The altitude of the area ranges between 400-900 metres above sea level. The area is characterized by low lying grassland with scattered acacia trees and shrubs. The study was carried out in two selected sites of Makueni County (Kilili sub-location in Makueni sub-county and Kyanguli sub-location in Kibwezi East sub-county). The choice of the study sites was based on research problem including increasing water scarcity within the study sites and existence of high numbers of water based project initiatives which are aimed at mitigating the negative impacts of water scarcity on the local communities [10].

2.2 Data Collection and Analysis

A total of 70 households from the two selected sites were interviewed, which included 33 households at Kyanguli and 37 households at Kilili. The household were selected using cluster and random sampling. Questionnaires were administered to households in selected sites through random sampling, which involved random visits to households. Questionnaire was used as a guide in household interviews so as to attain the set objectives. To validate data collected using questionnaires, interviews were conducted on various key informants from the institutions dealing with water conservation technologies. The collected data was coded and entered into the computer for analysis using the Statistical Package for Social Sciences (SPSS).

3. RESULTS

Results obtained on water sources (Table 1) revealed that rivers, shallow wells, boreholes, sand dams, roof catchment and springs were the sources of water in the study sites. However majority of the households obtained water from rivers (78%), followed by shallow wells (31%), boreholes (28%), sand dams (24%) and springs (11%). At Kyanguli, rivers (94%), shallow wells (55%), sand dams and also roof harvesting (42%) were the four sources of water. However at Kilili rivers (62%) and boreholes (43%) were the main sources of water (Table 1).

In overall, most of the households (46%) in both sites got water within 1-3 km away from their homes, in which 43% were from Kilili and 48% were from Kyanguli (Table 2). However, a substantial number of households in Kilili sub-location (46%), got water within less than 1km (46%) compared to Kyanguli (9%). Further, Kyanguli led in the households who accessed water within 4-5 km (27%) and over 5 km (15%), compared to Kilili, 3% and 5%, respectively (Table 2).

Five major water access problems were revealed in the study sites (Table 3) which included increased distance, high cost of water, dirty water, water scarcity and conflict with neighboring communities. In overall, scarcity of water was the commonest problem in both study sites (77%), followed by dirty water (62%), increased distance (45%), high cost of water (44%), and conflict with neighboring communities (43%). However, priority problems varied from site to site. Thus at Kilili, main water problems included scarcity of water (86%), followed byconflict with neighbouring communities (43%), dirty water (35%), high cost of water (30%) and finally increased distance to water sources (27%), while at Kyanguli, priority problems included dirty water (88%) followed by water scarcity (67%), increased distance (64%), high cost of water (58%) and there were no water conflicts reported in the site (Table 3).

Table 1. Water sources (%) in selected study sites of Makueni County

Water source		Sub-locations			SD
		Kilili N=37	Kyanguli N=33	Mean	
1.	Rivers	62	94	78	16
2.	Shallow wells	8	55	31	23.5
3.	Boreholes	43	12	28	15.5
4.	Sand dams	5	42	24	18.5
5.	Roof catchment	5	42	24	18.5
6.	Spring	11	0	11	11

Table 2. Water access (%) in selected study sites of Makueni County

Water access		Sub-locations			SD
		Kilili N=37	Kyanguli N=33	Mean	
Distance					
1.	Less than 1 km	46	9	28	18.5
2.	1-3 km	43	48	46	2.5
3.	4-5 km	3	27	15	12
4.	Over 5 km	5	15	10	5

Table 3. Problems in accessing water (%) in selected study sites of Makueni County

Water access problems		Sub-locations (%)			SD
		Kilili N=37	Kyanguli N=33	Mean (%)	
1.	Increased distance	27	64	45	18.5
2.	High cost of water	30	58	44	14
3.	Dirty water	35	88	62	26.5
4.	Scarcity of water	86	67	77	9.5
5.	Conflict with neighbouring communities	43	0	43	43

The main water use coping mechanisms identified by the respondents in the study sites included use of water harvesting structures, soil conservation techniques, diversification of crop types and varieties, irrigation, water reuse, reducing number of livestock, and reduced water use (Table 4). In overall, the common used water copying mechanisms included soil conservation (85%), water reuse (71%), reduced livestock (64%), reduced water use (55%) and crop diversification (54%). The major water coping mechanisms at Kyanguli in decreasing frequency included soil conservation techniques (94%), water reuse (88%) and reduced livestock (82%), while at Kilili the major coping mechanisms in order of decreasing frequency included reduced water use (89%), soil conservation techniques (76%) and water re-usage (54%) (Table 4).

Table 4. Water use coping mechanisms (%) in selected study sites of Makueni County

Water use coping mechanisms		Sub-locations			SD
		Kilili N=37	Kyanguli N=33	Mean	
1.	Build water harvesting structures	11	24	18	6.5
2.	Use of soil conservation techniques	76	94	85	9
3.	Diversification of crop types and varieties	30	79	54	24.5
4.	Irrigation	30	3	16	13.5
5.	Reusing water	54	88	71	17
6.	Reduced number of livestock	46	82	64	18
7.	Reduced water use	89	21	55	34

4. DISCUSSION

Sources of water in the study sites included rivers (78%), shallow wells (31%), boreholes (28%) sand dams (24%) roof catchment (24%) and springs (11%). Rivers were the commonest source of water (78%) most probably because of the availability of rivers in the study sites. Further, rivers in the drylands are public utilities and many inhabitants can freely access river water. This is most probably why rivers were the commonest source of water in the study sites (Kyanguli, 94%; Kilili, 62%, (Table 1). This observation was in agreement with [15] who noted that rivers are the main sources of water as long as weather remains favorable. Besides rivers, the next most important source of water at Kilili were boreholes (42%). This is because the area is dry and water table is low thus sinking a borehole being the next option to getting more water for the inhabitants. However at Kyanguli, shallow wells were the next most important source of water (55%) after rivers, followed by sand dams (42%) and roof catchments (42%).

