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Factors Influencing Sustainable Household Domestic Water use in Nzoia River Basin, Kenya

[*1]Ernest Othieno Odwori, [2]Prof. John F. Obiri

[*1] Ministry of Water, Environment and Natural Resources, Kakamega County, Kenya.

[2]Department of Disaster Management and Sustainable Development, Masinde Muliro University of Science and Technology, Kakamega, Kenya

Corresponding author: [*1] Ministry of Water, Environment and Natural Resources, Kakamega County, P.O. Box 36-50100, Kakamega, Kenya

ABSTRACT

A comprehensive understanding of the factors influencing domestic water use is necessary for effective and efficient design of water management strategies. Despite global efforts to identify the factors that influence domestic water use, those related to domestic water use in rural regions such as Nzoia River Basin in Kenya have not been sufficiently studied. To address this gap, we investigated 403 households in three counties of Nzoia River Basin (Trans Nzoia, Kakamega and Busia) between May, 2017 and September, 2017 with a view of assessing various socio-demographic, economic, cultural and geographical factors influencing domestic water consumption/use. Data was collected from households using multi-stage random sampling technique and analyzed with SPSS (Statistical Package for Social Sciences) software. Household water consumption was found to be correlated with socio-demographic, economic, cultural and geographical factors. Results show that domestic water consumption (liters per capita per day) was positively correlated with; age of household head, gender of household head, household income, amount paid for water per month, number of functional water sources available, hours of water service in 24 hrs., volume of water stored/number of water storage containers, vegetable gardening and yard area and possession of livestock. A negative correlation was observed with education of household head, household size, main dwelling in terms of roofing materials, main dwelling in terms of walling materials, main dwelling in terms of flooring materials, total time taken to walk to get water and back and distance covered to reach water source. It is important to note that some of the independent variables are endogenous; that is, they are influenced by some of the same variables that determine domestic water consumption. Statistical analysis has been done utilizing a Pearson correlation matrix with a view of minimizing complexity and simplifying the interpretation of data. It would be desirable to extend this work to cover other un-surveyed counties of Nzoia River Basin on different seasons of the year and also to include investigations on water quality. Further research that considers a wider range of socio-demographic, economic and cultural factors influencing domestic water consumption such as gender of the household head, ethnicity, traditional habits and cultural background of water consumers, religion, residential tenancy arrangements, water use characteristics of each member of the household and climate conditions are recommended.

Keywords : Nzoia River Basin, Domestic Water Consumption, Socio- Demographic, Economic, Cultural and Geographical Factors.

I. INTRODUCTION

Water is one of the vital and most fundamental natural resources and an essential component of life on the earth's surface. Worldwide, 663 million people lack access to safe drinking water although there is regional variation. The populations without access to safe drinking water are mainly in Sub-Sahara Africa and Asia accounting for 84.33% of the total. Of the 663 million people, 319 million people (51.88%) are in Sub-Saharan Africa while 260 million people (39.22%) are in Asia (WHO/UNICEF JMP, 2015). Sub-Sahara Africa has the largest population without access to safe drinking water. Millions of people in rural communities and poor urban centers throughout this region suffer from lack of clean, safe drinking water (The Water Project, 2015). Safe drinking water provision in rural areas of Africa and Asia still remains a major challenge. Although domestic water use/consumption accounts for only 7% of the total water use in Africa (Hinrichsen et al. 1997), the benefits related to an improved water supply, such as effects on health, time savings and high productivity, are quite immense (Sharma et al. 1996).

In the first large-scale assessment of domestic water use in Africa, researchers examined the use of water for basic consumption, hygiene, and amenities in domestic life (Thompson et al., 2001). Numerous studies on water supply were based on the findings of the Drawers of Water I (DOW I) study (Rosen and Vincent, 1999). The findings from the DOW I study revealed that increasing the quantity of water used per capita was more important for a household's health and well-being than improving its quality. The United Nations World Water Assessment Programme (UN WWAP) (2009:97) has noted that "our knowledge of water use is poor" and the limited knowledge of water use patterns inhibits the ability to manage water resources appropriately.

A further review of the literature suggests that, from the late 1960s, North American economists moved ahead in investigating the factors influencing domestic water use/consumption and focused on price and income as a means of regulating water demand. (Corbella and Pujol, 2009), Arbues et al. (2004), and Garcia and Reynaud (2004) demonstrated that domestic water consumption is significantly influenced by price. In addition, Arbues and Villanua (2006) and Hoffmann et al. (2006) emphasized the influence of income on domestic water consumption. In reality, domestic water consumption is not only influenced by economic factors but also by socio-demographic factors such as population growth (Morehouse et al. 2002), age (Kenney et al., 2008), education (House-Peters et al., 2010), age of building (Chang et al., 2010), and number of bed rooms (Fox et al., 2009).

Recently, there have been demands for further research into socio-demographic factors of water demand to complement information regarding economic factors such as price and income (Corbella and Pujol, 2009). The Intergovernmental Panel on Climate Change (IPCC) indicated that residential water demand management will be a critical issue that will engage the attention of city authorities due to projected decrease in water supply and increase in demand for water (Bates et al., 2008). In order to address the demand for water, there have also been calls to understand domestic water use behavior and the factors that influence it (Russell and Fielding, 2010). Efficient management of water resources for rural areas requires a full understanding of existing patterns of water demand. Demand analysis can help to determine factors influencing water use, predict their effect and help to develop policy options

accordingly. For policy makers and water planners to effectively manage water resources, they must consider the factors influencing water use; and it's against this background that the present study seeks to examine factors influencing sustainable household domestic water use in Nzoia River Basin, Kenya.

II. MATERIALS AND METHODS

A. Description of study area

The study was carried out in Nzoia River Basin which lies entirely within Kenya along the border with Uganda in the Lake Victoria Basin. The Basin is located between latitudes 1^0 30' N and 0^0 05' S and longitudes 34^0 E and 35^0 45' E and has an area of 12,959 km^2 and a river length of 334 km up to its outfall into Lake Victoria (Figure-1).

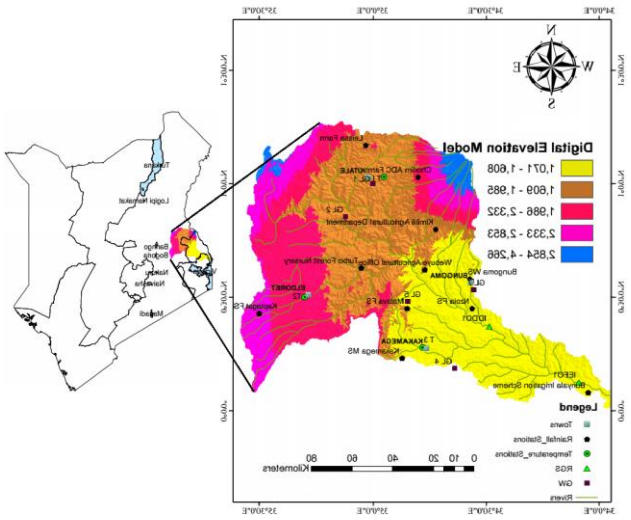

Figure 1 : Map of Nzoia River Basin, Kenya
Source: Author, 2017

The county governments within Nzoia river basin have put a lot of emphasis on up-scaling safe drinking water coverage which currently stands at 51% as compared to the national figure of 58% (83% in urban areas and 50% in rural areas) (WASREB, 2015).

This region has tropical humid climate characterized by day temperatures that vary from 16 °C in Cheranganyi and Mt. Elgon areas to 28 °C in the lower semi- arid plains of Bunyala. Night temperatures vary from 4 °C in the highlands to 16 °C in the semi-arid lowlands. The highest rainfall ranges from 1100 – 2700 mm annually. Lowest rainfall ranges from 600 – 1100 mm annually. The dominant topography consists of rolling hills and lowlands in the Eldoret and Kitale plains. The dominant land use in the region is agriculture and the main food crops include maize, sorghum, millet, bananas, groundnuts, beans, potatoes, and cassava while the cash crops consist of coffee, sugar cane, tea, wheat, rice, sunflower and horticultural crops. Dairy farming is also practiced together with traditional livestock keeping (WRMA, 2012). The basin's population of approximately 3.5 million people live in the nine counties of Elgeyo/Marakwet, West Pokot, Trans Nzoia, Uasin Gishu, Nandi, Kakamega, Bungoma, Busia and Siaya.

Groundwater is the main domestic water resource, supplying 78.8% of the residents leaving 21.2% for surface water resources. Many of the large piped schemes supplying the towns and rural areas have their intakes built on rivers, hence the classification under surface water. On the existing sources of domestic water supply, 62 % of the residents of Nzoia River Basin use improved water sources. Out of these, 3 % use piped water into dwellings, 7 % water piped into compound, yard or plot, 3 % public tap/standpipe, 6% tube well or borehole, 11% protected dug well, 31% protected spring and 1% rainwater collection. Those using non-improved sources are 38%. Out of these, 10 % use unprotected dug well, 19 % unprotected spring, 1% tanker truck/cart with small tank, 8 % surface water (river, dam, lake, pond, stream, canal, irrigation channel) and 0 % bottled water. The variability in use of sources during dry and wet seasons is quite small.

B. Data collection and analysis

The survey was carried out from May, 2017 to September, 2017. The study adopted survey research design and sought to establish the factors influencing

sustainable household domestic water use in Nzoia River Basin, Kenya. Random sampling was used to select Trans Nzoia (upper basin catchment), Kakamega (middle basin catchment) and Busia (lower basin catchment) counties from the nine counties of Nzoia River Basin for household survey. A pilot study (or pre-test) was used to identify errors and omissions, and to familiarize the Research assistants with the process and tools. The pre-test survey was conducted in the neighbouring Siaya county. 403 household questionnaires were proportionately divided amongst Trans Nzoia, Kakamega and Busia based on the number of households under each county. The households interviewed under each of the ward units were selected through multi-stage random sampling. This sampling technique was deemed ideal as it gave the targeted population equal chances of being represented. The unit of analysis in the study was the household. The household head was the targeted respondent.

The Key informant interview method was used for more in-depth data collection from community members, and in particular, institutional representatives, who had diverse experiences on factors influencing household domestic water use. The aim was to get information that would not easily be obtained from the other data collection methods. The Key informant interviews were conducted with selected community members based on their experience in the subject matter and experts from selected organizations. The national government, county government, parastatals, private sector and NGO officials were identified based on the work of their respective institutions in relation to domestic water use in the study area. A total of 51 key informant interviews were conducted with the Researcher capturing data on flip charts, note books and voice recording tapes.

Informed by the fact that some respondents get the motivation to share their views while in a group, focus group discussion was used to get in depth knowledge about factors influencing domestic water use in the study area. The FGD was chosen to provide more detailed interactive information as it created an environment in which the respondents freely discussed the issues at hand and were allowed to give their personal opinion regarding the issues. A total of nine FGDs were conducted with each FGD meeting having between 8-12 participants. The researcher also used observation checklists to collect additional data while in the field.

Data processing involved data cleaning and identifying contradictions in the generated data and hot pursuits being made through face to face interviews. The responses given by various respondents were categorized into specific themes and sub-themes of either qualitative or quantitative data. Qualitative data was descriptively analyzed and presented in discussion form while quantitative data was analyzed using the embedded methods in Statistical package for social scientists (SPSS).

C. Ethical Consideration

The ethical approval for this study was obtained from the National commission for science, technology and innovation (NACOSTI) with issuance of research permit requiring adherance to all conditions spelt therein .At all levels of data collection, the relevant administrative officials were contacted and permission secured. All the necessary explanations about the purpose of the study and its procedures were explained with the assurance of confidentiality for the respondents.

III. RESULTS AND DISCUSSION

Establishing the relationship between domestic water use -demand (dependent variable) and the factors

influencing use/consumption (independent variables) by use of correlation is a convenient way of tracing the driving forces (Keshavarzi, et al., 2006). To help understand this relationship, a correlation matrix was constructed among 16 independent variables namely; age of household head, gender of household head, education of household head, household income, household size, amount paid for water per month, number of functional water sources available, main dwelling in terms of roofing materials, main dwelling in terms of walling materials, main dwelling in terms of flooring materials, total time taken to walk to get water and back, distance covered to reach water source, hours of water service in 24 hrs., volume of water stored/number of water storage containers, vegetable gardening and yard area and possession of livestock. Table 1 shows the nature of relationship between household water use/consumption (per capita water consumption), dependent variable, and the 16 independent variables identified.

It is evident from the correlation matrix that there are several independent variables which have significant positive correlation with water consumption. Age of household head ($r = 0.28$, $P < 0.01$) and Household income ($r = 0.49$, $P < 0.01$) have a significant positive correlation with water consumption. This implies that where there is higher age of the household head and accelerated income, it aids to increased consumption of water. This is possibly due to the different attitudes of elder and rich individuals of the families where they prefer a luxurious and comfortable life. Similar results were also revealed by (Chen, et al. 2012) where they emphasized that domestic water consumption is highly influenced by the age and income of the family head in China which controls the quantity of water use. Household level of income does influence access to water and the water sourcing behavior of households in a great way as several studies have shown. Smith and Hanson (2003) established that household income is one of the main determinants of access to water and sanitation facilities. From their study conducted in Cape Town, South Africa, households with lower incomes (below 800 rands) have limited opportunities to improve their water and sanitation conditions. Bosch et al. (2001) indicates income levels of households as one of the factors that determine access to water and sanitation facilities and services. This is because, the low-income groups are hardly able to afford high connection fees to piped water and hence limit their connectivity. Fotue, et al. 2013, in a study on awareness and the demand for improved drinking water sources in Cameroon found that a household's wealth index has a statistically significant role in demand for drinking water quality. Households that are better-off are more likely to consume safe and reliable water.

Table-1: Nature of relationship between Household water consumption (per capita water consumption) (dependent variable) and 16 independent variables

Independent variables	Relationship with per capita water consumption
Age of Household head	+
Gender of Household head	+
Education of household head	-
Household income	+
Household size	-
Amount paid for water per month	+
Number of functional water sources available	+
Main dwelling in terms of roofing materials	-
Main dwelling in terms of flooring materials	-
Main dwelling in terms of walling materials	-
Total time taken to walk to get water and back	+

Distance covered to reach water source	
Hours of water service in 24 hrs.	
Volume of water stored/number of water storage containers	
Vegetable gardening and yard area	
Possession of livestock	

Source: Author's survey data, 2017

Totouom and Fondo (2012) used the per capita expenditure as proxy for household welfare in their study and their conclusion was that as households become better-off, they are much more likely to choose improved quality water. Bosch et al. (2000) notes that many poor households have access to lower-quality services than non-poor households. They further claim that fewer poor households are connected to water networks. Studies have shown that majority of the urban poor who live in the slums are disproportionately underserved (World Bank, 2003). In most cases these people are almost never directly connected to the public utility. They not only buy water by the bucket at very high unit prices but also rely on vending systems, and therefore consume poor quality and little water. Moreover, the benefits of subsidized water accrue primarily to wealthier households connected to public networks. Poorer households do not benefit of such subsidies since they have irregular or non-potable water supplies and have to purchase water from other, non-subsidized sources (Fotue, et al. 2013). Mahama (2013) in a study to establish factors which influenced householders' access to improved water and sanitation facilities in five selected low-income communities in Accra, Ghana, found that income (wealth) statistically influenced the likelihood of access and use of improved drinking water.

Amount paid for water per month and the number of functional water sources available is another group of variables showing significant positive correlation. A positive relationship exists among number of functional water sources available ($r = 0.19$, $P < 0.05$) and amount paid for water per month ($r = 0.15$, $P < 0.05$) with domestic water consumption at significance level of 0.05. People use more water when it is easily available at a fixed cost and vice versa and this is a contributing factor for the high significant positive relationship.

A negative correlation on water consumption is observed with household size ($r = -0.17$, $P < 0.05$), total time taken to walk to get water and back ($r = -0.33$, $P < 0.01$), walking distances covered to reach water source ($r = -0.41$, $P < 0.01$) and education of household head ($r = -0.19$, $P < 0.01$). Household size has consistently been found to be inversely related to per capita water consumption in previous studies (Darr et al. 1975; Feachem et al. 1978; White et al. 1972; Wong 1987). This negative correlation implies that in households with larger families, average water consumption per person is suppressed and distant water source leads to low water consumption. This is consistent with the findings of (Schefter, 1990) and (Martin, 1999), which conclude that domestic water consumption is highly influenced by the increase in the number of single-family homes. The relationship among the household size and water consumption demonstrates that increase in water consumption can be better explained by the expansion in the number of households rather than population growth. Studies in rural Nicaragua in Central America have also shown that household size, site of clothes washing, types of water source and distance to water source were negatively correlated with per capita daily domestic water consumption (Sandiford, et al. 1990). Households with more family members use larger quantities of water, but the average water consumption per person decreases. Keshavarzi et al.

2006 shows that water consumption per capita is lower in large families than in small families because some water usage activities (use for kitchen, vegetable gardening, livestock needs, and house and yard cleaning) are relatively independent of family size. Sandiford, et al. 1990, observes that decrease in the distance to the water source from 1000 to 10 m drives water use to increase up to 20% which is in-consistent with our finding of negative relationship of water consumption and time to collect water due to distance associated.

The negative correlation observed for household head's education is due to the attitude towards proper water management at household level, where educated individuals are highly informed. On contrary, the findings of (Keshavarzia, et al. 2006) suggest higher education of the family head leads to more concern to use water for hygiene in Iran. Nonetheless, the attitude of water use depends on many other extraneous factors such as topography, water availability, climatic factors which can also be the contributing factor in our study for the negative relationship. Fotue, et al. (2013) indicates that the level of education especially for the household head is very vital in influencing access to clean drinking water by households in many parts of the world. Lack of or low level of educational attainment serves as a great barrier to empowerment. Bosch et al (2001) also noted that the lesser the educational attainment of an individual, the more he or she has limited opportunities to demand better facilities from the authorities as he or she is powerless. Level of education is believed to play an important role in understanding how safe a water source can be and what measures can be taken to have access to water of good quality.

Gender of household head ($r = 0.13$, $P < 0.01$) has a positive correlation with water consumption in the households. According to DFID, (2003) the impact of collecting water from traditional sources (particularly during the dry season) takes its toll on the livelihood opportunities of women and girls in particular whereas investment decisions to improve water sources at the household level usually rest with men in their role as household heads. Totoum,et al (2013) notes that gender of the head of the household plays a role among the determinants of household choice of water source. Totoum, et al. (2012) suggests that female-headed households are more likely to adopt private tap or collective tap as main water source, compared with male-headed households. Totoum et.al (2013) looking at gender explained that women, because they are the ones most frequently collecting water, better understand water quality than other household members who are fetching water much less frequently. Mu et al. (1990) using data collected by in-depth personal interviews from 69 households in Ukunda, Kenya found that the number of women in a household greatly influenced its decision on where to source their drinking water from.

Oyekale and Ogunsanya (2012) reveals that rural households' access to safe water is negatively affected by the sex of the household head. The implication is that male headed households have significantly lower access to portable water. The argument they advance is that women are domestically more inclined towards water fetching. Abebaw et al. (2010) similarly found that in Ethiopia, female headed household have higher probability of having access to improved water sources and one of the reasons adduced was that women and children are directly responsible for fetching water and as heads and decision makers, they may be more inclined to invest in the effort of fetching clean water. Women possess the power to allocate and determine how and who uses what water in households.

A negative correlation on water consumption is observed with main dwelling in terms of roofing

materials ($r = -0.16$, $P < 0.05$), main dwelling in terms of walling materials ($r = -0.20$, $P < 0.05$) and main dwelling in terms of flooring materials ($r = -0.21$, $P < 0.05$). Housing conditions have implications for provision of other services such as connections to water supply, electricity, and waste disposal. A study conducted by Gazzinelli et al. (1998) revealed that certain socio-economic factors, house quality, type of water source, and a utility index were significantly correlated with water use. The majority of main dwellings in the households within the study area had corrugated iron sheet roofing. The iron sheets roofs also make it possible for the residents to harvest rain water for domestic use during the rain season. Even where they don't have big storage tanks, the sufurias, cooking pots, jerricans and small tanks they use provide enough water for household use. This, the study established, significantly reduced the time they spent sourcing for water from other alternative sources that are far away. Household's type of main dwelling structure in terms of roofing, walling and flooring materials can serve as an indicator of the wealth status. A close relationship was found between water consumption and the type of household flooring (clay versus concrete or tile), a variable found to be a good indicator of wealth in this setting (Sandiford et al. 1989). There is a close correlation between wealth and domestic water consumption. Other studies have also observed associations between water consumption and socio-economic indicators (Darr et al. 1975; White et al. 1972; Wong 1987). There are several reasons why poor people might consume less water. On the one hand they may have fewer tools or equipment associated with water use, smaller gardens, or fewer containers and less time to draw water. On the other hand, there may be cultural factors such as differences in hygiene practice between the wealthy and the poor.

A positive correlation with domestic water consumption was also observed with hours of water service in 24 hrs. ($r = 0.15$, $P < 0.05$), volume of water stored/number of water storage containers ($r = 0.26$, $P < 0.05$), vegetable gardening and yard area ($r = 0.19$, $P < 0.05$) and possession of livestock ($r = 0.13$, $P < 0.05$). Surprisingly, households that receive 24-hour water services show a lower per capita water consumption. This is explained by the fact that probably the source may have intermittent flow of water or low flow rates of the water. Thus, although water may be available at a particular water source 24 hours a day, the total volume that can be collected may not be adequate for the households' daily needs. Where water is available in abundance at source for 24 hours, household water consumption is expected to increase. Per capita water consumption in households will increase when there is an increase in the volume of water stored/number of water storage containers. This suggests that the ability of a household to store more water is increased when there is an increase in the volume or number of water storage containers. The health implication of the use of large storage containers (above 40 liters) or securing more than one storage container is that it affords the household the ability to collect more water for domestic, as well as hygiene, purposes. Vegetable gardening is crucial to rural households in developing countries and more so Kenya's Nzoia River Basin as it increases the annual income of small farm families by providing fresh vegetables (partly for sale) and reducing the food budget.

Vegetable gardening strongly affects water consumption because watering gardens accounts for the largest outdoor water use, or specifically, more than 50% of outdoor water consumption. The number of livestock kept in each household shows a positive correlation with water consumption but this relationship is not statistically significant. This result was due to the fact that different households kept different numbers of livestock units and during the day, majority of these livestock were taken to the

farm where they consumed water from other sources like rivers/streams or existing dams and water pans.

IV. CONCLUSION AND POLICY IMPLICATIONS

The objective of this study was to analyze factors influencing sustainable household domestic water consumption in Nzoia River Basin, Kenya. The results showed that a positive correlation on water consumption is observed with age of household head, gender of household head, household income, amount paid for water per month, number of functional water sources available, hours of water service in 24 hrs., volume of water stored/number of water storage containers, vegetable gardening and yard area and possession of livestock. A negative correlation on water consumption was observed with education of household head, household size, main dwelling in terms of roofing materials, main dwelling in terms of walling materials, main dwelling in terms of flooring materials, total time taken to walk to get water and back and distance covered to reach water source. It is important to note that some of the independent variables are endogenous; that is, they are influenced by some of the same variables that determine domestic water consumption/demand within Nzoia River Basin.

The study established that total time taken to walk to get water and back and distance covered to reach water sources negatively affected domestic water use/consumption/ demand. This could be explained by the high opportunity cost of allocating labor for fetching water, especially in the rainy season. In the study area, the rainy season is the period of farm activities, which represent the main source of income for the area residents; therefore, a water policy intended to reduce the time required for fetching water will likely lead to an increase in the time allocated for productive activities such as cultivating land, sowing and weeding crops, harvesting crops, attending to small scale income generating activities and saving the girl child time for school attendance. This shows that water supply improvements might be of great importance to the population's welfare and poverty reduction. One policy implication is to design and implement a dense network of improved water systems (e.g., drilling boreholes that penetrate into the deep aquifers and equipping them with appropriate hand pumps and solar powered pumping equipment, protecting available water springs and constructing small gravity schemes where applicable, intensifying rainwater harvesting through roof catchment and expanding the existing urban piped water supply schemes to cover the peri-urban and rural populations). The analysis and discussion of the results above shows that poverty reduces water use. This implies that poverty reduction and development policies within Nzoia River Basin must include an objective of water supply improvement.

On water pricing, this study established that 79.2% of the respondents were willing to pay for water bills if supplied with water services. The policy implication to this is that water projects based on the principle of generating revenue from water sales to maintain and manage a water system are likely to be feasible in the study area. However, we suggest that the involvement of the user communities be incorporated at all stages of project development in a participatory manner.

In summary, it is clear that different socioeconomic variables, such as household size and composition, number of functional water sources available/access to water sources, household income /wealth and total time taken to walk to get water and back and distance covered to reach water source, are the most important factors influencing domestic water use in Nzoia River Basin. This is unsurprising since it is consistent with economic theories and other findings for developing countries (e.g., Sandiford et al. 1990; Keshavarzi et al. 2006). These factors need to be considered by policy

makers for the planning and implementation of rural water supply projects in order to ensure sustainability.

This survey was carried out in the three counties of Trans Nzoia (upper catchment), Kakamega (middle catchment) and Busia (lower catchment) of Nzoia River Basin. It would be important in future if a similar survey on water use/consumption could be carried out covering the remaining 6 counties of Elgeyo/Marakwet, West Pokot, Uasin Gishu, Nandi, Bungoma and Siaya in Nzoia River Basin. The survey was conducted in the period of May, 2017 to September, 2017, while the water consumption can change in the other months of the year; therefore, it is also strongly suggested that the survey be conducted on periodic basis throughout the year. This study covered the factors influencing domestic water use/consumption without considering water quality. It could be important if a study based on water quality parameters of chemical, physical and bacteriological analyzes could be carried out for Nzoia River Basin. We suggest further research on the socio-demographic, economic and cultural factors influencing domestic water use/consumption such as gender of the household head, ethnicity, traditional habits and cultural background of water consumers, religion, residential tenancy arrangements, water use characteristics of each member of the household and climate conditions.

V. REFERENCES

[1]. Arbues, F., Barberan R., and Villanua, I. (2004). Price impact on urban residential water demand:A dynamic panel data approach. Water Resources Research, 40, 1-9.

[2]. Arbues, F., and Villanua, I. (2006). Potential for pricing policies in water resource management estimation of urban residential water demand in Zaragoza, Spain. Urban Studies, 43(13), 2421-2442. http://dx.doi.org/10.1080/00420980601038255.

[3]. Abebaw, D., Tadesse F., and Mogues T. (2010). Access to Improved Water Source and Satisfaction with Services. Evidence from Rural Ethiopia, IFPRI Discussion Paper.

[4]. Bosch, C., Hommann, K., Rubio, G.M., Sadoff, C., and Travers L. (2001). Water, Sanitation and Poverty, available at www.intussen.info/OldSite/Documenten/ Noord/Internationaal/WB

[5]. Bosch, C., Hommann, K., Rubio, G., Sadoff, C., and Travers, L. (2000).Water and Sanitation. Sourcebook for Poverty Reduction Strategies Washington, D.C.: World Bank

[6]. Bates, B. C., Kundzewicz, Z. W., Wu, S., and Palutikof, J. P. (2008). Climate Change and Water.

[7]. Technical Paper of the Intergovernmental Panel on Climate Change. Geneva: IPCC Secretariat.

[8]. Chen,H,. Zhang, Y. Ma L., Liu, F. Zheng,W. , Shen,Q. Zhang,H. WeX. X, Tian,D. Gengsheng,

[9]. H. and Weidong, Q (2012). Change of water consumption and its potential influential factors in Shanghai: A cross-sectional study. BMC public health, 12(1): p. 450.

[10]. Corbella, H. C., and Pujol, D. S. (2009). What lies behind domestic water use? A review essay on the drivers of domestic water consumption. Boletin de la A.G.E.N. 50, 297-314.

[11]. Chang, H., Parandvash, H., and Shandas, V. (2010), Spatial variations of single-family residential water consumption in Portland, Oregon. Urban Geography, 31, 953-972. http://dx.doi.org/10.2747/0272-3638.31.7.953

[12]. Darr P., Feldman S.L. and Kamen C.S. (1975) Socio-economic factors affecting domestic water demand in Israel. Water Resources Research 11, 805.

[13]. DFID, (2003). Very-low-cost Domestic Roof Water Harvesting in the Humid Tropics: User trials, Development Technology Unit, School of Engineering: University of Warwick

[14]. Fox, C., McIntosh, B. S., and Jeffrey, P. (2009). Classifying households for water demand forecasting using physical property characteristics. Land Use Policy, 26, 558-568.

http://dx.doi.org/10.1016/j.landusepol.2008.08.004.

[15]. Fotue, L.A.T. and Sikod, F. (2013). Determinants of the Households Choice of Drinking Water Source in Cameroon, Journal of sustainable Development in Africa 14(3).

[16]. Garcia, S., and Reynaud, A. (2004). Estimating the benefits of efficient water pricing in France.

[17]. Resource and Energy Economics, 26, 1-25. http://dx.doi.org/10.1016/j.reseneeco.2003.05.001

[18]. Gazzinelli, A., Souza, M.C.C., Nascimento, I.I., Sa, I.R., Cadete, M.M.M., Kloos, H., (1998).

[19]. Domestic water use in a rural village in minasgerais, Brazil, with an emphasis on spatial patterns, sharing of water, and factors in water use. Pub. Med. 14 (2), 265-277.

[20]. House-Peters, L., Pratt, B., and Chang, H. (2010). Effects of urban spatial structure, socio-demographics, and climate on residential water consumption in Hillsboro, Oregon. Journal of the American. Water Resources Association, 46(3), 461-472.

[21]. Hinrichsen D, Robey B, Upadhyay UD (1997) Solutions for a water-short world. Population

[22]. Reports 14. Johns Hopkins School of Public Health, Population Information Program, Baltimore, Maryland

[23]. Hoffmann, M., Worthington, A., and Higgs, H. (2006). Urban water demand with fixed volumetric charging in a large municipality: the case of Brisbane, Australia. The Australian Journal of Agricultural and Resource Economics, 50, 347-359. http://dx.doi.org/10.1111/j.1467-8489.2006.00339.x

[24]. Keshavarzia, A.R, Sharifzadehb,M., Kamgar A.A, Amina,S. Keshtkara S., Bamdada, A.(2006).

[25]. Rural domestic water consumption behavior: A case study in Ramjerd area, Fars province, IR Iran. Water research, 2006. 40(6): p. 1173-1178.

[26]. Kenney, S. D., Goemans, C., Klein, R., Lowery, J., and Reidy, K. (2008). Residential water demand management: Lessons from Aurora, Colorado. Journal of the American Water Resources Association, 44(1), 192-207. http://dx.doi.org/10.1111/j.1752-1688.2007.00147.x

[27]. Mu X., Whittington D., and Briscoe J. (1990). Modeling Village Water Demand Behavior: A Discrete Choice Approach. Water Resources Research 26(4).

[28]. Morehouse, B. J., Carter, R. H., and Tschakert, P. (2002). Sensitivity of urban water resources in

[29]. Phoenix, Tucson, and Sierra Vista, Arizona, to severe drought, Climate Research, 21(3), 283-297. http://dx.doi.org/10.3354/cr021283

[30]. Mahama, A. M. (2013). Determinants of Factors Influencing Householders' Access to Improved

[31]. Water and Sanitation Facilities in Selected Low-Income Urban Areas of Accra, PhD Thesis. University Of Ghana, Legon, Ghana.

[32]. Martin, N., (1999). Population, households and domestic water use in countries of the

[33]. Mediterranean Middle East (Jordan, Lebanon, Syria, the West Bank, Gaza and Israel). International Institute for Applied Systems Analysis Report, Schlossplatz 1, A-2361 Laxenburg, Austria, 1999.

[34]. Oyekale, A.S and Ogunsanya, O.A. (2012). Factors Influencing Households' Access to

[35]. Portable Water in Rural Nigeria. Life Science Journal 9(3).

[36]. Rosen, S., and Vincent, J. R. (1999). Household water resources and rural productivity in sub-

[37]. Saharan Africa: A review of the evidence. Development Discussion Paper No. 673. Harvard Institute for International Development.

[38]. Russell, S., and Fielding, K. (2010). Water demand management research: A psychological perspective. Water Resources Research, 46. http://dx.doi.org/10.1029/2009WR008408

[39]. Schefter, J.E.,(1990). Domestic water use in the United States, 1960-85. In: National Water

[40]. Summary1987: Hydrologic Events and Water Supply and Use, US Geological Survey Water-Supply Paper 2350, pp. 71-80, 1990.

[41]. Sandiford, P., Gorter, A.C., Orozco, J.G. and Pauw, J.P. (1990). Determinants of domestic water use in rural Nicaragua. The Journal of tropical medicine and hygiene, 1990. 93(6): p. 383-389.

[42]. Sharma NP, Damhaug T, Gilgan-Hunt E. (1996) African water resources: challenges and

opportunity for sustainable development. World Bank Technical paper 331. The World Bank, Washington, DC

[43]. Sandiford P., Gorter A.C., Davey Smith G. & Pauw J.P. (1989) Determinants of water quality in rural Nicaragua. Epidemiology and Infection 102, 429.

[44]. Smith, L. and Hanson, S. (2003). Access to Water for the Urban Poor in Cape Town: Where Equity Meets Cost Recovery, Journal of Urban Studies 40, 1517-1548.

[45]. Thompson, J., Porras, I. T., Tumwine, J. K, Mujwahuzi, M. R., Katui-Katua, M., Johnstone, N., and Wood, L. (2001). Drawers of water II. 30 years of change in domestic water use and environmental health in East Africa. International Institute for Environment and Development. Nottingham: Russell Press. UN WWAP. (2009). United Nations World Water Assessment Programme. The World Water Development Report 3: Water in a changing.

[46]. Totouom, F. L A. (2013). Awareness and the Demand for Improved Drinking Water Source in Cameroon International Journal of Economic Practices and Theories, 3(1). UNDP. (2009). Resource guide on gender and climate change, Available at http://www.undp.org/content/dam/aplaws/publication/en/publications/womens.

[47]. Totouom, F. L. A., and Fondo, S. (2012). Determinants of the Households' Choice of Drinking Water Source in Cameroon. Journal of Sustainable Development in Africa 14, (3).

[48]. The Water Project 2015. Accessed from http://www.thewaterproject.org/why-water.

[49]. UN WWAP. (2009). United Nations World Water Assessment Programme. The World Water Development Report 3: Water in a changing world. Paris: UNESCO.

[50]. White G.F., Bradley D.J. and White A.U. (1972) Drawers of water: Domestic water use in East Africa, University of Chicago Press, Chicago.

[51]. WRMA. (2012). Water Resources Management Authority. Annual reports. Nairobi, Kenya.

[52]. Wong S.T. (1987) Thai rural domestic water consumption: A case study of a village community with no organized water supply system. Water International 12, 60.

[53]. WHO/UNICEF JMP (2015). Progress on drinking-water and sanitation 2015 update retrieved from http://www.wssinfo.org/fileadmin/user_upload/resources/JMPUpdate-report-2015.

[54]. WASREB, (2015). Water Services Regulatory Board, Impact Report, Ministry of Water and Irrigation, Nairobi, Kenya.

[55]. World Bank (2003). World Development Report 2003. Sustainable Development in a Dynamic World. Transforming Institutions, Growth, and Quality of Life. World Bank, Washington DC.

[56]. WHO. (2003). Domestic water quantity, service level and health. Geneva: World Health Organization.