ASSESSMENT OF THE WATER RESOURCE USERS ASSOCIATION IN WATER MANAGEMENT IN THE UPPER CATCHMENT OF LAKE BOGORIA BASIN, NAKURU COUNTY, KENYA

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A Thesis Submitted to the Graduate School in Partial Fulfillment for the Requirements of the Award of Master of Science Degree in Environmental Science of Egerton University.

EGERTON UNIVERSITY

APRIL, 2013

DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not, wholly or in part, been presented for an award of a degree in any other university.

Signed _____ Date 25/4/2013

Veronica Wangui John

NM12/2447/09

Recommendation

This thesis is the candidate's original work and has been prepared with our guidance and assistance: it is submitted with our approval as the university supervisors.

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DEDICATION

This work is dedicated to my dear and loving husband, Jackson.

ACKNOWLEDGMENT

It is with sincere heartfelt gratitude that I acknowledge the support, guidance and encouragement of very special people who directed their energy, time, ideas and other relevant resources, directly or indirectly, towards the realization of this invaluable piece of work.

I am greatly indebted to my supervisors, Dr. George M. Ogendi and Dr. Wilkister N. Moturi for their encouragement, enormous input in reading, correction and guiding the form and the substance of this thesis. Thanks to Mr. George Kobia, Mr. Geoffrey Maina, Mr. Joseph Maina, Mr. Edward Kimani, and my fellow colleagues for their encouragement and positive criticism that made this work a success. In the same tone, I do thank all the LBB-WRUA officials, Ministry of Agriculture and Ministry of Health staff for their cooperation during field work. I also thank the Principal St. Josephs' KARI Lanet and my workmates for their encouragement. Likewise, I do appreciate my husband Jackson and our daughters Mary and Winnie for their patience, inspiration and support. Lastly, thanks to Egerton University Management and Administration for having provided a conducive working environment without which I would not have successfully completed this thesis.

ABSTRACT

Water Resource Users Association (WRUA) is a name given to a community group that focuses on the management of the water resources at community level. In Kenya, the Water Act (2002) section 15 mandates Water Resource Management Authority (WRMA) to facilitate WRUA formation to allow more community participation in water resources management. The upper Lake Bogoria Basin (LBB) WRUA has a total of fifty legally operating water projects with the main source of fresh water being Waseges River which drains into Lake Bogoria. The problem of water supply for domestic and for irrigation is becoming increasingly acute and during the dry season, the communities downstream are forced to trek up to seven kilometers in such of water and lose crops to drought. It is for these reasons that the study sought to assess how the LBB-WRUA manage water in the upper LBB. A cross-sectional survey research design was used in this study. Simple random sampling was used to select household survey respondents while purposive sampling was used to select Focus Group Discussion (FGD) and in-depth interview participants. A sample size of 221 was obtained, proportions of 149 non-WRUA and 71 WRUA worked out and individual households for the study selected by use of simple random sampling. The data obtained was analyzed by use of both descriptive and inferential statistics (using chi-square). The study results indicated that the LBB-WRUA has initiated catchment protection through awareness creation and soliciting funds from government agencies and NGOS. Fifty-eight percent of household survey respondents lacked large capacity water storage facilities while only 30 % collect flood flow into their water pans. There was a significant difference on distance covered by respondents to fetch water before and after WRUA formation ($\chi 2 = 69.886$; df=4; p=0.000 at $\alpha=0.05$). The percentage of respondents that walked more than 1km in search of water reduced from 56% to 52% after WRUA formation. Per capita water availability was 14 litres in Subukia Division and 17 litres in Mbogo-ini Division compared with the WHO recommended amount of 25 litres. Cases of illegal water abstraction, inadequate law enforcement and low education levels of water project officials negatively affect the LBB-WRUA activities. There is still considerable work to be done by the LBB-WRUA so as to ensure that the envisioned objectives and goals are achieved. The study recommends enhanced and efficient rainwater harvesting through use of water pans and storage tanks. Further, alternative water sources should be sought and all stakeholders be actively involved in the Waseges River catchment rehabilitation.

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ABBREVIATIONS AND ACRONYMS

ADB	African Development Bank
BRWUA	Burguret River Water Users Association
CAAC	Catchment Area Advisory Committee
CBO	Community Based Organization
CDF	Constituency Development Fund
CFA	Community Forest Service
CMC	Catchment Management Committee
CMS	Catchment Management Strategy
EMCA	Environmental Management Co-ordination Act
ESP	Economic Stimulus Programme
FAO	Food and Agriculture Organization
FGD	Focus Group Discussions
ITCZ	Intertropical Convergence Zone
KAPP	Kenya Agriculture Productivity Program
KEFRI	Kenya Forestry Research Institute
KFS	Kenya Forest Service
LBB	Lake Bogoria Basin
MDGs	Millennium Development Goals
MFG	Mbogo-ini Facilitation Group
MLRWD	Ministry of Land Reclamation and Water Development
MOA	Ministry of Agriculture
MRWUA	Mara River Water Users' Association
NEMA	National Environmental Management Authority
NGO	Non- Governmental Organization
NWRMS	National Water Resources Management Strategy
OSHO (K) LTD	a company which manufactures and distributes agricultural inputs, industrial chemicals and veterinary products
Prout	Progressive Utilization
RVCARO	Rift Valley Catchment Area Regional Offices
RWSBs	Regional Water Service Boards

RWUA	River Water Users' Association
SPSS	Statistical Package for the Social Sciences
SYNGENTA	A world leading agri-business committed to sustainable agriculture through innovative research and technology
UN	United Nations
UNEP	United Nations Environmental Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
WAB	Water Appeals Board
WBCSD	World Business Council for Sustainable Development
WHO	World Health Organization
WMO	World Meteorological Organization
WRMA	Water Resource Management Authority
WRUA	Water Resource Users Association
WSC	Water Sewerage Company
WSTF	White Sands Test Facility
WTF	Water Trust Fund
WUA	Water Users Association
WUG	Water Users, Group
WWF	World Wide Fund for Nature

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Water is a basic necessity for the survival of an individual and a nation (UNEP, 1989). Water scarcity being a global issue of concern, drove the authoritative United Nation (UN) committee on economic, social and cultural rights to adopt the General Comment 15 on the right to water in November 2002. The general comment clearly recognizes water as a basic human right as it is fundamental to life and health. The right to access drinking water is recognized in a number of international conventions and treaties including the international conference on Hydrology, convened in Geneva in February, 1999, which resolved that the solution to the world's water problems must be sought immediately to stop the escalating water crisis (WMO, 1999). Access to sufficient water supplies adds value to the well-being of communities and societies in general (UN, 2006)[a].

According to NEMA (2009) and FAO (2008), Kenya is a water scarce country where the demand for water exceeds renewable fresh-water sources; its potential annual fresh water are quite small, with surface water estimated at 19,590 million m^3 and ground water at 619 million m^3. Access to water has been on the decline since 1970 as indicated by UNEP (1989). According to Katua, *et al,* (2010), Kenya had some 1500m^3 per person per year renewable fresh water in the early 1970s. Per capita availability now stands at 647 m^3, compared with 2,940m^3 in Tanzania and 2, 696 m^3 in Uganda. This is projected to fall to 245 m^3 per capita by the year 2025 (NEMA, 2009). Moreover, the available resources are unevenly distributed both geographically and seasonally. With over eighty percent of the country being arid and semi-arid, rainfall is highly variable and poses serious environmental challenges (NEMA, 2009). Ideally, a country is called water sufficient if on average, every citizen can access 1000 m^3 of water a year (Thiene, 2005).

Water Resource Users' Associations have been created in various countries worldwide in order to incorporate the communities in the conservation and management of water (Gender and Water Alliance, 2003). They were formed as a result of reforms in the Water Resource Management to improve the management of irrigation systems. The reasons for the formation of most associations were either to resolve water related conflicts, like it was the case of Burguret

River Water Users Association (BRWUA), Nyeri (Mumero, 2005). It would even have been due to strong and generous leadership that existed in the villages like in the case of Tamil Nadu, India (UNESCO, 2002). WRUAs make water resource management more transparent, which leads to more equitable access. Establishment of WRUAs ensures inclusion of minority groups in decision making and equitable distribution of irrigation water for their livelihood (Neupane, 2009).

In Kenya, WRUAs were established following the enactment of the Water Act 2002 which provides the framework for water sector reforms, following the challenges that the water sector was facing between 1980s and 1990s (Water Governance Project Partners, 2009). The challenges included inefficiencies in the management of water and sanitation installations, increased pollution, climate change, catchment areas degradation, rampant abuse of power by officials and very limited participation by stakeholders (Mumma, 2005). These challenges called for reforms in the water sector. Recent policy statements and strategies identified irrigation as a key element for the intensification and expansion of agricultural production. This would lead to achieving national food security and increasing the country's market share in the international markets (Grimm and Richter, 2006). The 2002 Water Act lays emphasis on the role and active participation of local communities organized as Water Users Associations, in the management of water (Mumma, 2005; Vardhan, 2005). Section 15(5) states that these associations will act as fora for conflict resolution and cooperative management of water resources.

Despite the efforts made by LBB-WRUA to ensure implementation of what was envisioned in the Water Act through community participation, the community in the study area continues to experience water shortage. The river water recharge depends on tributaries which include Subukia, Mumoi and Igwamiti, while the ground water tables are recharged by precipitation. Water shortage may have been attributed to declining precipitation which has been experienced over the last one decade reducing the water flow in Waseges River, one of the main rivers in the study area (WWF, 2008).

1.2 Statement of the Problem

Globally, scarcity in water resources has been noted to affect availability of fresh drinking water and irrigated agriculture. This limits the chances of meeting the Millennium Development Goals (MDGs) in most developing countries including Kenya. The upper Lake Bogoria Basin (LBB) is not an exception hence water shortage affects rural livelihoods and economic development. The problem of water supply and water quality in the area is becoming increasingly acute because of turbidity due to high sediment load from erosion, and discharges of sewage by upstream users which is an environmental risk to downstream communities. During the dry season, the communities downstream are forced to trek for long distances in search of water, thus a significant expenditure of time and energy. Despite provision for community participation through WRUAs in the Water Act (2002), the community in the Upper LBB continues to suffer water shortages. So far, there is limited information on the causes of these shortages as well as progress of water resource management in spite of the existence of the LBB-WRUA. This study is meant to assess how the LBB-WRUA is managing water in the study area.

1.3 Objectives of the Study

The broad objective was to assess water management and conservation by the Water Resource Users Association in the upper catchment of the Lake Bogoria Basin of Kenya.

The specific objectives were to;

a. Assess the current status of water conservation and management by the LBB- WRUA in the basin.
b. Investigate the current status of water supply to the community by the LBB-WRUA in the basin.
c. Determine challenges facing the WRUA in its efforts of supplying water to the communities.

1.4 Research questions

This research was guided by the following questions;

a. What is the current status of water management and conservation by the LBB-WRUA in the study area?
b. What is the current status of water supply to the community by the LBB-WRUA in the study area?
c. What challenges does the WRUA face in supplying water to the communities?

1.5 Justification and significance of the study

Every person is entitled to have access to sufficient and affordable water of acceptable quality. Hence, poor management and uncontrolled abstraction of water may lead to discontent among the various water users due to its scarcity (Ministry of Water and Irrigation, 2008). A crucial element for a successful water governance system is that water users rich and poor, male and female, are able to influence decisions that affect their daily lives (Bayoumi and Abumoghli, 2007). The study provides information to the LBB-WRUA on how it can properly represent the interest of the Waseges River water users and to channel community participation as required in the Water Act (2002). This will greatly reduce conflicts over water resources and significantly increase active involvement of women who can play a central part in the provision, management and sustainable use of water resources.

Information obtained from the study will be relevant in promoting the protection and conservation of water catchment areas to preserve the environment for the present and future generations, support sustainable, more equitable access and efficient use of water. Information obtained would be provided to the WRUA on how it can curb illegal abstraction of water, hence, increasing water flow in the river. This would culminate in a reduction in water resource use conflicts. A steady and reliable supply of water will improve irrigated agriculture and thus increased food security in the area. Efficient water management will also create employment for the area residents. Further, the findings of this study will also serve as a basis for the LBB-WRUA to revise its operational strategies.

1.6 Scope of the study and limitations

The area chosen for this study included Mbogo-ini division and some parts of Subukia division which form the upper LBB. The study area was chosen because it met the research objectives. The target population was WRUA and non-WRUA households abstracting water for domestic and irrigation purposes. The study focused on the operation of water projects that are interdependent on the LBB-WRUA. The study utilized a household questionnaire, Focus group discussion (FGD), in-depth interviews and observations. Both quantitative and qualitative data were obtained from primary and secondary data. Household questionnaires provided information on the extent of community involvement in water management and conservation, the percentage of people able to access water and attend meetings. FGDs provided more details concerning water management and conservation. In-depth interviews helped follow up important information emerging from the questionnaire responses.

One limitation of the study was the determination of the quality of water which was based on whether the respondents treated the water or not. No actual physico-chemical measurements on water quality were made.

1.7 Definition of terms

Adequate water is water that can satisfy basic human needs and should be at least 25 liters per capita per day.

Drip irrigation is an irrigation method which allows water to drip slowly to the roots of plants through a network of pipes or tubings.

Graduated sanctions are sets of integrated intervention strategies designed to enhance accountability and ensure public safety in water utilization.

Negative culture culture that leads to degradation of catchment areas and cause water pollution

'Reasonable access' is the availability of at least 20 litres of water per person per day from a source within one kilometer of the users dwelling.

Safe drinking water is treated surface water or untreated water from protected springs, boreholes, and wells.

Sprinkler irrigation is a method of irrigation which uses overhead high-pressure sprinklers or guns to water the plants.

Surge irrigation is the intermittent application of water to irrigation pathways, creating a series of on and off periods of contact or variable duration.

Water conservation is the protection of water sources including catchments, ground water aquifers and wetlands.

Water infrastructure facilities are water facilities that include pipes, conveyances, water storage and treatment facilities.

Water intake point is a chamber within a weir (a water barrier across a river) connected to a pipe that supplies water to the water users.

Water kiosk it is an outlet through which formal water providers deliver safe and reliable water at affordable prices to residents of low- income areas.

Water management is the activity of planning, developing, distributing, managing and optimum use of water resources under defined water policies and regulations.

Weir a small overflow used to raise the level of a river or a stream.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter covers the history of community water projects in various countries including Mexico, India China and Kenya. Introduction of such community water projects was in the bid to manage and conserve the available water resources while ensuring equitable allocation to all water users. The chapter also covers community participation in water resource management through WRUAs as provided in the Water Act 2002, the challenges that face most of the WRUAs and finally the conceptual model. A WRUA has to be a legal entity to be able to establish a bank account, own tools and equipments, get grants and technical assistance from the government for the operation and maintenance of the irrigation system (Winrock International India, 2001).

2.2 History of community water projects

Associations of irrigation water users are among the earliest institutions established by man and still continue to be a useful means of developing and managing irrigation schemes (FAO, 1986). In India, water management has been a government priority for several centuries. In fifty years of independence, the Indian government has developed the country's water resources and today the scope for expanding surface and ground water sources is limited (Obolla, 2006). India has helped improve water supply in areas by increasing ground water extraction and rain harvesting, through Water Users Association (WUAs). Here participatory approach is deemed to be the major solution in the operation and maintenance of water resource system (Fanes and Turner, 2007). Mula and Bhima water projects in Maharashtra India are examples of community water projects that have improved the quality of life of their communities. This is through construction of dams with canals providing irrigation water to the communities. Participatory management has led to significant increase in the efficiency of water use and the value of irrigation agriculture production. Farmers have benefited through considerable saving of time to obtain water (Naik, *et al,* 1998).

Mexico too has long and well established tradition on water resource management which started approximately in 1905. Decentralization of responsibilities and promotion of water user participation and maintenance started in 1970s. The country has made some progress in dam

construction in arid areas for irrigation and flood control (Mckinney, 2010). In China, water users associations were introduced by the World Bank in 1994, promoting participatory irrigation management, in response to scarcity of water resources. As at the end of 2006, 30,000 WRUAs had been established in China (Caizhen, 2010). Lingpo and Xintuan in China are considered the poorest villages which currently have portable water through their WRUAs. Water tanks have been constructed and piping done to bring water closer to the villagers (Global Aid Network, 2012).

In Kenya, community water projects have a long history. According to FAO 2008, there are records indicating that there were irrigation systems in the 16th century along the coast and the Kerio valley (Marakwet escarpment). These water projects allocated water to different clans and the rotation among the different users could vary from year to year. These traditional developments have greatly influenced the present day pattern and distribution of water especially for irrigation in the country (FAO, 2008). Nyamilu community water project in Nyanza has enabled its community to continue enjoying the availability of clean water for drinking and cooking. The water borne diseases that were rampant in the community have disappeared. This is attributed to the increase in the number of bore holes in the area and piping to provide clean water to the community near their homes (Fierstein, 2007).

Water Resource Users' Associations in Kenya started with the enactment of the Water Act (2002). Before then, large irrigation schemes based on political objectives existed and were aimed at settling landless households. Later in the seventies, the Ministry of Agriculture (MOA) started to embark on small-scale group irrigation schemes organized by Water User Groups (WUG) to address famines in the remote and arid parts of the country. This led to a process where such schemes were also implemented in the fertile highland regions (Grimm and Richter, 2006). Following shortage of funds to support the water sector in late 1980s, the government of Kenya published a manual in 1997 giving guidelines on handing over of rural water supply system to local communities (MLRWD, 1997) The manual stated the criteria for handing over as being capacity of the community to take over; ability to pay; capacity to operate and maintain the system; involvement of women in management and ability and willingness to form a community based group with legal status.

Building on this experience, the government developed a fully-fledged policy; The National Water Policy which was adopted by parliament as sessional Paper No.1 of 1999. It stated that the policy act, chapter 372 would be reviewed and updated, attention being paid to the transfer of water facilities to communities at the local level. The policy justified handing over, arguing that ownership of a water facility encourages proper operation and maintenance. A task force was established to review the Water Act, chapter 372 and draft a bill to replace it. This started with publishing of a bill; the water bill 2002 on 15th march 2002. The bill was passed by the parliament on 18th July 2002 and was gazetted in October 2002 as the Water Act 2002. The Act went into effect in 2003 when effective implementation of its provisions commenced (Mumma 2005).

WRMA expects each WRUA to create awareness, act as a bridge between WRMA and water projects, install water devices, ensure a given water reserve at all times, start tree nurseries and with assistance from WRMA, educate water users, disseminate rainwater harvesting techniques, collect revenue, manage water projects and resources (Rupert, 2007). A number of WRUAs have been established in various parts of the country and they include Liboi, Bura and Mpeketoni in Garissa (Obolla, 2006), Burguret in Nyeri (Mumero, 2005), Kisima in Isiolo (Mati, 2011) , Ngare Nything/Sirgon River, Ngusishi (Thomas, 2010), Mala River, and Lake Bogoria basin (WRMA, 2008) among others. The objectives of WRUAs in Kenya is to conserve the water catchments, manage the resources, increase the availability of water resources, increase the usage of the water for economic and social improvements and to develop sustainable and responsive institutions.

Isiolo WRUA is among the most successful in Kenya and is regularly visited by other WRUAs with the aim of learning more on water management and conservation (Mati, 2011). This WRUA was officially registered in 2003 as a Community Based Organization (CBO). Each member of the WRUA pays a total of Kshs 6600 a year as membership and subscription fee. It has a total irrigated area of 600 acres which benefit 4,000 households and also support 120,000 water users. The WRUA has re-vegetated their springs, catchments and riparian lands (including fencing) through participatory approaches. It has established livestock troughs, washing dhobi and water storage tanks away from the springs to avoid direct access to the springs. The WRUA elected in office a central management committee (CMC) comprising of educated office bearers, holds elections regularly and keeps accounts and records. The CMC works closely with

government, donors, private sector for example Lewa conservancy, and good accountability has seen the WRUA receive several donor- funded projects (Mati, 2011). Other successful WRUAs include Kisima in Isiolo and Burguret in Nyeri which also receive visitors from other WRUAs in the country (Ministry of Water and Irrigation, 2008).

The Lake Bogoria Basin WRUA (LBB -WRUA) was established in 2005 by the WWF, in liaison with the Water Resource Management Authority, Rift Valley Catchment Area Regional Offices (WRMA, RVCARO) the lead government authority (WWF, 2009). The basin is currently a home to 50 legally operating water projects. The objectives of the LBB-WRUA include having equitable sustainable allocation of water to all users, to have co-operatives of water use management in the basin, promote community education on water, environment conservation and conflict resolution. Their mission is to have the community that is responsible to protect, to conserve and manage the environment. Their vision is to ensure that the degraded water catchment is rehabilitated and that the ongoing negative trend is reversed (LBB-WRUA, 2010).

Each member of a water project is expected to construct a pan/reservoir measuring 20m by 20m by 1m as recommended by the ministry of irrigation (MOA) (FAO, 2008). When completely full, the reservoir is expected to carry a maximum of $400m^3$ of water which is enough to last three months when using drip irrigation on a one acre plot. No permit can be issued without this condition being met (FAO, 2008). On average the LBB- WRUA expects all the water projects to provide irrigation water 2 to 5 hours per day, twice a week; and domestic water 24 hours daily. On average, each water project is expected to have at least 40 water kiosks by the year 2015 to cater for members who are not served with piped water (LBB- WRUA, 2010). The cost of securing water services from these kiosks should not exceed 5% of the household income (Water Governance Project Partners, 2009). As stipulated in the LBB-WRUA constitution 2005, all land owners shall have 10% of their farmland as woodlots. The study sought to investigate the milestones attained by the LBB-WRUA in achievement of what they envisioned during its inception.

2.3 The Water Act 2002

The Water Act (2002) addresses the rising concerns over declining quantity and quality of water and low coverage of water services in Kenya. Under this Act section 7(1), the Water Resources Management Authority (WRMA) was established to allocate the water resources

(Thomas, 2010), to manage and protect the water catchment areas, collaborate with other institutions as required for better water resource management and allocation of the water resources through a permit (Republic of Kenya, 2002). The Water Act section 11(1) provides for formation of national water resources management strategy (NWRMS) for effective management, protection, use, development, conservation, and control of water resources (WRMA, 2008).

The Act also requires that local authorities to form autonomous Water and Sewerage Companies (WSC) with independent Water Boards of Directors to provide services and re-invest water financial returns in service delivery improvement. However, the water is not owned by the water companies but by the Regional Water Services Boards (RWSBs). The Act provides for the creation of Catchment Area Advisory Committees (CAAC) to oversee the uses, control, development, protection and conservation of water resources within each catchment area. It also provides for creation of the Water Services Trust Fund (WSTF) to offer financial support for water projects in areas lacking adequate water services. But to date due to financial constraints, the fund has not lived to its purpose. The Act also established Water Appeals Board (WAB) with the responsibility of arbitration of disputes that may arise from the implementation of the act such as proprietary rights (Mumma, 2005).

The structure of WRMA as an institution include a national office and regional offices in six catchment areas delineated based on six major river basin systems of Kenya, in accordance with the National Water Resources Management Strategy (NWRMS): 2007–2009 and section 14 of the Water Act (2002). Through these offices, WRMA monitor water resources and administers the water resource regulation for example, water abstraction and discharge permits. One of the Six Catchment Areas is Rift Valley Inland Basin, where Lake Bogoria Basin is situated (WRMA, 2008).

The Regional Water Services Boards are responsible for licensing water service providers and determining the standards for the provision of water to the consumers. In order to manage the water within the catchment area, the NWRMS published in January 2007, formulated the Catchment Management Strategy (CMS). This recognizes the role of the stakeholders as being key to effective management of water resources, hence the emphasis of public consultation in section 15(1) (WRMA, 2008). The Water Act 2002 Section 15(5) provides for establishment, at

the local level, of Water Resources Users Associations (WRUAs) in the management of water resources. This ensures that water users participate in decision making concerning management of water resources in sub-catchment areas (Republic of Kenya, 2002). This sub-section states that these associations will act as fora for conflict resolution and cooperative management of water resources.

The water act (2002) provides for regulation of riverine vegetation and catchment forests and protection of wells and springs in the forests. It supports the user pays principle for water benefits and therefore opens opportunities for catchment forest management by forest communities' revenue generation through payments to ecosystem services (World Bank, 2011). The study investigated implementation of the water Act (2002) requirements by the LBB-WRUA.

2.4 Community participation in water management

Community participation involves direct and voluntary involvement by individuals and groups, in the management of a river and its catchment through a system of meetings and actions aimed to include all stakeholders (Cook, et, al. 2012).Water resources are extremely difficult to control as they are considered 'common property' and are available to all (UN, 2006)[a]. Protection and management of these resources is made possible with the support of the local community which include both men and women. Women are the major players in poverty eradication; they do a lot of work in the field; cultivating the family plots and marketing the produce. It is therefore imperative that they be involved in running of water projects. This implies that they should be kept informed and be given a chance to air their views (UN, 2006)[a].

Community involvement makes it possible for those affected by decisions to periodically review the performance of those who make decisions (Woods, 2008). Involvements of water users in the management of irrigation schemes and in operation and maintenance are a precondition to improving the performance of these schemes, as well as reducing the financial burden on governments. It is more preferable to ask the community to provide work forces during construction other than relying entirely on the government. However, there is always the danger that advocating increased community accountability and responsibility will be seen as a way for governments to cut off spending and community contact. The government therefore needs to

continually support communities, otherwise the approach will simply not be sustained (LBB-WRUA, 2010).

WRUAs aim at involving the community and stakeholders to protect, regulate, monitor, equitably allocate and conserve water resources, and ensure environmental sustainability within the catchment area (Ministry of Water and Irrigation, 2007). Monitoring can be in form of water guards or graduated sanctions. Penalties for those breaking the rules of the water projects must be imposed by the members or an elected board. Because farmers have vested interest in the facilities and have to pay for repairs, they are less likely to allow damage to structures. However, the extent of community participation may be determined by the frequency of officials' consultation with the members of the project as well as community factors such as attitude and land tenure which are different for different communities.

2.5 Challenges of small community groups/WRUA projects

According to WHO/UNICEF (2010), escalating population growth rates steeply raise demand for water abstraction beyond the supply capacity of the ecosystems. On the other hand, desires for agricultural expansion including irrigation schemes use very uneconomical methods of water usage (e.g. furrow and overhead sprinkler irrigation) (Mukhtar, *et al*, 2010). Efficient methods of water use for irrigation includes, use of drip, surge and some types of sprinkler systems where sprinklers are operated near ground level (WBCSD, 2010). Small-scale water supply schemes that are managed by operators, who lack adequate training, pose a risk of outbreak of infectious

diseases such as an acute diarrhooeal illness (WHO/UNICEF, 2010). Some community members lack understanding of the implications of their activities on the environment. Even when the communities understand the negative impacts of certain human activities on the environment, they still engage in the same. In Meru central, river catchment areas degradation, results in 70% of rainfall being lost as runoff (Ministry of Water and Irrigation, 2008).

Other challenges include inadequate funds to meet investment demand, especially water infrastructure development. Illegal connections and abstractions have remained a major challenge for the water projects, interfering with water distribution efforts. Uncontrolled and illegal over abstraction of rivers is a major challenge for the Ena River Water Resources Users Association (Ena WRUA) in Embu District (Ministry Of Water and Irrigation, 2008). Some WRUA committee members misappropriate funds meant for project activities for example, Samburu elders who were collecting contributions for pump maintenance and diesel purchase were found to have embezzled the money (UNICEF, 2010). Finally, low quality construction works arising from corruption deals affect water projects for example when constructors use low quality materials in construction or even less cement in concrete (Indian Society of Water Management 2007). However the challenges in different WRUAs differ depending on some factors such as the leaders' level of education and the extent of community involvement. The study therefore investigated the challenges that are typical to the upper catchment of the LBB-WRUA.

2.6 Theoretical framework of the study

The conceptual model (Figure 4) demonstrates the effect of water management and conservation by the LBB-WRUA on water supply to the community. The concept was borrowed from Sarkar's theory; the Progressive Utilization theory (Prout) (Sarkar, 2005). The theory advocates for cooperative coordination, maximum utilization of available resources, and employment of people who are able to work. The advantage of Prout is that it advocates for distribution of materials and products of the land and market in a manner that helps the largest number of people develop to their personal and community potential. A Proutist society seeks to meet certain needs of the people by ensuring that everyone is working in a way that will meet their basic needs, rather than through handouts. One disadvantage is that for a capitalistic nation, it is difficult for Proutist to ensure their first principle which states that no individual should be allowed to accumulate any physical wealth without the clear permission or approval of the collective body. This principle may discourage hard working people.

Cooperatives are considered the best economic structure for human society (Sarkar, 2005 and PNA, 1977). Community involvement is key to ensuring proper management of water resources through creating a sense of ownership. The model demonstrates the effect on water supply, management and conservation when community is involved in water issues. The community can be involved in water issues such as choice of conveyance systems, the location of weirs and water intake points. This involvement immensely motivates the community to participate in management and conservation of water through accepting to take training sessions and attending seminars, meetings and participating in electing officials. The community will always want to safeguard the water resources by feeling it is their responsibility to assist in water monitoring and reporting infrastructure breakages for repair in time. With maximum coordination in water management and conservation, the WRUA challenges will be few. This will finally culminate in sustainable water supply to the community and ensure adequate and quality water which is accessible and equitably distributed. If the community is not fully involved, all the processes intended for its benefit might not succeed.

2.7 Conceptual framework of the study

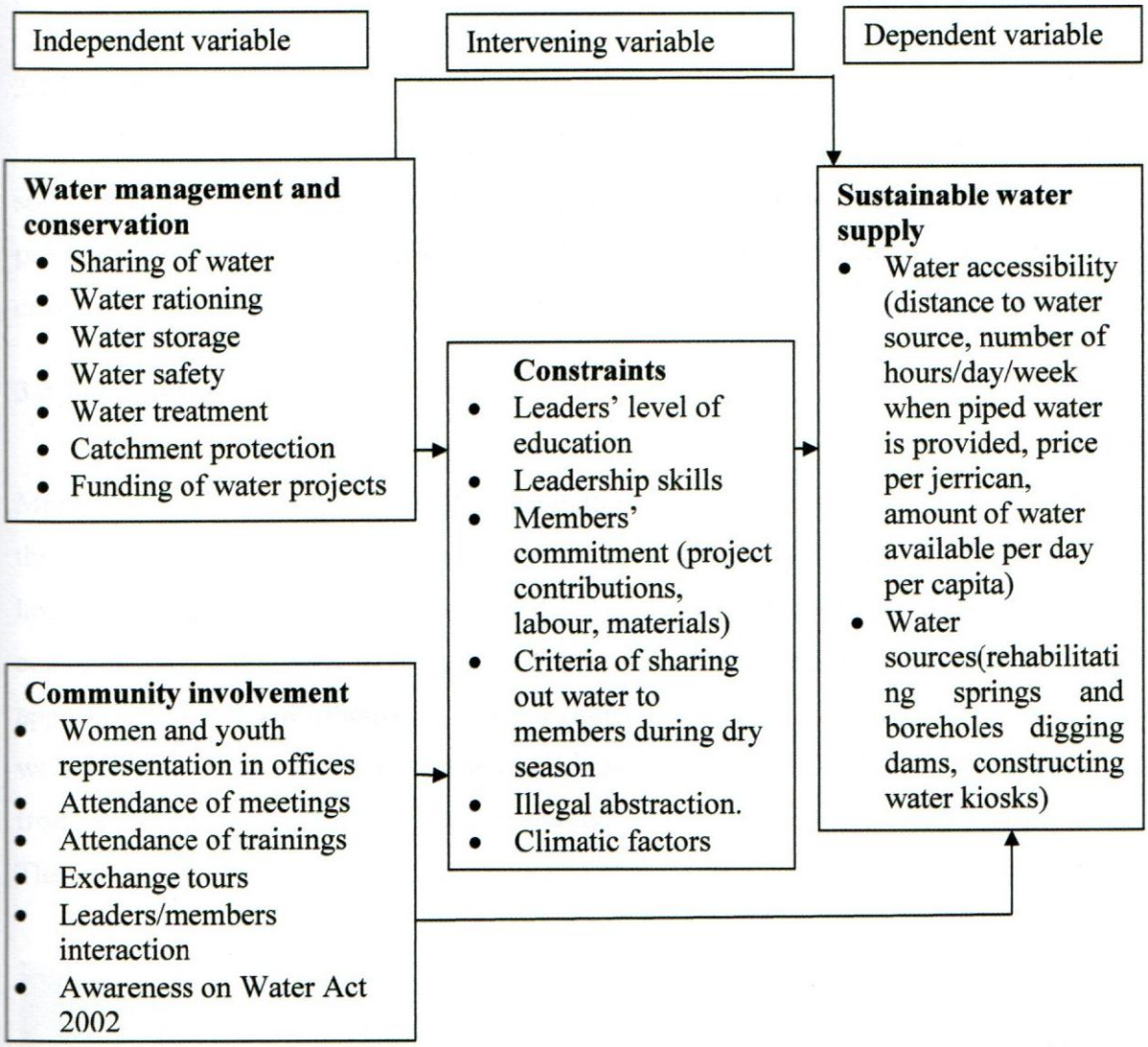

Figure 1: Conceptual framework
(Source: researcher)

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter gives information about the study area, the climatic conditions, vegetation and soil types as well as the socio-economic activities. It covers the research design and sampling procedure in a household questionnaire, FGD and in-depth interviews. The last two sections cover methods used to collect data and data analysis.

3.2 The study area and duration of data collection

The study area was the upper catchment of Lake Bogoria Basin (LBB) which comprises of Mbogo-ini and Subukia divisions. According to the 2009 Population and Housing Census report, the population in this part of the basin was estimated to be 72,910 people with 12,258 households. According to WRMA (2008), the major source of fresh water for upper LBB communities is Waseges River and its tributaries whose catchment covers a total area of approximately 475 km^2 (Figure 2). The catchment experiences water shortage and the condition worsen between the months of January and March (WWF, 2007). The WWF, 2008 reports that from late 1990s, Waseges River channel and its tributaries dry up during dry seasons (Plate 1). The study took eleven months to be completed, that is from October 2010 to September 2011.

Plate 1: Dry river bed of River Waseges at Mbogo-ini /Kabirira boundary

(Source: African Woman on Conservation, 2008)

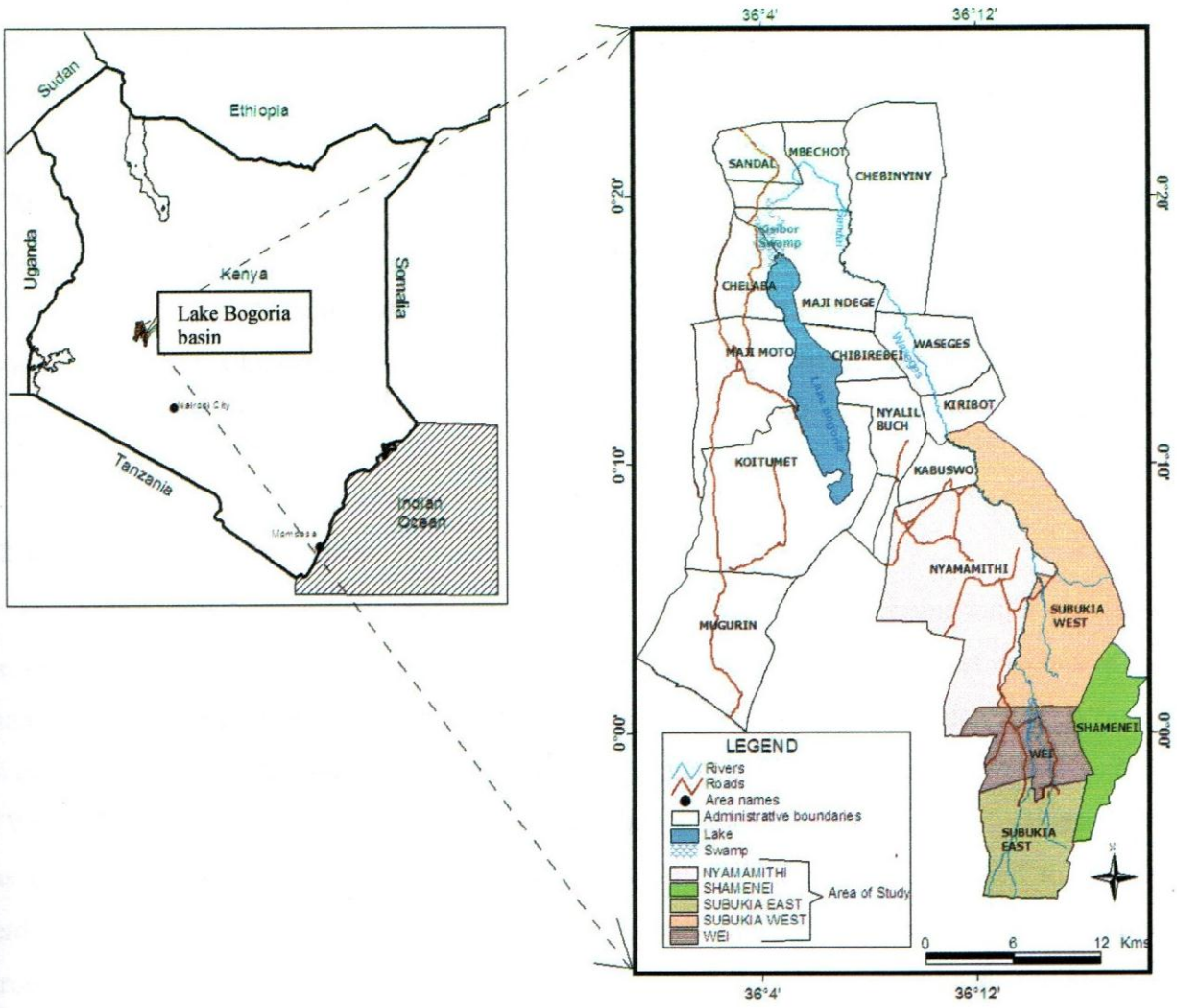

Figure 2: Map of the study area

(Source: Modified from WRMA, 2008)

3.2.1 Climatic conditions

The climate in the study area is arid and semi- arid except in the moist highlands around Subukia Division (WRMA, 2008). The climatic conditions of the upper LBB are influenced by Inter Tropical Convergence Zone (ITCZ) and experiences bimodal type of rainfall. Long rains come in the month of March to May and short rains in the month of October to November. The remaining months form the dry seasons (WRMA, 2008). The average annual precipitation is about 700mm per year. On the northern side of the upper LBB, the climatic conditions are harsh with daily mean temperature of 25°C (WWF, 2007).

3.2.2 Vegetation and soil types

Mountane forests are found around the catchment area of the Waseges River in Subukia Division. The other areas of the upper catchment comprises of grasslands, bush lands, shrubs, scrublands and woodlands (WWF, 2009). The LBB is a geological product of past tectonic events of faulting, warping and volcanic eruptions associated with the formation of the Rift Valley. According to WWF (2009), the upper LBB has three major soil types; clay soils, clay loam and silt loam. The riverine soils are complex with varied textures depending on the drainage conditions and are composed of eroded volcanic sediments and alluvial deposits. They consist of diverse types of granulomites, silts and gravels. The northern part of the LBB is dominated by clay loam (WWF, 2007).

3.2.3 Socio-Economic activities

The wider catchment area has multiple land- use types that have undergone major changes in the last 100 years (WWF, 2007). The community living in the moist uppermost catchment area changed the area from forests to large scale commercial farms and ranches, which were later sub-divided into small-scale holdings where irrigation agriculture is the mainstay (Obolla, 2006; WWF, 2007). The northern side (Mbogo-ini) was under nomadic livestock productions, which has changed over time and are restricted to a smaller range/sedentary compared to the past herding system (WWF, 2007). Irrigated agriculture is also practiced. Currently, the government through the Kenya Agricultural Productivity Programme (KAPP) has funded a fish industry for some groups in the upper catchment area. The upper catchment already has 350 reservoirs most of which have fish (tilapia and cat fish) (WWF, 2008).

3.3 Research design

A cross sectional survey research design was used where a group of respondents was asked a set of questions at one point in time and space. The cross-sectional survey was conducted using some modes of data collection which included a household survey questionnaire, focus group discussions, in-depth interviews and observation in the field all used to collect primary data. Secondary data was obtained from training manuals and pamphlets obtained from the LBB-WRUA Offices in Subukia and WRMA offices in Bahati. The study captured some information on the current state of water management and conservation by the LBB-WRUA. Such

information included the current state of water accessibility, community involvement in water issues, water management and conservation and identifying challenges that face the LBB-WRUA

3.3.1 Household Survey

3.3.1.1 Sampling procedure

The target population comprised of WRUA and non-WRUA households. According to Nassiuma, (2000), the sample size is determined in the following way:

$$n = \frac{NC^2}{C^2 + (N-1)e^2}$$

Where n=Sample size

N= Population size (Source; Population and Housing Census report, 2009)

e= Error margin

C= Coefficient of variation

$$n = \frac{12{,}258 \times 0.3^2}{0.3^2 + (12{,}258-1) \times 0.02^2}$$

n=221 households

Using this formula, it was established that a sample size of 221 households from both WRUA and non-WRUA were required for this study. This sample was then divided proportionally to obtain the sampling size for the WRUA and non-WRUA households. The water project lists indicated that there were 3947 water project households while the rest (8311) were non water-project households.

Proportion of non-WRUA households were;

$\frac{8311}{12{,}258} \times 221 = 149$

Proportion of WRUA households was;

$\frac{3947}{12{,}258} \times 221 = 71$

The 149 non-WRUA households were divided proportionally among the five blocks (A, B, C, D and E). The selection was such that each farm within the blocks provided at least 12

households. Block A provided 48 households, 12 from each of its four farms; block B 60 households, 12 from each of its five farms; block C 13 households while block D and E each provide 14 households. Block C, D and E contributed a higher number of households since they have one, but large farm each. The selected households were obtained by use of simple random sampling. Lists of heads of households per farm were used, names fed into a computer and random numbers generated by use of SPSS version 17. In the case of the 71 WRUA households, each category of water project provided sampling units as indicated in Table 1, to ensure fair representation of all the WRUA households. A proportion was worked out for each water project depending on the number of the households. Using lists of project members, simple random sampling was carried out to select the specific households to be included in the study for each category of water project.

The five blocks in the upper LBB included the following;

Block A–This comprises Marana farm, Lari Wendani, Igwamiti and Kipsigis Tugen. These farms are at the far end of Eastern upper LBB within Subukia West.

Block B–. The farms included are Akuisi, Limuru, Nyamamithi, Simboyon and Wiyumiririe. It extends from the northern side to the central region of the upper LBB within Nyamamithi and Wei.

Block C–It comprises of Mihango farm

Block D–This is also made up of one farm, Kianoe.

Block E–It is made up of one farm called Tetu.

Block C, D and E are located on the southern side of the LBB within Subukia East and form the uppermost catchment area that is the source of the Waseges River tributaries (LBB-WRUA, 2008).

Table 1: Categories of water projects in the upper LBB

Classes	Number of projects	Number of (households)	Proportion of households
<50	24	216	4
51–100	16	1127	20
101–150	1	150	3
151–200	2	400	7
201–250	3	720	13
251–300	2	600	11
301–350	1	334	6
>351	1	400	7
Total	**50**	**3947**	**71**

Source: (LBB- WRUA, 2010)

Pre-testing of the questionnaire was done in the neighbouring Sidai sub-location and the data utilized in measuring the instruments' reliability (Mugenda and Mugenda, 2003). The value of Cronbach's alpha coefficient obtained by use of SPSS was 0.75. Bryman and Cramer (1997) recommend a threshold level of 0.70 alpha for an acceptable reliability coefficient. The questionnaire was found to be reliable since the alpha coefficient obtained was above 0.70.

3.3.1.2 Data collection

A household survey questionnaire was used and comprised mainly of closed-ended items and a few open-ended items. It sought communities' opinions and attitudes on water management and conservation from the targeted respondents. This led to provision of the percentage of respondents that access water at a distance less than one kilometer, harvest and store water when it rains, use economical irrigation methods, have standard water pans and the percentage that treat water before drinking. It also provided percentage of leaders and members that attend training seminars, projects that organize tours to other basins and respondents with at least 10% (200 trees per acre) of their land under woodlot as per the LBB-WRUA constitution. The survey provided the percentage of the most prevalent water related challenges in the basin.

3.3.2 Focus group discussion

One Focus Group Discussion (FGD) was held in Subukia center and comprised individuals selected from within the LBB-WRUA stakeholders. Purposive sampling was employed in selection of these individuals. Mulwa and Nguluu (2003) recommend six to twelve participants per FGD. The FGD for this study included ten representatives comprising of three government officials (one from WRMA in Bahati, one from the ministry of agriculture and another one from the ministry of health), one WWF official (an NGO funding the LBB-WRUA), two LBB-WRUA officials (one from Subukia Division and the other one from Mbogo-ini Division) and four water project officials (two from each Division). The FGDs helped obtain information about responses to issues that required more knowledgeable and informed individuals. Such information included how the LBB-WRUA ensure fair distribution of water during the dry season, the measures that the WRUA is putting in place to ensure catchment protection, how the WRUA ensure safety of water in the upper catchment of the LBB, the main challenges that the WRUA face when trying to provide water and ensuring its conservation and their views on how they can overcome them.

3.3.3 In-depth interviews

Purposive sampling was also employed in selection of individuals who participated in the in-depth interviews. Participants for inclusion were identified during the course of administering the household questionnaire. These are the individuals who were found to be more knowledgeable on WRUA issues and could provide more information on the subject. They included two water project chairmen and seven water project members among them two administration officers (a chief and a councillor). In-depth interviews were used to follow up some important information that was of pertinent concern in the management and conservation. They answered questions on how the LBB-WRUA manage the little flow of water for irrigation purposes during the dry season, where the LBB communities get water when the flow reduces, whether all irrigators abide to the rule in the constitution of washing Knapsack sprayers 100m away from the river, whether there are moments when all water projects interact, the areas that the WRUA should improve on and why they think WRUA is not performing in the areas that they mentioned.

3.3.4 Observation

Observation was made on types of irrigation methods in use in the upper part of the LBB, presence of pipes, water storage facilities, tree nurseries, water kiosks, woodlots, evidence of illegal water abstraction and alternative water sources among others. Photographs of water pans, dams, sources of water pollution along the Waseges River were taken to assist in the analysis.

3.4 Data analysis

The data collected was organized and coded. Coding of data involves converting the observations and measurements made about a construct into a case × variable matrix suitable for SPSS to understand (UNEP, 2000).Coding of household questionnaires was done immediately after the questionnaires were filled. This was followed by data entry into a computer and analysis done by use of the Statistical Package for the Social Sciences (SPSS) computer software version 17. The results obtained were presented in form of frequency distribution tables, bar graphs, pie charts and measures of central tendency. Chi-square tests were carried out to obtain levels of association between different variables (Table 2). According to Mathbeans (2013), Chi-square statistics compares the tallies/counts of categorical responses between two or more independent variables. The data (topic guides, audio tapes and observation notes) obtained from the focus group discussions and in-depth interviews were reviewed and organized. Tapes were transcribed verbatim (word for word) (Mulwa and Nguluu (2003) in order to capture the exact word and phrases voiced by the participants.

Table 2: Summary of data analysis procedures

Research question	Independent variable	Statistical methods
a. What is the current status of water management by the LBB-WRUA in the study area	• Sharing of water • Water storage • Water safety • Water treatment • Catchment protection • Women and youth in office • Attendance of meetings • Attendance of trainings • Exchange tours • Leaders/members interaction • Awareness on Water Act (2000)	• Descriptive statistics • Cross-tabulation • Chi-square
b. What is the current status of water supply to the community by the LBB-WRUA in the study area?	• Water accessibility • Water sources	• Descriptive statistics • Cross-tabulation • Chi-square
c. What challenges does the WRUA face while supplying water to the communities?	• Leaders' education level • Leadership skills • Members' commitment • Mode of sharing water	• Descriptive statistics

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter covers the demographic characteristics of respondents in the Lake Bogoria Basin, water management by the LBB-WRUA, current status of water supply to the communities, community involvement in water projects and challenges facing the LBB-WRUA. Some sub-topics covered under water management include sharing of Waseges River water, water rationing, water storage facilities, water safety and irrigation methods in use in the Basin. It also covers irrigation before and after establishment of the LBB-WRUA, catchment protection, river bank protection and funding of water projects.

Water accessibility and water sources are covered under the current status of water supply to communities in the LBB. Under community involvement in water projects, information on gender representation in leadership positions has been covered. Other sub-topics covered in this chapter include, attendance of meetings, and contribution of ideas in group discussions. Training seminars for project leaders and their members, exchange visits, interaction between leaders and members as well as community knowledge of water act (2002) are also covered.

4.2 Demographic characteristics of the respondents

Demographic characteristics of respondents in the study area are as shown in Tables 3 and 4. The household survey respondents were obtained from WRUA and non-WRUA households and were either the heads of the households or their representatives with mean ages of 43 years with a standard deviation of 12.99. Fifty six percent of the WRUA and 56% of non-WRUA respondents had attained primary education. The mean family sizes for WRUA and non-WRUA households were 6 persons each. The average monthly income of the respondents was found to be Kshs 4520 for members and Kshs 4532 for non members.

Table 3: Total family members

Membership	Total number of family members(N)	Mean	Std. Deviation
Member	87	5.9559	2.46428
Non-member	134	5.5739	1.94242

Table 4: Level of education

	Frequency		Percent	
Education level	member	Non-member	member	Non-member
None	7	21	9.3	9.5
Primary	39	124	55.8	56.1
Secondary	19	69	26.7	31.2
College	6	5	8.2	2.3
Adult education	0	2	0.0	0.9
Total	71	221	100.0	100.0

The study revealed that out the 221 household survey respondents, 11% were confined within the riparian area. The remaining 89% were found far away from the river, explaining why non-members dominate the upper LBB. However, membership to water projects is not restricted to riparian land owners only, but is open to other community members. About 99% of the 71 household survey respondents in the WRUA water projects indicated that non-project members are welcome to join their projects. Non-members had not applied to join the water projects for fear of gambling their hard earned money for water that is not forthcoming. With proper catchment management and rehabilitation of other water sources, it is possible for water to be equitably distributed to as many members of the community as possible.

4.3 Water management and conservation by the LBB- WRUA

According to Brundtland (Brat, 2009; Calder 2005), water is one of the basic human needs and should be managed sustainably or else continued economic growth will not be feasible. Proper water management and conservation is the only remedy to water scarcity and water borne diseases in the upper catchment of the LBB. Water projects in the upper catchment of the LBB

are managed by the LBB-WRUA and the water project committees in liaison with WRMA, Rift Valley Catchment Area Regional Offices in Nakuru.

4.3.1 Sharing of Waseges river water

The report obtained from the FGD indicated that all the water projects had identified locations for weirs and some had done the construction. However, it was observed that, apart from Akuisi and Lari Wendani water projects, all the other water projects had not completed piping. From the study findings, WRMA permits direct water abstraction from the river using portable pumps, where piping has not been done, while strictly following water allocation timetables. Nyamamithi water project had not laid pipes and its members use portable pumps, to abstract water. Their time table was such that during every given two hours, six pumps are operating. In-depth interviews revealed that there is a serious problem with this kind of arrangement since farmers with larger pumps abstract more water compared to those having smaller pumps leading to temptations for members to violate the time table.

In-depth interviews revealed that farmers with large farms were unable to fully water their crops within two hours, and have a tendency of illegally abstracting water at night and very early in the morning to avoid being apprehended by the law enforcers. The study indicated that illegal water abstraction is also done by non-project members who are not incorporated in the water allocation time tables. Violation of water allocation time tables is experienced by all the water projects in the upper LBB with exception of Lari Wendani. The FGD revealed that Lari Wendani water project officials are very vigilant and ensure members strictly follow water allocation time tables by fining those who violate the time tables and apprehending the non-members who illegally abstract water.

The in-depth interviews carried out in the study area indicated that there was unequal distribution of water between the upstream and downstream communities as well as between the water users in the two divisions. Inequitable distribution of water has instigated conflicts among some communities. During in-depth interviews, it was revealed that Mwiteithia and Thuthwa both in Mbogo-ini Division had conflicts over irrigation water and farmers confronted each other with machetes early January, 2011.Thuthwa community claimed that water had been diverted at Mwiteithia which was actually the case, leaving no water flowing in the river for them.

The household survey conducted in the study area revealed that out of the 71 household respondents who were members of the LBB-WRUA, about 90% lacked valid water abstraction permits and those who did rarely adhered to conditions of the permit, leading to water scarcity downstream. Lack of water abstraction permits was due to lack of standard water pans. Uncontrolled abstraction in the Upper Subukia, which was reported during in-depth interviews, was responsible for frequent water scarcity facing people living between Limuru and Mbogo-ini. This was mainly in Tetu farm where shallow wells had been dug very close to the river and also diversion of water by large scale farmers to their pans especially during the dry season. Based on the in-depth interview findings, no effort had been made to bring the upstream and downstream communities together to discuss their common resource (Waseges River water).

One of the objectives of the LBB-WRUA was to ensure that Waseges River water is fairly shared by all water users. The WRUA encourages water users to form water projects to ensure fair sharing of water among their members by constructing common water abstraction points and preparing time tables to help them share out water during the dry season. However, these expectations have not been realized. There was inequality in water supply systems which promoted illegal water abstraction. Poorly designed water supply system can cause inequalities in water distribution. In such cases, community management may not be feasible because the different groups cannot find a common denominator upon which to base solutions (Lammerink 1999).

Generally, upstream water users are harder to convince of the benefits of association, as they enjoy the privileged position of never experiencing water shortages. Ones members of a WRUA, they may still be difficult to persuade to share the burden of managing the catchment (Mumero, 2005). However, 32% of community members in Subukia division are already members of water projects manned by the LBB-WRUA. This is an indication that the LBB-WRUA members upstream are ready to cooperate with the community downstream in catchment protection and also share water fairly. They just require further direction from the officials in the LBB-WRUA through a series of meetings involving communities in Subukia and Mbogo-ini Divisions.

A similar case of unequal sharing of water was noted in Nyeri before the establishment of Burguret River Water Users Association (BRWUA). The downstream water users would invade the farms upstream, destroying their reservoirs. This ended when the members of this

Association, both up and downstream sat down and identified their water users, their daily requirements and then decided when each user will have full access to the facility (Mumero, 2005). The LBB-WRUA can follow the BRWUA example to ensure its members on the lower reaches of the Waseges River access water throughout the year.

4.3.2 Water rationing

The household survey indicated that about 24% of the 71 respondents get domestic water once per week from their water projects while 41% do not get water at all (Figure 3). Among the 59% supplied with domestic water, 54% of them are served with water for less than 6 hours a day (Figure 4). During the driest months of the year (January to March), the river channel is usually dry hence no water for sharing. This explains why the 41% of the respondents were not supplied with water. It was observed that respondents on the upper reaches of the Waseges River were supplied with water for more hours and the supply reduced downwards along the river course with the respondents in the lower reaches getting less or no water.

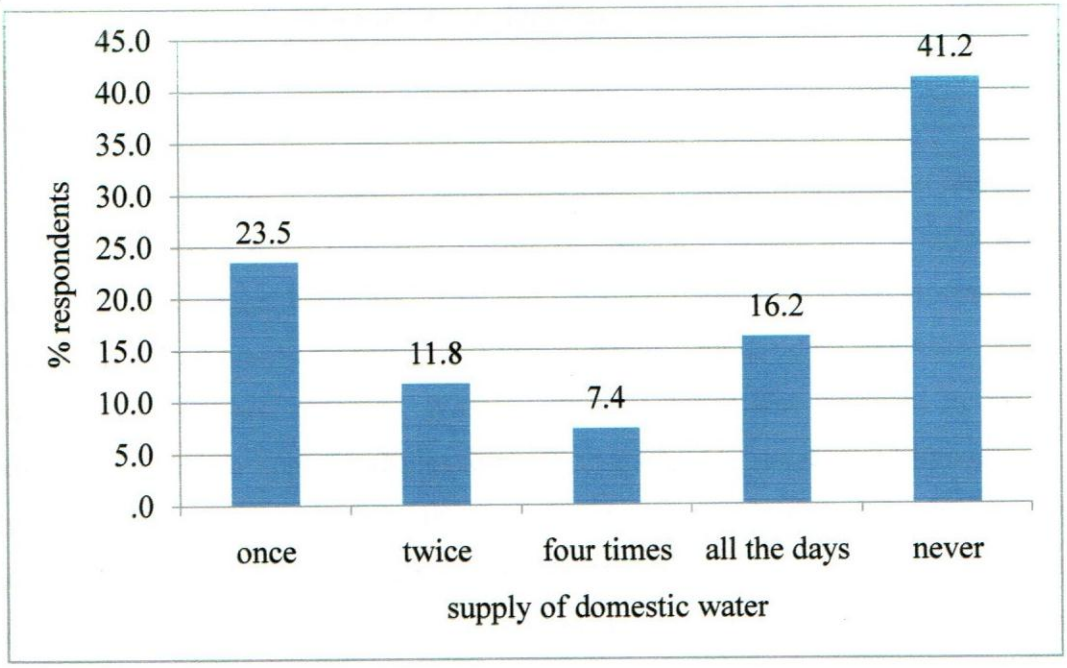

Figure 3: Number of times per week domestic water is provided

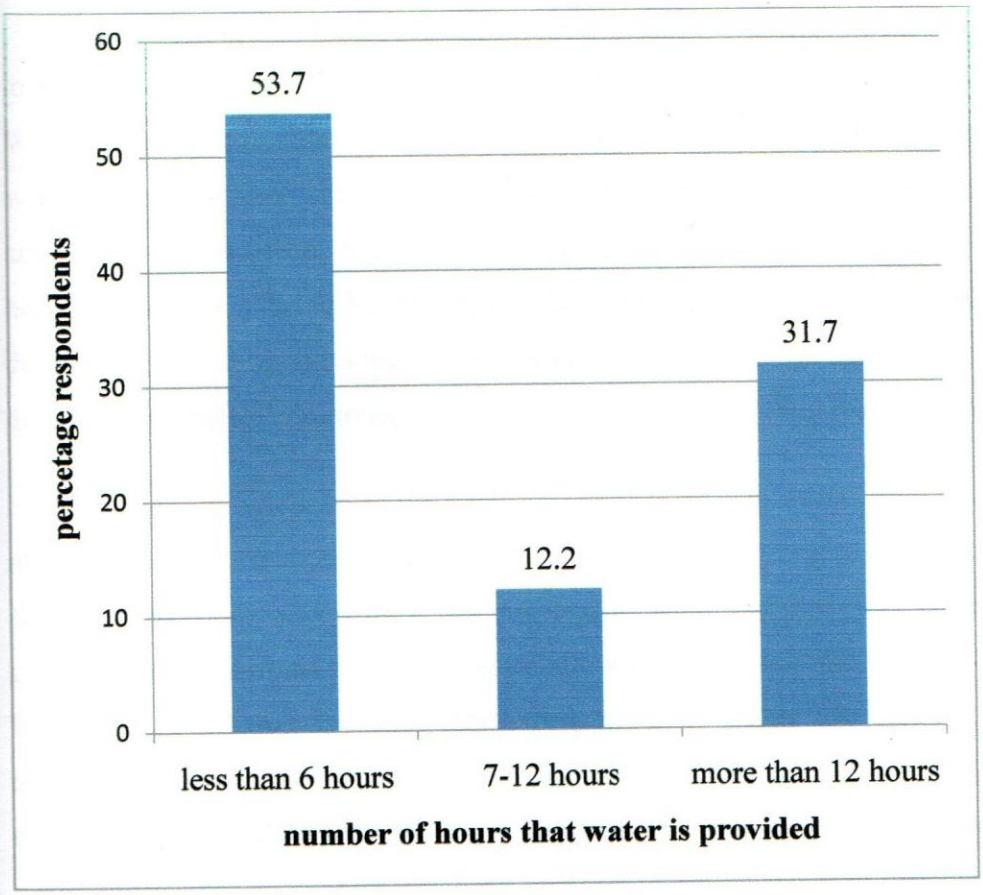

Figure 4: Number of hours domestic water is provided per week

From the information obtained during the FGD, water allocation time tables for domestic and irrigation purposes work very well during the first few weeks after a rainy season. As the dry spell progresses, water becomes scarce and cases of illegal abstraction increase. By the end of the day, there is no water to be shared or even to ration. The in-depth interview report indicated that efforts of sharing and rationing Waseges River water is also curtailed by some law enforcers whose inabilities to apprehend illegal water abstractors motivate the offenders. In addition, lack of water for domestic use especially downstream can be blamed on inadequate sources of water and illegal abstraction by irrigators. In-depth interviews revealed some covering up of offenders (illegal water abstraction and violators of time tables) by the water project committees and their members.

Water rationing is done during the dry season to ensure availability of water for domestic use to all users to allow environmental flow and to provide minimum amount of water to irrigators. Water rationing is mandatory in this part of the basin during the dry spell and involves changing water allocation time tables with water flow fluctuations in the Waseges River to regulate amounts abstracted from the river at any given time. Priority is given to domestic water users because water is a basic human right. The LBB-WRUA constitution indicates that water for domestic use should be supplied for twenty four hours on daily basis. However, water for domestic use has to be rationed during the dry season following reduced water flow.

According to Gichuki (Chakravarty, 1985) Kenya's water problem is not shortage but mismanagement. He therefore concluded that we are not going to tell farmers to stop farming or allow our livestock and wildlife die for lack of water. He therefore concluded that we are not going to tell farmers to stop farming or allow our livestock and wildlife die for lack of water. Instead we have to acknowledge that river water is no longer adequate for our present and future needs. This means that we have to adopt necessary technologies to enable us to exploit alternative water sources (Chakravarty, 1985). In the LBB, the communities have continued experiencing water shortage that compels the LBB-WRUA to ration water. Time has come for alternative water sources such as dams, springs and bore holes to be rehabilitated to allow irrigated agriculture to go on. This would ensure food security and a regular income since the communities in the LBB depend on agriculture for their livelihoods.

4.3.3 Water storage facilities

The WWF in conjunction with WRUA have sensitized communities on the issue of water storage facilities. These include water pans that hold water for irrigation and masonry tanks used to store water for domestic use.

4.3.3.1 Storage of irrigation water

The household survey indicated that about 30% of the 221 respondents have been collecting and storing flood flow for irrigation purposes while the remaining 70% watch as rains pour and subside (Figure 5). About 98% of the 221 household survey respondents in water projects that collect flood flow, store it in water pans, while 2% store in tanks.

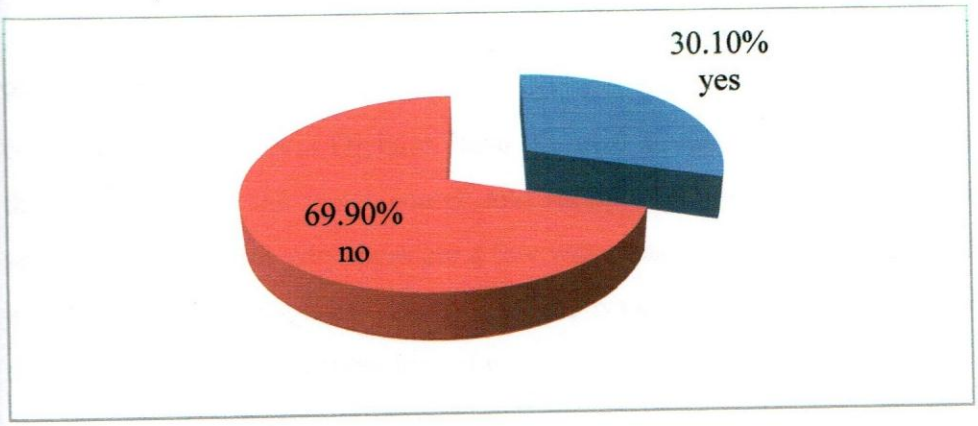

Figure 5: Percentage of respondents who store flood flow

As indicated in Table 5, the water project members involved in the study had 54 water pans.74% of them were found to be leaking explaining why river water abstraction activities increases after the rains subside and the river channel dries up during the dry spell (Table 5). The FGDs indicated that communities in the study area are unable to harvest enough water due to leaking water pans and the high cost of transporting clay to the site, or even buying lining papers for sealing pores in the water pans. About 20% of the 221 household survey respondents had water pans measuring 20m by 20m by 1m. The cost of constructing a standard water pan in the LBB as provided during the FGD is currently standing at Kshs 25,000 compared with Kshs 16,000 in 2005. This is beyond the reach of many community members in the upper catchment of the LBB, with an average income of Kshs. 4526 per household per month.

Table 5: Comparing dimensions of water pans in Subukia and Mbogo-ini Divisions

Size of dam	**Subukia**		**Mbogo-ini**		**Number of leaking water pans**	
	Frequency	Percentage	Frequency	Percentage	Subukia	Mbogo-ini
20mx20mx1m	4	80.0	7	14.2	3	4
15mx15mx1m	1	20.0	5	10.2	1	3
10mx10mx1m	0	0.0	22	44.9	0	18
15mx10mx1m	0	0.0	12	24.5	0	8
20mx10mx1m	0	0.0	2	4.1	0	2
12mx12mx1	0	0.0	1	2.0	0	1
Total	5	100	49	100	4	36
Grand Total			54			40

Among the 71 water project members involved in the study, 54 of them had water pans. About 90% of water pans were in Mbogo-ini Division while only 10% were in Subukia Division. The communities in Subukia Division have physical advantage over Mbogo-ini Division because of their proximity to the water source and rarely experience water shortage even during the dry season. This explains why there are a few water pans in Subukia division as compared to Mbogo-ini. Irrigators in Mbogo-ini division require water pans to store water for their crops when the river flow subsides to prevent loss of crops.

Plate 2 shows a leaking water pan in Mwiteithia; though it is April (wet month), it is empty. The water pan had the required dimensions but was lacking lining to prevent water seepage.

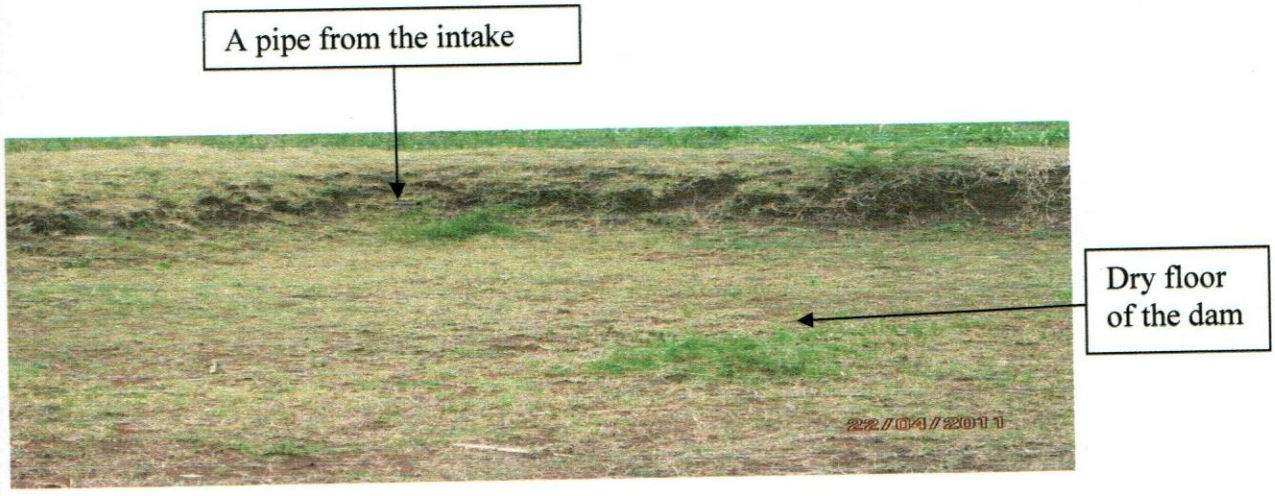

Plate 2: An empty water pan at Mwiteithia

(Source; photograph courtesy of Wangui, April, 2011)

There was a significant difference between the project and the non-project members on harvesting and storing of flood flow ($\chi 2 = 8.699$; $p = .004$) (Table 6). The disparity on flood flow storage among members and non-members is due to difference in awareness creation. The LBB-WRUA members are more aware of the importance of water pans through the facilitators. It is also a requirement by WRMA that all members dig a water pan before being issued with water abstraction permit. If the water pans were not mandatory and in absence of early adaptors, they would have been even fewer than they were. However, not all the water project members have managed to dig water pans because of the high cost of digging and lining with either clay or polythene papers.

Table 6: Comparing Member and non- members on flood flow harvesting

Does your family collect storm flood?	Member of a water project		Total
	Yes	No	
Yes	34	31	65
No	47	104	151
Total	81	135	216

Pearson Chi-Square=8.699; df=1; p=.004

There was a significant difference between project members and non-members (Table 7) on the dimensions of the water pans ($\chi 2$=10.340; p=0.000). The water project members had bigger water pans as compared to the non-members. The non- members are not allowed to abstract water from the river into water pans since they do not have permits and those who do, do it illegally. Those who have water pans harness the flash floods before they reach the river and the sizes of the water pans are not restricted. Some irrigators have benefited from funding and have been able to put up standard water pans while others have demonstration pans dug in their farms. Digging of fifty six water pans was on going during the process of data collection and it took three months (June, July and august, 2011) for the pans to be completed. The process was funded by Economic Stimulus Programme (ESP) under fisheries department in collaboration with Subukia Constituency Development Fund (CDF) committee. The fifty six water project farmers were given 1000 fish and 20 bags of fish feed each to start with. The water in these water pans is also applied to crops. This explains why non-project members have fewer and smaller water pans.

Table 7: Comparing the dimensions of the dams between members and non-members

Water project member	The dimensions of the dam (m)						Total
	10x10x1	15x10x1	15x15x1	20x10x1	20x20x1	12x12x1	
Yes	10	5	3	2	10	0	30
No	12	7	3	0	1	1	24
Total	22	12	6	2	11	1	54

Chi-square= 10.340; df=1; p=0.000

During the FGD, it was revealed that the Government of Kenya once provided lorries for transporting clay soil for lining the leaking water pans. The activity never took off since the project members were not ready to cooperate. Instead, they expected the government to fuel the

lorries as well as get the clay soil for them. They also expected the respective funding agencies to initiate projects, fund them and pay the beneficiaries for work done in their own farms. Based on the FGD report, the WWF; an NGO facilitating the LBB-WRUA had advised members whose water pans were leaking to ensure their water pans were constantly supplied with water during the rainy season for fine soil particles to seal pores and reduce seepage with time. On the contrary, many project members dug their water pans and abandoned them on realization that they were leaking.

The information obtained from the FGD revealed that the LBB-WRUA in conjunction with Mbogo-ini Facilitation Group (MFG) does capacity building on water harvesting, using water pans within the projects in Mwiteithia and Mbogo-ini. According to Bolt, *et al* (1999), communities are expected to own the process of change while the facilitators together with local researchers are expected to participate in the communities' projects and not the other way round. According to Lammerink, *et al*, (1999), communities are no longer the passive receivers of technical goods, but are active participants, knowledgeable and accountable for their actions. As long as the communities in the upper LBB continue playing a passive role on water issues, efficient water management and conservation will remain a pipe-dream.

The storage facilities recommended by the Ministry of Agriculture (MOA) for storing irrigation water are water pans measuring 20m by 20m by 1m which can hold enough water to support one acre crops for three months, using drip irrigation after the rains have subsided (FAO, 2008). Tanks and very small water pans might not serve the farmers for long after the rains and may lead to low yields or even losing the entire crop. The Rainy seasons in the LBB are accompanied by flash floods which flow down the river to the Lake Bogoria, and within a very short time; the flows subside to the base flows of the river. The available water for irrigation and domestic use is therefore the normal flow and drought flow annually. This leaves the community scrambling for the available water resources which cause water conflicts among them.

It is becoming a common practice for the medium and low potential areas of the country through the construction of individual water pans and the diversion of roadside runoff, to improve food security, as is the case of Lare Division in Nakuru County (FAO 2008). Community members in the upper LBB depend on agriculture for their income but the climate in the basin is arid and semi- arid except in the moist highlands around Subukia division (WRMA, 2008). It is

therefore advisable that the LBB-WRUA encourage improved water conservation and management to accommodate more irrigators hence improving the communities' income as it is the case with communities in Lare.

4.3.3.2 Storage of domestic water

The household survey indicated that about 93% of the 221 respondents collect and store rain water. However, 58% of them were found to be collecting and storing rain water in small containers (barrel and 20 liter jerricans). Only 42% the respondents were having water tanks (Figure 6). This was due to close proximity to the river for some community members or inadequate funds to buy water tanks or construct masonry ones. Thirty six percent of the household survey respondents revealed that they are close to the river and see no need of having storage facilities.

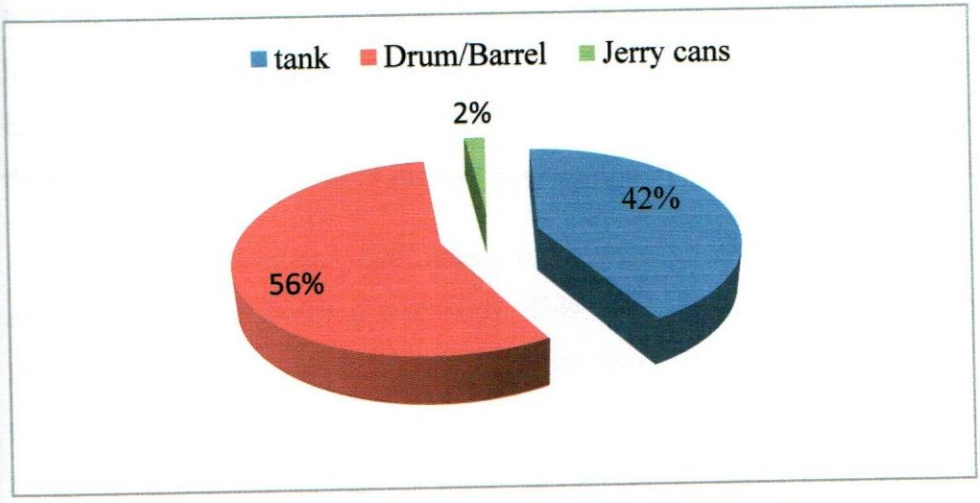

Figure 6: Domestic water storage facilities in the study area

There was no significant difference between project members and non-members on rain water harvesting for domestic use ($\chi 2$=0.126; p=0 .790) (Table 8). As stated earlier in section 4.2, 11% of the 71 water project members were within the riparian area and could access water with ease. However, they also require clean drinking water hence the need for large water storage facilities. It might be that they are not well supported financially to put up large storage facilities like masonry tanks, or there is no cohesion between community members forming water projects and are unable to assist each other through merry go rounds. Low capacity storage facilities which

were common for both the project members and the non-members, hold water for a limited duration of time forcing community members to result to fetching water from the river.

Table 8: Comparing the project and non-project members on rain water harvesting

Does your household collect rain water	Member	Non-Member	Total
Yes	77	126	203
No	5	10	15
Total	82	136	218

Pearson Chi-Square= 0.126; df=1; p=0 .790

. With growing pressures on water supplies worldwide, rainwater harvesting is increasingly seen as a viable option to provide drinking water to ever expanding population, particularly in developing countries (Adler, *et al.* 2011; Mazlin, *et al*, 2011). Lack of adequate water storage facilities in homes may continue increasing dependency on the Waseges River for water. The livelihoods of poor people are threatened more by water shortage as they may spend more of the family income in treatment of water borne diseases. They may also continue spending more of their time searching for water instead of engaging in income generating activities

UNEP (1982) explains that humans often increase storage capacity by constructing reservoirs and decrease it by draining wet lands. This has been the case in the Upper catchment of Lake Bogoria basin. The potential water sources like springs and dams have been drained through cultivation reducing the availability of clean water. Without an alternative source of water, the river water is over abstracted explaining why the Waseges river channel dries up during some periods of the year. Further, the communities are reluctant to construct reservoirs for storing rain water. Being close to the river does not guarantee water quality, hence exempting riparian land owners from harvesting rain water. The Waseges river water has a variety of pollutants ranging from sewage, agro-chemicals and silt. It is therefore advisable that all the water users, WRUA or non-WRUA harvest rain water enough to take them through the dry season. Rain water supplement the river water for domestic purposes and is safer for drinking if handled hygienically.

4.3.4 Water safety as perceived by the respondents

During the course of the study, it was observed that a lot of water pollution came from Subukia shopping Centre which lacked sewerage systems and drained sewage directly into the river. Plate 3 shows a toilet with a channel connecting it to the river (Plate 4) indicating that the toilet contents get their way directly to the river. From the FGD, it emerged that like many urban centers in Kenya, planning was not done when Subukia Centre was being established hence lack of sewerage systems. Other sources of pollution included eroded soil and agro-chemicals applied mostly on tomatoes; a major cash crop in the upper catchment of LBB. This indicates high level of ignorance among the irrigators on the effect of agro-chemicals on the health of the downstream communities.

Plate 3; Toilets adjacent to the Waseges river tributary at Subukia center

(Source: photograph courtesy of Wangui, September, 2011)

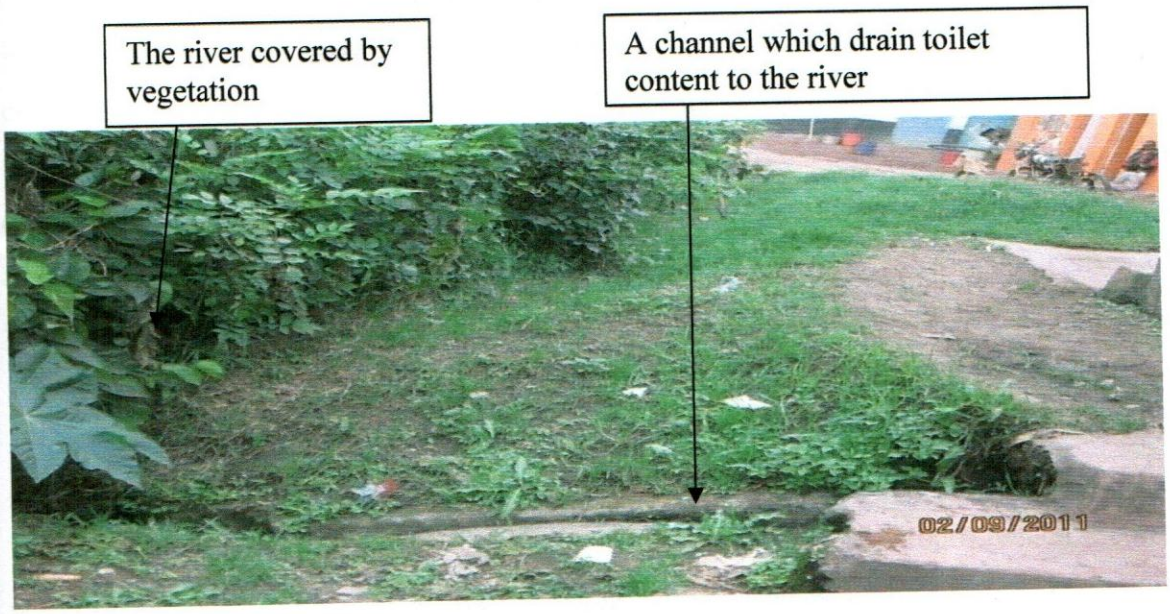

Plate 4: A channel behind the toilets draining contents into the river

(Source: photograph courtesy of Wangui, September, 2011)

The household survey indicated that about 77% of the 221 respondents perceived that the water they use for domestic purposes was not safe for drinking while about 23% thought it was safe. Water was perceived to be less safe in Mbogo-ini Division as compared to Subukia Division with the percentages of the respondents being about 81% and 63% respectively (Table 9). Most of the lower Subukia (Mbogo-ini division) communities depend on river water which cuts across an urban area (Subukia shopping centre) and farms where fertilizers and other agro-chemicals are constantly being used. The quality of water therefore deteriorates as one move downstream. The upper Subukia communities (Subukia division) are at the source of the Waseges River and the water here is not much polluted.

Table 9: Water safety in Subukia and Mbogo-ini Divisions

Water safety	**Subukia**		**Mbogo-ini**	
	Frequency	Percentage	Frequency	Percentage
Safe	35	37.5	24	18.7
Unsafe	59	62.5	103	81.3
Total	94	100.0	127	100.0

Health officers have been on the forefront in sensitizing the upper LBB communities on the issue of river and spring water protection, as well as good and safe use of chemicals to avoid contamination of the water. The LBB-WRUA officials once invited OSHO (K) limited and SYNGENTA to enlighten the farmers on safe use of agro-chemicals. Despite these efforts, the community in the LBB perceives Waseges River water as unsafe for drinking or for domestic use because of pollution taking place along the course of the river. The major causes of water pollution in the LBB are ignorance, high poverty levels, soil erosion, poor sanitation practices such as bathing, washing of car and clothes in the River Waseges and its tributaries, lack of sewerage treatment works, use of farm chemicals and fertilizers, high population density, lack of seepage pits and unhygienic drawing of water such as loading donkeys inside the river (LBB-WRUA, 2009). This is in agreement with UNEP assessment report (2000), which found out that pollution of river waters, comes from washing, bathing and watering of animals directly in the river, point sources like toilets, and inappropriate solid waste disposal in market centers.

According to the LBB-WRUA (2010), shallow wells dug in Mwiteithia to supplement the River water were perceived to be contaminated. A research done by Mbogo-ini Facilitation Group (MFG) in 2010 revealed that 9 out of 10 wells are contaminated with either human waste or run off water thus the water tastes salty or Magadi soda. Pollution of water sources is a public health risk, as it degrades water quality which is detrimental to human when the same water is used for drinking and other domestic purposes. According to WHO/UNICEF, 2010, some community members lack understanding of the implications of their activities on the environment. It is the human activities in and along the river course that have caused massive pollution of Waseges River water. Nanyuki Water Resource Users' Association (NWRUA) has succeeded in curbing some pollutants such as organophosphates from soaps by erecting stands, one hundred metres away from the rivers to reduce water pollution (Nyaboro, 2010).

4.3.4.1 Treatment of water by LBB-WRUA

Ninety three percent of the 71 household survey respondents perceived that WRUA does not treat water before being distributed to the users (Table 10). The water distributed through pipes is primarily meant for irrigation but due to lack of clean water sources, it is also used for drinking and other domestic purposes. Water treatment by WRMA through WRUA is the most assured

way of ensuring water safety before the communities use it for drinking and other domestic purposes.

Table 10: Treatment of water by WRUA

Does WRUA treat your drinking water before supplying it to you?	Frequency	Percent
yes	5	2.1
Occasionally	12	5.3
no	204	92.6
Total	221	100.0

The household survey indicated that the LBB communities suffer from a variety of water borne diseases. Typhoid was the most prevalent disease affecting about 60% of the respondents, followed by amoeba at 22.9% (Figure 7). Treating typhoid is very expensive given that the salmonella typhi (pathogen causing typhoid) is resistant to drugs if not taken as prescribed (Philippa, *et al,* 1998). To prevent these diseases WRMA has to come up and install water analysis stations and treat the water.

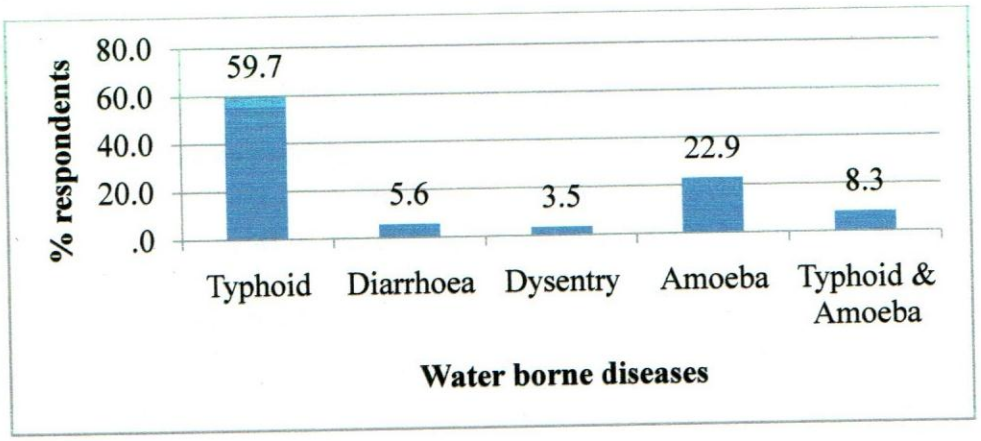

Figure 7: Common waterborne diseases in the LBB

The study revealed that WRMA is yet to initiate the process of determining water quality along the Waseges River. WRUAs like Ena and Rupingazi have their water samples analyzed in Embu and central laboratory in Nairobi (Ministry of Water and Irrigation, 2007). When the community members are left to treat their own water, they either use methods that are not effective or they ignore it all together though they might be aware of its implication on their

health. This culminates to increased cases of water borne diseases. It is a challenge to the LBB-WRUA to arrange forums for demonstrations and teaching its members as well as the other community members on the link between water pollution and healthy issues. Probably they can borrow a leave from successful WRUAs like Ena and Rupingazi.

Water supply and sanitation require a huge amount of capital investment in infrastructure such as pipe networks, pumping stations and water treatment work. Operating water supply and sanitation systems entails significant ongoing costs to cover personnel, energy, chemicals maintenance and other expenses (FAO 2010). This may explain why the LBB-WRUA has not initiated water treatment process. However with good management of the available funds from members' contribution, the Government of Kenya, NGOs and donor countries, the WRUA can establish a treatment plant. Unskilled labour can be sought from water project members to reduce on the expenses.

4.3.4.2 Treatment of water by community members

The household survey indicated that about 33% of the respondents frequently treat water before drinking, 44% treat occasionally while 23% do not treat (Table 11). Lack of water treatment by the community members may imply lack of understanding on the causes of water borne diseases. Water borne diseases are added costs to the community members and drain their hard earned money making them poorer.

Table 11: Treatment of water by project members

Does your house hold treat water before drinking?	Frequency	Valid Percent
Yes	57	33.1
Occasionally	75	43.6
no	40	23.3
Total	172	100.0

There was no significant difference between the project and non-project members on treatment of water (χ^2=1.573; p= 0.455) (Table 12). All community members involved in the study (water project members and non- members) were found to be ignorant about health issues. This might have been due failure by water project members to attend meetings. The LBB-WRUA arranges many forums where communities can be enlightened on benefits of treating water before

drinking. During the study, it emerged that 53% of the household survey respondents leave the water to settle as one of the treatment method. This method only gets rid of the insoluble particles leaving the dissolved materials and pathogens in the water. There is need for the LBB-WRUA officials to continue encouraging communities to treat water before drinking to reduce water borne disease incidences.

Table 12: Comparing project members and non-members on water treatment

		Membership		
		Member	**Non-member**	**Total**
Does your household treat water at home?	Yes	22	38	60
	Occasionally	25	41	66
	No	22	24	46
Total		69	103	172

Chi-square test= 1.573; df=2 ; p= 0.455

There was a significant difference between education and home treatment of water ($\chi 2$=21.862; p=0.005) (Table 13) meaning the higher the education, the higher the percentage of people treating their water. The educated people were able to link water treatment with health issues. Education is therefore an issue that have to be addressed in the study area to enable the communities appreciate water treatment as a way of maintaining hygiene.

Table 13: Comparing education level and home treatment of water

		Does your household treat water at home?			
		yes	Occasionally	no	Total
Level of education	None	4	12	1	17
	Primary	28	41	26	95
	Secondary	25	12	12	49
	College	2	1	4	7
	Adult education	0	0	1	1
Total		59	66	44	169

$\chi 2$=21.862; p=1; p=0.005

The LBB-WRUA, with the help of health officers, has been sensitizing community members on the importance of constructing and using pit latrines and treating water before drinking

especially through boiling. Good hygiene practices and access to sanitation facilities are critical to achieving sustainable improvement in community health (UNEP 1982). The communities in Mbogo-ini Division need to be protected from the pollution coming from the upper reaches of the Waseges River. This calls for tough measures by WRMA through the LBB-WRUA against those responsible for polluting water. In fact, this issue needs to have been addressed in the early years after inception of WRUA in order to engage a healthy community in water management issues. Continued water pollution is likely going to increase burden on community downstream hence hindering their economic development. However, it is not too late for the LBB-WRUA to act.

The methods used by majority of community members in the study area were found to be inadequate for elimination of pathogens. Without a good understanding of the link between hygiene and disease, the health benefits of safe water and sanitation can easily be lost (UNICEF,WHO 2009). There is need for WWF and LBB-WRUA officials to hold intensive training and motivating seminars in all water projects on the link between good health and good hygiene. This will increase communities' commitment and involvements hence improve their health.

4.3.5 Irrigation methods in use in the LBB

The household survey indicated that about 73% of the respondents use hose pipes to water their crops. The remaining 27% use overhead irrigation, low ground sprinkler irrigation, flood, canal, bucket and drip irrigation. Hose pipes are the most common method of irrigation in both Subukia and Mbogo-in Divisions. About 64% of the household survey respondents in Subukia use hose pipes to irrigate their crops while in Mbogo-ini Division, they were 76% (Table 14). Though use of drips is the most economical irrigation method, no respondent in Subukia division reported to have been using it. About 4% of the Mbogo-ini household survey respondents use it.

Table 14: Irrigation methods used in Subukia and Mbogo-ini Divisions

	Subukia		Mbogo-ini	
Irrigation methods	Frequency	percent	Frequency	Percent
Horse pipe	23	63.9	83	75.5
Overhead sprinkler	6	16.7	1	0.9
Bucket	4	11.1	19	17.3
Low ground sprinkler	3	8.3	0	0.0
Canal	0	0.0	1	0.9
Drip	0	0.0	4	3.6
flood	0	0.0	2	1.8
Total	36	100.0	110	100.0

Failure to adopt drip irrigation method can partly be explained by the relatively large quantities of water in Subukia division which make the farmers see no need of switching to more economical methods. Over abstraction of water in Subukia division lead to water scarcity in Mbogo-ini division prompting the community here to result to some economical methods of irrigation. This explains why there are some farmers in Mbogo-ini division that use drip irrigation method. The other reason that emerged during the FGD and in-depth interviews, for general reduction in use of drip irrigation in the upper LBB, is that the initial cost of the drip irrigation kits is very high and not all the farmers can afford.

Use of uneconomical irrigation methods implies that the water stored in the water pans cannot serve the farmers for the required 90 days after the rains have subsided. They have to pump water directly from the river, leading to competition for this resource. Uneconomical irrigation methods affect other water users by reducing the volume of water flow in the river during the dry spell leading to inequality in distribution. Most affected are the communities downstream whose crops yields become less or is totally lost due to drought and lack of irrigation water.

It is estimated that 15-35% of irrigation withdraws used worldwide are unsustainable (WBCSD, 2010). Irrigation methods such as furrow and overhead are usually less expensive but also less efficient, because much of the water evaporates, runs off or drains bellow the root zone. As global population grow, and as demand for food increases in a world with fixed water supply, there is need to learn how to produce more food with less water, through improvement in irrigation methods and technologies as well as agricultural water management (WHO, 2010). The

methods that can be more efficient in the LBB and can offer greater potential to minimize runoff, drainage and evaporation are drip and low ground sprinkler irrigation. They are more expensive hence requiring the government of Kenya to subsidize their prices. The high cost of acquiring more efficient irrigation kits explains why large numbers of water project members prefer using hose pipes.

4.3.6 Irrigation before and after establishment of WRUA

The household survey indicated that about 65% of the 221 respondents were carrying out irrigation even before inception of the LBB-WRUA while 35% depended on rain fed agriculture. The number carrying out irrigation increased to 69% after the WRUA was formed. The reason for increased irrigation activities might have been as a result of increase in population and rate of unemployment. Agriculture seems the most viable economic activity in the upper LBB where tomato farming is booming. From the in-depth interviews, it emerged that large scale farmers from within the basin, mobile farmers (farmers from outside the basin) and a few administrators have rented large portions of land adjacent to the river from land owners who cannot afford farming capital. In section 4.2.9, it is indicated that Akuisi, Wiyumiririe, Kirurumo and Tetu Milimani have piping going on. Farmers in the other water projects abstract water directly from the river by use of portable pumps. This reduces the water flow in the river affecting the communities downstream.

The project members downstream depend on the same river to irrigate their crops as well as for domestic purposes. Increased irrigation activities may pose as a challenge to the LBB-WRUA hence the urgency of increasing water sources by rehabilitating the springs, dams and bore holes as well as speed up catchment areas rehabilitation. With adequate sources of water, irrigation may considerably raise per capita income of the communities in the LBB-WRUA hence reducing poverty levels while at the same time ensuring food security.

4.3.7 Catchment protection

From the in-depth interviews conducted during the course of this study, it emerged that catchment protection has improved since establishment of WRUA. This has been achieved through creation of Community Forest Associations (CFAs) by WRUA in conjunction with the WWF in water catchment areas to ensure tree planting, conservation of the existing ones, and

establishment of tree nurseries. The already established CFA aims at rehabilitating Shamenei forest and membership is open to all water project members regardless of where they come from within the LBB. The LBB- WRUA, World Vision Kenya, Kenya Forest Service (KFS) and other stakeholders have sensitized the water project members on planting trees, having their own tree nurseries besides providing tree seedlings and financial support.

The FGD also revealed that the World Vision Kenya supported three tree nurseries in 2010, namely Ol' Manyatta, Lari Wendani and Gakingi Primary schools. They were either given Kshs 100,000 or seedlings and as a result 3334 seedlings were planted in the three schools. Kenya Forest Service (KFS) gave over 10,000 seedlings for planting in forests during the tree planting day on 27th June, 2011. Lari Wendani has two tree nurseries that give every water project member ten seedlings to plant every year during the wet season. Akuisi Water Project and MFG have a tree nursery each. There are also individually owned tree nurseries like the one shown in Plate 5. It is good to appreciate that the LBB-WRUA has made some progress in catchment rehabilitation. From the focus group discussion, it emerged that plans were underway to introduce ecosystem friendly projects such as ecotourism, apiary and controlled grazing; all to improve water conservation and management. hence boosting the LBB communities' economic status.

Plate 5: A tree nursery belonging to a member of Akuisi water project

(Source: photograph courtesy of Wangui, September, 2011)

From the FGD held in the cause of this study, it emerged that cases of logging and charcoal production have been banned although the communities continue sneaking charcoal and poles out of the Basin. This is attributed to poverty, few employment opportunities as well as collaboration of some administrators with offenders. Further, there has been large scale commercial logging by saw millers which further threatens water quality and quantity in this catchment area. Besides catchment area destruction, only 2% of the 71 water project respondents and about 1% of individuals had their own tree nurseries. About 20% of the 221 household survey respondents had 10% of their farms under woodlots, and 74% had 5%woodlots (Figure 8).

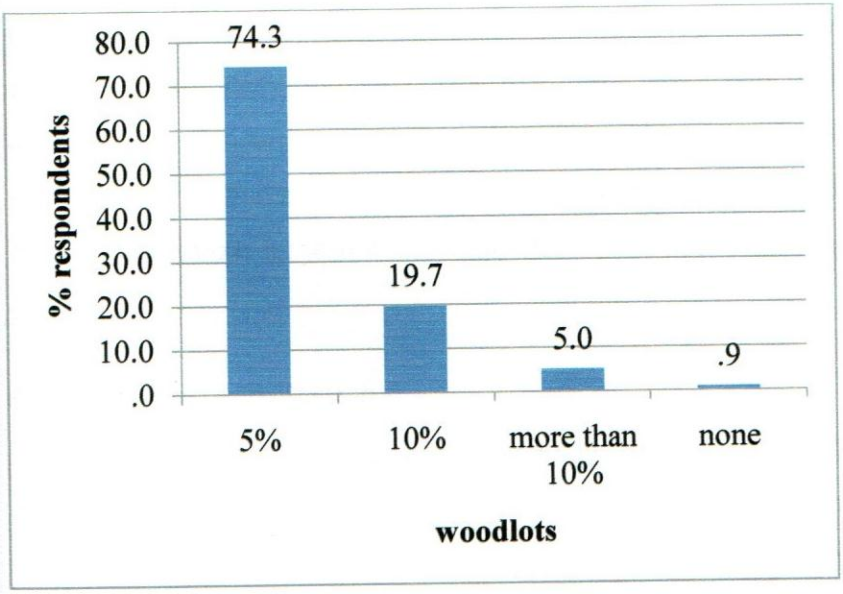

Figure 8: Percentages of people with woodlots

The agriculture Act (Cap. 318) on Farm Forestry Rules (2009), stipulates a 10% forest cover on farms (KEFRI, 2011). The new constitution also provides for the establishment and maintenance of a 10% forest cover in order to deal with challenges of climate change and improve the lives of all Kenyans (Kenya Forest Service, 2012). In areas like Meru central, river catchment areas degradation, results in 70% of rainfall being lost as runoff (Ministry of Water and Irrigation, 2008). Despite the LBB communities' dire need for cultivation area, they have to think about ecological sustainability.

Low percentage of land under woodlots was attributed to increased demand for land as a result of increase in population, need for an income and high rate of unemployment hence overdependence on farming/agriculture for their livelihoods. It was observed that there was a general lack of awareness on the importance of planting trees by the communities living in the upper catchment of the LBB, who preferred clearing vegetation and planting cash crops like tomatoes and other horticultural crops. These reasons may explain why most respondents had woodlots covering less than 10% of their farms. Economic recovery strategy for wealth and employment creation (2003-2006), the Forest Act (2005), and Vision (2030) recognize the intrinsic link between poverty and environmental destruction and particularly forest destruction (Mathu 2011). The Sessional Paper No. 1 of 2007 on Forest Policy and the Forests Act (2005) emphasizes the development of Farm Forestry as a way of increasing the low forest cover, diversifying subsistence products and income, while contributing to soil and water conservation (KEFRI, 2011). Failure to plant enough trees and continued clearing of forests will worsen the climatic conditions as well as water increase pollution in the upper LBB which is already a semi desert.

4.3.8 Riverbank protection

Focus Group Discussion held in Subukia center revealed that river bank protection has not been achieved to date since pegging has only been done in a few sections of the Waseges River; Akuisi and Limuru. Plate 6 shows tomato farming adjacent to the river bank in Wiyumiririe. The brownish colour of water is due to intense erosion from the river banks and riparian corridor which has been degraded. With pegging not done, it is difficult for the irrigators to keep off river banks hence increased river bank degradation. Evaporation rates increase with exposure of the river surface to direct sunlight and consequently increase concentration of all matter in solution especially during the dry season. The in-depth interview report revealed that a lot of pollution of river water occurs resulting from river bank destruction mainly from cultivation and clearing of riverine vegetation to obtain fuel wood and fodder for livestock.

Plate 6: Tomato farming adjacent to the Waseges River channel at Wiyumiririe
(Source: photograph courtesy of Wangui, September, 2011)

The WRUA, WWF and other stake holders have been advocating for riverbank protection. River bank degradation is common phenomenon in most Kenyan rivers, but with rehabilitation, some of them have been improved. An example is the Mara River whose river banks were subjected to erosion. Currently, they have been protected by Mara River water users (MRWUA) through innovative use of high-value fruit trees along "riparian buffer strips'' which, apart from protecting the river banks also, give local farmers an additional income (Equator Initiative, 2010). The LBB-WRUA in conjunction with agricultural officers can borrow a leaf from MRWUA. Every river is required by law to have a specified amount of land along its bank where no farming or tree cutting is allowed. (UNEP, 1982). In the LBB, continued cultivation of riverbanks without adequate conservation measures has triggered intense soil erosion causing persistent turbidity of water.

4.3.9 Funding of water projects

Forty seven percent of the 71 household survey respondents in water projects revealed that they get funds from the government, 47% from members' contribution and 6% from both the government and members' contribution (Figure 9). The funds are used to dig water pans for some water project members and buy drip irrigation kits like it has been the case of Lari Wendani. The FGD revealed that the WWF, the government of Kenya through Water Trust fund (WTF), donor countries and some NGOs fund some water projects in the upper LBB.

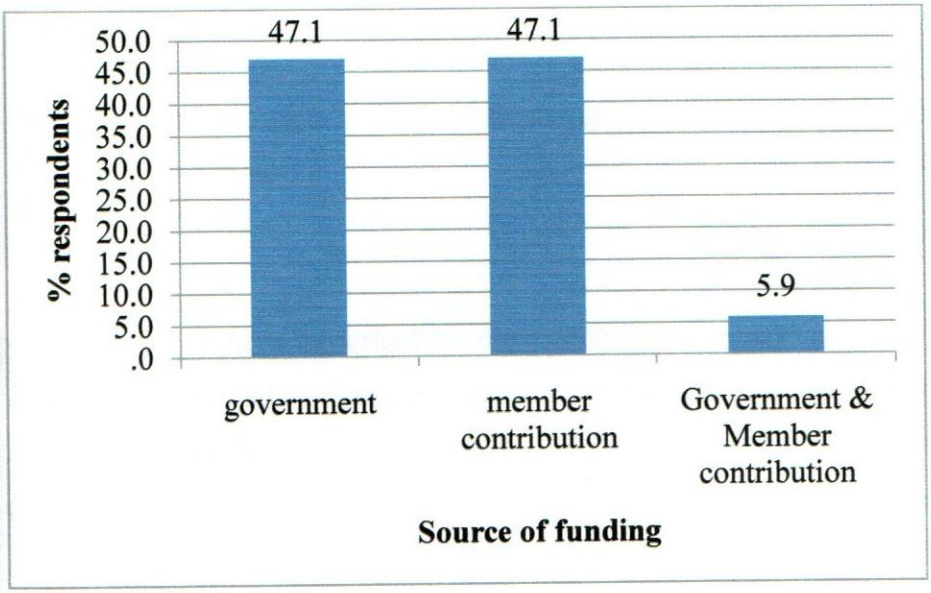

Figure 9: Source of funds for LBB water projects

Before the LBB-WRUA came into the picture, Lari Wendani was operating as an irrigation scheme which started in 1986 as a group scheme through technical assistance by the Ministry of agriculture. The Irrigation and Drainage department developed the physical infrastructure including canals. The scheme started with ninety four farmers (Kenya Engineer 2013). Lari Wendani water project is currently being assisted by African Development Bank (ADB) to do piping so as to discard canals that have been in use for a long time. Piping in Akuisi, Wiyumiririe, Kirurumo and Tetu Mirimani water projects were partially funded by the Kenyan government. However, it is upon the project leadership to write and forward proposals to the relevant funding bodies requesting for funding and state how the funds are to be used. Water projects without good leadership and leaders who are uninformed on how to write proposals miss chances of being funded.

Fifty five percent of the 50 water projects have bank accounts while the remaining 45% do not. Out of the 45% who lack bank accounts, 86% revealed that they do not have money to deposit, while the other 14% lacks awareness on the process of opening bank accounts (Table 15).

Table 15: why some water projects do not have bank accounts

Why no bank accounts?	Frequency	Percentage
No money to deposit	43	86.4
Lack of awareness	7	13.6
Total	50	100.0

A bank account is important for depositing the members' contribution as well as funds from donors. Projects without bank accounts may have their funds misappropriated by their officials. An example is Samburu elders who misappropriated funds meant for pump maintenance (UNICEF, 2010). Members in such water projects will therefore never stop complaining of shortage of funds. Water projects with insufficient funds fall short of infrastructures like pipes and water storage facilities. This implies that some water project members cannot access water even from a short distance and such community groups lose their meaning and members pull out. Adequate funding and sustained funding is vital for the rehabilitation and expansion of the water supply (Water wiki.net, 2009). This can be assured if the LBB-WRUA water project officials plan for the donated funds and members' contributions well.

4.3.10 Community involvement in water Projects

Community involvement in water issues is a requirement of the Water Act (2002) aimed at having institutions at the community level that are fully aware of their responsibility to manage their resources in a sustainable manner. The WRUA encourages water projects to ensure community representation from men, women and the youth in leadership positions. The LBB-WRUA has a provision in its constitution for a third of women representation in leadership positions.

4.3.10.1 Women and youth representation in leadership positions

The household survey revealed that 80% of men held positions in offices in the 50 water projects, 16% were women while 4% were the youth (Figure 10). In-depth interview results indicated that women and youth are poorly represented in the water project committees and water project offices are dominated by elderly men. The report indicated that there were some water projects that did not have even a single woman in leadership position. This is despite the fact that

the LBB-WRUA has a provision in its constitution for a third of women representation in leadership positions.

Poor representation of women is attributed to their high illiteracy levels that make them shy away from leadership positions. At the same time, men are custodians of the land title deeds hence decide on who gets into leadership positions explaining why elderly men dominate offices. The respondents perceived that men stick to power but expect the youth to do manual work such as carrying construction materials like blocks. In-depth interview report indicated that the youths fail to understand why they should only be considered when there is manual work and left out of office.

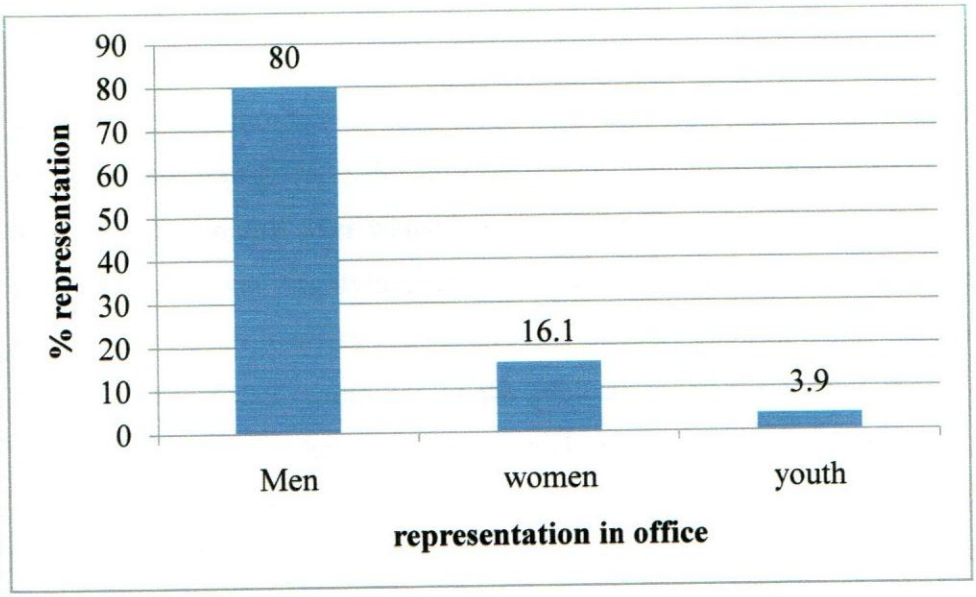

Figure 10: Representation in offices

In a FGD, it emerged that there was a case that came up where women and the youth ousted old men out of a water project (Kirurumo water project) office in Subukia division. A weir was being constructed and the building materials had to be manually transported to the site down a slope not accessible by lorries. Only the women and the youth contributed labour in this construction and this acted as a base for removing elderly men from office. The presence of women and the youth has improved Kirurumo water project through implementation of new ideas in office. The piping process is almost complete and the non-riparian land owners are now enjoying the fruits of irrigation and easily accessible water for domestic purposes. In upper

Subukia, Kirurumo water project is leading in tomato farming which is sold locally and outside the division.

Community participation involves holding discussions, open for community members themselves and government authorities or NGOs involved in advocacy so as to contribute ideas for inclusion in policy development and change in operation strategy. The process of community consultation helps in the planning process. Consultation should develop mechanism of monitoring agreed undertakings and their enforcement (FAO 2008). The increased cases of illegal water abstraction and vandalism of water conveyance structures stated in section 4.5.2, might be due to lack of consultation since most water project members do not attend consultation fora.

UNICEF; WHO (2012) indicates that one of the project activities is for the community to elect a local water committee including women members since women disproportionately bear the burden of collecting water. Social justice and human rights GWA (2003), believes that equitable access to and control over water is a basic right for all as well as a critical factor in promoting poverty eradication. Involving both men and women in integrated water resources management, can increase project effectiveness and can support environmental sustainability (UNDP 2006). Locking women and youth out of the project leadership as it is the case with the LBB water projects will mean reduced speed at which environmental sustainability and poverty eradicated are achieved. During a field activity in Nepal India, women declared that they would not be stopped by men procedural hassles and they were heard (Women in society 2013). The LBB-WRUA women and youth should take the same stand and demand their rights in water projects.

4.3.10.2 Attendance of meetings and contribution of ideas

The household survey indicated that about 13% of the 71 respondents very often contribute ideas in group discussions, 60% contribute often, and 19% occasionally and 8% never contribute (Figure 11). Opposing general views in group discussions also followed the same trend. This means that the community members who attend meetings are actively involved in decision making regarding water use and management.

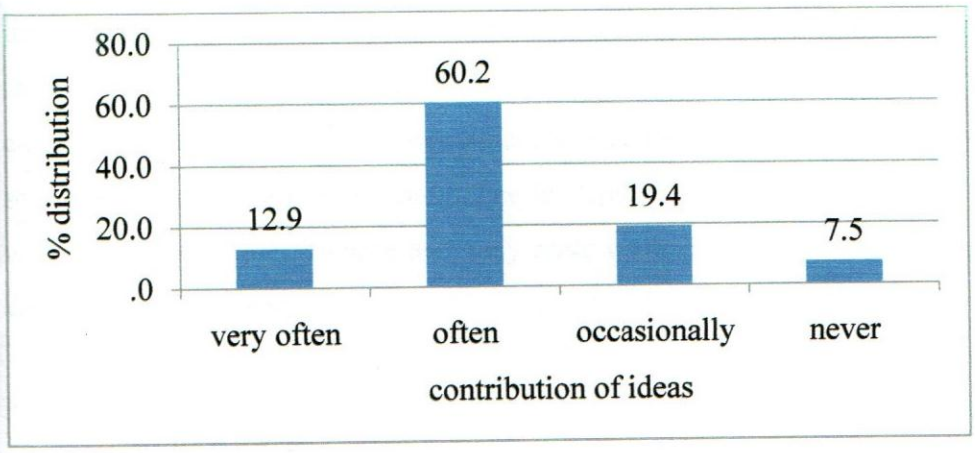

Figure 11: Contribution of ideas in group discussions

There was no significant difference between men and women on contribution of ideas in group discussions ($\chi 2$= 2.820; p=0.420) (Table16). Both the Men and the women contribute equally indicating that they are all capable of healthy discussions and making decisions that affect them. This is in line with the requirement of UN (2006) [b], which recommends that women be given a chance to air their views in meetings. Women play a very central role in availing water in their homes and working in farms while ensuring that crops are watered. They deserve an opportunity to contribute their views on matters concerning water. Active participation in decision making enables the locals to own the water projects and take active part in ensuring that the projects are successful.

Table 16: Comparing men and women on contribution of ideas in discussions

	Sex		Total
Response	**Female**	**Male**	
very often	3	9	12
often	20	29	49
occasionally	10	8	18
Never	2	3	5
Total	35	49	84

Chi-Square=2.820; df=3; p=0.420

Thirty one percent of the 71project members attend meetings thrice a year, 52% attend twice a year while 4% never attend (Figure 12). The study revealed that most community members prefer working in their farms than attend meetings, indicating that they consider meetings a waste of

time. It might also be because there are no immediate direct benefits in form of either lunches or cash payments. Other community members are so poor that even if they attend meetings, they cannot implement what they learn since they cannot afford to have water in their farms unless some assistance is offered to them. The in-depth interviews revealed that the leadership of most water projects is questionable and may have contributed to non-attendance of meetings by the water project members.

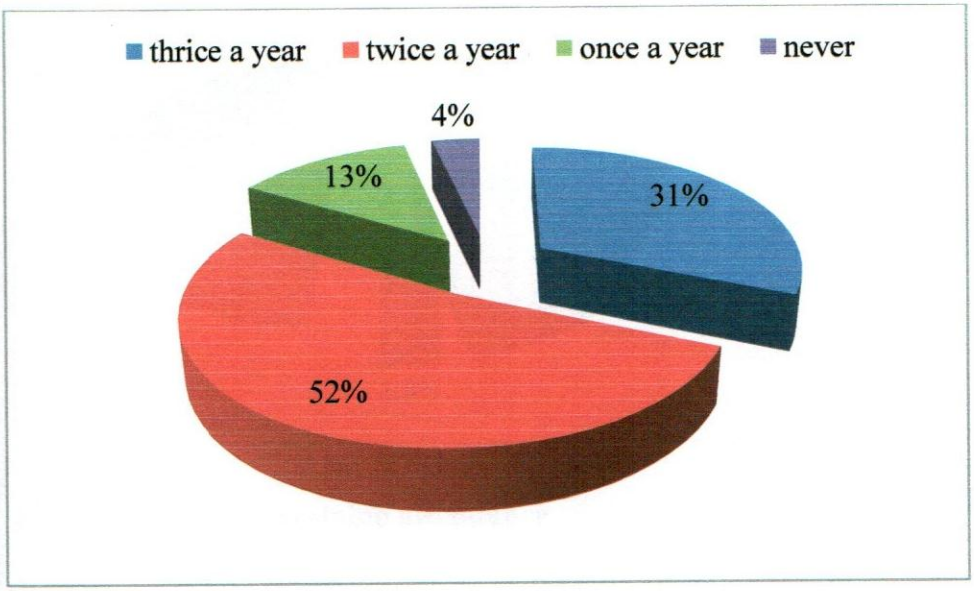

Figure 12: Attendance of meetings by water project members

Meetings which attract crowds are those that provide relief foods or free medical services. The participants reported that sometimes it is very embarrassing when government officials invite people to meetings and only a few people attend. In such cases, it is very difficult for the LBB-WRUA officials to attain their objective of managing and conserving water while ensuring equitable distribution of water to all users. This mentality will see communities in the upper LBB drown in poverty due to food shortage resulting from water scarcity. According to Shirley (2013) project leaders and team members become disheartened by and irritated with other members who are absent at meetings. These feelings can be prevented by establishing some rules for meeting attendance and associated penalties for non- attendance. In the LBB, penalties would act as an incentive to make the water project members attend meetings.

4.3.10.3 Training seminars for project leaders and their members

Fifty two percent of the 71 respondents revealed that their leaders do attend leadership training seminars while 48% do not attend. The frequency of leaders training was however poor with 37% revealing that the process takes place once a year, 10% twice a year, 4% thrice a year and 49% revealed that training seminars never take place (Figure.13)

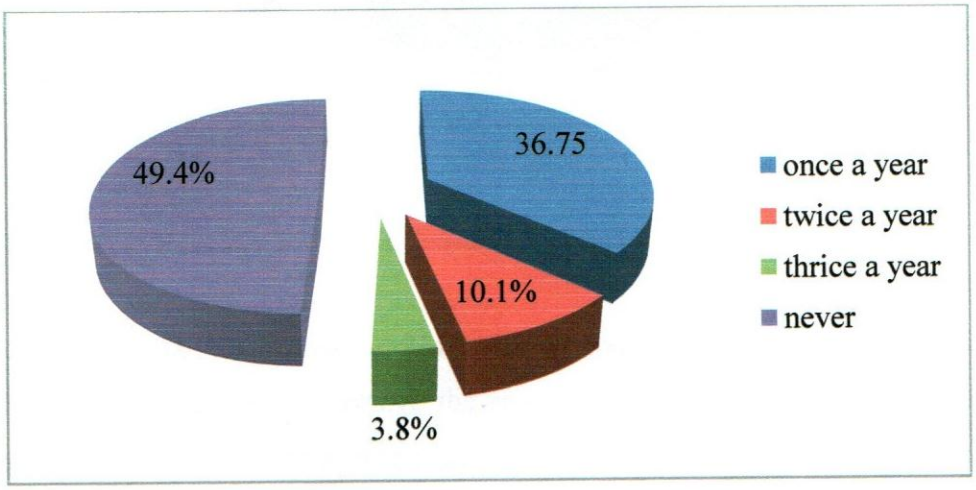

Figure 13: Leaders training attendance

There were various reasons given for leaders not being able to attend training seminars. About 63% of 71household survey respondents revealed that training sessions are never arranged, 31% reported that there are no resources to meet the training expenses, while 6% revealed that there was lack of awareness on importance of training seminars by their leaders (Figure 14). It is recommended that institutions working with rural communities should educate them on available support services (Folifac and Gaskins, 2011).The study results indicate that majority of the LBB communities are not receptive to change hence not willing to learn since most of them fail to attend meetings or any educative fora. This has lead to low water projects performance.

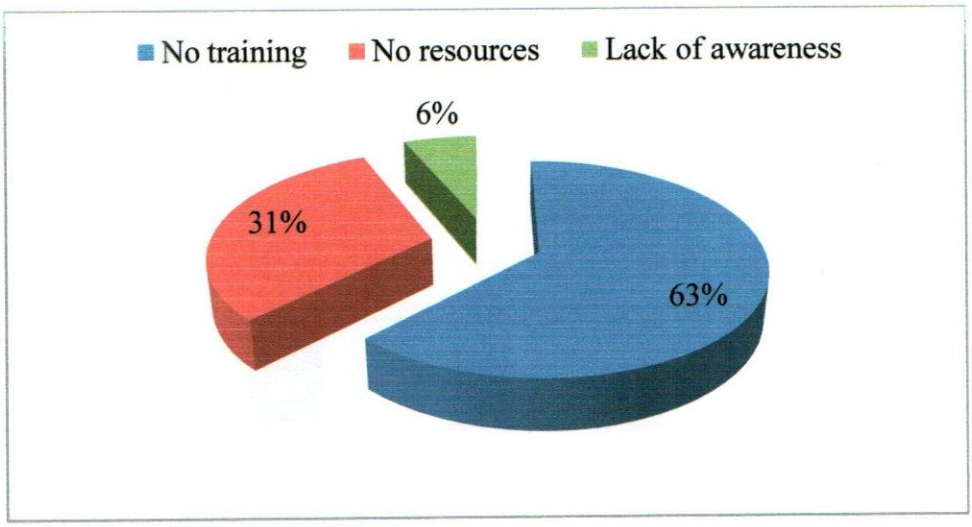

Figure 14: Reasons for non-attendance of training seminars

The in-depth interviews held in the study area indicated that some project officials who attend training sessions fail to arrange the same for their members. About 64% of the 71 household respondents revealed that their water projects never organize seminars to train their members on water management and conservation issues. Members trained by their projects benefit from the sessions, and utilize the skills. Training seminars empower local communities to be able to take charge of development confidently, independent of the government and according to their needs. Nothing can be achieved if the community is not enlightened and orientated in water management and conservation issues.

Sixty three percent of the 71 household respondents revealed that their water projects do not invite extension officers to advise their members on better irrigation methods. The 37% of the respondents whose water projects invite extension officers do so once a year, twice a year or thrice a year (Figure 15). Extension officers advise the farmers on how they can economically utilize the reserved water in their water pans, best irrigation methods, suitable varieties of crops to grow among other things.

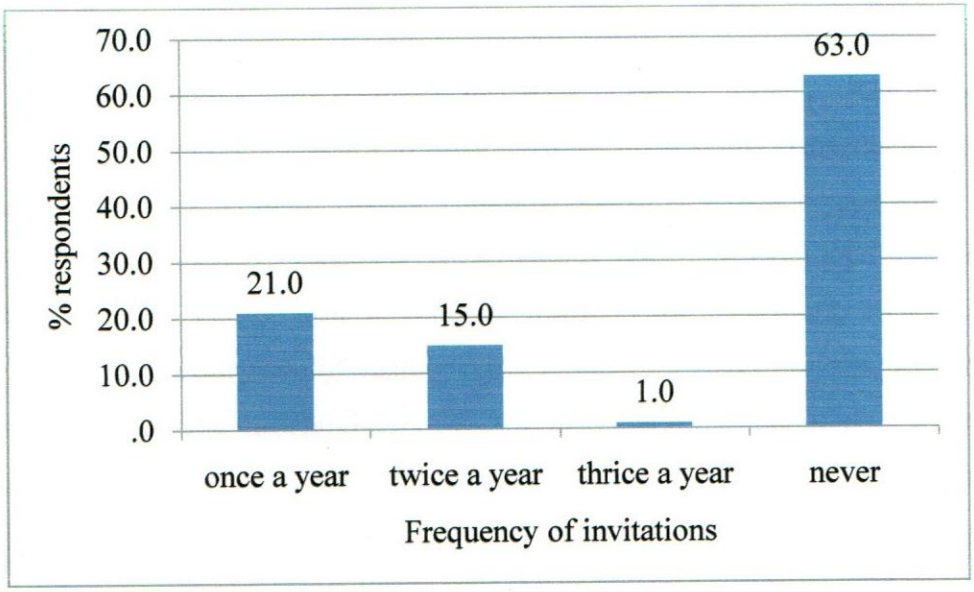

Figure 15: Frequency of water projects inviting Agricultural Extension Officers

Low level of education as indicated in section 4.5.4 is the major contributor to training seminars absenteeism. All the water project leaders in the existing water projects are invited for trainings organized by the WWF and WRUA officials. Sometimes, the line ministries for example Ministry of Agriculture, Ministry of Water and Irrigation as well as NGOs provide training seminars where all the water project leaders are invited. It is therefore the responsibility of the project officials to ensure that they attend. Good leaders embrace training in leadership and make the best out of it. Nanyuki River Water Users' Association, (NRWUA) committee serves as an example to be followed by the other WRUAs. NRWUA has been empowered on resource mobilization through training and participation in knowledge sharing fora (Republic of Kenya, 2002). If the water project members and their leaders can accept to attend meetings and other knowledge sharing fora without fail, they can also be empowered on water management issues.

Using advisers and external elites will improve the community's pool of expertise (Folifac and Gaskins, 2011). Environmental education, awareness and training plays a significant role in encouraging and enhancing peoples participation in activities aimed at conservation, protection and management of environment, essential for achieving sustained development. Inviting extension officers and lead agencies by the LBB-WRUA on a regular basis may improve the LBB community knowledge on environmental education.

4.3.10.4 Exchange visits

The household survey indicated that 95% of the 71 water project members have never been taken for tours to other basins to learn what the other projects are doing with regard to water use and conservation (Figure 16). This may be due to lack of adequate funds to facilitate the trips. Funds may come from members' contributions, donations from NGOs and donor countries and if well managed, can be used to cater for transport for such tours. Some water projects have not even taken the initiative of visiting the neighbouring water projects. Asked why this was so, the participants in the in-depth interviews revealed that it was due to poor leadership, lack of interest within the project members and the perception that there is nothing new they can run from their immediate neighbours.

The FGD held in the study area revealed that one of the water projects that have made visits to other water projects is Lari Wendani. The members and their officials have already made some exchange visits to Meru and Sagana. They learnt a lot including use of closed system instead of canals for conveying irrigation water. They are in the processes of laying pipes and have introduced pigeon peas which fetch better returns as compared to beans. This is a water project that other water projects within the basin should visit and learn more about crops that take about three months to mature, equitable distribution of water and how to curb illegal water abstractions.

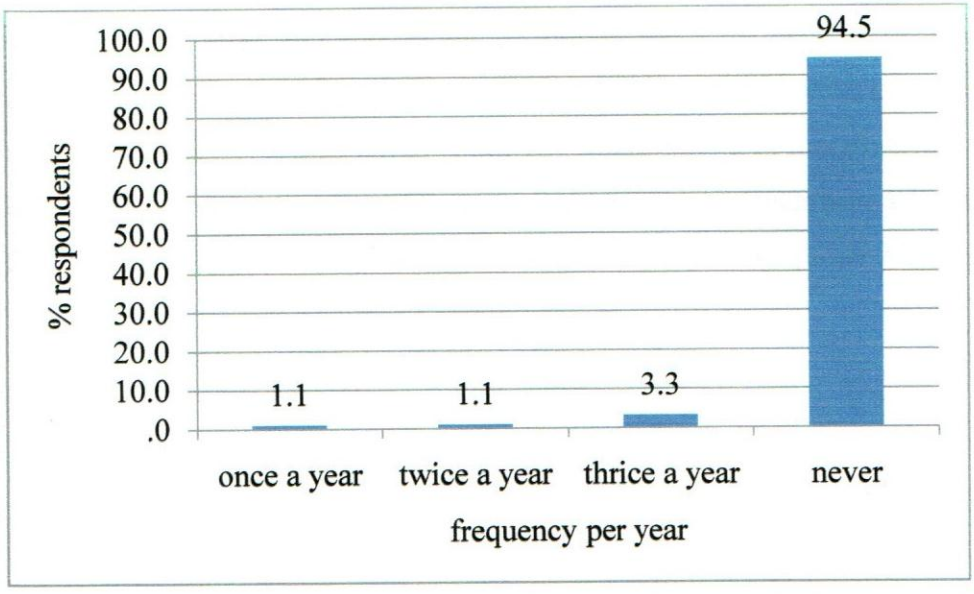

Figure 16: Frequency of organizing tours to other WRUAs

Through tours made to other water projects, the project members who visit get to learn successes and failures in water resource management of the projects that they visit. They learn how to avoid some problems that other water projects have encountered and learn how to overcome some challenges through experiences of others. Some water projects in Kenya have benefitted much from exchange tours. This includes Ena and Rupingazi WRUAs which went for an exchange visit to more successful WRUAs (Burguret and Kisima WRUAs) in Nyeri and Isiolo respectively where they learnt and exchanged ideas on the management of WRUAs (Ministry of Water and Irrigation, 2008). Water project members and officials of Tharaka were taken on an exchange visit to Mbeere to learn more on riverine aforestation. The community is influencing others to participate in environmental conservation (Ministry of Water and Irrigation, 2008). Lari Wendani is a successful water project and can be used by the LBB-WRUA to influence other projects to also improve participation in water management.

4.3.10.5 Leaders/water project members Interactions

Thirty seven percentnof the 71 household survey respondents reported that there were interactions between project members and their leaders, another 37 interact occasionally while about 26% reported lack of interaction (Figure 17). The low level of interaction was attributed to leadership that lacked vision and collaborative skills. As stated earlier in section 4.2.10.4, some water project leaders fail to attend leadership training sessions organized by the LBB-WRUA or other stake holders and this might be the reason why there were poor leaders'/ member's interaction. