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Sources, Accessibility and Reliability of Water for Various Uses in Ruiru District of Kiambu County, Kenya

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Abstract

Numerous challenges regarding the availability of water availability for various socioeconomic development activities exist in many areas across the globe. This is particularly so in most peri-urban areas where scarcity is one of the critical problems affecting sustainable development of these areas. In this study, sources, accessibility and reliability of water in Ruiru District of Kiambu County in Kenya were examined. A multistage sampling design using both stratified and random sampling techniques was used to select the required sample. A household survey approach with the aid of questionnaires and observation record sheets were used to collect data from representative sample of 198 households in three different clusters. The data collected was analyzed using frequencies, percentages and ranking. The study established the main water sources to be tap water, borehole, wells, rivers and Community Based Organization’s supply. Most of the sources were found to be inaccessible of their location at various distances from the homesteads. It is recommended that efforts be made by water providers to improve access to water so that people can be engaged in other productive activities instead of spending a lot of time to access water. Appropriate water conservation measures such as protection of water and storage should also be encouraged through public awareness.

Keywords: sources, water, peri-urban, conservation, Ruiru

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1. Introduction

Most peri-urban areas of Kenya face serious water availability challenges which affect the social and economic development of these areas. Ruiru District in Kiambu County is an example of an area that faces water shortages and land use changes that has led to transformations in the hydrological, ecological, geomorphological and socio economic systems in the area. The District is also characterized by a high population from different ethnic communities of the country. The high concentration of people has placed enormous pressure on the available water resources. This has increased demand on the available water supplies. At the same time, under decentralization of policies, the responsibility for delivering such services face a lot of facilitation challenges in terms of financial and human resources. As a result these areas have suffered slow progress towards sustainable water development [4].

The problem of access to water sources is one of the major problems that currently confront many communities in the world. According to the Kenya's Poverty Reduction Strategy Paper (PRSP) 2000-2003 study found that access to improved water sources (piped water) by both rural and urban populations is limited (30% and 70% respectively) and declining due to non-performance of existing schemes. Moreover, 73% had pipe network but had no water or experienced irregular flow of water. The study also observed that households without access to pipe water tend to rely on a variety of less reliable sources, including mobile water tankers, fixed vendors of water, shallow wells and deep wells, boreholes, springs and commercially bottled water. Lack of water threatens progress towards sustainable development in the peri-urban areas of the country. The unregulated use of water in these areas has caused over-exploitation and degradation of water sources leading to drying of rivers and shallow boreholes [9]. This leads to increased water scarcity which in turn leads to competition for available water sources for domestic, livestock and irrigation activities. This competition leads to low levels of agricultural production leading to starvation of the people and livestock which eventually results in the people being supplied with relief food in these areas.

Most studies have focused on highlighting the current water shortage and management in the urban and rural areas. Research in water management in cities has been restricted to large capital cities. There is a lack of studies relating to other smaller cities especially small and medium size ones and in particular the peri-urban areas. Much of information on water use and management is reported within figures for total annual water consumption or is contained in information about existing problems. There appears to be no specific information about water use and management in the domestic, livestock and irrigation sectors in peri-urban areas. This study addressed the management of water resources in the peri-urban areas of Ruiru District from the perspective of the various sources from where water is drawn, the accessibility of these sources and the amount of water used in the various sectors and the methods used to conserve water in the District.

The district falls within the arid and semi-arid lands (ASALs) of the country and receives a mean average annual rainfall of between 116mm and 965mm [4]. The problem of low precipitation in the area is compounded by exceedingly high rates of potential evaporation that also affects the volume of water accessible to households since some water sources such as surface wells dry- up. Agricultural activities in the District have been affected by lack of sufficient water. The farmers grow crops like maize, beans, bananas and Napier grass. The rain that falls in the District doesn't support crops to maturity. This results in food shortages such that people are supplied with relief foods. The farming lands are being subdivided into small plots of quarter and an eighth of an acre for residential purposes due to shifting production activities and little benefits from crop farming. Existing records show that the number of livestock has decreased drastically due to water shortages that have affected livestock farming since the available water is first used for domestic purposes. The number of chicken, on the other hand, are on the increase because many people keep them and also possibly because of the many people settling in the area who provide good markets for their products. The district is in Kiambu County and lies between latitudes 3°53’ and 1° 45’ South and longitudes 36° 35′ and 37° 25′ East. It covers an area of about 527 km². It is bounded to the north by Gatundu and Thika West Districts, to the east by Gitrhunguri, Kiambu and Nairobi North Districts and to the south by Nairobi East and Kangundo Districts. The district includes within its boundaries two administrative divisions, six locations and ten sub-locations as shown Figure 1.

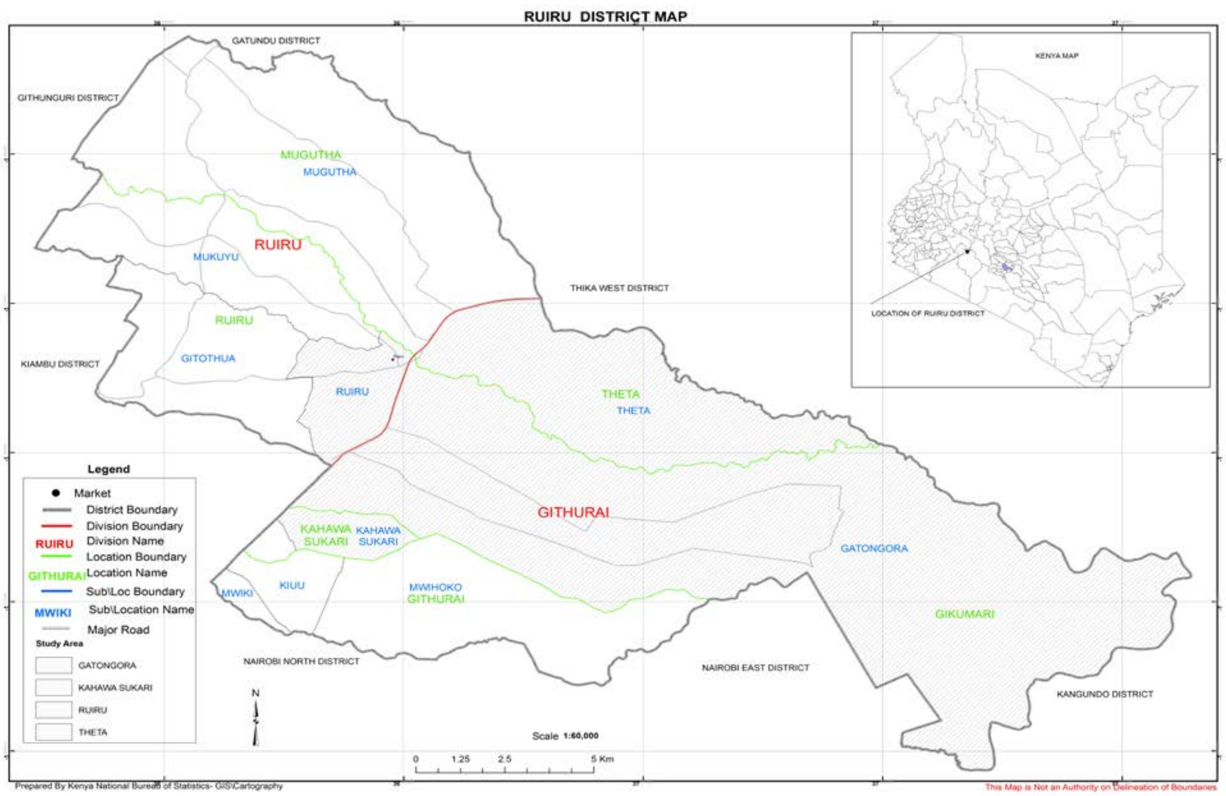

Figure 1. *Location of Ruiru District showing the sites where the study was conducted*

The district is dominated by peri-urban activities and due to its proximity to Nairobi city and Thika town, a significant population working in the two towns resides within the district and its environs. According to the Kenya’s National Bureau of Statistics the population of Ruiru District had grown at approximately 10% in 2009. This has significantly increased the population density and consequently increased the demand for water in the district due to increasing multiple economic activities such as small scale but intensive crop and livestock production systems which require significant amounts of water.

