WATER RESOURCES ALLOCATION AND USE IN THE LOWER SONDU MIRIU RIVER BASIN, KENYA

BY

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ABSTRACT

The adoption of a holistic approach to water resources allocation where all water resources in a river basin, their quality, quantity and the socioeconomic linkages are considered has been a global issue. However, small scale water resources use across river basins in the world are numerous, which limit how and to what extent they should be managed. They are as a result not adequately known yet when concentrated in a given area, leads to depletion of water resources. Also, when small scale water users are unknown, their rights to water are likely to be violated by the allocating authority and estimating their cumulative impact is difficult. Information about small scale water resources use in Kenya just like in the Lower Sondu Miriu River Basin (LSMRB) is limited. Thus, water resources are often allocated on a "first come first served" basis which has limited regard on small scale uses. As a result, many households living in rural areas have had their rights to water for domestic and other productive uses violated. This study therefore focused on small scale water resources allocation and use in the LSMRB. The specific objectives of the study were to: identify water resources in the Lower Sondu Miriu River Basin and their accessibility to households; establish water resources allocation and use and identify the socioeconomic factors influencing household water allocation in the basin. A cross sectional descriptive research design was adopted for the study. From a target of 39,818 households, 384 were sampled proportionately from the five districts within which LSMRB lie using stratified simple random sampling. A household questionnaire, key informant interview guides, Focus Group Discussion (FGD) guides, an observation checklist and photography were used in primary data collection while journals and policy papers provided secondary data. Six key informants were interviewed and ten FGDs conducted. Descriptive and inferential statistics were used to analyse quantitative data while qualitative data was summarised and emerging patterns analysed. The study established that 85.4% of households in LSMRB primarily drew water from surface water sources. On average, a household allocated 119.7 litres of water for domestic use per day, 107.2 for livestock, 332.6 for irrigation, 496.4 for vending and 51.6 for use in commercial entities. Livestock water use was practised by 62.2% of the households, irrigation 18.2% commercial use 6.8% and vending 5.7%. Increase in household size ($r = 0.841$) was associated with increase in quantity of water allocated for household domestic use, supply population ($r_s = 0.897$) with increase in quantity of water allocated for vending and animal population ($r = 0.486$) with quantity allocated for livestock use all at $P<0.01$. Surface water was the main source of water in LSMRB but households only had basic access to water. Therefore, WRMA, WRUA and Water Services Providers in the basin should prioritize allocation of water from surface water sources to household domestic and productive uses, taking into consideration the various socioeconomic factors identified to influence quantities of water allocated.

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

Globally, about 70% of the Earth's Surface is covered by water of which 97% is saline while only 3% is freshwater with over 2% of this frozen in glacier and polar ice caps leaving merely less than 1% for use by humans and the ecosystem survival (Fry, 2005). Humans mainly depend on freshwater resources for domestic, agricultural, municipal, industrial, commercial and hydroelectric power generation. According to FAO (2012), the last century has witnessed water use growth that was more than twice the rate at which the population was increasing. This implied that as the population was growing at 80 million people per year, fresh water demand increased by about 64 billion cubic metres a year. Geo – 4, 2007 also predicted that water resources withdrawal were expected to rise by 50% by 2025 in the less affluent countries and by 18% in more affluent countries. Currently, over, 1.4 billion people live in river basins where water resources use outstrips minimum rechargeable levels (Human development report, 2006). This has resulted to drying up of rivers and depletion of groundwater resources. Regardless of scarcity and finite nature of world water resources, use competition exists at all level and is predicted to increase in most countries (WWDR, 2012). This therefore calls for proper and sustainable management of water resources at all levels.

Global fresh water resources are found in rivers, lakes, springs and ponds as surface water and in underground aquifers as groundwater (WaterAid, 2012). Rainfall also provides an important source of water for many households across the world (Lanka Rainwater Harvesting Forum, 1999). Kenya is endowed with both surface and groundwater resources (Mocha et al, 2012 and Onjala, 2002). However, water resources allocation issue in most basins in the country relates to water availability and accessibility (GoK, 2009). A study by UNWWDR (2006) established that 6.8% of households in Nyanza Province drew water from ponds/dams, 39.9% lake/rivers, 24% springs, 16.9% wells/boreholes and 8.5% piped water. Also, the same study established that in Rift Valley Province, 5.6% sourced water from pond/dams, 35.5% from lakes/rivers, 7.8% springs, 23.2% wells/boreholes and 23.4% piped water. The same study also observed that reasonable access to water in Kenya is defined as 2Km. However, the target is to ensure access to water of 20 l/c/d at a distance of 1 km (WRMA, 2012) or at most 30 minutes water collection time (GoK, 2009). Hakijamii (2014) also pointed out that more than half of Kenyans living in urban areas have access to safe drinking water and only 40% of those residing in rural areas have access to safe drinking water. But, such macro level statistics are too general that realities in smaller areas of Kenya like in LSMRB are masked.

A study by Lankford et al (2013) in Kisumu indicated that household access to water was low as only 39% of the residents had access to piped water. According to his study, water obtained from wells and vendors was of questionable quality. Okotto et al (2010) as quoted by Lankford (2013) established a water consumption of 14.6l/c/d in Kisumu. But Okotto and Lankford studies were limited to urban areas of Kisumu and may not apply in LSMRB which is mainly rural. Studies by Ong'or (2005) and Opiyo (2005) pointed out that LSMRB is endowed with both surface and groundwater resources. However, their studies only gave general statements on water resources which fail to give empirical dependency of the residents on the water resources. This study therefore intended to identify the types of water resources in LSMRB, household population drawing water from each water resource identified and their accessibility to households. Water resources accessibility in the basin was determined in relation to distance, quantity, quality and the water use patterns.

The river basin is globally accepted as the most appropriate unit for sustainable water resources management (Ong'or, 2005). Water resources allocation is at the heart of integrated Water Resources Management (IWRM) and a core function in river basin water resources management. The principles of social equity, economic efficiency and environmental sustainability should guide the criteria used in allocating scarce water resources (Wang et al, 2007). The water resources allocation decision making process requires sufficient information on water resources and use in a river basin. Of global concern however, is how and to what extent small scale water resources use should be managed given that resources are always scarce and small scale water resources uses numerous (UN, 2000). Local concentration of small scale water resources use leads to depletion of water resources. Since small scale water resources users do not require authorization, information about the quantities they allocate to various use is often scarce. It thus becomes difficult to estimate the cumulative impacts of such uses. As well, the small scale users right to water become threatened in that the allocating authority may issue water right that remove water from them.

Water resources allocation in Kenya is defined by provisions in the Water Act, 2002 (GoK, 2002) and the subsequent legislation WRM Rules, 2006 (GoK, 2006). The Act requires water for Basic Human Needs (BHNs) defined in the Reserve to be accorded priority over all other water allocations. This should be followed by prioritization of water for domestic use. The Act does not explicitly define what constitutes water for domestic use but in rural areas, domestic use also includes water for other households productive uses such as small scale irrigation (Mumma, 2007). WRMA is therefore expected to leave such quantities of water in water sources for small scale users. This is to be achieved through the development of SCMPs and WAPs at the river basin level. However, the SCMP and WAP for LSMRB is not yet developed and water resources are allocated on a "first come first served" basis (WRMA, 2012) yet information generally on water resources in the basin is inadequate (GoK, 2009). WRMA and WRUAs are however in the process of developing a SCMP. About 65% of total water use in Kenya is for agriculture. Domestic use accounts for 18% of the other use, industrial 13% and other purposes including commercial 4% UNWWDR, 2006). Studies by Ouma et al (2013) and Masese et al (2012) pointed out that residents of LSMRB used water resources for domestic, livestock, agriculture, fisheries and industrial supplies. However, these studies made general statements on water resources uses that were limited in application. An attempt to empirically quantify water resources use in the basin by Bakibinga-Ibembe et al (2011) was biased only on Sondu Miriu River yet there are other water resources in the basin. Also, the criterion used by his study to select the study sites was not a reflection of the entire basin. This study therefore intended to establish water resources allocation and use in LSMRB in relation to the types of uses practised by households, population practising each use and the quantities of water they allocated to the various uses. The aim was to create a general impression on small scale water resources use in the basin.

Water allocation at the household level is often influenced by various socioeconomic factors. However, many studies have focused on analysing water demand and consumption at the point of use (Brown, 1999; Shepel, 2010; USA Government Report, 2013; Rice et al, 2010; Nevada department of water planning, 2013 and Collins et al, 2009) at the expense of withdrawal. In LSMRB, no study has particularly addressed the socioeconomic factors influencing small scale water resources allocation as depicted by existing reviewed literature. This study therefore intends to analyse the socioeconomic factors influencing quantities of water allocated for the various households water uses. This would go a long way in informing water resources allocation planning and in the basin; and the water allocation policy in general.

1.2 Problem statement

Water resources allocation planning should be based on the principles of Integrated Water Resources Management (IWRM) where all interrelated freshwater bodies, their quality and quantity and the socioeconomic linkages are considered holistically (UN, 2000). However, small scale water resources use across river basin in the world are numerous limiting how and to what extent they should be managed given that resources are limited in most instances. The solution has generally been creating a cut-off point below which small scale water users are not required to be registered by the authorities (Speed et al, 2012). Consequently, the number and extent of such uses in many river basins across the world is generally not well known. Estimating in a cumulative sense, the extent and impact of small scale water resources uses in river basins is therefore difficult yet the effects of such uses eventually become widespread. In LSMRB, information on small scale water resources use is limited (GoK, 2009). In particular, information on types of water resources available for small scale water users, their accessibility and the number of users depending on a particular water resource source is inadequate. Also, the SCMP and WAP for the basin are not yet developed (WRMA, 2012) but WRMA in collaboration with WRUAs are in the process of developing a SCMP. Water resources in the basin are therefore allocated on a "first come first served" basis. This has particularly creates a room for violation of households right to water which has resulted to water use conflicts (Africa River Network, 2002). It was therefore important to understand small scale water resources allocation and use in LSMRB in relation to types of uses, population practising such uses and the quantities of water they allocated to the uses. This would provide a basis for estimating cumulative impacts of small scale water resources use in the basin. Designing a new water allocation system that will address households water needs in the LSMRB requires information on socioeconomic factors influencing household water allocation for domestic and other productive use. However, this information is currently scanty which hampers solid water resources allocation decisions making. This study therefore intended to provide information on various socioeconomic factors influencing quantities of water allocated to the various household water resources uses. This would enable informed and sustainable water resources allocation decision making in the basin through enhanced development of appropriate water resources allocation plans and policies.

1.3 The objective of the study

The overall objective of the study was to establish water resources, allocation and use; and the socioeconomic factors influencing household water allocation in Lower Sondu Miriu River Basin

The specific objectives included;

1. To identify water resources in Lower Sondu Miriu River Basin and their accessibility to households.
2. To establish water resources allocation and use in Lower Sondu Miriu River Basin
3. To identify the socioeconomic factors influencing household water allocation in Lower Sondu Miriu River Basin

1.4 The research questions

1. What are the water resources used by households in Lower Sondu Miriu River Basin and how accessible are they?
2. How do households allocate and use water resources in Lower Sondu Miriu River Basin?
3. What are the socioeconomic factors influencing household water allocation in Lower Sondu Miriu River Basin?

1.5 Justification of the study

The enactment of the Water Act, 2002 shows the Government of Kenya commitment in ensuring that its citizens' right to water is protected in the water allocation systems. The Act requires that water for BHNs defined in the Reserve to be given priority over all other water allocations. Water for domestic use should be given the second priority after the Reserve. Majority of the Kenya's' population (GoK, 2009) Lower Sondu Miriu River Basin inclusive live in rural areas where they derive their livelihoods from available water resources. The Act does not explicitly define what should constitute water for domestic use. However, water for domestic use in rural areas also includes water required to meet the livelihood needs of rural households. WRMA is therefore required to leave such quantities of water in water resource sources during water allocation. In order to ensure that households right to water is protected in the water allocation system in Lower Sondu Miriu River Basin, adequate information on water resources used by households and their accessibility is vital. However, this information is currently inadequate and water resources are allocated on the basis of "first come first served" which has resulted to violation of households' right to water and water use conflicts especially in the dry season. This study was therefore necessary particularly to provide information on the various types of water resources used by household and their accessibility needed for sustainable water resources allocation decision making.

Small scale water resources uses in a river basin are often numerous yet water use authorisation is not required. Therefore, households in most rural areas are allowed to draw water for domestic other productive uses such as water for small scale irrigation and livestock use without a permit. Knowledge on allocation, nature and the extent of such uses is thus vital in assessing their cumulative impacts and protecting the users' rights during water resources allocation. This information however is inadequate in LSMRB yet most of the residents draw water from natural water sources. Also, water for Reserve is not only concerned with the quantity but also quality of water at water source. Nevertheless, some water resources use practises such as waste disposal in water courses in LSMRB impacts negatively on the quality of water. It was therefore important to establish water allocation in the basin and the different ways in which households used water resources in order to inform Reserve quantities and quality.

The household decision to allocate given quantities of water to the various household uses is often informed by various socioeconomic factors. These factors need to be understood when designing household water entitlements. However, this area has not been adequately addressed. In particular other studies in LSMRB focused on other aspects of water resources. Examples are; study by Ouma et al (2013) whose main aim was on sedimentation and land use, Said et al (2011) as compiled by Owour et al (2011) nutrients load, Ogembo (20ll) and Mutua (2012) modeling, Owiti et al (2013) and Willoughby (2008) fisheries, Opiyo (2005) wetlands management, Mungai et al (2011) Floods and Ong'or (2005) community participation in water resources management. Identifying the socioeconomic factors influencing household water allocation in LSMRB was therefore important in order to inform water resources allocation planners on important factors that influence household water allocation. The overall aim was to inform water resources allocation decision makers and general water allocation policy on the extent of small scale water resources allocation and use; and the socioeconomic factors influencing water allocation at the household level.

1.6 Scope and limitation of the study

The study was limited to Lower Sondu Miriu River Basin (LSMRB). LSMRB covers in larger portion, parts of Nyakach, Rachuonyo and Nyamira Districts. A small part is found within the southern parts of Kericho and Buret Districts. It begins about the confluence where the two main tributaries (Kapsonoi and Yurith) of Sondu Miriu River meet downwards up to areas around the delta where Sondu Miriu River enters Lake Victoria. The desire to bring forth information for decision making to the lowest level of a drainage basin guided the choice of the study area. The study was based on hydrological boundary and not administrative units. However, the administrative units were used in the determination of study population. The study undertook to examine the extent of small scale water resources use in LSMRB. This was done by first determining the types of water resources and household population drawing water from each water resource type and their accessibility. Then, various uses in which households allocated water were identified and the quantities allocated to each use examined. The various water resources uses by households were analysed and household population practising each use determined. Finally the various socioeconomic factors influencing quantities of water allocated to the various household uses were analysed. The overall aim was to inform water resources allocation planning in the basin and water allocation policy in general. The key group of actors incorporated in the study were government water resources managers (WRMA – Lake Victoria South Water Resources Management Authority and Kericho Sub-Regional Office), Water Services Providers (Municipal), WRUAs and other relevant water resources stakeholders in the river basin including hydropower generation authority KenGen

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This Chapter reviews literature relevant to the study in three sub-sections which subsequently culminates in development of a conceptual framework for the study. The sub sections relate to each specific objective. Sub-section 2.2 examines existing literature on water resources and household use in relation to water resources availability and accessibility. This is followed by sub-section 2.3 where information relating to water resources allocation and use is examined. Further, sub-section 2.4 looks at literature on socioeconomic factors and household water allocation. Finally the conceptual framework of the study is explained and illustrated using a diagram.

2.2 River basin water resources and household use

Water resources is a concept with multiple dimensions. It is not only limited to the physical measure, that is the hydrology of flow and stock, but also includes environmental and socio-economic aspects (FAO, 2013). Nevertheless, water resources in relation to small scale water use are concerned with presence of water resources and socioeconomic aspects related to their use. Asare (2004) observed that reliable access to water is one of the socioeconomic aspects of water resources in a river basin. This study main focus was on small scale water resources allocation and use in LSMRB and therefore will be concerned with water resources available to the households and their accessibility

2.2.1 Water resources availability

Globally, about 70% of the Earth's Surface is covered by water of which 97% is saline while only 3% is freshwater. Over 2% of this is frozen in glacier and polar ice caps leaving merely less than 1% for use by humans and the ecosystem survival (Fry, 2005). Human beings depend on freshwater resources for agricultural, transportation, industrial and recreational activities yet they are unevenly distributed across the world. Uneven distribution is often attributed to differences in climatic conditions that deliver rainfall. Africa for instance has only 9% of global renewable freshwater resources, about 50.66% of which is found in the Central Africa and 2.99 in the Northern Africa (UNEP, 2010). In Kenya, freshwater resources are distributed across five drainage basins namely Tana, Athi, Rift valley, Lake Victoria and Ewaso ng'iro North (UNWWDR, 2006). Mocha et al (2012) observed that Lake Victoria Basin covers only about 8% of Kenya's total area, yet accounts for over 54% of the national freshwater resources endowment. Uneven distribution of water resources affects water availability as it creates regions of water scarcity and abundance. In Lower Sondu Miriu River Basin (LSMRB) for example, the highland region is characterised by numerous perennial streams while the lowland region has seasonal ponds and streams (Ogembo, 2012). Sondu Miriu River however traverses across the basin which further influences water availability across the basin.

Global freshwater resources are often found in streams, rivers, springs, lakes and ponds as surface water and in underground aquifers as groundwater. People across the globe therefore use water from either surface or groundwater sources depending on what is readily available in their region. In Africa for example, about 75% of its populations obtain drinking water from groundwater resource. However, water availability in the continent is constrained by its limited groundwater resource which represents only 15% of its total renewable freshwater resources. It is estimated that Africa has a per capita annual internal renewable water resources of 5,133M^3 which is below the world value of 6,918M^3 and all other continents except Asia (Nicol, 2000). Nevertheless, water availability varies from one country to another. For instance per capita availability in South Africa is about 908M^3 (World Bank, 2009) compared to that of Tanzania i.e. 2700M^3 (Republic of Tanzania, 2002).

Kenya has about 20 Billion Cubic Metres freshwater endowment (UNWWDR, 2006). World Bank (2011) noted that the per capita water availability was estimated at 526m^3 a value below global set threshold of 1000M^3. It is predicted that this value will go as low as 235m^3 by the year 2025 (GoK, 2009). Mocha et al (2012) and Onjala (2002) observed that the annual quantity of renewable groundwater resources is about 10% that of surface water resources in the country. In addition, their studies pointed out that majority of Kenyan rely on both surface and groundwater resources for their everyday use. However, this was a general statement with limited applicability when dealing with region specific water resources issues. Nonetheless, a study by UNWWDR (2006) established that 6.8% of households in Nyanza Province drew water from ponds/dams, 39.9% lake/rivers, 24% springs, 16.9% wells/boreholes and 8.5% piped water. Also, the same study established that in Rift Valley Province, 5.6% sourced water from pond/dams, 35.5% from lakes/rivers, 7.8% springs, 23.2% wells/boreholes and 23.4% piped water. While results from the UNWWDR (2006) further expounded the statement made by Mocha et al, 2012 for both Nyanza and Rift Valley Provinces, such a macro level statistics masks realities at a sub basin level. In addition, the study was based on administrative boundaries yet sustainable water resources management calls for management of water resources at the river basin level where hydrological rather than administrative boundaries are used. River basins are hydrological units exhibiting almost similar hydrology and socioeconomic characteristics (GoK, 2009). LSMRB constitutes only a small portion of both Nyanza and Rift Valley Provinces.

World Bank (2011) established that Lake Victoria Basin has an estimated surface water resource reliable yield of 7,226 and 5,242 Million Cubic Metres (MCM)/Year at 80 and 90% reliability levels respectively. The same study also established a groundwater reliable yield of about 97MCM/Year and environmental flow requirement of about 3,873MCM/Year. Nevertheless, water resources availability information for LSMRB is scanty but KenGen (2004) indicated that Sondu Miriu River discharges about 41 cubic meters of water per second. Studies by Ong'or (2005) and Opiyo (2005) pointed out that LSMRB was endowed with both surface and groundwater resources which include a river, streams, lake, ponds, boreholes, springs and shallow wells. However, their studies only gave general statements on water resources which fail to give empirical dependency of the residents on the water resources. This study hopes to fill this gap by identifying the type of water resources in LSMRB and establishing the number of households drawing water from each water resource identified.

2.2.2 Water resources accessibility

The physical availability of water resources in a river basin alone is not adequate to guarantee household access to their water entitlements. Reliable access to water of sufficient quantity and quality for domestic and small scale livelihoods from such water resources is also important (WaterAid, 2012). Water resources accessibility is when households have full or firm control over available water resources. Therefore, their physical location and timely availability of water from such sources determines accessibility. In a river basin where some households have piped water while others do not have, the location of a natural water source or the siting of a water supply point will determine the ease of access. WHO/UNICEF JMP (2000) defined "Reasonable access" to water as at least 20 l/c/d from a source within one kilometer of the user's home. WHO (1996) as quoted by Asare (2004) cited 200m as convenient distance, and 20 l/c/d as the minimum amount of water needed for metabolic, hygienic and domestic purposes. Alcamo (2000) noted that 40 l/c/d was the minimum amount recommended globally and Howard and Bartram (2003) after analyzing water resources use quantities in three East African Countries (Kenya, Uganda and Tanzania) and other parts of the world devised household water access levels as illustrated in Table 1. The authors established that collection of less than 5 l/c/d of water at more than 1000m; or more than 30 minutes total collection time was considered as *no access,* about 20 l/c/d at 100 and 1000m or 5-30 minutes as *basic access*, around 50 l/c/d with on plot use e.g. a single tap in house or yard as *intermediate access* and about 100 up to 300 l/c/d piped into homes with multiple taps as *optimal access*.

Table 1: Service level descriptors of water in relation to hygiene

Service level description	Distance/time Measure	Likely quantities Collected	Level of health concern
No access	More than 1000m or 30 minutes total collection time.	Very low (often less than 5 l/c/d).	Very high as hygiene not assured and consumption needs may be at risk. Quality difficult to assure; emphasis on effective use and water handling hygiene.
Basic access	Between 100 and 1000m (5 to 30 minutes total collection time).	Low. Average is unlikely to exceed 20 l/c/d; laundry and/or bathing may occur at water source with additional volumes of water.	Medium. Not all requirements may be met. Quality difficult to assure.
Intermediate access	On-plot, (e.g. single tap in house or yard).	Medium, likely to be around 50 l/c/d, higher volumes unlikely as energy/time requirements still significant.	Low. Most basic hygiene and consumption needs met. Bathing and laundry possible on-site, which may increase frequency of laundering. Issues of effective use still important. Quality more readily assured.
Optimal access	Water is piped into the home through multiple taps.	Varies significantly but likely above 100 l/c/d and may be up to 300 l/c/d.	Very low. All uses can be met, quality readily assured.

Source: Howard and Bartram, 2003

Gleick (1999) further recommend 50 litres/capita/day (l/c/d) as the standard water for basic human needs. Other values suggested range from between 20-100 litres per capita per day (l/c/d) although there has been an ongoing debate on the sufficiency of these amounts especially to the poor and marginalized groups that may not have access to high quality health care facilities (Speed et al, 2013). Due to the very high incidences of HIV/AIDs, Tuberculosis and other illnesses in Africa, WHO suggests 100l/c/d as the most appropriate minimum amount (Speed et al, 2013). UNWWDR (2006) observed that reasonable access to water in Kenya is defined as 2Km. However, WRMA target is to ensure BHNs access to water of 20 l/c/d at a distance of 1 km from demand point (WRMA, 2012). But the government target is to ensure all citizens including those in LSMRB spend at most 30 minutes to and from a water resource source (GoK, 2009).

WaterAid (2012) suggested ways in which access to water can be measured. They include distance, queuing time, number of people served per water source and availability all the time or quality impaired at any time of the year. Also, negative impacts on community health and livelihoods as a result of unreliable water supply can be examined. Therefore, any significant health risk arising as a result of use of water from a give water resources source is measured. In the same way, water should be acceptable to the user in taste, odour and appearance. Other aspects of water resources accessibility include access to potable water and water usage patterns ((Lanka Rainwater Harvesting Forum, 1999 and Asare, 2004). Access to piped water is an indicator of household access to safe drinking water. Water usage patterns such as reliance on alternative water sources are an indicator of unreliability household access to water supplies. Also, water charges imposed on water resources and supply may limit access to water for poor households. Nonetheless, the values provided by UNWWDR, Gleick, Howard and Bartram, GoK and WRMA only provide a benchmark for comparison and does not depict the situation in LSMRB.

Current statistics in Kenya indicates that more than half of Kenyans living in urban areas and about 40% of those residing in rural areas have access to safe drinking water (Hakijamii, 2014). Rural areas in Kenya are therefore lagging behind in terms of access to safe drinking water. This should be a cause of concern since majority of Kenyans live in rural areas. But, the information provided by Hakijamii above is too general that it masks realities in smaller areas of Kenya like in LSMRB. Kenya envisages 80% nationwide cover of safe water supply by the year 2015 (84% in urban areas and 74% in rural areas). This is guided by Millennium

Development Goal (MDG) 7 target 10 to halve by 2015, the proportion of people without sustainable access to safe drinking water and sanitation services (UNWWDR, 2006). Nevertheless, chances of Kenya meeting these targets are slim (World Bank, 2011). A study by Lankford et al (2013) in Kisumu indicated that household access to water was low. His study established that only 39% of the residents in Kisumu had access to piped water and water obtained from wells was of questionable quality. The quality of water supplied by vendors to the households was also noted to be unsafe. Okotto et al (2010) as quoted by Laneford (2013) established a water consumption of 14.6l/c/d in Kisumu. But, these studies were limited to urban areas of Kisumu and may not apply in LSMRB which is mainly rural. Studies on household water accessibility in LSMRB are limited. The operational principle adopted for water resources management in LSMRB are of ensuring improved water availability, access and reliability as outlined in the Lake Victoria South Catchment Area (LVSCA) Catchment Management Strategy (CMS) (GoK, 2009). However, no study has been carried out in the basin establishing water resources accessibility to household. This study therefore intended to establish water resources accessibility in the basin in relation to quantity collected, quality as perceived by households and based on percentage with access to potable water, distance to water sources and water use patterns

2.3 River basin water resources allocation and use

Water resources allocation can be defined as a combination of actions which enable water users to take or receive water for beneficial purposes according to a recognized system of right and priorities (UN-ESCAP, 2000 as quoted by Wang et al 2003). It is at the core of Integrated Water Resources Management and a key function in water resources management (Wang et al, 2007). According to Kohli et al (2010) water resources use is a general non-specific term describing any action through which water provides service. Kohli further classifies water resources use into different categories including instream and offstream (withdrawal) uses; consumptive and non consumptive uses; and anthropogenic and natural uses. All in all, water resources allocation and use in a river basin are related in that users are given water entitlement through a particular water allocation system for a given particular use which may be domestic, agriculture, hydropower generation, industrial or commercial uses

2.3.1 Water resources allocation

Global calls for sustainable water resources allocation planning have been heightened by the increased scarcity of water resources, population growth, and water use competition notwithstanding river basins catchment degradation (Wang et al, 2003; Speed et al, 2013; Dinar et al, 1999; USAID, 2009 and UN, 2000). In particularly, the first Dublin Principle on freshwater adopted at the 1992 Dublin Conference on Water and Sustainable Development, recognizes that water resources are finite and vulnerable, yet essential for sustaining life, development and the environment (UN, 2000 and GWP, 2012). Therefore, world water resources should be managed and allocated in a sustainable manner. Dinar et al (1999) noted that the principle of equity, economic efficiency and environmental sustainability should guide any water resources allocation. While equity is concerned with sharing of total wealth generated from water resources, economic efficiency is interested in the amount of wealth generated and environmental sustainability on today's use that does not compromise water availability in the future. The three principles therefore go hand in hand and are vital for sustainable water resources allocation at any level of water resources allocation including in LSMRB.

Water resources are often allocated for various uses including domestic/public supply, commercial, agriculture and industrial uses. For example, a study by World Bank (2010) showed that domestic/public supply water withdrawals (including commercial use withdrawals) accounted for 17.2% of total water withdrawn in Kenya. However, industrial water allocations differ between less affluent and more affluent countries. More affluent countries like Florida used more water for industrial use (accounted for 7% of total withdrawals) compared to less affluent countries e.g. Kenya (accounted for 3.7% of total withdrawals). While industrial water use increased by 10% in low income countries, high income countries use increased by 59% (World Bank, 2010). This reflects slow pace of industrialization in many developing countries. Agricultural water withdrawals also differ between low and high income countries. FAO (2012) indicated that both irrigation and livestock water use accounted for 91% of water withdrawals in low income countries compared to only 39% in high income countries. This shows the importance of agriculture to most developing countries. Household water resources allocations also differ from one basin to another. For example Asare (2004) established that a household in Volta Basin, Ghana allocated an average of 200 litres of water per day compared to an average household in Omaruru-Swakop River Basin, Namibia which allocated 60 litres (IWRM Joint Venture Consultant report, 2012). The difference could be explained by differences in water resources availability and the unique socioeconomic characteristics of households in the two basins.

There are four institutional mechanisms mainly applied globally for water resources allocation. These are; User based allocation which requires the collective action of users and the authority to make decisions on water rights, Marginal cost pricing which targets the price for water to equal the marginal cost of supplying the last unit of the water, Water markets which involves exchange of water-use rights and Public/Administrative where the government intervenes in water resources allocation (Dinar et al, 1999). Water markets is the least popular mechanism because it is difficult to implement in real world as water is generally viewed as public good. Nonetheless, countries like Australia, India, Chile and Spain use it. Public/Administrative is on the other hand the most popular because it takes care of the public interest and the huge costs associated with large scale water developments (USAID, 2009). However, it is argued that public mechanism does not promote efficient use of water (Wang et al, 2003). Countries like Tanzania (Republic of Tanzania, 2002) and Kenya Water Act, 2002 (GoK, 2002) use public mechanism in water allocation. This implies that the interest of household in LSMRB should be taken care of by legal and institutional framework set for water allocation by the Kenyan Government.

A multi-level approach to water allocation is often adopted depending on the complexity of the water system which further depends on factors such as presence of large river basins, transboundary basins and interbasin transfers. A multilevel approach requires development of allocation plans at the various levels that gives priorities to users. China for instance has four levels namely National, Basin, Sub-basin and the Individual. South Africa on the other hand has 3 levels, that is, National, Basin and the Individual. Kenya has a four tire approach to water resources allocation which include National, Regional, Sub-regional and the community level. At the National level, Water Resources Management Authority (WRMA) is the main Agency responsible for the implementation of the cross-sectoral water resources management issues. There are 6 sub regional offices in the country based on five drainage basins in Kenya. These are; Lake Victoria Basin (Divided into Northern and Southern Catchment areas), Athi, Tana, Rift Valley and Ewaso Ng'iro North. At the Regional level WRMA in collaboration with stakeholders develop Catchment Management Strategies (CMSs) which define how water resources will be allocated in the catchment area (GoK, 2007). Kenya has 25 sub-catchment areas at the sub-regional level. There are expected to develop in consultation with stakeholders, Sub-Catchment Management Plans (SCMPs) which also among other things define how water resources will be allocated to the different users in the sub-region. The Water Resources Users Associations (WRUAs) are at the community level. WRUAs provide a forum for community participation in water resources management, allocation and conflict resolution. They play a key role in developing Water Allocation Plans (WAP) in their areas of jurisdiction (GoK, 2009 and GoK, 2002). The CMS developed by WRMA, Lake Victoria South Catchment Area (LVSCA) guides water resources allocation in LSMRB. However, the SCMP and WAP plans are not developed (WRMA, 2012) though a SCMP is already being developed by WRMA in collaboration with WRUAs. Water resources are therefore allocated on a "first come first served" basis a system considered sub-optimal according to the Government (GoK, 2009).

Water resources allocation culminates in granting of water entitlement to individual abstractors at a given level of management (Speed et al, 2013). In the last three decades, right to water in many states across the world has been falling to the governments and its agencies (speed et al, 2013). The governments impose rules and regulations around access to water resources and water use at the individual level is regulated through a licensing system. In Kenya, the Water Act, 2002 vested all water resources to the state and individual users are required to apply for a water use license through WRMA in order to acquire use rights (GoK, 2002). Water resources use in Kenya is classified in the WRM rules, 2006 into four categories based on possible impact of use. The categories determine whether a user requires a license for use or not. In particular, water use in Category A is deemed to have low risk by virtue of its scale and users are therefore not required to apply for a water use license (GoK, 2006). Speed et al (2012) pointed out that due the subsistence nature of small scale water resources use and its importance to rural livelihoods, many policies and laws often recognize it as permissible water use with no further requirement for authorization. To ensure that all users right to water is protected, water resources management and allocation systems should be comprehensive. However, small scale water resources uses are usually numerous posing the question as to how and what extent they should be managed given that resources are limited in most cases (UN, 2000). Since such uses are not registered, their number and extent of use are generally not well unknown and often ignored in water resources assessments. Local concentration of such uses leads to water resources depletion and the cumulative impact of their use eventually becomes widespread. Also, small scale water users right to water become unprotected as the allocating authority may issues water rights that remove water from them.

Water resources use amongst households in LSMRB is small scale in nature and therefore falls under water use Category A defined in WRM rules, 2006. The Water Act, 2002 prioritizes water allocation for Reserve which constitutes water for environmental protection and Basic Human Needs (BHNs). The Act requires that water allocation for domestic use take precedence after the Reserve (GoK, 2002). However, it does not explicitly define what constitutes water for domestic use. UNWWDR (2006) observed that water requirement for domestic purpose include provision of water for household and sanitary purposes, watering and dipping of livestock, for public purposes to municipalities, townships, villages, communities and small industries and for all other reasonable demands for public undertaking but not involving the use of water for generation of power or other major irrigation and industrial uses. In rural setting, Mumma (2007) observes that water for domestic purposes also include use for minor irrigation or kitchen gardening. While such broad definitions do not specifically address the water needs of a household, the impression created is that water for other household productive uses falls under domestic uses. WRM Rules, 2006 developed and enacted by WRMA to reinforce the Water Act, 2002 defined water for BHN as the quantity of water required for drinking, food preparation, washing of clothes, bathing and basic sanitation and is assumed to be 25l/c/day. Also, what constitutes water for domestic use is not clearly defined in the rules but it is assumed to mean the same as water for BHN. However, the rules require that allocation of water for subsistence irrigation take precedence over any other irrigation allocation (GoK, 2006). Nonetheless, household water use in LSMRB ranges from domestic and livestock use to irrigation and small scale commercial use. This needs to be clearly defined in order to ensure households right to water in the basin is protected in the developed allocation systems.