The presence of shallow wells at Kyanguli can be attributed to high water tables in this study site, especially along river banks where sand is commonly trapped by riverine vegetation during rain seasons. In addition, high presence of roof water harvesting recorded at Kyanguli was most probably enhanced by perennial water shortages in the study site. Water shortage at local community levels can result to adoption of roof catchment practices and installation of water storage tanks to harvest rain water [14].

Water constitutes a vital element of household food security for humans and livestock. During drought in the semi-arid areas people, especially women and children, walk for long distances to search for water, which is usually of poor quality. In this study, it was evident that majority of the households had to travel up to 3 km to get water in both the sub-locations while a few had to get water over 5 km away from their households. This can be attributed to scarce water sources across the study sites. In Kilili majority of the households got water in less than one kilometer (46%) or within 1 to 3 km (43%) due to presence of sources of water in the seasonal rivers and boreholes near the village. However, in overall Kyanguli residents travelled a long distance to search for water which was mostly attributed to distant sources of water in the seasonal rivers, shallow wells and sand dams. During long trips to fetch water, substantial time is lost that can otherwise be used in other income generating and livelihood activities [16]. Similarly, when livestock have to walk for long distances from their regular dry season pasture and water sources, they lose body weight and weaken thereby fetching lower prices, or they become emaciated and die [17]. Thus water scarcity and distant water sources can lead to reduced food security, low living standards due to compromised access to livelihoods [16].

In overall water scarcity was commonly (77%) recorded in both study sites followed by dirty water (62%). This phenomenon is likely to be contributed bydegradation of both surface and ground water resources through over-abstraction and illegal abstraction, decreasing rainfall due to climate change among other factors leading to serious degradation of the water resources in terms of quantity and quality [14]. However, water scarcity was the commonest problem at Kilili (86%) most probably due to limited diversity of major water sources accessible by the majority of the respondents. It was noted that Kilili had only two major water sources, rivers and boreholes (Table 1). The limited number of the water sources at Kilili could have been the reason for the reported conflicts with neigbouring communities at the study site (Table 3).

With respect to water access problems, Kyanguli had most of the water access problems most probably due to water scarcity and long distancetravelled by about 27 percent of the respondents in the sub-location to water sources (Table 2). With long distances travelled, the respondents are most likely to have no control of water quality and will most probably fetch any water available at the water sources, whether clean or dirty. Also with distant water sources, some residents usually opt to buy water. In most cases, water vendors' fetch the water available at the water sources, which can be either clean or dirty. In addition, many water sources in the drylands consist of open pools of stagnant water or open shallow well on sand, which in most cases are easily accessed. Further, in most communal water sources there are no water access control measures and in most cases water hygiene is compromised. For example, some of the people fetching water can use the same water source for bathing, washing and watering their livestock. These scenarios may explain why many respondents at Kyanguli (88%) cited dirty water as a problem related to water accessibility.

High cost of water in the study sites was most probably caused by the water access problems commonly water scarcity, dirty water and increasing distance to water sources. This is because many residents cited that they found it easier to buy water from water vendors rather than spending most of their time looking for water. The effect of water scarcity and increasing distance to water sources on water cost was most felt at Kyanguli which led in the number of residents (58%) who reported that water access was costly (Table 3). In the semi-arid regions, increasing numbers of the rural poor are recognizing access to water for food production, livestock and domestic purposes as more critical than access to primary health care and education [18].

Results obtained showed that the coping mechanisms in the two study sites were slightly varied. Thus the major water coping mechanisms at Kyanguli included soil conservation techniques (94%), water reuse (88%) and reduced livestock (82%) while at Kilili the major coping mechanisms were reduced water use (89%), soil conservation techniques (76%) and water re-usage (54%) (Table 4). This observation agrees with [19] who found that variation of many adaptation mechanisms were local, district, regional or national issues rather than international. Further, according to [20], rural community cope with climate variability, but can adapt differently to climate change as varied as the agro-climatic zones and expected impacts on peoples' livelihoods. In addition, differences obtained at Kyanguli were most probably more related to distant water sources and water scarcity where water scarcity could have been more important. Distance to water sources would negatively affect both livestock and human. This is because long distances walked by livestock is likely to lead to loss of body weight, weakening, loss of market value, and even death of the livestock, especially when livestock walk for long distances from their regular seasonal pasture and water sources [17]. This may partly explain why at Kyanguli sub-locationa one of the coping mechanisms was reducing livestock. Thus, the Kyanguli respondents might have found livestock uneconomical as distance to water sources increase hence resolved to cut down on livestock numbers. Further, while reduced water use and water reuse, construction of water structures, and reduced livestock numbers were some of the coping strategies used in both study sites to address both water scarcity and distant sources of water (Tables 2 and 3). However, use of diversification of crop types and varieties, irrigation and soil conservation techniques were coping mechanism aimed at enhancing food production in the semi-arid environment. The coping mechanisms reported most probably enhanced water sources, water conservation and food access to the residents of the selected study sites.

5. CONCLUSION

We concluded that most respondents in the selected study sites got water from rivers most of which were within 1-3 km from their households although 15% of the respondents at Kyanguli indicated that they accessed water 5 km away from their homes, which took time. However, water was scarce and dirty forcing inhabitants to adopt water saving mechanisms which included soil conservation, water reuse, and reduction of livestock numbers. This study recommended the results of this study to be adopted by the county policy makers so that they can address the water access problems in the study sites.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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