2. Study design and sampling procedures

The study used a multistage design involving stratified and random sample surveys with the help of household questionnaires. The purpose of the survey was to obtain information of the sample so as to generalize for the population so that inferences could be made about certain parameters. The information required from the study included establishing the main sources of water, their accessibility and reliability for use in the domestic, livestock and irrigation activities. The district has two Divisions namely Ruiru and Githurai. These are subdivided into six divisions and ten sub-locations. A simple random sampling method was used to select representative sub-locations for the study. Each sub-location was assigned a random number. Using shuffled numbered sub-location specific balls, a ball was picked at random without replacement. The process was continued until 40% of the total number of sub-locations was attained. The four sub-locations selected in the study were Kahawa Sukari, Gatongora, Theta and Ruiru.

The plot sizes in the study area range from 40x60 feet to several acres [4]. Because of multi-demand in terms of water needs and usage, the study formed clusters as structure of the study based on plot sizes. The study was carried out on three types of plot sizes: 100x100 feet, 200x250 feet and 200x650 feet which were considered as *Cluster I* or small plot sizes, *Cluster II* was of medium plot sizes whilst *Cluster III* comprised large plot sizes, respectively. This is because these plot sizes are owned by the majority in the peri-urban areas of the study sites and are considered to have multiple water uses such as domestic water use, livestock water use and water use for irrigation [4].

A list of all residential estates in the three sub-locations was then obtained from the Ruiru District listing of 2006. Using the list obtained, only the residential estate that had the above plot sizes were marched to one of the three clusters thus giving rise to the formation of 19 estates. Random sampling was then used to select 40% of the estates from each cluster for use in the study (Table 1). The sample size was calculated based on the standard formula for categorical data [3]. The sample was further increased by 5% to account for contingences such as non-response or recording error. The sample size for the household interviews was therefore selected to be 290. The number of selected households was distributed proportionally in the three selected clusters based on population densities. 109 households were selected in *Cluster I*, 97 in *Cluster II* while 78 households were picked in *Cluster III*. In each selected estate, systematic random sampling was used from a central location then moved eastwards then to other directions until all the selected households were visited. Every 5th household was considered until the last respondent was obtained from each cluster. In the case where the key representative of the household was not available, the next household was considered. The head of the household or anybody above 18 years was taken as the respondent for the household.

2.1 Data collection tools and analysis

Household questionnaires, key informant guides, focus group discussion guides and observation record sheets were used to collect data in the field. The raw data from the questionnaires was coded, thoroughly cleaned and analyzed as per the objective of the study. Cross tabulation was used to compare availability of the water sources, their accessibility and reliability for domestic, livestock and irrigation activities in the study clusters.

Table 1. Selected characteristics for cluster formation in Ruiru District

Cluster	Plot size in feet	Estates within the cluster	Names of selected estates
Cluster I Small plot sizes	100x100	Kahawa Sukari, Gitothua, Finance, Manguu, Wendani, Fourty, Githurai Kimbo, Ruiru and Ting'ang'a	Kahawa Sukari, Ting'ang'a, Finance and Ruiru
Cluster II Medium plot sizes	200x250	Gatong'ora, Kihunguro, Iriuko	Gitambaa, Gatong'ora
Cluster III Large plot sizes	200x650	Zone A, B, C, M, N, P and R.	Zone A, M and P

3. Results and discussion

The general background information of the respondents in Ruiru District is summarized in Table 2. Overall, 284 household respondents were interviewed during the study with 62% being females as they are normally the people responsible for taking care of water in the household. A large proportion of the respondents (>50%) had formal education in the three clusters, where 17%, 35% and 33% in the three clusters had attained primary, secondary and tertiary education and only 11% of the total respondents were without any formal education. From the Table, 48% of the total respondents had a family size between 4 to 6 members with *Cluster I* at 54%, *Cluster II* at 46% and in *Cluster III* at 42%. Family income varied in all the clusters. From Table 2, 48% respondents of *Cluster I* earned above Kshs. 40,000 per month as most of them had attained tertiary education and therefore were able to get high paying jobs such as senior civil servants and good businessmen while in *Cluster II* majority 42% of the respondents earned between Kshs. 20,000 and 40,000 and in *Cluster III*, 60% earned below Kshs. 20,000 per month as most of them were farmers and housewives.