Water resources assessment is a tool often applied to give a general impression on water resources allocation in a river basin. However, such assessments often ignore small scale water resources uses which eventually negatively impacts on the right of such users (UN, 2000). Since most household water resources use in LSMRB is small scale in nature, residents draw water from the various water resources in the basin without applying for use permit. Presence of a SCMP and WAP in a river basin provides an opportunity for water resources assessment but currently, they are lacking in LSMRB (WRMA, 2012). Thus the extent of small scale water resources allocations in the basin is currently not well known. The current water allocation system is on a “first come first served” basis yet, there is insufficient data on water resources and their use in the basin (GoK, 2009). The legal provisions required to guide water allocation in the basin also do not explicitly define what should constitutes water for domestic use. Thus, water use conflicts have been reported in the basin due to violation of household's right to water (Africa River Network, 2002). This study was therefore necessary in order to establish the different households water uses, number of households practising each use and the quantities of water they allocated to the uses

2.3.2 Water resources use

Water resources use across the world varies considerably with India, China, the United States, Pakistan, Japan, Thailand, Indonesia, Bangladesh, Mexico and Russian Federation being listed as the largest water resources users in the world (3rd UNWWDR, 2009). WWDR (2012) indicated that agriculture and food production accounts for about 70% of the global freshwater withdrawals while domestic and industrial uses accounts for 10% and 20% respectively. The same study also observed that groundwater resource in Arid and Semi-Arid Lands (ASALs) accounts for about 67% of agricultural water use, 22% domestic use and 11% industrial use. This implies limited availability of surface water resources in most ASALs and the importance of groundwater resources especially in providing water for domestic and agricultural uses to communities living in these areas. Sub-Saharan Africa barely uses 5% of its annual renewable freshwater resources (UNEP, 2010). This is attributed to the low level of technological development in the continent and inefficiency in agricultural water use. Agriculture in the continent is mostly rain fed and accounts for between 85-88% of total water use. Nevertheless, water resources use varies from one African country to another. For instance, agricultural water use in South Africa accounts for 65.5% of total water use while domestic use accounts for 27% and industrial use 7.5 (World Bank, 2014). This is different from Tanzanian case where agriculture use accounts for 92.9%, municipal 6.1% and industrial use 1% (UNWWDR, 2014).

Emerging issues of global concern on water resources use are many. According to FAO (2012), the last century has witnessed water use growth that was more than twice the rate at which the population was increasing, that is, as the population was growing at 80 million people per year, fresh water demand increased by about 64 billion cubic metres a year. Geo – 4 (2007) also predicted that water resources withdrawal were expected to rise by 50% by 2025 in the less affluent countries and by 18% in more affluent countries. Currently, over, 1.4 billion people live in river basins where water resources use outstrips minimum rechargeable levels (Human development report, 2006). This has resulted to drying up of rivers and depletion of groundwater resources. Regardless of scarcity and finite nature of world water resources, use competition exists at all level and is predicted to increase in almost all countries (WWDR, 2012). (UNWWDR, 2006) cited water scarcity, illegal and over abstraction of water resources in river catchments, wetland degradation, water allocation, insufficient information on water quality, quantity, rainfall, water use and sediment yield and high incidences of poverty among the water resources management challenged in Kenya. Water scarcity situation is expected to worsen in coming years creating concerns over water security in the country. This situation is not unique for Lake Victoria Basin, Lower Sondu Miriu Basin inclusive. High incidences of poverty, economic water scarcity and high population growth have been reported by several studies among them World Bank, 2011 and Onyango, 2008. This therefore calls for proper and sustainable management of water resources at all levels.

According to UNWWDR (2006), Kenya has most of its water resources use in agriculture which accounts for about 65% of total water use. Other uses in the country include industrial use (13%), domestic (18%) and other purposes such as use in commercial entities (4%). Water resources uses in Lake Victoria Basin (LVB) include domestic, livestock, public water supply, irrigation, hydropower generation, transportation, fishing and supply for wildlife (Orindi and Huggins, 2005). World Bank (2011) estimated irrigation water requirement in the LVB as about 552MCM/Year, livestock at 57, commercial and institutional 59, industrial 15 and domestic 307. These values were predicated to increase considerably by the year 2030. The study however did not establish values for LSMRB. However, studies by Ouma et al (2013) and Masese et al (2012) pointed out that residents of LSMRB used water resources for domestic, livestock, agriculture, fisheries and industrial supplies. But, these studies only made general statements on water resources uses that may be limited in application when making water resources allocation decisions. Nonetheless, a study by Bakibinga-Ibembe et al (2011) indicated that 22% of residents in the basin used Sondu Miriu River as a fishing resource, 20% as a source for domestic water, 21% transport activities, 9% grazing ground, 9% agricultural activities, 6% sand harvesting, 4% climate moderation and less than 1% as a source of papyrus. But, Bakibinga-Ibembe study was only limited to Sondu Miiru River yet there are other water resources used by residents in the basin. Also, the criteria used in the selection of the study sites in his study was based on the distance from the river, land disturbing activities nearness to the river, how the wetland was degraded and physical infrastructure endowment like road network which may not give a true picture of water resources use in the river basin. This study focused on all water resources used in the basin and the different ways in which households allocated and used them. The study not only focused on household water allocation for domestic uses but also other productive uses such as irrigation, livestock and commercial uses.

2.3 Socioeconomic factors and household water allocation

Water abstraction is the process of removing from a water resource for an intended use (WRMA, 2010). At household level, the quantity abstracted becomes the allocated quantity since majority of the household uses do not require a permit from the authorities. Households' water abstraction is mainly tailored toward provision of water for domestic and other household productive uses that are aimed at sustaining livelihoods (speed et al, 2012). Productive uses include use for livestock and small scale irrigation (UN, 2000), and for small scale uses in public supply (vending) and use in small commercial entities (UNDP, 2011). Various studies have shown that water use at the household level is influenced by various factors. For instance, Alcamo et al (1997) and Shen (2008) established that increase in household size increased household water demand. This study was however done in an urban set up while in LSMRB, the population is mainly rural. Similarly, Asare (2004) established that large household sizes in GLOWA Volta Basin, Ghana, were associated with high water consumption. This finding may however not apply in the LSMRB case, since the residents in the two river basins exhibit difference socioeconomic characteristics such as using water at the sources which was common in LSMRB. In the same way, Army and Davis (2012), Houstone (2003) and Salman and Al-karablieh (2013) indicated that gender composition and income positively influenced household domestic water consumption. Nevertheless, Distance from the water sources and education level were found to have no relationship with household domestic water consumption (Asare, 2004 and Salman and Al-karablieh, 2013). This was attributed to the closeness of water sources to the households. However, this may not be the case in LSMRB as some households have access to piped water while other have to walk over a kilometre to obtain water.

Information on the socioeconomic factors and water allocation for household productive uses is scanty. However, several studies have been conducted linking various socioeconomic factors to the various general uses of water. For example, Studies by Brown (1999) and

Shepel (2010) noted that supply population was one of the determinants in estimating public water supply demand. This indicated that there existed a positive relationship between quantity of water supplied and the total population supplied. The USA government report (2013) supported this observation by noting that 97% of variability in total public water supply could be explained by the total population served. Income was also found to have a positive relationship with water vending. This was because vending has often been used as an avenue for income generation by vendors (Brown, 1999, Pangare and pangare, 2006 and Kjellen and Mcgranaham, 2006). A study by UNDP (2011) showed that tap vendors sold an average of 94 20 litre jerry cans of water per day compared to water kiosks which sold 238 20 litre jerry cans. This implies that the mode of vending influences the amount supplied but may not apply in LSMRB since the study was conducted in the urban and peri-urban areas around Nairobi city while LSMRB is mainly rural and the modes of water vending are different. Commercial water use was also found to be influenced by different socioeconomic factors as shown by the following studies. Shepel (2010) observed a strong positive relationship between commercial water use and number of commercial service consumers. At the same time, USA government (2013) and Zena et al (2001) indicated that number of employees in a commercial entity could be used to estimate water demand for that commercial entity. Studies by Brown (1999), Shepel (2010) and the USA government report (2013) focused on factors that could be considered in estimation of public water supply demand which adds valuable information to water supply and demand management. But the observations are general and may not apply to water allocation at the household level in LSMRB. This also applies to the studies by Shepel (2010) and Zena et al (2001) on commercial water resources use.

Agricultural water demand was also noted to be influenced by different socioeconomic factors. Rice et al (2010) noted that an animal unit represented by many individual animals could be used to estimate the amount of water and feeds needed for livestock operations. This observation was supported by Alcamo (2012) who noted that livestock water demand depended on the number of animals. Distances from the water source was found to positively influence livestock water use as animals walking longer distances desired more water (Rice et al, 2010). Mujib and Schisholm (2007) indicated that a household was likely to participate in a natural resources management activity that supported their socioeconomic status and source of livelihood. For instance, households with farming as their primary source of income had a high likelihood of a positive attitude towards soil conservation activities. This implied that participation in water resources management was determined by the benefits households were likely to get from the activity. Size of farm under irrigation on the other hand was found to be positively correlated with the amount of water used for irrigation (Nevada department of water planning, 2013 and Brown 1999). Different types of crops like maize and sorghum were also established to have different water demand and requirements (Collins et al, 2009). Use of animal unit by Rice et al (2010) limits generalisation of a study in that an animal unit in one region may be different from an animal unit in another region like in LSMRB. Also, Nevada department of water planning (2013), Brown (1999) and Collins et al (2009) statement are mainly aimed at pointing out factors that influence water demand for general irrigation uses rather than use at the household level.

Information on socioeconomic factors and household water allocation in LSMRB is also scarce. Other studies in the basin focused on other aspects of water resources. Examples of these studies are; Ouma et al (2013) Sedimentation and land use, Said et al (2011) as compiled by Owour (2011) nutrients load, Ogembo (20ll) and Mutua (2012) modeling, Owiti et al (2013) and Willoughby (2008) fisheries, Opiyo (2005) wetlands management, Mungai (2011) Floods and Ong'or, 2005 community participation in water resources management. There is no study particularly addressing socioeconomic factors and household water allocation in the basin. This study aimed at filling this gap by identifying the socioeconomic factors influencing water allocation for both domestic and other household productive uses.

2.4 Conceptual framework

Sustainable water allocation planning in Kenya is hampered by water resources management challenges among them water scarcity, illegal and over abstraction of water, river basins degradation, insufficient resources and inadequate information on water resources. Majority of Kenya's population live in rural areas where they derive their livelihoods from available natural water resource base. Households water resource uses in many river basins in Kenya are small scale in nature. Households right to water entails provision of water for domestic and other productive uses such as irrigation. Sustainable water resources allocation planning in a river basin therefore requires that information on the extent of small scale uses be known. That way, their cumulative impacts on water resources can easily be determined and small scale users rights to water protected in the designed water allocation systems.

This study attempted to assess the extent of small scale water resources allocation and use amongst households of Lower Sondu Miriu River Basin. This was to be achieved through first identifying available types of water resources in the basin, determining the household population drawing water from each resource and assessing how accessible the sources were to the households. Accessibility was determined by the quantity of water they drew from the water sources, time they took to obtain the water (distance), perceived water quality, access to safe drinking water and use patterns. Further, household water resources allocation and use was analysed by first establishing the different types of uses and household population practising them. The average quantities of water allocated by households for each type of use were also established. In order to inform the design of future water resources allocation systems in the basin, various socioeconomic factors influencing the quantity of water allocated for each type of use identified was finally analysed.

Figure 1 show that understanding the extent of small scale water resources use is important in attaining sustainable water resources allocation planning in a river basin. Households are the main small scale water resources users. They draw water from different water resources available in the basin including surface water (streams, rivers, ponds and springs) groundwater (boreholes and wells) and also rainwater. Accessibility of water resources is determined by quantity, distance, quality and usage patterns. Households allocate specific quantities of water to various uses. This depends on the types of water use practised by a household. The quantity allocated for each use is influenced by various socioeconomic factors among them household size, mode of water transport and instream water use practises.

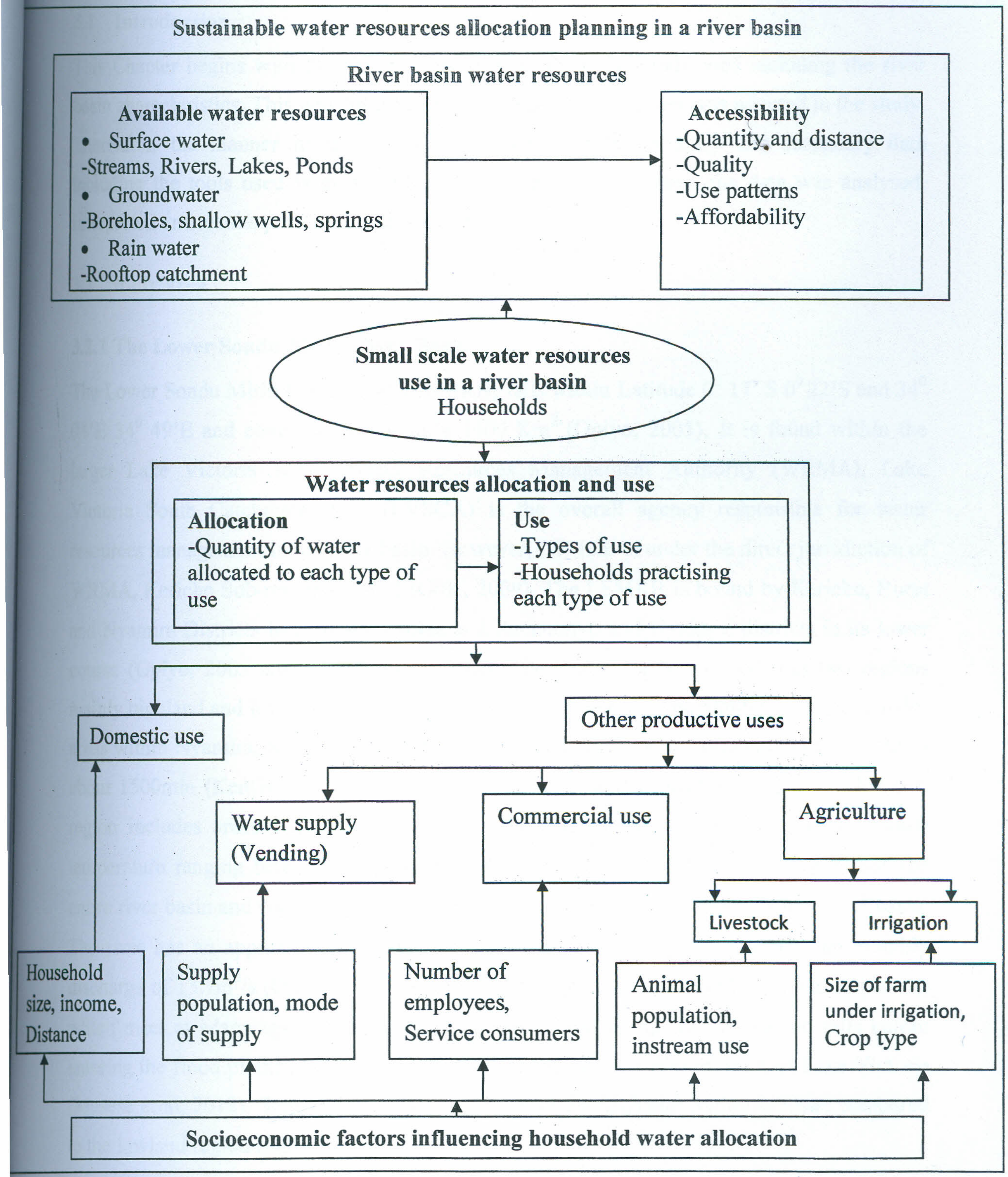

Figure 1 Conceptual framework

(Source: Researcher, 2013)

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This Chapter begins with the general information about the study area including the river basin characteristics. This was followed by the research design that was adopted in the study. Thereafter, the manner in which the researcher collected primary and secondary data including the tools used is discussed. Lastly the manner in which the data was analysed, interpreted and results presented is discussed.

3.2 Study area

3.2.1 The Lower Sondu Miriu River Basin

The Lower Sondu Miriu River Basin (LSMRB) falls within Latitude 0^0 17' S 0^0 22'S and 34^0 04'E 34^0 49'E and covers approximately 3400 Km^2 (Opiyo, 2005). It is found within the larger Lake Victoria Basin. Water Resources Management Authority (WRMA), Lake Victoria South Catchment Area (LVSCA) is the overall agency responsible for water resources management in the river basin. However, LSMRB is under the direct jurisdiction of WRMA, Kericho Sub-regional office (GoK, 2009). The LSMRB is bound by Kericho, Buret and Nyamira Districts in its upper course and Rachuonyo and Nyakach districts in its lower course (Opiyo, 2005 and Masese et al 2012). The basin can be divided into two regions mainly highland and lowland based on temperature and rainfall. The highland region includes areas within Nyamira, Kericho and Buret Districts and receives an average annual rainfall of about 1500mm (KenGen, 2004) which decreases towards the lowland region. The lowland region includes areas within Rachuonyo and Nyakach Districts and has a mean annual temperature ranging between 18-30°C (Ogembo, 2012). Sondu Miriu River traverses the entire river basin and forms an important water resources source for households in the basin. The river has an approximate length of 176km (UNWWDR, 2006) with a mean monthly discharge of 13.7m^3/s (Opiyo, 2005). It is fed by two main tributaries (Yurith and Kapsonoi) which meet at Magwagwa then flows downstream meandering into the Odino falls before entering the flood plains of Nyakwere where it drains into the Winam Gulf of Lake Victoria (Masese et al, 2012). Sondu Miriu River flow rate in the highland region is faster compared to the lowland region (Opiyo, 2005).

