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Households' Perceptions on Impact of Drought on Water Resources in Makindu Sub-County, Kenya

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Abstract

Drought is a major threat to water sources in the world. It causes variation in volumes of water flow. Once compounded with other factors, water scarcity arises. However, perceptions of households on the impact of drought on water sources vary from region to region. Understanding the perceptions of households is critical in ensuring people cope with water shortages. Thus, this paper sought to examine household's perception on the impact of drought on water resources in Makindu Sub-County, Kenya. The study employed descriptive survey research design. A total of 370 households were sampled using simple random sampling. Purposive sampling was used to select the key

informants. Questionnaires and key informants' interview schedules were used to collect primary data. Data from questionnaires was coded and analyzed using SPSS Version 20. As perceived by the households' drought led to drying up of water sources and further its impact varied from one drought intensity to another. The study also established that overuse by households, high rates of evaporation and encroachment of people to water sources were also affecting water sources. It was concluded that households should embrace adaptation and coping strategies to minimize water shortages. It is recommended that sensitization is required to equip individuals with knowledge to conserve water sources. The study provides new knowledge that is beneficial for water resource saving policy making, governance as well as for education at community and institutional levels.

Key Words: Perceptions, drought, households

Introduction

Water scarcity is a major problem experienced by world in the 21st century (UNDP, 2006). Approximately 1.2 billion people live in regions that experience acute water scarcity and another 1.6 billion are faced serious challenges with respect to water for economic use (UN Water, 2013). Water scarcity, especially due to drought is one of the most complex natural hazards that negatively impact on agriculture, water resources, natural ecosystem and society. The negative outcomes of drought include severe economic losses, famine, epidemics and land degradation (Beguería, Vicente-Serrano, & Angulo, 2010). For example, the 1996 drought led to water shortage in U.S.A where water levels in the Edwards aquifer which is the key source of water for about 1.5 million people in San Antonio and five counties in South Texas, reached lowest level recorded in 2010, prompting water restriction by up to 25 percent in Sante Fe (usimpacts.htm, n.d.).

In 1994, drought ravaged Australia resulting to enormous losses associated with water scarcity for irrigation. Australia experienced extreme temperatures resulting to increased evaporation of water dams and reservoirs, which resulted in decreasing levels by about 27% percent of their average capacity (Melbourne Water n.d.). Drought also led to reduced irrigation water in Texas leading to reduction in horticultural production and subsequent losses in jobs and income (usimpacts.htm, n.d.). A notable increase in drought frequency and duration throughout the country demanded for water in many water basins and exceeded available supply even in normal years, especially in the West Coast U.S. (U.S. Department of Interior (2005).

In Texas, the Colorado River municipal water district asked its water customers to reduce their water use by 10 percent because its three supplies lakes that is Lakes J. B Thomas, E. V. Spence reservoir and O.H. I vie reservoir were at 6, less than 3 and just over 30 percent, respectively (Odessa American, 2011). Canals in Loxahatchee Grover's in Palm Beach County in Florida were low from lack of rain (Town Crier, 2011) and declining groundwater levels led the South Florida water management districts to implement emergency water restrictions. As Changnon, (1980) puts it, drought conditions should be investigated to determine their physical dimensions as well as their socio-economic impacts. They cause temporal imbalances in available water due to persistently low and fluctuating precipitation, which results in uncertainty that bedevils water availability and livelihood planning. Fluctuating frequency and duration of droughts as well as their unpredictability result in poor water resource management while associated scarcity leads to reduced carrying capacity of ecosystems (Dracup *et al*; 1980, Wilhite & Glants, 1987). Low precipitation often results in declining stream discharge and reservoir storage capacity, which in turn complicates water scarcity management (Tarhule, 1997).

In Kenya drought has had a lot of impacts on water resources. For example, Wendy, Mpoke and Yishak, (2012) argue that pastoralists in Moyale are forced to migrate in search of water and they

have been assisted by Water Users Associations (WUAs) to construct dams and underground tanks to harvest rainwater reducing the distance they walk and increase the availability of water between rains by increasing storage capacity. Osbahr and Vines (2006) also argues that increase in temperatures impacts negatively on water availability through extreme losses of surface and ground water associated with rapid evaporation rates.

Objective of the Study

This study aimed at examining households' perceptions on the impact of drought on water sources in Makindu Sub-County, Kenya. Specifically, the study examined the following:

(1) Households perceptions on causes of drying up of Rivers and streams in the area.

(2) Households perceptions on the impact of drought on shallow wells, boreholes, earth and sand dams.

(3) Impact of drought on the permanent KwaVombo spring.

Study Area and Methodology

Makindu Sub-County has an average elevation of about 1064 meters above sea level. It is located in south eastern Kenya with a size 2075.6 km^2. It lies on latitude 2^0 10^1 and 2^0 South and longitude 37^0 40^1 and 37^0 55^1 East (Makueni CIDP, 2013). It is served mainly by River Kiboko and Maangi-uvungu which are permanent and Rivers Kyumbi, Makindu, Kikuu, Muooni which are seasonal and their flows become irregular as they move to the low lying areas due to high usage of water for small scale irrigation at the source. Surface and ground water resources found the locale are unevenly distributed. There is spatio-temporal variability of river water resources. Other sources of water in the area of study include communal dams, private dams, roof catchment, boreholes and Kwa-Vombo spring which is the main spring in the study area. Due to scarcity of water in the sub county, people have settled near water catchment areas near River Makindu hence affecting the supply in Makindu town and its environs. Sand harvesting along the river bed has had effects on retention of water in rivers in the area leading to water scarcity (Makueni CIDP, 2013).

The main economic activities are subsistence agriculture, agro-pastoralism, small scale trade, irrigation farming. The area is dominated by Kamba Maasai ethnic groups. The Sub-County is served by the Nairobi-Mombasa railway. This eases the transportation of goods in the area. The main crops produced in the area are maize, green-grams, yams, pigeon peas, sorghum, paw paws and oranges. The area has a Motor Cycle assembly and offers employment to its residents. (Makueni CIDP, 2013). It is typically arid and semi-arid land (ASAL) and often experiences prolonged drought. The area normally experiences a bimodal rainfall distribution patterns. The long rains mainly fall from March to May and short rains fall from October to December (Makueni CIDP, 2013). However, this has kept on changing over time with respect to climate changes, which have involved shifts in the timing when rains begin in the area. The area lies in lower side of Makueni County and receives annual rainfall ranging from 300mm-400mm (Makueni CIDP, 2013). Drought is a recurrent phenomenon in the history of the region that has often been marked by crop failure. Generally, the area experiences maize crop failure during short rains every 1 in every 3 years. Rainfall has been characterized by spatio-temporal distribution and variability which leads to water scarcity. Over the last couple of years, extreme temperatures have been reported, for instance, the area often experiences a minimum temperature of 24^0C to a maximum temperature of 35.8^0C (Makueni CIDP, 2013). During the dry periods between May and October the area experience severe heat at a temperature of 30^0 C on average.

The soils in this area are well drained, shallow to deep, yellowish red to dark brown colored, friable high rich in calcisols, cambisols, luvisols dominated by calcium carbonate (Muchena, Mbuvi & Wokabi, 1988). The predominant vegetation in this area is mainly a cover of shrubs and thicket, grass and herbaceous plants. The dominant wood tree species include baobab trees (*Adansonia digitata*), Umbrella thorn tree (*Acacia tortilis*), *Terminalia brownie, Sanseveria*, *Acacia melliferra* and *Acacia etbaica* (Gichuki, 2000).

The study is descriptive and relied on primary data. Data regarding of Households perceptions was sought from residents of the area using questionnaires. Key informant data was sought through interview schedules. The target population of the study was 9,907 households. A total of 370 households were randomly sampled. Purposive sampling method was used during data collection from key informants. Key informants included Makindu Sub-County water supply and connections officer, Regional Coordinator of the Ministry of Water and Irrigation in the Sub-County, KIMAWASCO Manager. To supplement the data from rural households, photography was also used.

Results and Discussion

1. **Households' Perception on Causes of Drying up of Rivers and Streams**

Drought was considered the major cause of dried rivers and streams by 71.4 percent of the households while 11.6 percent of the household considered over abstraction as the main reason. This points to a general consensus among residents of the area that drought was the main cause of water scarcity. Table 1 shows the respective seasonal rivers that supply water in the area and their seasonal flow characteristics.

Table 1 Rivers and Streams in Makindu Sub-County

Rivers and streams	Category	Locations served by rivers and streams	Perceived Impact of Severe Drought on Rivers And Streams
Makindu	Seasonal	Makindu	Dries up
Kyumbi/Kiumbi	Seasonal	Makindu	Dries up
Kiboko	Seasonal	Kiboko	Dries up
Maangi-Uvungu	Permanent	Kiboko	Reduced flow
Muooni	Seasonal	Twaandu	Dries up
Kikuu/Kiangini	Seasonal	Twaandu	Dries up
Wayona	Seasonal	Makindu	Dries up
Mukononi Stream	Seasonal	Makindu	Dries up
Kwa-Matuku stream	Seasonal	Nguumo	Dries up
Kwa-Mbwau stream	Seasonal	Nguumo	Dries up

Source: Authors compilation from Makindu District Water Office data

From analysis of data on Table 1 out of the 10 rivers and streams mentioned, only one of the rivers was permanent while the rest were seasonal. This implied that majority of rivers and streams in the study area were seasonal and prone to prolonged droughts. This forced households to adopt other water scarcity adaptation strategies. Some of the possible strategies to address water scarcity in the area included rainwater harvesting techniques, sand dams, shallow wells, boreholes and earth dams.

2. Sand Dams

The study established that households were supported by N.G.O s for example Germany Agro-Action to construct sand-dams (Plate 1) along the river beds as a strategy to address water scarcity. Sand-dams were found along River Kikuu in Twaandu location, River Muooni in Ngaaka and Kisingo Sub-location, Rivers Makindu, Kyumbi in Makindu location and Maangi-Uvungu in Kiboko location. Sand dams found in River Muooni were constructed in 2011, Kalii sand dam was constructed in 2010 and serves Kalii sub location households and Kisingo sand dam constructed in 1999 serves people from Kisingo sub location.This implies that sand dams are reliable adaptation strategy to water scarcity especially in areas with seasonal rivers. This statement corroborates with Mati *et al*., (2005) who stated that sand dams are cost effective and reliable. However, as perceived by households, sand dams were negatively affected by sand harvesting.

Plate 1 Kisingo Sand Dam Constructed along River Makindu {Source: Field data}

3. Impact of Drought on Shallow Wells

Results show that 64.1 percent of the households perceived that drought led to reduced amount of water in shallow wells while 35.9 percent indicated that drought led drying up of water in shallow wells (Table 2).

Table 2 Impact of Prolonged Drought on Shallow Wells

Impact of prolonged drought on shallow wells	No. of households	Percentages (%)
Reduced flows	237	64.1
Dried	133	35.9
Total	**370**	**100.0**

Source: Authors compilation from field data.

Shallow wells were common in Rivers Makindu, Kiumbi, Muooni, Kikuu and Wayona. The study established that there were communal shallow wells which included Mathayoni, Kalakalya, Mumbuni and Soto that served residents of Kaunguni Sub Location. Kwa-Samuel shallow well was sunk in

1988 by the Syumile Sub-Location community to serve households from the sub-location following a moderate drought of 1987. Other shallow wells included Nthaku, Kwanzioki well dug in 2008-2009 by N.G.O (PASS-AFRICA), Kwa-nzamwa. Tunguni, Jacob, Ngundo, and Ng'anzomo, which were used by households of Syumile LocationThe study established that prolonged droughts of 2002-2005 and 2007 -2011 led to drying up of all shallow wells.

4. Earth Dams and Water Pans

Earth dams and water pans were also affected by prolonged and severe droughts. Results showed that 42.2 percent of the households stated that drought led to drying up of earth dams and water pans, 26.2 percent of the households stated that drought led to reduction of water levels in earth dams and water pans. About 31.6 percent of the households argued that levels of water in the earth dams and water pans went down because of siltation and overuse by households (Table 3).

Table 3 Impact of Drought on Earth Dams

Impact of Drought on Earth Dams	No. of households	Percentages (%)
Reduced amount of water	97	26.2
Dried Completely	156	42.4
Others e.g. siltation, leaching, high rate of evaporation and over use by households	117	31.6
Total	**370**	**100.0**

Source: Author compilation from field data

Rainfall data showed that rainfall reduced from May to October in 2010 and 2011 (Appendix iii) when three of the earth dams dried up. This statement corroborates with KFSSG (2011) that due to failed short term rains and subsequent failing of long rains there has been reduced flow and drying up of water resources such as earth dams and water pans. Earth dams in the area were used to ease overuse of boreholes by rural households and livestock in different sub locations as stated by the Chief of Makindu location. They included Sekeleni, Kwa-Mweu/Munyalo, Miangeni, Kwa-Kasina and Kwa-Luma (Table 4).

Table 4 Earth-Dams found in Makindu Sub-County

Earth dams	Sub-locations it serves	Uses	Year it was sunk	Impact of prolonged drought on Earth dams
Kwaluma	Mitendeu	Domestic	2010	Reduced flow of water
Sekeleni	Ndovoini	Domestic and livestock	2008/2009	Reduced flow of water
Kwa mweu, Kwa Munyalo	Ngakaa	Domestic	2009	Dried up in 2010
Kwa -Kasina	Ngakaa	Domestic and livestock	2010	Dried up in 2011
Miangeni	Kamboo	Domestic and Livestock	2009	Dried up in 2011

Source: Authors compilation from Makindu District Water Office data.

The study established that the earth dams were constructed to harness water during rainy season. The earth dams were constructed during the prolonged drought of 2007-2011. An interview with water manager from KIMAWASCO revealed that Kwa-Mweu, Kwa-Munyalo, Kwa-Kasina and Miangeni earth dams were both poorly constructed and maintained hence reducing their water holding capacity. They dried up during the 2011 drought. Further, households indicated that prolonged drought led to lack of recharge of Kwa-Munyalo, Kwa-Kasina and Miangeni earth dams which made them to dry up. When prompted further, households from Mitendeu and Ndovoini Sub-Location argued that siltation and overuse by residents led to reduced water holding capacity of water in Sekeleni and Kwa-Luma earth dams. This statement agrees with Mati *et al*., (2005) who observed that earth dams in Laikipia County were faced by the problems of siltation, high evaporation rates, seepage, ownership and community management. Households stated that Kwa-Luma and Kwa-Mweu earth dams were used for domestic purpose so as to ease congestion from Ngakaa, Ngomano and Kwanzioka boreholes which were all located in Twaandu Location.

5. Boreholes

The area was served by 9 boreholes which included Syumile and Kisingo which were constructed in 1952, Katangini (2007), Kwanzioka (2007), Ndalani (2007), Kwa-Kyambi (2007), Ngakaa (2008), Kalakalya (2009), Ngomano (2011). About 78 percent of the boreholes were sunk during the droughts which occurred between 2000-2011 except Syumile and Kisingo which were sunk in 1952 by colonial government (Table4). Boreholes in the study area were used by households from various Sub-Locations. All the households indicated that drought led to reduced flow of water in the boreholes.

Table 5: Boreholes in the Study Area

Name of the borehole	Sub-locations it serves	No. rural households	Quality of water	Uses	Year it was sunk
Syumile	Syumile	1483	Saline	Domestic and livestock	1952 (Colonial Government)
Kisingo	Kisingo	1110	Saline	Domestic and Livestock	1952 (Colonial Government)
Katangini	Muuni	3580	Fresh	Domestic	2007
Kwakyambi	Kalii	750	Saline	Domestic	2007
Ndalani	Kalii	750	Saline	Domestic	2007
Kwanzioka	Ngakaa	786	Saline	Domestic	2007
Ngakaa	Ngakaa	786	Saline	Domestic and Livestock	2008
Kalakalya	Muuni	3580	Fresh	Domestic	2009
Ngomano	Twaandu (Mitendeu sub-location)	651	Saline	Domestic and livestock	2011

Source: Authors compilation from Makindu District Water Office data.

Analysis of data from Table 5 indicates that 70 percent of the boreholes were saline while 30% were fresh water. However, water from boreholes was used both domestically and for livestock.

6. Spring

Makindu sub-county is served by one spring namely Kwa-Vombo. The spring gets its water from Chyullu hills. This spring serves rural households from five zones namely Kiu sub location, Misongeni, Manyatta, Shauri moyo and yinzau. Water is pumped in bulk from the spring and stored in large water projects from which selling kiosks have been built to enable easy accessibility by the households. The water projects include Mulilii, Kai, Ikoyo, Nzouni, Kisae-Miangeni and Kiu-Muuni water project. Results showed that 85.7 percent of the households perceived that drought led to reduced flow of water in the spring while 14.3 percent of households stated that encroachment of people who practiced irrigation farming around the spring contributed to reduction levels of water leading to rationing of amount of water supplied to households' (Table 6).

Table 6 Impact of Prolonged Drought on Kwa-Vombo Spring

Impact of Prolonged Drought on Kwa-Vombo Spring	No. of Households'	Percentages (%)
Reduced flows	317	85.7
Others e.g. Encroachment of people near the spring for agricultural activities,	53	14.3
Total	**370**	**100.0**

Source: Authors Compilation from field data.

The study established that prolonged drought of 1985-1987 led to notable reduction of water in the spring compared to mild drought of 1991, 1993, 1995 and 1996. During these mild droughts, the water company (KIMAWASCO) established connections by use of pipes to increase water accessibility and shorten the distance travelled by households. According to WARIS (2015), 2,596 rural households' had access to piped water which was connected from the year 1991 to 2015 when the spring was taken over by government from Railway Company. The households' resided in Mulilii, Kyale, Manyatta, Kiu, Syumile, Kisingo, Kai and Kamboo sub locations. According to Makindu area water manager the spring also supplied water to 340 multi-dwellings, 53 kiosks, 117 commercial water users, 20 schools and 72 institutions (Table 7). The study established that the severe drought of 2005 (-1.76) led to reduced flow ever experienced since the spring was established. This prompted KIMAWASCO to ration the amount of water used by the households' and institutions leaving water taps dry. During this period Germany Agro-Action started construction of masonry tanks to the communities to help them get water from one point as it is pumped from the spring.

Table7 Water Service Coverage Scheme in the Area from 1991-2015

Categories of Consumers	Total Number of Consumers
Households	2,596
Multi-dwellings-small, medium, large	340
Kiosks managed by WSPs	53

Source: WARIS Data, KIMAWASCO-Makindu Area.

Conclusions

Kenya is classified as 88 percent arid and semi-arid. Therefore, drought is recurrent phenomenon in these regions. As perceived by the households, drought impacted negatively on water sources leading to reduced flow of water volumes and drying up. Other causes included high rate of evaporation, overuse by households, siltation, leaching and encroachment to water sources. Households should therefore embrace adaptation and coping strategies to ensure water availability. This paper will be suitable and applicable to policy makers, County government and non-governmental agencies as they carry out water management projects to sensitize community best water management practise.

Recommendations

The study recommends the following;

1. Integration of rural households' perceptions on impact of drought on water resources with rainfall data from Makindu Meteorological station is necessary for adequate planning, policy making and acquiring the best adaptive strategy to drought induced water shortage.
2. Proper use and fencing of Kwa-Vombo since it is the main source of water and is crucial for the future of water availability in Makindu Sub-county. The County government should therefore sensitize people on the importance of that spring to the future of water availability in the Sub County.

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