3.1 The main water sources their accessibility and reliability for domestic activities

The major sources of water accessed for domestic activities in the district are tap water from the National Water Connection (NWC) mains, supply from the Community Based Organizations (CBOs) mains, boreholes, rivers and wells. 100% of respondents of *Cluster I* accessed the NWC mains, 42% respondents of *Cluster III* accesses CBO water mains through in house water connections and stand pipes, while 64% of respondents of *Cluster II*. The results on water sources accessibility in the clusters could be explained by the fact that *Cluster I* households have piped water distributed in the whole area and that the connection fee was reported to be affordable. It was observed that in *Cluster II* and *Cluster III* residents queued for water at the water *kiosks* indicating that these clusters were significantly underserved with water ($p<0.05$) thus increasing water accessibility difficulties in the two clusters. Due to the water scarcity in *Cluster II* and *Cluster III* as a result of most of the rivers being seasonal, some residents were motivated to drill private boreholes for their own water use and also sell to the community members. Previous studies elsewhere have demonstrated similar findings where due to long queues at the water sources some individuals drill boreholes to sell water to the community in an attempt to solve the problem [1, 8].

Table 2. Socio-demographic characteristics of the respondents in the study area

Parameter	**Description**	**% of Respondents from each cluster**			
		Cluster I (N=109)	*Cluster II (N=97)*	*Cluster III (N=78)*	*Total (N=284)*
Sex	Male	43	40	28	38
	Female	57	60	72	62
Marital status	Single	11	9	12	11
	Married	76	79	78	78
	Separated	1	3	4	3
	Window/Widower	6	5	4	5
	Divorced	3	0	3	1
	No Response	4	3	3	3
Family size	1-3	28	22	24	25
	4-6	54	46	42	48
	7 and above	27	32	33	30
Level of Education	No formal education	0	14	23	11
	Primary	6	22	28	17
	Secondary	32	39	35	35
	Tertiary	50	23	22	33
	No Response	5	2	3	3
Family income per month	Below 20,000	20	38	60	37
	20,000-40,000	32	42	24	33
	Above 40,000	48	20	15	29

17% of the respondents in *Cluster I* accessed rivers for domestic water use, in *Cluster II*, 28% and in *Cluster III* 29%. None of the respondents in *Cluster I* reported accessing river water for domestic water use because the respondents perceived the quality of river water to be polluted. This presumably reflected the prevailing attitude towards river water quality, rather than simply distance to the water source. This may be because the rivers pass through highly populated estates that are not connected to the sewerage system and thus dispose their domestic waste along trenches that drain into these rivers. Further, Ruiru District has several industries which the residents suspect, dispose their waste into the ground. This may find their way into the water sources. The results show water accessibility disparities favoring residents in *Cluster I* over residents in *Cluster II* and *Cluster III*. This could possibly be due to its high population density settlements in the area and improved infrastructure compared to *Cluster II* and *Cluster III* which have low population densities settlements and poor infrastructure. The results were consistent with studies carried out in South Africa which show that water demand and supply for urban and poor urban settlements are less favorable [5].

3.2 Reliability of water sources for domestic activities

The results show that reliability of all the main water sources was reported to be average 50% with 55% from *Cluster I*, 50% from *Cluster II* while 43% were from *Cluster III*. The frequency of main water sources reliability in each cluster was observed to differ significantly ($p<0.05$). Up to 50% of the total respondents reported average reliability of main water sources majority of who were from *Cluster I* at 55% followed by *Cluster II* at 50% and lastly *Cluster III* at 43%. Other respondents (31%) reported main water sources to be unreliable. The majority (36%) of those was from *Cluster III* followed by *Cluster I* at 30% and finally *Cluster II* at 28%. Among the total respondents 19% reported main water sources as reliable. Among them 22% were from *Cluster II*, 20% from *Cluster III* and 15% from *Cluster I*.

There was a strong association between the frequency of the main water sources reliability and study cluster ($p<0.5$). Some of the reasons why respondents in *Cluster I* and *Cluster III* reported average piped water sources reliability were that there was no continuous supply of water from the water pipes while respondents of *Cluster I* reported that borehole water sources were reliable due to the fact that most of the boreholes were always operating. 20% of respondents in Cluster I and 23% of *Cluster III* reported that rivers and boreholes were average in reliability due to the fact that the water sources were mainly accessed through vendors who lacked consistency in supplying the water. This means that there exists inadequate and inconsistent reliability of water sources in *Cluster II* and *Cluster III*. The respondents reported that they are not connected to Nairobi Water Company (NWC) mains who are the major water service provider in Athi Water Catchment where Ruiru Division is located. This could be due to the fact that cluster II and III have unplanned settlements hence less likely to attract planned and focused services. This result is consistent with that of [7].