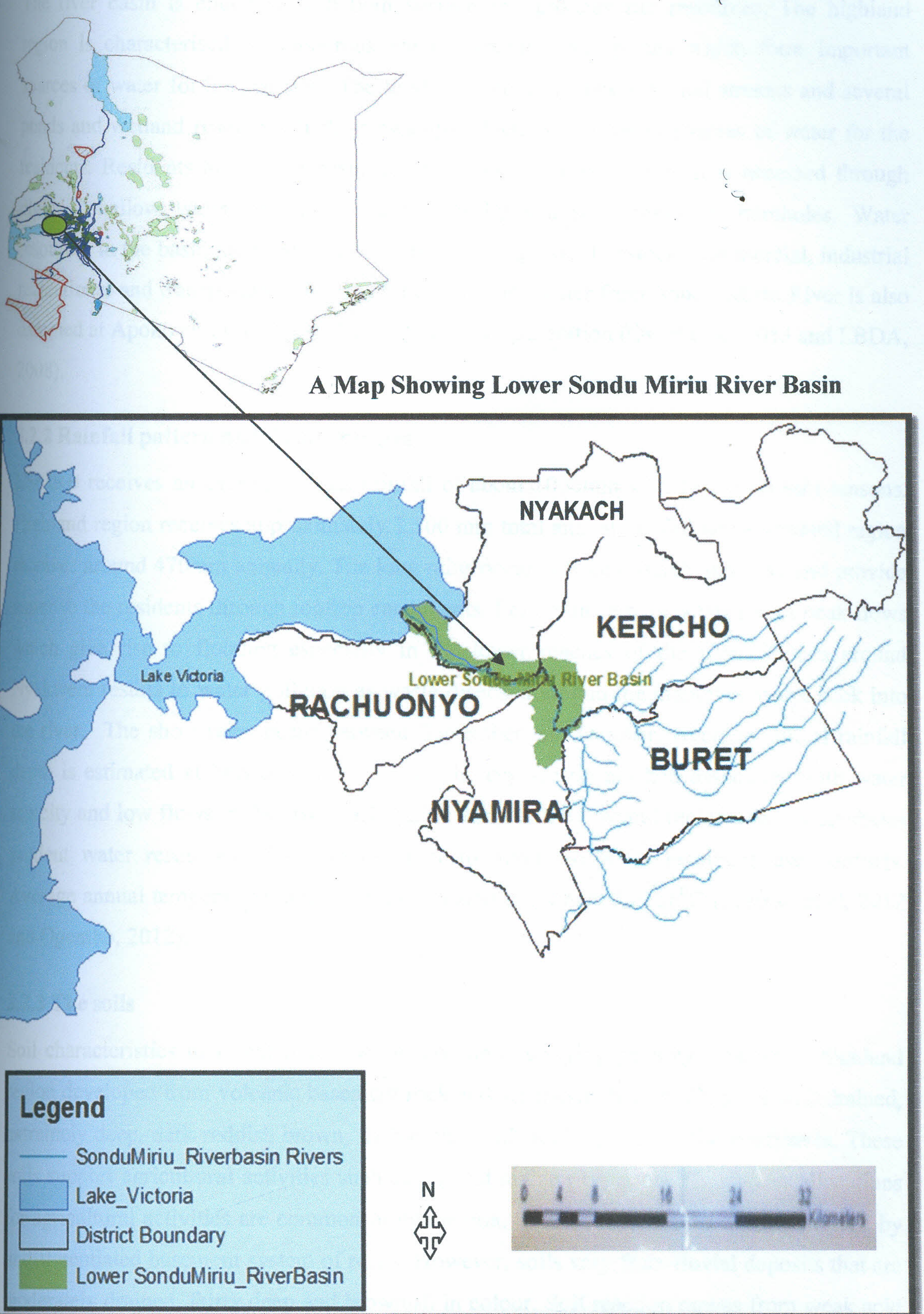

Figure 2: A map showing the area of the study

(Source: Compiled by this study using the ILRL Gis database, 2012.

The river basin is endowed with both surface and groundwater resources. The highland region is characterised by numerous annual streams and springs which form important sources of water for households. The lowland region has few seasonal streams and several ponds and wetland resources such as swamps which also serve as sources of water for the residents. Residents across the basin use groundwater resource which is accessed through digging shallow wells within homesteads or by sinking community boreholes. Water resources in the basin are used to meet domestic, irrigation, livestock, commercial, industrial recreational and transportation needs of the residents. Water from Sondu Miriu River is also dammed at Apoko and used for hydroelectric power generation (Owiti et al, 2013 and LBDA, 2008).

3.2.2 Rainfall pattern and Temperatures

LSMRB receives an average annual rainfall of about 1000mm with two main rain seasons. Highland region receives approximately 1,500 mm total annual rainfall while lowland region receives around 470mm annually. The long rains occur between March and May and provide water to the residents through rooftop catchments. Long rains are associated with peak flows which give rise to flooding especially in the lower reaches of the river. Floods around Nyakwere results to water pollution as waste disposed around the market is swept back into the river. The short rains occur between September and October. Average annual rainfall depth is estimated at between 0.3 to 0.6m. The dry season is often associated with water scarcity and low flows in the river basin particularly in the lowland region. This necessitates prudent water resources allocation in order to minimize water resources use conflicts. Average annual temperature in the low land region is estimated at 26^{0}C (Masese et al, 2012 and Ogembo, 2012).

3.2.3 The soils

Soil characteristics in LSMRB follow closely the underlying geology. Those in highland region developed from volcanic basement rock and are mostly humic. They are well drained, extremely deep, dark reddish brown, friable clay with acid top soil on the interfluves. These soils support agricultural activities such as tea and maize plantation. Thus water allocations for agricultural activities are common in this region. The lowland region is characterised by undifferentiated basement system of rocks. However, soils vary from fluvial deposits that are moderately drained, fairly deep and brownish in colour. Soil reaction ranges from weak acid

(4.4pH) to very weak acid (6.9pH). The soils support limited agricultural activities associated with bucket irrigation in the basin. Therefore water resources allocations for irrigation use in the lowland region are generally low (Ogembo, 2012 and Opiyo, 2005).

3.2.4 Topography, land use pattern and vegetation

Based on altitude and climatic condition, the highland region of LSMRB falls between altitude 1494 and 2003m ASL and the lowland regions 1137-1394m ASL with semi humid climatic conditions. The highland region of the basin is mostly hilly and covered by herbaceous vegetation and tea (both plantations and small-holder farms). The hilly topography in the highland region limits water resources accessibility to residents but provides an important avenue for harnessing water and distribution through gravity flow. Land cover in this parts allow for water retention and infiltration into groundwater. The lowland region has a flat topography which exposes river water to easy access for instream use activities like fishing, swimming and boating. It is generally semi-arid with bare soils covered by sparsely distributed shrubs dominated by acacias. This zone discourages infiltration and generates a lot of runoff during rainy season which combine with upstream flow causes floods at the lower reaches of the river. This zone also has several wetlands with the predominant wetland vegetation being cyprus and papyrus (Ogembo, 2012; Mungai et al, 2011 and Opiyo, 2005).

3.2.6 Population size and distribution

The LSMRB forms the administrative boundary within Nyakach, Rachuonyo, Nyamira, Kericho and Buret districts. The river basin however only covers parts of the districts has show in Table 2. In Nyakach district for example, the basin covers only Kadianga West, East and Kajimbo Sub-locations of South Nyakach Location and Koguta East and West, Lower and Upper Kadianga Sub Locations of West Nyakach Location both in Upper Nyakach division. A total population of 186,302 and 39,818 households were computed in LSMRB based on these administrative units. This was achieved through Geography Information System (GIS) map overlays that were used to establish the sub-locations falling within LSMRB. The maps were obtained from the international Livestock Research Institute (ILRI) GIS data base. The population of LSMRB is distributed in both rural and urban centres within the basin. Rachuonyo district has a population density of 403/km^2, Nyakach 321/km^2, Nyamira 818/km^2, Kericho 366/km^2 and Buret 639/km^2

Table 2: The Administrative Units forming Lower Sondu Miriu River Basin

No.	District	Division	Location	Sub-location
1.	Nyakach	Upper Nyakach (13,125)	South Nyakach (7,306)	Kadianga West
				Kajimbo
				Kadianga East
			West Nyakach (5,819)	Koguta East
				Upper Kadianga
				Lower Kadianga
				Koguta West
2.	Rachuonyo	Kabondo (5,848)	Kabondo East (2,602)	Kodumo West
				Kodhoch East
				East Kakangutu
			Kabondo West (3,246)	Kakangutu West
				Kodhoch West
		Kendu bay (1,458)	Wang'chieng' (1,458)	Kobala
				Kobuya
3.	Nyamira	Ekerenyo (13,629)	North Mugirango chache (9,834)	Bonyegwe
				Magwagwa
				Boikeira
			Ekerenyo (3,750)	Ikonge
				Bokurati
		Borabu (938)	Mekenene (938)	Nyankono
4.	Kericho	Belgut (3,062)	Kiptere (3,062)	Chemamul
				Kaplelartet
				Kiptere
				Kabenet
5.	Buret	Roret (1,758)	Kisiara(1,758)	Tebesonik
				Roret

Key () = Household population

Source: Compiled by this study using data from IRLS Gis database, 2012 and KNBS, 2009

3.2.7 Socioeconomic activities

The main economic activities in the highland region of LSMRB are tea farming, small and large scale agriculture (including livestock keeping) and agro-based industries. Residents also engage in wholesale and retail businesses in urban centres including selling of farm produce like pineapples, bananas and sweet potatoes. The lowland region is semi arid and supports subsistence agriculture for crops and livestock, hydroelectric power generation; and harvesting and trading wetland resources such as fish. The combined effects of these activities and their scale and intensity over the years have imposed multiple threats to water resources in terms of quality, availability and ecological imbalances. Of evidence is increased sedimentation in the river which has reduced river depth over the years (Ochumba and Manyala, 1992 and Opiyo, 2005). The various socioeconomic activities represented the nature of water resources use and allocation in the river basin. For instance agricultural activities such as livestock keeping showed that residents allocated water for livestock use.

3.3 Research design

A cross-sectional descriptive research design was adopted for this study. Descriptive research is a process of collecting data in order to answer questions concerning the current situation (Nzisa, 2012). This design was adopted because it enabled collection of both qualitative and quantitative data that was used in analysing the relationship between variables. The study aim was to establish the current situation on small scale water resources use including the type of water resources, households drawing water from them and their accessibility. Also the types of water resources use, population practising each type of use and quantities of water allocated was determined. This information was used in establishing the relationship between quantities of water allocated to different uses and the socioeconomic factors. Thus this research design was considered appropriate for the study. A cross sectional method of data gathering that involved collecting information from households as a single event over a specific period of time was used. Households were requested to provide data on water resources and use, quantity of water allocated to the different types of uses and their socioeconomic characteristics. Households which comprised those headed by male and female were targeted for responses. This is because they are responsible for meeting the daily needs of their family which also involved provision of water for domestic and other productive uses.

3.4 Sampling procedure

Data for the study was collected in LSMRB based on the five Districts within which the basin is found. Stratified random sampling technique was used in selecting the households for the study. It involved dividing the sample size into proportions based on the target districts household population. To ensure that the sample was representative enough, the district sample proportions were further sub divided proportionately based on target Divisions and Location household populations. Simple random sampling was thereafter used to select households from the Locations in each District for interviewing. This is because it offered an equal chance for all the households in the respective Districts and subsequent Divisions and Locations to be selected. The total population and household population of LSMRB was computed from the administrative units (Table 2) found within the Districts forming the basin and are summarised in Table 3.

Table 3: Estimated total household population within LSMRB

No.	District	Total population within lower SMRB/District	Household Population within lower SMRB/District
1	Nyakach	60,388	13,125
2	Rachuonyo	33,336	7,306
3	Nyamira	67,267	14,567
4	Kericho	15,759	3,062
5	Buret	9,552	1,758
	Total	**186,302**	**39,818**

Source: KNBS, 2009

To ensure a representative sample, the following fishers' formula as cited by Mugenda and Mugenda (2003) was used.

Sample size (n) $=Z^2Pq/d^2$ where;

Z= Level of confidence required

P = Proportion of the sample population estimated to have the characteristics being measured

q= 1-P

d= Maximum tolerable error

The formula was adopted for the study because the target population was greater than 10,000. When level of confidence required is 95%, the z statistics is 1.96 and maximum tolerable error 0.05. Where the proportion of the sample population estimated to have the characteristics being measured is unknown, Fishers' formula suggests 50% (0.5) to be used (Nzisa, 2012).

Therefore the sample size for the study was calculated as follows:

Sample size $=1.96^2 \times 0.5 \times (1-0.5)/0.05^2 = 384.16$ which is approximately 384

The sample proportions were calculated using the formula shown below;

Proportion sample size = (District target household population/Total target household population) x sample size.

For example proportion sample size for Nyakach was;

Proportion sample size = (13,125/39,818) x 384 = 126.5 which is approximately 127

Proportions for the other districts were calculated as 70 for Rachuonyo, 140 for Nyamira, for 30 Kericho and 17 for Buret.

The same concept applied in calculating the division and locations sample proportions. Therefore, 71 households were selected from South Nyakach location and 56 from West Nyakach; 25 from Kabondo East, 31 from Kabondo West and 14 from Wang'chieng; 95 from North Mugirango chache, 36 Ekerenyo and 9 Mekenene; 30 from Kiptere and 17 from Kisiara.

The sample size and proportions calculated above were therefore used for the study. All households in the Locations in the respective Districts were listed in a table, in put in the computer and used to generate randomly 384 households comprising both male and female heads. These household were later used for interview by use of a structured questionnaire.

Purposive sampling was used in selection of Key Informants. Purposive sampling technique is used when a researcher targets a group of people believed to be typical or average or group of people specially picked for some unique purpose. It allows the researcher to use cases that have the required information with respect to the objective of the study (Nzisa, 2012). Therefore, WRMA, WRUA and KenGen officials and Water Services Providers (WSPs) of LSMRB were specifically targeted for the special role they play in water allocation. This technique was also used partly in selecting FGD members particularly, community members that were actively involved in water resources management issues in the river basin.

3.5 Data collection

3.5.1 Data sources

Data for the study was collected mainly from both primary and secondary sources. Primary data collected was concerned with types of water resources in LSMRB, types of households' water resources uses, quantities of water allocated and households' socioeconomic characteristics. This data was chiefly obtained from households' heads and was used in establishing the extent of small scale water allocation and use in the basin. Secondary data was largely obtained from WRMA, KenGen, WSPs (both private and public) and WRUA officials. The data obtained was used in examining water allocation criteria and household water entitlements. Focus Group Discussions participants also provided data on types of water resources in the basin, their allocation and use. Secondary data sources generally provided relevant literature on water resources, allocation and use and the socioeconomic factors. The data was obtained from government documents, databases and official statistics, technical reports, newsletters and scholarly journals. They were obtained from WRMA, KenGen, KNBS and Nyakach Water Supply offices, the internet and Maseno University Library.

3.5.2 Data collection tools

The primary data collection tools used generally consisted of a structured household questionnaire, key informant interview schedules, participant observations and photography. The structured questionnaire which had both closed and open-ended questions was the main tool in collecting primary data. It was administered to the households to collect data on types of water resources used by households in LSMRB, different ways in which they used water, mode of water transport, time taken to obtain water, water resources use patterns, quantities of water they allocated to the various household uses, their socioeconomic status and their perception on quality of water from the sources. A total of 384 questionnaires were administered to household heads in the study area except in some cases where the household was unavailable and his/her assistance or other responsible member of the family responded. A similar questionnaire was used for all households in order to ensure that information obtained was consistence and addressed the intended questions.

Key Informant Interview Schedules were also administered to WRMA, KenGen, Water Supply Companies and WRUA officials to obtain information on types of water resources in LSMRB, different uses, allocation and their roles in providing water to the households. Different interview schedules were used based on the role of the respondent and the official/s dealing with issues of concern in a particular institution was/were interviewed. FGDs were also used to obtain information that was not adequately captured by the questionnaire and interview schedules. A total of ten sessions of FGDs were conducted three in Nyakach District, 2, 3, 1 and 1 in Rachuonyo, Nyamira, Kericho and Buret districts respectively. This was guided by the target household sample size in each district and the desire to ensure each district was represented in the FGDs. Each session of the discussion was conducted separately and consisted of between 10-12 participants (Nzisa, 2012). They included men, women and youths in equal proportions. A deliberate attempt was however made to involve participants who were actively involved in water resources management activities in the river basin and from the different Locations within the Districts. Help was sought from WRUA officials and sub –chiefs to identify them. Once they were identified, they were informed of the aim of the study, the venue for holding the discussion was identified (Location level was considered convenient) and the researcher facilitated their transport to the venue for discussion. This was especially important in ensuring equal representation in the discussions and addressing the water resources issues in the river basin. A FGD guide composed of open-ended questions was used in the process of conducting FGDs.

Additional information concerning the study was obtained by the use of participant observations and photography. Various water resources and the different ways in which they were being utilised by the residents of LSMRB was noted by the use of observation checklists and taking photographs using the Camera. This was done alongside the data collection process. The data collected was used to validate and support data collected using household questionnaires and interview schedules. Finally, secondary data collection tools comprised of in depth review of relevant materials. Information of interest was captured in writing, synthesised, analysed and a final copy prepared that was incorporated into the thesis.