The results revealed that the sources of water available to the communities are not enough to meet the water demand of the communities for different sectors. For cluster I the water lacked pressure because of the many connections that have been done arising from the many people who have migrated to the area. The key informant (water officer) reported that the existing water serving pipes were designed for a small population and therefore predicts the need for expansion of the main water pipes to correspond with the population density target in Vision 2030. For cluster II and III all the sources of water aside the river and rain water are privately owned. These private owners determine when the water from their sources is made available to the public and also have full control over the prices. It is therefore not reliable for the community to continue depending on these sources for water.

3.3 Accessibility of water for livestock use

The results show that only 35% of the total respondents kept livestock where 21% were from cluster I, 31% from cluster III and 45% from cluster III. Among the total respondents, 31% reported that their animals mainly accessed river water sources followed by 28% who accessed NWC mains, 20% mainly accessed CBO mains, 10% reported that their animals accessed shallow wells and finally only 9% of the total respondents watered their animals with water from boreholes. The result shows that there were significant differences in the accessibility of the main water sources for livestock use in the study clusters ($p<0.05$). Majority of respondents (90%) in *Cluster I* mainly watered their animals with water from NWC mains while 50% of the respondents in *Cluster II* used river water for their animals. However, 41% of the respondents in *Cluster III* reported that their livestock mainly accessed river water which was accessed away from their home compounds. According to the results, approximately 20% and 9% of respondents in *Cluster I* and *Cluster III* respectively water their animals with water from shallow wells while 28%

and 24% of respondents of *Cluster II* and *III* water their animals with water from CBO mains. No such practice was reported in *Cluster I*. A significant 50% and 41% of respondents in *Cluster II* and *III* used river water to water their animals. This can be explained by the fact that *Cluster II* and *III* had animal watering zone along the rivers cluster I did not have animal watering zone at the rivers and therefore none of the respondents watered their animals at the river while majority of the residents preferred accessing other water sources.

The frequency of animals accessing well water sources in the three clusters was less significant ($p<0.05$) at 20% and 9% in *Clusters II and III*, respectively. The wells were reported to be unprofessionally dug and therefore dried up a few weeks after the rains. This explains why wells were not popular sources of water among the respondents. The available water sources in all the clusters are significantly inadequate for livestock use. The respondents of *Cluster I* reported that lack of reliable water sources made the respondents reduce the number of livestock owned and that others died for lack of enough water. Previous studies have demonstrated near similar findings [6, 2].

3.4 Adequacy of water for livestock use in Ruiru District

The results show that the main water sources for livestock use were average adequacy 45%, 39% inadequate and 18% adequate. This was due to the fact that residents used available water first priority to domestic water use while other uses come after. This explains why there was 24% and 34% of the respondents in *Cluster II* and *III* respectively who reported the water sources as inadequate. Some of the reasons why borehole water sources were regarded as inadequate for livestock use were because the water sources were privately owned, the community boreholes were not operational, and also due to long distances to the water sources. Respondents of *Cluster I and II* reported piped water sources as inadequate source of water for livestock use due to lack of continuous flow and low pressure.

3.5 Accessibility of water for irrigation activities in Ruiru District

The results indicate that accessibility to water sources by the respondents for irrigation water use differ significantly from each cluster ($p<0.05$). According to the results approximately 75% of respondents in cluster I accessed NWC mains compared to 11% of *Cluster III* respondents who accessed CBO mains. This water is normally treated and therefore huge amounts of treated water are lost through irrigation. River water sources were accessed by 18% from cluster I, 85%, from *Cluster II* and 52% were from *Cluster III*. The frequency of the respondents accessing borehole water for irrigation activities in the three clusters is less significant ($p<0.05$) at 7%, 15% and 18% of *Clusters I, II and III*, respectively. This could be because most of the boreholes are privately owned and the few community boreholes are most of the time not operating due to management and maintenance problems.

3.6 Adequacy of water for irrigation use in the District

The results show that the main water sources for irrigation use were adequacy 49%, 37% said the main water sources were average adequate and 14% of the respondents said the water sources were adequate majority 20% were from cluster I, 11% from *Cluster II* and 10% were from *Cluster III*. The frequency of main water sources adequacy for irrigation activities was observed to differ significantly ($p<0.05$). The main water sources were regarded by the majority 49% of the total respondents as inadequate with 36% respondents from cluster I, 50% from cluster II and

65% from cluster III. Among the reasons given include priority, distance to water sources and cost involved in accessing the water sources. The respondents reported that available water is given first priority to domestic water use while all other uses came later. This explains why the majority of respondents indicated the main water sources as inadequate for irrigation activities. The findings also indicate that significant proportions of the residents in the three clusters do not carry out irrigation activities ($p<0.05$). Among the reasons given include inadequacy of the water sources due to the fact that the District falls within the semi arid areas of Kiambu County which due to the hot climate and land degradation make several sources of water to dry and others seasonal. This therefore makes irrigation activities difficult.

In cluster I majority of respondents (80%) reported that the available water sources were averagely adequate to inadequate for irrigation activities. This was reported to be due to lack of continuous flow of pipe water and that the boreholes were privately owned. Due to the cost of availing enough water for irrigation only 20%, 2% and 10% from *Cluster I, II* and *III* respectively reported that the water sources were adequate. The unprotected water sources were considered by the majority as inadequate except the rivers. This was reported to be due to the fact that most of them were seasonal as well as competition with other uses such as domestic and livestock use and also distance to the sources.

4. Conclusions and recommendations

The study revealed that there are various main sources of water that are available to the community in Ruiru District. The sources are NWC mains, CBO's mains, boreholes, rivers and wells. The residents in the District accessed specific main water sources for use in domestic, livestock and irrigation activities. The residents of cluster I access NWC mains for their domestic, livestock and irrigation activities, those of cluster II accesses CBO's, boreholes and rivers while the residents of cluster III access CBO's mains, boreholes, wells and rivers for their domestic, livestock and irrigation activities. Despite the fact that there are various water sources in the District, most of them are regarded by the respondents as averagely reliable to unreliable due to lack of continuous flow. Some are seasonal and others are non-operational while some are contaminated, located far away from residential areas and high costs of accessing them make them unreliable. The constraints faced in this study included lack of support and or minimal support from various stakeholders who were required to provide information on the status of water resources in the district. Other respondents were suspicious of the study and so were unwilling to answer questions put to them. Lack of understanding was another constraint by some stakeholders regarding the critical issues related to the study.

Several recommendations can be made from this study. They include

a) Concerted efforts to improve water sources reliability in the three clusters by adopting several short term solutions such as water storage. In essence, this can reduce the number of visits made at various water source points such as rivers, boreholes and wells.

b) Initiating public awareness and sensitization regarding protection of water sources, availing new water sources in the District. This would play a major role for it would pass information to the residents/extension workers and students so that people can change their attitude and culture towards technology. This would be important to the community so that roof rain water harvesting, use of dual flush toilets and use of efficient taps could be increased and installed for its sustainability. Specific efforts should be made through the Ministry of Water and Irrigation and other related actors to increase water conservation awareness programmes through workshops, seminars, chiefs' barazas and public meetings to enable the people appreciate the importance of water management in the District.

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References

[1] Abu-Eid A. Water as a Human Right: the Palestinian occupied territories. *International Journal of Water Resources Development,* 36:233-247, 2007.

[2] Akhilu Y, Wekesa M. Livestock and Livelihoods in Emergencies: Emergency Response in the Pastoral Sector in Kenya. OAU-IBAR, Kenya and Feinstein International Famine Centre, USA, 2001.

[3] Bartlett JE, Kotrlik JW, Higgins C. Organizational research: Determining appropriate sample size for survey research. Information Technology, Learning and Performance Journal, 19, 235-348, 2001

[4] Government of Kenya (GoK). Kiambu District Development Plan, government Printer, Nairobi, 2002.

[5] Macy P. 'Urban water demand management in Southern Africa: the conservation potential', Swedish International Development Cooperation (SIDA), Harare, Zimbabwe. 2001.

[6] Peden D, Taddese G, Mulugeta M. Improving the water productivity of livestock: An opportunity for poverty reduction: Ministry of Agriculture, Addis Ababa, Ethiopia, 2003.

[7] Postel S, Thompson BH. Watershed protection: capturing the benefits of nature's water supply services. Delft, Netherlands, 2005.

[8] Nowlan L. The Human Right to Water, Water Perspectives. *International Journal on Water Policy and Perspectives.* www.worldwaterinstitute.org/docs/WP2.doc [Nov. 24, 2011].

[9] Turton AR,Warner J. Exploring the population/water resources nexus in the developing world. In Dabeelko, G.D (ed). Finding the source: linkage between population and water. Washington DC. 2002.