Pre-tested of the research instruments and ethical issues

The household questionnaire developed was first tested for validity and reliability. This involved administering 38 questionnaires (about 10%) to the households across LSMRB, that is, Nyakach 13, Rachuonyo 7, Nyamira 14, Kericho 3 and Buret 1. The result obtained was used to check for the strength and weaknesses of the questionnaire. In particular, the ability and willingness of the respondents to answer the questions and time taken to fill the instrument was accessed. In addition, the capability of the instrument in appropriately answering the research questions was examined. The exercise revealed that the instrument required some changes that were addressed accordingly. The households involved in the exercise were later excluded from the data gathering exercise i.e. when generating the random samples covered earlier in this chapter. During the data collection exercise, the respondents were assured of total confidentiality of all information given. This was stated clearly on all the research instruments and verbally whenever necessary.

3.6 Data analysis, interpretation and presentation

The data collection exercise generated both qualitative and quantitative data. Types of water resources, uses together with number of households drawing water from the various uses was analyzed using mean, percentages and cross tabulation. This also applied to data on water quantities allocated by households to different uses, population with access to safe drinking water and household population practicing various water resources uses. Qualitative data obtained on water allocation and use was summarized for analysis. The emerging patterns were then examined in order to establish the extent of small scale water resources use in the basin. Both parametric and non parametric analysis techniques were used in establishing the relationship between variables. Non parametric tools were used where some households did not practice certain water resources use activities such as irrigation or small scale water supply (vending). This caused the sample size (n) to reduce. StatSoft, Inc (2013) suggested that non parametric data analysis techniques could be used when the sample size was small, that is, when number of observations was less than 100. Therefore Pearson's Product Moment was used in the analysis of the relationship between quantities of water allocated for household domestic use and household size, income and number of children below five years.

The Independent Sample T-Test was used to establish the relationship between quantity of water allocated for household livestock water use and livestock watering at home and at water source. Kruskal –Wallis H test was used in the analysis of the relationship between quantities of water allocated for public supply (vending) and mode of water transport; and quantity of water allocated for household irrigation use and types of crops. Spearman Rank Correlation was also used to establish the relationships between quantities of water allocated for household commercial use and number of serve consumers. The results were presented using texts, statistical tables, graphs and photographs.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 Introduction

This Chapter contain the findings of the study which are presented in text, tables, photographs and graphs. The presentation is done in three sub-sections in line with the specific objectives. Section one addresses objective one of the study which was mainly to identify water resources in Lower Sondu Miriu River Basin (LSMRB) and subsequent determination of their accessibility. Accessibility is analysed in relation to quantity of water collected, distance measured in relation to time taken to make a return trip to and from a water resource, quality as perceived by households and usage patterns. Sub- section two examines water resources allocation and use in the LSMRB where the types of water uses by households are identified and the population practicing each use and quantities of water allocated determined. The aim was to establish the extent of small scale water resources use in the basin. Finally, results of socioeconomic factors identified to influence water allocation at the household level are presented and discussed. The objective was to identify the important factors that should be taken into consideration when formulating policies that are aimed at address households right to water.

4.2 Water resources in the Lower Sondu Miriu River Basin

4.2.1 Water resources availability in the LSMRB

The study established that LSMRB is endowed with various water resources mainly surface water, groundwater and rainwater. Figure 3 A shows that majority (85.4%) of households interviewed relied on surface water as the main water resource, 14.1% on groundwater and 0.5% on rainwater. This result could be attributed to the relatively low cost associated with surface water extraction and larger abstraction volumes. A household only needed a 20-litre jerry can to draw water from a surface water resource compared to groundwater which required digging a shallow well or drilling a borehole which was more expensive. Rainwater on the other hand was seasonal and therefore required large storage facilities like tanks and water pans for long term use. Large storage tanks and construction of water pans were considered too expensive by most of the residents. However, residents harvested rainwater as an alternative water source during the rainy season. This was done by use of small tanks connected to the roof of the house or by use of buckets.

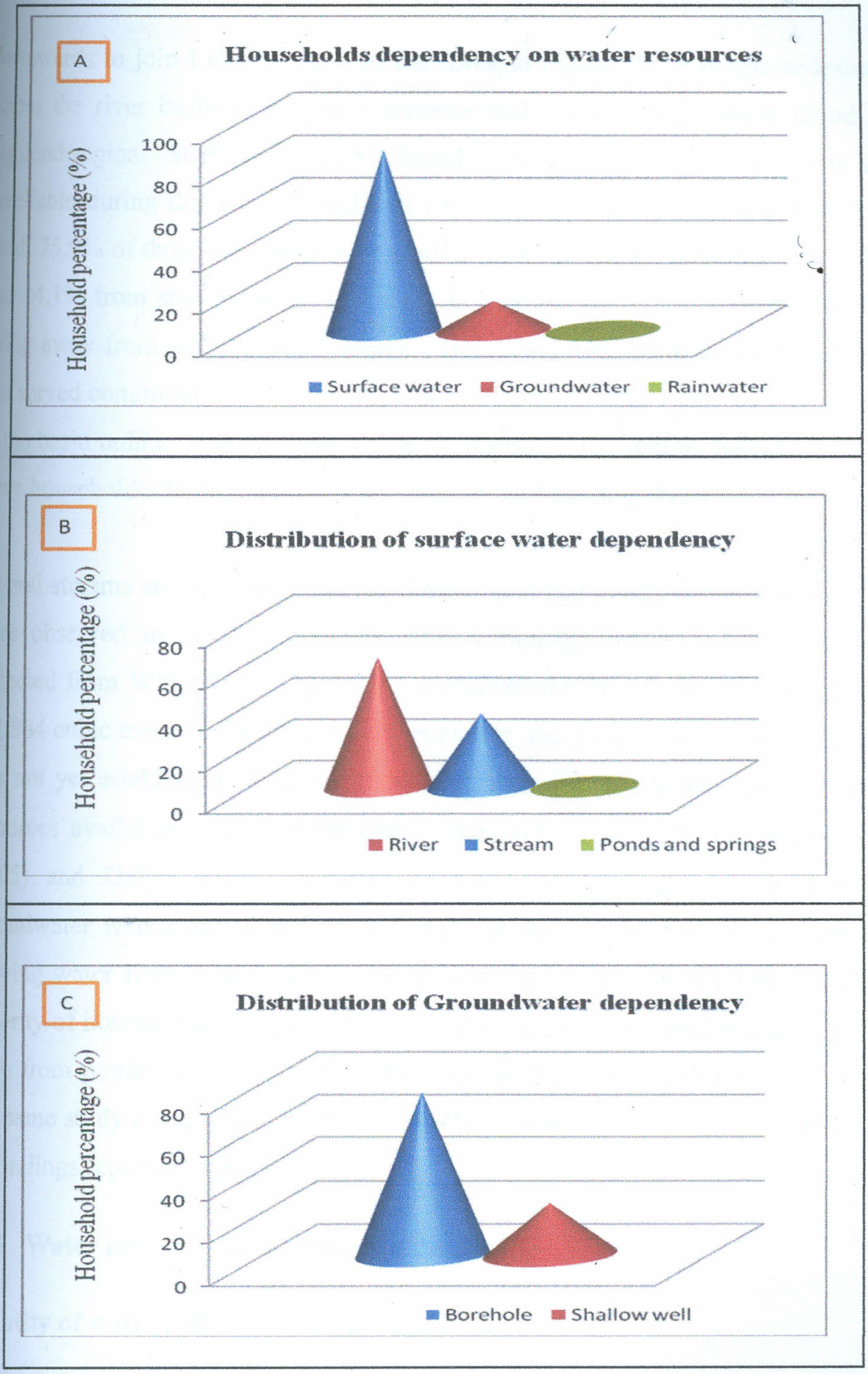

Figure 3: Households dependency on water resources and its distribution among different water resource sources

Source: Field data, 2013

The study further revealed that out of those mainly depended on surface water, 62.5% drew water from Sondu Miriu River, 35.7% from streams and 1.8% from ponds and springs (Figure 3 B). The Sondu Miriu River meandered from the highland of the river basin downwards to join Lake Victoria in the lowland region. Thus it was accessed by residents across the river basin unlike most streams and springs which were found mostly in the highland region. Streams and ponds found in the lowland region were only seasonal hence unreliable during dry seasons and this perhaps explains the results reported. On the other hand, 75.9% of those who mainly depended on groundwater, collected water from boreholes and 24.1% from shallow wells (Figure 3 C). Groundwater was mostly used by households living away from surface water sources. Boreholes were sunk through community projects and served community members with water. Thus they were likely to serve more households in the basin unlike shallow wells which were mainly dug within the homesteads and used to serve household's family members and their immediate neighbours.

Several streams and springs in the highland region and ponds and lake in the lowland region were observed in the basin which support findings reported above. Also, information collected from WRMA Sub-region office showed that Sondu Miriu River discharged about 501,984 cubic metres of water per day. However, the groundwater potential of the river basin was not yet established. Presence of several natural water sources is an indicator of water resources availability in the river basin. The study findings however agrees with Ong'or (2005) and Opiyo (2005) observation that LSMRB was endowed with surface and groundwater resources. However, this study further established the household population drawing water from each water resource. Also, results by UNWWDR, 2006 indicated that majority of households in Nyanza province drew water from surface water resources, that is, 6.8% from ponds/dams, 39.9% from lake/rivers, 24% from springs and 8.5% piped water. The same study also revealed that only 16.9% drew water from wells/bores which agree with the findings reported in this study.

4.2.2 Water resources accessibility in the LSMRB

Quantity of water collected and distance

The study revealed only basic but not adequate water resources access in the Lower Sondu Miriu River Basin based on average daily per capita quantity of water collected for domestic use and distance measured in relation to time taken to make a return trip to and from a water resource source. An average household in the study area was composed of 5.5 people and withdrew119.7 litres of water per day for domestic purpose from their main water resource

source. This translated to 21.7 litres/capita/day (l/c/d). Results in Table 4 shows that most (89.8%) of the respondents obtained water by foot and only 10.2% used other means of water transport that were faster or had bigger capacity to carry more water. Table 4 further reveals that of those who obtained water by foot, 84.9% took between 1-30 minutes to make a return trip to and from a water resource source, 12.2% 31-60 minutes and 2.9% more than 60 minutes. Only 46.2% that used other modes of water transport took between 1-30 minutes. The remaining 20.5% and 33.3% took between 31-60 minutes and over an hour respectively.

Note: The percentages were obtained by taking the number of observations in each time period of the mode of transport in Table 4, divided by total observations in that mode then multiplied by 100.

Table 4: Time Taken by households to make a return trip to and from a water resource source and mode of water transport

Time taken to make a return trip in minutes	Mode of household water transport		Total
	Foot	Other modes of water transport (Bicycle, Cart, motorbike, donkey car)	
1-30	*293 (94.2)	*18 (5.8)	***311 (100)**
31-60	*42 (84)	*8 (16)	***50 (100)**
>60	*10 (43.5)	*13(56.5)	***23 (100)**
Total	***345 (89.8)**	***39 (10.2)**	***384 (100)**

KEY: * = Count, () = Household percentage

Source: Field data, 2013

According to WHO/UNICEF JMP (2000), reasonable access is when households collect at least 20 l/c/d from a source within one kilometer. WHO (1996) as quoted by Asare (2004) cited 200m as convenient distance, and 20 l/c/d as the minimum amount of water needed for metabolic, hygienic and domestic purposes. In East Africa, collection of less than 5 l/c/d of water at more than 1000m; or more than 30 minutes total collection time was considered as *no access,* about 20 l/c/d at 100 and 1000m or 5-30 minutes as *basic access* and around 50 l/c/d with on plot use e.g. a single tap in house or yard as *intermediate access* (Howard and Bartram, 2003). Average quantity collected in LSMRB is slightly above what is considered basic access in East Africa and way below intermediate access. But, it was important to note that the other percentage of the respondents used other means of transportation (motorbikes, cars, donkeys and bicycles) that were faster or had the capacity to carry more water. While the collection time was reduced, other costs (monetary and energy) associated with these modes of transportation could limit access to water. Also, despite adopting these modes of transport, some took more than an hour to obtain water which could be an indicator of inaccessibility. However, reasonable access in Kenya is defined as 2 Km (UNWWDR, 2006). WRMA target is to ensure BHNs access to water of 20 l/c/d at a distance of 1 km (WRMA, 2012). But the government target is to ensure all citizens spend at most 30 minutes to and from a water resource source. It can thus be said that access to water in LSMRB was reasonable based on UNWWDR and WRMA figures given for water quantity but the government target of 30 minutes for all citizens is yet to be reached.The finding of the study that there was inadequate access to water resources in LSMRB agrees with Masese (2012) who pointed out that due to low development of water supply infrastructure in developing countries, a majority of residents were forced to obtain water for domestic use directly from sources including surface water sources with minimal or no treatment at all and at long distances.

Access to safe drinking water.

Access to safe drinking water was determined by number of household connected to piped water supply and on quality as perceived by the households. The study revealed that majority (84.6%) of the residents did not have access to piped water. Only 15.4% had access to piped water. Open water sources such as stream and unprotected groundwater source are generally considered not safe for drinking (Asare, 2004). Since majority of households were not connected to the water supply network, they resulted to fetching water directly from natural water sources. This is an indicator of low access to safe drinking water. Also, the study revealed that 75.5% of the households percieved water obtained from their primary sources of water was not safe for drinking. Only 24.5% indicated that water from their primary source was potable. It was also observed during the study that only two public water supply companies existed in the basin, all located in the highland region. The lower region was served by stand pipes from KenGen which were opened a few hours early in the morning and in the evening. According to District Water Officer, Nyawasi Water Supply Company, one of the main challenges in rural water supply was cost of water infrastructure. It was difficult to pipe water to residents living very far away from water supply network as cost of laying the water network, risk of vandalism and system monitoring and maintenance was high. This explained why most of the residents did not have access to piped water and only resulted to fetching water directly from natural water resource sources. Thus, the high percentage of those lacking access to piped and safe drinking water is an indicator of low water accessibility in LSMRB. The study finding disagree with Hakijamii (2014) observed that 40% of Kenyan living in rural areas have access to safe drinking water. This could be explained by the macro level nature of Hakijamii statistics that masks realities in smaller regions of Kenya. Also, Kenya envisaged 76% access to safe drinking water by 2015 (UNWWDR, 2006) but this is very far away from being realized in LSMRB.

Usage patterns

instream water resources uses and reliance on multiple sources of water were identifies as the main water resources usage patterns relating to water accessibility. Table 5 shows reasons cited by households for practicing various instream water resources use activities. Avoidance of carrying water was the most cited at 82.1% for bathing, 77.8% washing and 74.3% for watering livestock. This was followed by evasion of cost of water transportation; bathing 14.8%, washing 19.1% and watering livestock 15.4%.

Table 5: Reasons cited by households for various in stream water resources use

Reasons for in stream water resources use by households	Bathing	Washing	Watering livestock
	Frequency	Frequency	Frequency
Evade carrying water	183 (82.1)	199 (77.8)	130 (74.3)
Avoid cost of transportation	33 (14.8)	49 (19.1)	27(15.4)
Cultural reasons	7 (3.1)	8 (3.1)	0 (0)
Water scarcity during dry season	0 (0)	0 (0)	18 (10.3)
Total	**223 (100)**	**256**	**175 (100)**

Key: () - Percentage

Source: Field data, 2013

Avoidance of carrying water and reduction in cost of water transport were the most cited reasons for instream water resources use probably because the body energy required to carry the water to home for such uses would be unreasonable. In the same way, cost of water would be high hence limiting water accessibility. Water scarcity during the dry season affected access to water especially among livestock farmers. Other Instream uses such as waste disposal also undermined water quality further restraining access to safe drinking water. In addition, Table 6 shows reasons cited by households for relying on multiple sources of water. Free and readily available alternative source (rainwater) was cited by 70.5% of the respondents, cheaper alternative sources 16.7%, cleanliness and safety for drinking 11.3% and unreliability of the main source 1.5%

Table 6: Reasons cited by households for relying on more than one source of water

Reason	Frequency	Percentage
Free and readily available	325	70.5
Cheaper alternative sources	77	16.7
Clean and safe for drinking	52	11.3
Unreliable main source	7	1.5
Total	**461**	**100**

Source: Field data, 2013

Rainwater was the most preferred alternative water source for households especially during the rainy seasons. This was because it was perceived to be free and readily available. Since most the households' fetched water directly from natural water sources, it was more convenient to harvest rainwater and store in jerry cans rather than carry water situated far away from the homesteads. Also water bought from vendors and water supply companies was considered expensive by households forcing them to look for more affordable alternative sources of water. Rain water, groundwater and tap water (provided to residents by KenGen) were considered cleaner and safer for drinking. In the same way, piped water was considered unreliable by some residents. Secondary data sources revealed that residents could run a month without water in their taps due to operation closure by water supply companies. The main reason cited by company management for closure was high energy cost associated with water distribution. Also, piped water from KenGen was only available during early morning hours and late in the evening. Reliance on alternative sources of water by households meant unreliable access to water at one point in time of the household's main source. Asare (2004) observation that households with water insecurity adopts various coping strategies including relying on multiple water resource sources, commuting long distances and use of storage facilities which support the finding in this study that water use patterns such as reliance on multiple sources is an indicator of low water inaccessible.

4.3 Water resources allocation and use in the Lower Sondu Miriu River Basin

4.3.1 Water resources allocation in the LSMRB

The study established that water resource use at household level in LSMRB was small scale. Users were not required to apply for the authorization from WRMA and therefore drew their desired quantity of water from an identified source depending on the use they wanted to put the water to. The study further revealed that households in the basin allocated water for both domestic and productive uses. Household productive uses included allocation for livestock, irrigation, water vending and for use in small scale commercial entities such as hotels, bars and restaurants. On average, a household allocated 119.7 litres of water per day to meet domestic needs, 496.4 litres for vending, 51.5 for commercial use, 107.2 livestock use and 332.6 for irrigation. Table 7 shows the average daily quantities of water allocated to various household water resources uses in LSMRB.

Table 7: Average quantities of water allocated to the various households water resources uses

Type of use	N	Average quantity of water allocated to various household uses in litres/day
Domestic use	384	119.7
Water supply/vending	22	496.4
Commercial use	26	51.5
Livestock use	239	107.2
Small scale irrigation	70	332.6

Source: Field data, 2013

Water vendors allocated the highest quantity of water on daily basis. However, vending was not rampant (N=22). Irrigation accounted for the second highest daily water allocation in the basin but use was generally low (N=70). Domestic and livestock water use had lower allocations compared to irrigation and vending but had highest number of users (N =384 and 239 respectively). However, commercial water use had the lowest quantity allocated and users were also few (N=26). This implies that in the long term, domestic, livestock and irrigation allocations were likely to have more impact on water resources in the basin than vending and commercial water uses. Various factors could have however contributed to the quantities allocated to the various uses in the basin. These include availability of water resources and their accessibility, water allocating authorities and the socioeconomic characteristics of the households. The average household domestic water allocation observed in this study however differ from that (200 litres) of Volta Basin, Ghana (Asare, 2004) and 60 litres for Omaruru-Swakop River Basin, Namibia (IWRM Joint Venture Consultant report, 2012). This could be attributed to differences in water resources availability and the socioeconomic characteristic of the households in the river basins.

Secondary data sources also revealed that water resources in LSMRB were also allocated to large scale water resources users. Large scale water resources allocation required authorization from WRMA. Table 8 shows that surface water accounted for 99.9% of the total registered water resources withdrawals while groundwater accounted for less than 0.1%. Hydroelectric power generation was the main surface water resource use in relation to quantity accounting for 98.5% of the total allocated surface water. Public water supply accounted for 1.4% while the rest was shared among domestic, commercial, livestock and irrigation uses.

Table 8: Registered water resources allocations in the LSMRB

Water resource type	**Water resource use type**	**Total amount of water allocated in m^3/day**	**Total water resource type percentage**		**Total use type percentage**
Surface water	Domestic	91.5			0.005
	Commercial	353			0.02
	Public supply	25090			1.434
	Livestock	25			0.001
	Irrigation	45.9			0.003
	Industrial	682			0.039
	Hydroelectric power	1723680			98.5
	Sub-total	**1749967.4**	99.9	**Total**	**100**
Groundwater	Domestic	2.5			
	Sub –total	**2.5**	<0.1		
	Grand total	**1749969.9**			

(Source: WRMA databases, 2013)

Sondu Miriu hydropower project was established mainly due to the high electricity demand in Kenya (KenGen, 2004). The quantity of water required for hydroelectric power generation is usually high and this could perhaps explain the high percentage observed. Nevertheless, a substantial amount of the water allocated is return at about 14km downstream of the intake (Willoughby, 2008). Also, KenGen supplied the local community with water as part of its social cooperate responsibility. The Water Act, 2002 (GoK, 2002) makes it a legal duty for WSP to provide water services to the people of Kenya. There were two WSPs in LSMRB located in the upper and lowland region of the basin. Their water allocation constituted the allocation for public supply, that is, the second water resources user in terms of quantity. The percentage could be attributed to the government efforts in ensuring provision of water services to the rural community provided for in the water sector reforms. Industrial, commercial, domestic and livestock water allocations were generally low. Commercial water use is mostly concentrated in urban areas yet LSMRB is mainly rural. Provision of water for domestic purposes has often been viewed as the responsibility of the government thus attracting few private investors. Commercially viable irrigation and livestock keeping requires high capital investments which may not be affordable to most people in the basin. All these factors could probably explain the low allocations for commercial, irrigation and livestock use respectively. The low industrial water resources allocation could be attributed to the type of industrial activities observed in the study area. Tea and coffee factories were the main types of industries encounted in the river basin which were mainly located in the upper region of the river basin.

4.3.2 Water resources use in the LSMRB

The study established both offstream and instream water resources uses in LSMRB. Offstream water resources use involved use of water for domestic and other household productive uses away from a water resource source. Domestic offstream water resources use was reported by all the respondents Figure 4 shows that livestock water resources use was reported by 62.2% of the respondents, irrigation 18.2%, commercial use 6.8% and water vending 5.7%.

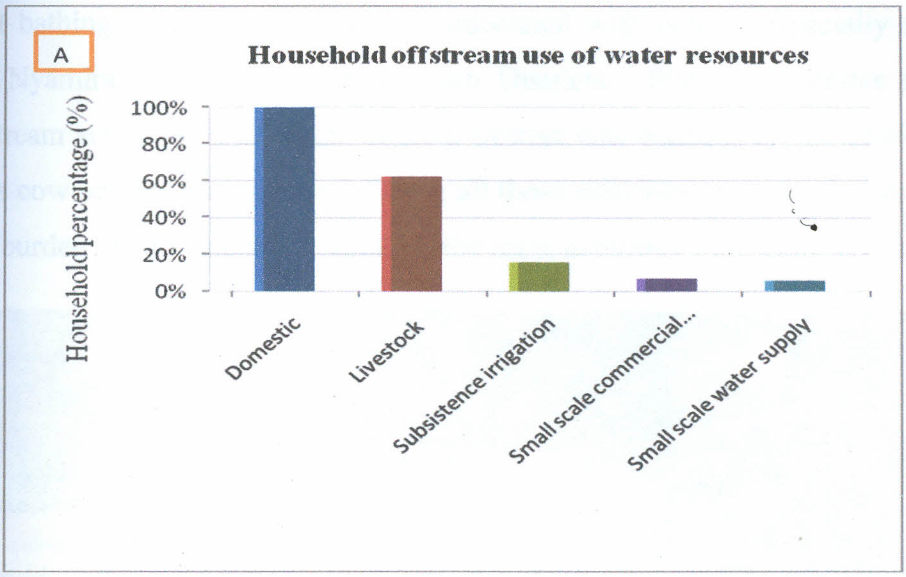

Figure 4: Different offstream water resources uses by households

Source: Field data, 2013

Observations during the study established that vending and commercial water resources use were popular among the urban dwellers of the river basin. This contrasted livestock and irrigation uses which were common among the rural dwellers. LSMRB is mainly rural (GoK, 2009) and this probably explains why livestock and irrigation water resources use were more common than commercial and water vending. However, livestock water use was widespread than irrigation use. This could be attributed to the high costs associated with irrigation water uses such as digging of water channels and buying of water pipes were that considered unaffordable by most residents unlike raring of livestock. Residents living far from water resource sources were disadvantaged in relation to channeling water to their farms for irrigation unlike those keeping livestock who took animals to the source for watering.

Instream water resources use on the other hand involved use of water inside or beside a water resource source such as a stream, river or pond. Instream water resources use activities reported by households included livestock watering (74.3%), washing clothes (62.5%), bathing 56.7%), recreation (33%), fishing (30%), waste disposal (8%) and transportation (3%). Watering livestock, washing clothes and bathing were the most reported instream water resources activities use perhaps because most homestead were not connected to piped water hence household members found it easier cleaning, bathing and watering animals at the source other than carrying water which was more tasking. Secondary data sources also revealed that bathing at a water source was associated with culture especially among the residents of Nyamira, Rachuonyo and Nyakach Districts. Plate 1 illustrates three most common instream activities in LSMRB where a woman was washing clothes, bathing a boy and grazing a cow besides a water pond. Doing all those activities at a water sources reduced time and the burden of carrying water unlike if the same activities were done at home.

Plate 1: A woman in LSMRB washing clothes, bathing a boy and a cow grazing besides a water pond located in the outskirts of Sondu Town

Fishing, transportation and recreational activities like swimming were most common in the lowland region of the basin and this could probably explain the percentages obtained. The low flow rate of Sondu Miriu River, larger water volumes, wider coverage and abundance of fish created a condusive environment for these instream activities in the lowland region of the basin. Also, the flat terrain in the lowland region encouraged human settlement along the banks of Sondu Miriu River which exposed the river to increased waste disposal. Plate 2 shows boats and fishing net used by residents of Kobala in LSMRB for fishing and water transport.

Plate 2: Fishing and water transport activities in the lower reaches of Sondu Miriu River

Other instream activities observed in the basin included washing vehicles and motorcycles and watering tea leaves as they were being transported to the factories. These activities were common near river and stream bridges and were associated with water courses pollution in the basin. Plate 3 shows residents of LSMRB washing a lorry inside Yabirago stream located in the highland region of LSMRB.

Plate 3: Residents washing a lorry inside a stream in LSMRB

The finding of the study that residents of LSMRB used water resources for both offstream and instream activities agree with several studies. Opiyo (2005) and Willoughby (2008) found out that resident of Sondu Miriu River Basin practice fishing, boating and used Sondu Miriu River for transportation activities. Mai (2013) also observed that water resources(including lakes, rivers and stream) in a river basin faced multitude of competing uses including water use for activities such as swimming, boating, religious activities, washing, clothes, bathing, sand mining, transportation, fishing, trading, hydropower generation and sustenance of the ecosystem. Also, Ouma et al (2013) and Masese et al (2012) stated that water resources in Sondu Miriu River Basin were used for domestic, agricultural and industrial activities.

4.4 Socio economic factors influencing household water allocation in the Lower Sondu Miriu River Basin.

Various socioeconomic factors influencing the quantity of water allocated for various household uses were analyzed. Water quantity in the analysis was measured in litres per day.

4.4.1 Water allocation for domestic use

i) Household size

Pearson's Product Moment correlation analysis results shown in Table 9, indicated a high positive correlation between household size and quantity of water allocated for household domestic use (r = 0.841) at (p<0.01).

Table 9: Correlation between household size and quantity of water allocated for household domestic use

		Household size	Quantity allocated for domestic use
Household size	Pearson Correlation	1	.841**
	Sig. (2-tailed)		.000

**. Correlation is significant at the 0.01 level (2-tailed), N = 384

Source: Field data, 2013

Some households in Lower Sondu Miriu River Basin (LSMRB) had has high as twelve household members. This was common mostly where a male household head had married more than one wife or incidences where the first wife had died and he had to remarry. This meant more children and consequently higher water demand for cooking, washing clothes and performing other house chores. Also, the wives had their own houses hence performed their household chores separately. This eventually increased the quantity of water the household drew for daily domestic use. This could probably explain the observed high positive correlation. It can thus be concluded that larger household sizes in the basin were associated with larger quantities of water allocated for household domestic use. Several studies agree with this study's finding. For instance Alcamo et al, (1997) and Shen (2008) observed that increase in population led to increase in water demand. Similarly, Asare (2004) found out that larger household sizes in GLOWA Volta Basin, Namibia had higher water consumption level compared to smaller households. Thus, higher water consumption levels associated with larger household sizes would mean more water allocation for households with larger household sizes as compared to those with smaller household sizes.

ii) Number of children below five years

Pearson's Product Moment correlation analysis performed between household number of children below five years and quantity of water allocated for domestic use established positive moderate correlation (r = 0.416 at P<0.01). This is as indicated by correlation results in Table 10.

Table 10: Correlation between number of children below 5 years and quantity of water allocated for household domestic use

		Quantity allocated for domestic use	No of children below five years
Quantity allocated for domestic use	Pearson Correlation	1	.416**
	Sig. (2-tailed)		.000

**. Correlation is significant at the 0.01 level (2-tailed), N = 384

Source: Field data, 2013

Children below five years are the most vulnerable to the effects of insufficient sanitation and hygiene according to UNICEF, 2014. While 20% of Kenyan population is children below five years, 4.7% of all outpatient cases nationwide are accounted for by these children. While some households did not have children below five years, presence of these children amongst other households increased the need for fetching water. It was common for adults and older children in the basin to bathe at water resource sources unlike for children below five years who could only be bathed at home due to their age. In addition, distance to most water resource sources was far for such children and they would be at the risk of drowning. Thus more children below five years meant that more water was requirement at home for bathing as well as taking care of their hygiene needs. However, the moderate correlation could perhaps be explained by instream activities such as washing clothes at a water resource source where even their clothes were washed together with other family member's clothes. This study finding agrees with Howard and Bartram (2003) who observed that availability of water was related to children hygiene. While improved sanitation was important in ensuring children's health, supply of sufficient quantity of water is equally important especially for children below five years. Therefore, larger number of children below five years in LSMRB was associated with larger quantities of water allocated for household domestic use.

iii) **Income**

A positive linear correlation (r = 0.177 at P<0.01) was revealed by the Pearson's Product Moment correlation analysis performed between income and quantity of water allocated for household domestic use. Results shown in Table 11

Table 11: Correlation between monthly income and quantity of water allocated for household domestic use

		Household monthly income
Quantity allocated for domestic use	Pearson Correlation	.177**
	Sig. (2-tailed)	.000

**. Correlation is significant at the 0.01 level (2-tailed), N = 384

Source: Field data, 2013

It was observed that households with higher income in LSMRB were mostly those engaged in some form of formal employment or had an established business as their main source of income. Also, most of those in formal employment had higher levels of education and those in business had mixed levels of education. Generally, they had better standards of living as they built modern houses, could afford piped water or dug their own shallow wells within the homestead. In contrast, those that depended on subsistence agriculture had lower income and their standard of living was generally low since most of the time, they walked to nearby rivers, streams and boreholes to fetch water and built thatched houses. Higher standard of living is often associated with high domestic water consumption (Asare, 2004). Thus households with higher levels of income were likely to allocate more water for domestic use as compared to those with lower levels of income. Majority of the residents nonetheless, fetched water directly from natural water resource sources which were accessible to all residents regardless of their financial background. This probably explains the weak correlation established by the study. Several studies concur with this study's finding. For instance, Houstone (2003) and Asare (2004) pointed out that increase in household incomes increased demand for water. Salman and Al-karablieh (2013) also established that increasing household income by 10%, led to 0.03% increases in household water consumption that is, there was a positive elasticity between household income and quantity of water consumed. Thus, higher household income was associated with larger quantities of water allocated for household domestic use.

iv)Time taken to make a return trip

To establish the relationship between time taken to make a return trip to a water source and quantity of water allocated for household domestic use, a Pearson's Product Moment correlation analysis was carried out. Results in Table 12 indicated a negative linear correlation ($r = -0.129$ at $P < 0.05$) between the two variables. This implied that while time to and from a water source increased, the quantity allocated decreased.

Table 12: Correlation between time taken to make a return trip to and from a water source and quantity of water allocated for household domestic use

		Quantity allocated for domestic use	Time taken to make a return trip
Quantity allocated for domestic use	Pearson Correlation	1	-.129*
	Sig. (2-tailed)		.011

*. Correlation is significant at the 0.05 level (2-tailed), N = 384

Source: Field data, 2013

Majority of the residents used between 1-30 minutes to make a return trip to and from a water source. While this could explain the weak linear relationship observed, the others residents used donkeys, carts, bicycles and motorbikes which could be an indicator of longer distances they had to walk to obtain the water. Others took more than 30 minutes and even more than an hour. In addition to these factors, steep river banks and hilly terrain that hindered access to water especially in the highland region could probably explain the negative relationship observed. Therefore, households that took more time to make a return trip to and from a water source were likely to allocate lesser quantities of water for domestic use as compared to those that took shorter time. A study by Minten et al, 2003 as quoted by Asare, 2004 established no significant effect of distance to water source on water quantity demanded in Madagascar. This disagrees with this study finding. However, his study result was attributed to the closeness of the water sources to the household. This was nonetheless different in LSMRB where distance to water sources varied across the basin due to terrain, steep river banks and poor access to piped water.

4.4.2 Water allocation for small scale public supply (Vending)

The study established that only 5.7% of households in LSMRB allocated water for small scale public supply (vending). The Spearman Rank correlation, which is the non parametric version of the Pearson's Product Moment correlation was therefore used to established the relationship between supply population and quantity allocated while the Kruskal-Wallis H test, a non parametric version of One Way Analysis of Variance was used in the analysis of quantity of water allocated and different households mode of water transport.

i) Population supplied

The Spearman Rank correlation analysis results shown in Table 13 revealed a strong positive correlation between supply population and quantity of water allocated for household small scale public supply use which was statistically significant (r_s (22) = 0.897, P = 0.000).

Table 13: Correlation between average number of people supplied with water and quantity of water allocated for household small scale public supply/vending use

			Quantity allocated for small scale public supply	Population supplied
Spearman's rho	Quantity allocated for small scale public supply	Correlation Coefficient	1.000	.897**
		Sig. (2-tailed)	.	.000

**. Correlation is significant at the 0.01 level (2-tailed), N = 22

Source: Field data, 2013

Majority of the household used 20-litre jerry cans to supply water to hotels, bars, wholesale and retail shops, offices, residential areas and some institutions like churches and nursery schools. Water was transported using motorbikes, bicycles, carts and by human beings on heads depending on the distance to the water source and the targeted consumers. This perhaps explains the high correlation established by this study. Also, some households bottled the water, then supplied while others used standpipes. Standpipes were seen to cover more people as consumers had to carry the water themselves unlike with 20-litre jerry cans where the household had to deliver the water to the consumers. Therefore, the more people a household supplied with water, the larger the quantity they were likely to allocate for public supply at the source. The finding of the study that there was a strong positive relationship between supply population and quantity of water allocated for household public supply use agrees with Brown (1999) and Shepel (2010) observation that water use determinants such as supply population are best used in estimation of water demand. This implied that there was a very high correlation between water used for public supply and the population supplied. USA Government Report (2013) also supports this study finding by indicating that 97% of variability in total public water supply can be explained by the population served

ii) **Mode of water transport**

A Kruskal-Wallis H test, showed that there was a statistically significant difference in quantity of water allocated for household small scale public supply use between the different modes of water transport by households X^2 (3) = 14.387, P = 0.002 (Table 14)

Table 14: Kruskal Wallis Test Statistics for quantity of water allocated for household small scale public supply and different modes of water transport

	Quantity allocated for small scale public supply
Chi-Square	14.387
Df	3
Asymp. Sig.	.002

Source: Field data, 2013

The mean rank water quantity was 7.25 for those supplying by foot, 13.2 by bicycle, 20.33 by carts and 19.5 by motorbikes (Table 15)

Table 15: Kruskal Wallis Ranks for quantity of water allocated for household small scale public supply and different modes of water transport

	Household mode of water transport	N	Mean Rank
Quantity allocated for small scale public supply	Foot	12	7.25
	Bicycle	5	13.20
	Cart	3	20.33
	Motorbike	2	19.50
	Total	22	

Source: Field data, 2013

According to the result, households that used Motorbikes and Carts as their mode of water transport allocated higher quantities of water for small scale public supply as compared to those that used bicycles and by foot. Nevertheless, the quantity allocated by those using Carts and Motorbikes was more or less similar. This could be attributed to carts being slower and having the capacity to carry more 20-litres jerry cans compared to motorbikes that were faster but with lesser capacity to carry the jerry cans. However, majority of the households did not use motorbikes and carts because they considered them unaffordable. In the same way, allocations for those by bicycles were higher than those by foot. Not every household could afford to buy a bicycle and most of them resulted to transporting water by foot. Compared to bicycles and other modes of water transport discussed here, the time and human energy required to transport water by foot reduced the amount of water a household could carry and consequently the quantity they allocated for household small scale water supply. In other words, households transporting water by foot were likely to allocate lesser water as compared to those transporting water by a bicycle, motorbike or cart. Nevertheless, those using motorbikes and carts were likely to allocate more or less the same quantity, different from those using bicycles. Observation by the UNDP (2011) that quantity of water supplied by water vendors depended on the type of vending (use of stand pipes, carts or tankers) adopted by a water vendor supports this study finding.

4.4.3 Water allocation for small scale commercial use

Only 6.8% of the households interviewed allocated water for commercial use. Thus, Spearman Rank correlation was used to establish the relationship between quantity of water allocated for household commercial use and both number of service consumers and employees.

i) Number of service consumers

Spearman Rank correlation analysis between average number of service consumers and quantity of water allocated for household small scale commercial use indicated a high positive correlation (r_s (26) = 0.792, P = 0.000) as shown by the analysis result in Table 16.

Table 16: Correlation between average number of commercial service consumers and quantity of water allocated for small scale household commercial use

			Quantity allocated for small scale commercial use	Number of service consumers
Spearman's rho	Quantity allocated for small scale commercial use	Correlation Coefficient	1.000	.792**
		Sig. (2-tailed)	.	.000

**. Correlation is significant at the 0.01 level (2-tailed), N = 26

Source: Field data, 2013

Households in LSMRB owned commercial entities like hotels, bar and restaurants, wholesale and retail shops as well as car wash. Hotels, bars and restaurants required more water due to the nature of their operation as compared to most retail and wholesale shops. They were also likely to serve more customers in a day unlike in shops. However, entities like car wash were likely to require more water per client as compared to other business entities. Water allocation for commercial use varied across the basin depending on the nature of business and this probably explain the result obtained. Consequently, larger number of commercial service consumers was associated with larger quantities of water allocated for commercial use. This finding agrees with Shepel (2010) observation that a strong relationship existed between commercial water use and number of commercial service consumers.

ii) Number of employees

The relationship between number of employees and quantity of water allocated for household commercial use was establishing using the Spearman Rank correlation analysis. Analysis results presented in Table 17 revealed a strong positive correlation (r_s (26) = 0.797, P = 0.000).

Table 17: Correlation between number of employees in a commercial entity and quantity of water allocated for household small scale commercial use

			Quantity allocated for small scale commercial use	Number of employees
Spearman's rho	Quantity allocated for small scale commercial use	Correlation Coefficient	1.000	.797**
		Sig. (2-tailed)		.000

**. Correlation is significant at the 0.01 level (2-tailed), N = 26

Source: Field data, 2013

The results could probably be attributed to the nature of businesses operated by households. Those that were service oriented like bars and restaurant hired more employees compared to commodity businesses like wholesale and retail shop. Also, the size and location of a business enterprise determined whether a household hired employees or not. Most businesses located in rural areas had fewer operations that could be carried out by household family members unlike those in urban centres. Thus a household operating business in an urban centre hired employees depending on the amount of work at the enterprise. Consequently, it can be said that larger number of employees was associated with larger quantities of water allocated for household commercial use. This finding concur with USA (2013) and Zena et al (2001) who indicated that the number of employees in a commercial entity could be used in estimation of water withdrawals in a river basin. Therefore the number of employees in a commercial entity is an indicator of how big an entity is and consequently the amount of water likely to be used.

4.4.4 Water allocation for agricultural use

A household agricultural water allocation was made up of both livestock and irrigation use. The study revealed that 62.2% of the respondents owned livestock and only 18.2% irrigated their farms. Therefore, both parametric and non parametric analysis techniques were applied accordingly.

a) **Allocation for livestock use**

i) **Animal population**

A Pearson's Product Moment correlation analysis performed between animal population and quantity of water allocated for household livestock use (results shown in Table 18) revealed a moderate positive correlation between the two variables ($r = 0.486$, $n = 239$, $P<0.01$).

Table 18: Correlation between animal population and quantity of water allocated for household livestock use

		Quantity allocated for livestock use	Animals population
Quantity allocated for livestock use	Pearson Correlation	1	.486**
	Sig. (2-tailed)		.000

**. Correlation is significant at the 0.01 level (2-tailed), N = 239

Source: Field data, 2013

Households owned a wide range of domestic animals including cattle, goat, sheep, donkeys and poultry. Water demand for the different animals owned by households varied and this could possibly explain the moderate correlation established. According to Rice et al (2010), animal units represented by many individual animals could be used to estimate the amount of water or feeds in livestock operations. This observation was also supported by Alcoma et al (2000) who indicated that livestock water demand depends on number of animals. Their observation agrees with this study finding thus concluding that larger animal population in LSMRB was associated with larger quantities of water allocated for household livestock use.

ii) **Livestock watering at a water resources source**

This study found out through the Independent Samples T-Test shown in Table 19 and 20 that there was a statistically significant difference between the mean quantity of water allocated for household livestock water use for those that watered livestock at a water source 123.77 ±113.428 and those that watered at home 65.51 ±54.479, $t_{(229)} = 5.343$, $P = 0.000$.

Table 19: Group statistics for quantity of water allocated for household livestock use and animals watering at source or at home

	Livestock watering	N	Mean	Std. Deviation	Std. Error Mean
Quantity allocated for livestock use	Watered at the source	171	123.77	113.428	8.674
	Watered at home	68	65.51	54.479	6.607

Source: Field data, 2013

Table 20: Independent Samples Test for quantity of water allocated for household livestock use and livestock watering at source or at home

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Quantity allocated for livestock use	Equal variances assumed	14.358	.000	4.050	237	.000	58.257	14.385	29.918	86.596
	Equal variances not assumed			5.343	228.951	.000	58.257	10.903	36.773	79.741

Source: Field data, 2013

Only the households that owned livestock (62.2%) in LSMRB were considered in this analysis. Watering at a water source meant that a household's livestock could drink as much water as they could because the distance was shortened unlike watering at home which depended on the ability of a household to fetch water for the animals. Also, some households grazed animals near natural water sources like streams and springs. These animals therefore watered whenever they desired unlike those locked in the homesteads. Rice et al (2010) observed that animals walking long distances to water sources were likely to desire more water than those that watered at home. In LSMRB, animals that watered at water sources had to walk to the sources and this could perhaps further explain the result revealed. Since the group statistics revealed that the mean for households that watered livestock at the water source was higher than that of the ones that watered at home, it can be concluded that watering livestock at a water source resulted to larger quantities of household livestock water allocation compared to watering animals at home.

b) Allocation for small scale irrigation use

i) Size of farm under irrigation

Spearman Rank correlation analysis was performed to establish the relationship between size of farm under irrigation and quantity of water allocated for household irrigation use. Results presented in Table 21 indicated a moderate positive correlation between the two variables (r_s (70) = 0.797, P = 0.000).

Table 21: Correlation between size of farm under irrigation and quantity of water allocated for household subsistence irrigation use

			Quantity allocated for small scale irrigation	Size of farm under irrigation
Spearman's rho	Quantity allocated for small scale irrigation	Correlation Coefficient	1.000	.697**
		Sig. (2-tailed)	.	.000

**. Correlation is significant at the 0.01 level (2-tailed), N = 70

Source: Field data, 2013

Irrigation water use by households in LSMRB was mostly subsistence in nature. This could be established from the quantities of water allocated and the small sizes of farm under irrigation. Households irrigated different types of crops including domesticated trees, napier grass, pineapples, kales, bananas, tea seedlings as well as maize. Water for irrigation was channeled mostly using pipes. In other instances, buckets were used depending on the type of crops and irrigation area. Also, green house and open irrigation was practiced depending on the type of crop/plant being irrigated and whether the crops were for sale or not. Probably, all these factors combined could explain the moderate correlation established. A study by Brown (1999) and Nevanda department of water planning report (2013) showed that the area of land under irrigation was positively correlated with the amount of water used for irrigation. This is in agreement with this study finding that a moderate positive relationship existed between size of farm under irrigation and quantity of water allocated for household irrigation use. As a result, bigger farm sizes under irrigation were associated with larger quantities of water allocated for household irrigation use.

ii) Type of crops

Kruskal-Wallis H test results shown in Table 22 and 23, established a statistically significant difference in quantity of water allocated for household irrigation use between the different types of crops irrigated X^2 (3) = 23.009, P = 0.000 (Table 22)

Table 22: Kruskal Wallis Test statistics for quantity of water allocated for household subsistence irrigation use and different types of crops

	Quantity allocated for subsistence irrigation
Chi-Square	23.009
Df	3
Asymp. Sig.	.000

Source: Field data, 2013

The mean rank water quantity was 29.89 for food crops, 27.96 trees, 39.71 pasture/fodder and 58.81 cash crops (Table 23).

Table 23: Kruskal Wallis Ranks for quantity of water allocated for household subsistence irrigation use and different types of crops

	Type of crops	N	Mean Rank
Quantity allocated for subsistence irrigation	Food crops	23	29.89
	Trees	27	27.96
	Pasture/fodder	7	39.71
	Cash crops	13	58.81
	Total	70	

Source: Field data, 2013

The quantity of water allocated for household irrigation use does not seem to differ much between households that irrigated food crops and trees but only in those that irrigated both pasture/fodder and cash crops. Also, those that irrigated cash crop were likely to allocate more water compared to those irrigating pasture and fodder. Cash crops irrigated amongst the households of LSMRB was commercial oriented. Therefore, requirement for commercially viable quantities at the small scale level could explain the larger quantities of water allocated to cash crops. Pasture/fodder irrigation was also commercial oriented in that it was mostly feed to cattle which later produced milk for sale. In most cases, pasture/fodder was irrigated for feeding animals owned by a household explaining the small quantity allocated. Unlike cash crops and pasture/fodder, most food crops were mostly irrigated for consumption by members of the household and trees for environmental conservation reason. This could possibly explain the lower quantities allocated. Consequently, the results implied that households irrigating cash crops and pasture/fodder were likely to allocate more but different quantities of water for household irrigation use compared to those that irrigated food crops and trees. This finding was supported by Collins et al, 2009 observation that different kinds of crops were likely to use different quantities of water. However, those that irrigated food crops and trees were likely to allocate more or less the same amount which could be explained by the reason for irrigation and the small scale nature of the irrigation activities.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This Chapter presents a summary of the study findings and draws conclusion based on emerging issues relating to water resources allocation and use at the household level. Further recommendations on how to incorporate household water resources use into the water resources allocation planning process are made and areas of further research outlined.

5.2 Summary

Three types of water resources namely surface water, groundwater and rainwater were identified in Lower Sondu Miriu River Basin (LSMRB). Surface water was the main water resource based on household population depending on a particular water resource. This was followed by groundwater then rainwater. Surface water resources identified in the basin were streams, river, springs, ponds and lake and groundwater accessed through sinking of boreholes or digging shallow well. Rainwater was harvested by residents mainly through rooftop catchment. Majority of the households had reasonable but not adequate access to water resources in the basin based on water quantity collected and time taken to collect water. Access to safe drinking water was generally poor based on households connected to piped water and water quality has perceived by households. Two water resource usage patterns mainly instream use and reliance on multiple water sources were identified in LSMRB. The patterns indicated low water resources accessibility.

Furthermore, the study established that water resources in LSMRB were allocated for both household domestic and other productive purposes including irrigation, livestock, water for vending and for use in small scale commercial entities. Household water resources uses were generally small scale and therefore did not require use authorisation. Vendors allocated the highest quantity of water on daily basis but were not many in the basin. Water for irrigation was the second largest in terms of daily quantities but the percentage of users was generally low. Daily water allocations for livestock and household domestic uses were lower compared to allocations for vending and irrigation but users' percentage was generally high. Water resources in the river basin were also allocated to large scale water users that were registered with WRMA. Hydroelectric power generation and public water supply were the main large scale water resources users in the basin. Two types of water use mainly instream and offstream uses were indentified in the basin. Domestic and livestock offstream water resources uses were the most common followed by irrigation, commercial and water vending in that order. Livestock watering, washing clothes and bathing were the most common instream water resources use activities. However, water resources in the basin were also used for recreation, transportation, fishing and waste disposal.

Various socioeconomic factors were identified to influence water allocation at the household level. Household size, number of children below five years and income were positively correlated with quantity of water allocated for household domestic use but distance measured in terms of time taken to obtain water from the source was negatively correlated with household domestic water allocation. Higher supply population was associated with larger quantities of water allocated for household vending and significant differences were established between different modes of household water transport and quantity allocated for vending. Number of service consumers and employees in a household commercial entity were positively correlated with quantity of water allocated for household commercial use. A positive relationship was also established between animal population and quantity of water allocated for household livestock use. In addition, significant mean differences were established between households that watered animals at the water source and those that watered at home. Size of farm under irrigation was found to be positively correlated with household water allocation for irrigation use and significant mean differences were established for quantity of water allocated to the various types of crops irrigated by households.

5.3 Conclusion

The Lower Sondu Miriu River Basin is endowed with several water resources including surface water in streams, ponds, river, lake and springs; groundwater in boreholes and shallow wells and rainwater. However, majority of residents draw water from surface water sources. In particular, Sondu Miriu River is the main surface water used by households. Use of groundwater and rainwater in the basin was generally low but residents used rain water as an alternative source of water particularly during the rainy season. Residents in Sondu Miriu River Basin had basic access to water but accessibility was generally not adequate. This is because some residents still took over an hour to obtain water from a particular source while others used means of transports that had cost implication such as motorbikes. This was further revealed by water resources use patterns such as washing clothes and watering animals at a water source and relying on other alternative sources of water. Access to safe drinking water was also generally low given that majority of residents drew water directly from natural water sources especially the surface water. Also majority of the resident had a general perception that water obtained from their primary source of water was not safe for drinking.

Water resources allocation and use at the household level was generally small scale and involved allocation of water for domestic and other household productive uses specifically for livestock, irrigation, vending and for use in small scale commercial enterprises. In terms of allocation quantity, vending and irrigation were the main water resources use in the basin. But in terms of household population, domestic and livestock were the main water resources uses in the basin. Therefore, water allocated for domestic and livestock use was likely to show no much effect at present but cumulative impact in the future will be widespread. Water allocation for irrigation was minimal but had the potential to expand since rural livelihood in LSMRB was dependent on agricultural activities. Nonetheless, water resources in the basin were also allocated for other large scale uses including hydropower generation, municipal supply and industrial uses which were also likely to impact on water allocation at household level as a result of competition over use. Even though instream water resources use activities lessened the household burden of carrying water, they were also associated with water resources pollution in the basin. This affected significantly the quality of water abstracted by households.

Higher number of household sizes and children below five years plus increased levels of income were likely to increase quantities of water allocated for household domestic use in LSMRB. But, a longer distance to water sources was likely to reduce the quantity allocated. Increase in the number of people supplied with water by water vendors was likely to increase water allocated for household vending but will also be determined by the mode of transport that a household adopts to transport the water. Increase in the number of service consumers and employees in commercial entities owned by households in LSMRB were likely to increase the quantity of water allocated for household commercial use. At the same time, increase in household livestock population was likely to increase household livestock water allocation. But, watering animals at water resources sources in the basin was likely to increase households' water allocation for livestock compared to watering animals at home.

While increasing household size of farm under irrigation was likely to increase household water allocation for irrigation, the quantity allocated will also be determined by the types of crops they irrigated.

5.4 Recommendation

Water resources in Sondu Miriu River Basin form a strategic social and economic resource to the residents of the river basin and the nation as a whole. This study recommends the following;

That WRMA gives priority to small scale water users in the basin especially when allocating water from surface water resources such as streams, springs and the river. This is because most households in the basin draw water from surface water sources. The government and other relevant stakeholders should also consider exploring the groundwater potential of the river basin in order to avail adequate and safe drinking water for the residents. This is because water accessibility in the basin was generally not adequate yet the groundwater potential was not adequately known. Also, rainwater harvesting as a way of providing reliable water access to household should be considered both at a macro level and household level. This could be achieved by construction of water pans in the basin and providing water tanks to households at affordable prices.

The study further recommends that WRMA considers water for other household productive uses when designing water for Reserve. In particular, water for livestock and irrigation needs of small scale water users should be well thought out since they have a potential to expand and create significant impacts in the future. Potential effects of instream uses should also be taken into consideration especially when designing the Reserve quality. Instream water resources activities that have the potential of having significant impact on water quality should be discouraged by enforcing law and providing water services at reasonable distances to the households homesteads. WRMA should hasten its efforts in developing a SCMP and WAP for the basin in order to ensure that small scale water resources uses are integrated in the water resource allocation planning.

Water resources managers, planners and policy makers should shift attention to small scale water allocation at the river basin level. Efforts should not only be geared towards providing water for household basic human need but also other productive uses. The various socioeconomic factors indentified to influence household water allocation for various uses should be taken into consideration when formulating policy regarding water resources use at the household level. in particular household sizes, number of children below five years and levels of education should be considered in designing domestic water needs; supply population and mode of transport in vending needs; number of commercial service consumers and employees household commercial needs; animal population and water use patterns in livestock water requirements and size of farm under irrigation and types of crops in household irrigation water requirements.

Areas of further research

The following areas have been identified for further research;

1. The study recommends further research that will employ methods of estimating water cost in relation to time and energy spent fetching water. Factors such as number of water carriers and number of trips made to and from should be put into consideration.

2. Research is needed to establish the full potential of groundwater resources in the study area.

3. Further research is also needed to investigate difference in actual withdrawals and actual amounts consumed. This will help improve water use efficiency in the basin.

REFERENCES

Africa River Network, (2002). *The impact of Sondu-Miriu hydro-power project on the people of nyanza* available at http://www.foejapan.org/en/aid/jbic02/sondu-miriu/nyanza2000.htm, last accessed 16/03/2012.

Alcamo, J., Henrichs, T. and Rosch, T., (2000). *World water in 2015 – Global modeling and scenario analysis for the World Commission on Water for the 21st Century.* Report A0002 Center for Environmental Systems Research, University of Kassel, Kurt Walters Strasse 3, 34109 Kassel, Germany

Alcamo,J., Döll,P., Kaspar, F. and Siebert, S., (1997). *Global change and global scenarios of water use and availability: An Application of WaterGAP1.0.* Center for Environmental Systems Research (CESR), University of Kassel, Germany

Amy, J. P. and Davis, J., (2012). *Freshwater Availability and Water Fetching Distance Affect Child Health in Sub-Saharan Africa.* ACS Publications, dx.doi.org/10.1021/es203177v | Environ. Sci. Technol. 2012, 46, 2391–2397 and Agricultural Sciences, University of Florida, Gainesville, FL.

Asare, O. B., (2004). *Household water security and water demand in the Volta Basin of Ghana.* Centre for Development Research (ZEF) in Bonn, Germany

Bakibinga-Ibembe, J.D., Said, V. and Mungai, N. W., (2011). *Environmental laws and policies related to periodic flooding and sedimentation in the Lake Victoria Basin (LVB) of East Africa.* African Journal of Environmental Science and Technology (Vol. 5(5), pp. 367-380

Brown, L., (2006). *Sources of water for livestock.* Water Resource Management Branch, Ministry of Agriculture and Lands 1767 Angus Campbell Road, Abbotsford, BC V3G 2M3

Brown, T.C. (1999). *Past and future freshwater use in the United States.* A technical document supporting the 2000 USDA Forest Service RPA Assessment. Gen. Tech. Rep. RMRS-GTR-39. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 47 p.

Collins,R., Kristensen, P. and Thyssen, N., (2009). *Water resources across Europe — confronting water scarcity and drought.* European Environment Agency (EEA), Kongens Nytorv 6 1050 Copenhagen, K, Denmark

Dinar, A., Rosegrant, M. W., and Meinzen-Dick, R. (1999). *Water allocation mechanisms; Principles and Examples.* World Bank, Agriculture and Natural Resources Department, Washington, D.C.: World Bank

Food and Agriculture Organization (FAO) of the United Nations, (2012). *Coping with water scarcity: An action framework for agriculture and food security.* Food and Agriculture Organization of the United Nations Viale delle Terme di Caracalla 00100 Rome, Italy y, A., (2005). *Facts and trends – water.* World Business Council for Sustainable Development, 4, chemin de Conches, CH - 1231 Conches-Geneva, Switzerland

eick, P., (1999). *The human right to water.* Pacific Institute for Studies in Development, Environment and Security, Oakland, USA

lobal Environment Outlook (GEO-4), (2007). *Environment for development*: Summary for decision makers, United Nations Environment Programme, Nairobi, Kenya

lobal Water Partnership (GWP), (2012). *Perspective paper- Increasing water security: A development imperative.* GWP

overnment of Canada, (2012). *Water sources for range livestock*, Agriculture and Agri-food Canada, Canada

overnment of Kenya (GoK), (2002). *Water Act, 2002.* Kenya Gazette Supplement, 2002, Government Printers, Nairobi, Kenya

overnment of Kenya (GoK), (2006). *Water Resources Management Rules, 2006.* Water Resources Management Authority Nairobi (WRMA), Nairobi, Kenya

overnment of Kenya (GoK), (2007). *The National Water Services Strategy (NWSS) 2007-2015.* Kenya Gazette Notice, 2007, Government Printers, Nairobi, Kenya

Government of Kenya (GoK), (2007). *The National Water Resources Management Strategy (NWRMS) 2007-2009.* Water Resources Management Authority Nairobi (WRMA), Nairobi, Kenya

Government of Kenya (GoK), (2009). *Integrated water resources management and water efficiency plan for Kenya.* Water Resources Management Authority Nairobi (WRMA), Nairobi, Kenya

Government of Australia, (2012). Glossary, *Water words*. Ganberra, Australia, available at http://www.nationalwatermarket.gov.au/site-information/water-words.html, last accessed 10/9/2013

Hakijamii, (2014). *A summary of The Water Act, 2002, The National Water Resources Management Strategy, The National Water Resources Management Strategy, The Pro-poor Implementation Plan of Water Supply and sanitation.* Nairobi, Kenya

Houston, L. L., Watanabe, M., Kline, J. D., Alig and R. J. (2003). *Past and future water use in Pacific Coast States*. Gen. Tech. Rep. PNW-GTR-588. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 37 p.

Howard, G. and Bartram, J., (2003). *Domestic water quantity, service level and health.* World Health Organization, Geneva, Switzerland

Huggins, C., (2001). *Water Policy and Law in a Water-Scarce Country: Implications for Smallholder Irrigation in Kenya.* Nairobi, Kenya

Human development report, (2006). *Beyond scarcity: Power, poverty and global water crisis*, United Nations Development programme (UNDP), New York, USA

Integrated Water Resource Management (IWRM) Joint Venture Consultants, (2012). *Integrated Water Resources Management; Omaruru-Swakop River Basin.* Ministry of Agriculture, Water and Forestry, Namibia

Kenya Electricity Generating Company Limited (KenGen), (2004). *Sondu hydroelectric power project, (*Project briefing paper). Nairobi, Kenya

Kenya National Bureau of Statistics, (2009). *Kenya Population and Housing Census.* Nairobi, Kenya

Kjellén, M., and Mcgranahan, G., (2006). *Informal water vendors and the urban poor*. International Institute for Environment and Development (IIED), 3 Endsleigh Street,

Kohli, A., Karen Frenken,K. and Spottorno, C., (2010). *Disambiguation of water use statistics*. FAO. 2010. *AQUASTAT*. http://www.fao.org/nr/aquastat. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 15/08/2013.

Lake Basin Development Authority (LBDA), (2008). *A concept paper on Sondu Miriu Multipurpose Development Programme*. Kisumu, Kenya

Lanka Rainwater Harvesting Forum, (1999). *Domestic roof water harvesting in the humid tropics: Concept of water security entailing domestic roof water harvesting*. Sri jayawardenepura kote, Sri-Lanka

Lankford, B., Bakker, K., Zeitoun, M. and Conway, D., (2013). *Water security: Principles, perspectives and practices*. London, Routledge, pp. 317-333, London

Masese, F.O., Raburu, P.O., Mwasi, B.N., and Etiégni, L., (2012). *Effects of deforestation on water resources: Integrating science and community perspectives in the Sondu-Miriu River Basin, Kenya.* Moi University, Eldoret, Kenya

Mocha, N. A., Iganga, f., Busienei, W. and Opaa, B., (2012). *Fresh water, coastal and marine resources*. Nairobi, Kenya

Mugenda, O. and Mugenda, A. (2003). *Research methods: quantitative and qualitative approaches*. Africa Centre for Technology Studies (ACTS) Press, Nairobi, Kenya.

Mujib, U. and Schisholm, N., (2007). *Factors affecting households' participation in the natural resource management.* Activities in District Abbottabad, NWFP, Pakistan : A Multivariate Analysis. *Journal of Asian and African Studies* 2007 42: 495

Mumma, A., (2007). *Kenya's new water law: An analysis of the implication of Kenya's Water Act, 2002 for the rural poor.* University of Nairobi, Nairobi, Kenya

Mungai, N.W., Njue, A. M., Abaya, S.G., Vuai Said, A. H. and Ibembe, J.D., (2011). *Periodic flooding and land use effects on soil properties in Lake Victoria basin* available at http://www.academicjournals.org/ajar/PDF/pdf2011/19th%20Sept/Mungai%20et%20al.pdf, last accessed 16/03/2012.

Mutua, F., (2012). *Rainfall-runoff modelling in selected catchments in the Lake Victoria basins.* Kisumu, Kenya

Nicol, A., (2000). *Adopting a sustainable livelihoods approach to water projects: Implication for policy and practice.* Overseas Development institute, London, United Kingdom

Nevada Division of Water Planning, (2013). *Nevada State Water Plan,* Part 2: Part 2 — Water use and forecasts, Section 3: Water withdrawal forecasts, Nevada

Nzisa, *M. I., (2012). Assessment of the effect of anthropogenic activities on terrestrial biodiversity conservation in Matayos Division of Busia County; Kenya.* Maseno University, Kenya

Ochumba, P.B.O., and Manyala, J.O., (1992). *Distribution of fishes along the Sondu-Miriu River of Lake Victoria, Kenya with special reference to upstream migration, biology and yield.* Kisumu, Kenya

Ogembo, W.O., (2012). *Limitations of hydrodynamical models with limited data available case study: Sondu River Basin (Kenya)* available at http://www.unesco.org/new/fileadmin/multimedia/field/Cairo/pdf/limitations_of_hydrodynamical_models_with_limited_data_available.pdf, last accessed 16/03/2012.

Ongór, D.O., (2005). *Community participation in integrated water resource management: The Case of the Lake Victoria Basin.* Department of Agriculture, Moi Institute of Technology, Kisumu, Kenya

Onjala, J.O., (2002). *Managing water scarcity in Kenya.* Industrial Response to Tariffs and Regulatory Enforcement. Roskilde University, Denmark

Onyando, J., (2006). *Framework for development of catchment management strategy (CMS) in Kenya.* Nairobi, Kenya

Onyango, L.A., (2008). *Poverty, livelihoods and property rights in Nyando Basin, Kenya. A case for integrated approaches to development planning.* Maseno University, Kenya.

Orindi, V. and Huggins, C., (2005). *The dynamic relationship between property rights, water resource management and poverty in the Lake Victoria Basin.* International workshop on 'African Water Laws: Plural Legislative Frameworks for Rural Water Management in Africa', 26-28 January 2005, Johannesburg, South Africa

Ouma, K.O., Mungai, N.W. and Kitaka, N., (2013). *Temporal variation of sedimentation from surface runoff from agricultural land uses in Sondu Miriu Basin, Kenya.* Research Journal of Environment and Earth Sciences, 2013

Opiyo, O., (2005). *Sustainable management of Osodo wetlands on the Sondu Miriu River Basin, Kenya.* Maseno University, Kisumu, Kenya witi, D.O, Kapiyo, R.A. and Bosire, E.K., (2013). *Status of the Sondu Miriu River fish species diversity and fisheries: Sondu Miriu Hydropower Project (SMHPP) operations*. Journal of Ecology and the Natural Environment, 2013

wour, P.O., Banadda, E.N., Obua, J. and Okoth, S., (2011). *Natural resources management and land use: Proceeding of the cluster workshop*. Inter-University Council of East Africa, Lake Victoria Initiative, Nairobi, Kenya.

ngare, G. and Pangare, V., (2008). *Informal water vendors and service providers in Uganda: The Ground Reality*. The water Dialogues, Kampala, Uganda

epublic of Tanzania, (2002). *National Water Policy*. Dar-es-salam , Tanzania

ice, J., Albright – Freese, J. and Nichols, (2010). *Water use by livestock and game animals in the plateau regional water planning area*. Plateau Region Water Plan, 2011

alman, A. and Al-karablieh, E., (2013). *Socioeconomic factors influencing the household water demand function in Jordan*. Department of Agricultural Economics and Agribusiness, Faculty of Agriculture, University of Jordan, Jordan

Shen, y., Oki, T., Utsumi, N., Kanae, S. and Hanasaki, N., (2008). *Projection of future world water resources under SRES scenarios: water withdrawal*. Centre for Agricultural Resources Research, Chinese Academy of Sciences, 286 Huaizhong Road, Shijiazhuang 050021, China. Hydrological Sciences journal, 2008

Shepel, C. and Raimondo, R., (2010). *Edmonton's Water Supply*. The Edmonton Sustainability Papers – May 2010 Discussion Paper 3 – Edmonton's Water Supply

Speed, R., Yuanyuan, L., and Quesne, T., (2013). *Basin water allocation planning*. UNESCO, Paris

StatSoft Inc, (2013). *Electronic statistics textbooks*. Tulsa, ok: Statsoft WEB: http://www.statsoft.com/textbook/.

United States of America, (2012). *Uses of water; Technology Department*. Washington, DC

United Nations (UN), (2000). *Principles and practices of water allocation among water use sectors*. United Nations, New York

United Nations Development programme (UNDP), (2011). *Small scale water providers in Kenya: Pioneers or predators?* New York, USA

United Nations Environmental Programme (UNEP), (2010). *Africa Water Atlas*. Division of Early Warning and Assessment (DEWA), UNEP

United Nations World Water Development Report (UNWWDR), (2014). *United republic of Tanzania, UN-Water country brief*. United Nations, New York

United Nations World Water Development Report (UNWWDR), (2006). *Water a shared responsibility: Kenya National Water Development Report*. United Nations, New York

Wang, L., Fang, L., and Hipel, K.W. (2003). *Principles and practices of water allocation: Cooperative game theoretical approach*. University of Waterloo, Ontario, Canada

Wang, L., Fang, L., and Hipel, K.W. (2007). *O.R. Applications; Basin-wide cooperative water resources allocation*. Department of Systems Design Engineering, University of Waterloo, Waterloo, Ontario, Canada, N2L 3G1, European Journal of Operational Research DOI:10.1016/j.ejor.2007.06.045

Water Resources Management Authority (WRMA), (2012). *Draft strategic plan 2012-2017*. Nairobi, Kenya

Water Resources Management Authority (WRMA), (2010). *Water Allocation Plan (WAP) - Naivasha Basin 2010-2012*. Nairobi, Kenya

WaterAid, (2012). *Water security framework*. WaterAid, London

Willoughby, (2008). *Fisheries and ecology of Sondu Miriu River*. Western, Kenya

WHO and UNICEF, (2000). The *Global Water Supply and Sanitation Assessment 2000 Report* (GWSSAR), Geneva, Switzerland. available at http://www.who.int/water_sanitation_health/monitoring/globalassess/en/ last accessed 8/19/2013

WHO & UNICEF JMP, (2004). *Millennium development Goal mid-term Assessment report*. Available at http://www.wssinfo.org/documents-links/documents/?tx_displaycontroller[category]=&tx_displaycontroller[year]=2004&tx_displaycontroller[search_word]=&tx_displaycontroller[type]=, last accessed 8/19/2013

World Bank, (2010). *Annual freshwater withdrawals; total (% of internal resources) in Kenya*. Available at http://www.tradingeconomics.com/kenya/annual-freshwater-withdrawals-total-percent-of-internal-resources-wb-data.html

World Bank, (2011). *Towards a strategic analysis of water resources investment in Kenya: Hydrological, economic, and institutional assessment for storage development*. Washington DC, USA

World Bank, (2009). *Republic of South Africa: Water profile*. Washington DC, USA

World Water Development Report (WWDR), (2012). *Managing water under uncertainty and Risks*. Vol. 1, United Nations World Water Development Report 4, New York, USA

Zena, C., Urban, S., Maupin, M., Pratt, R. and Church, J., (2001). *Domestic, commercial, municipal and industrial water demand assessment and forecast in Ada and Canyon,* Idaho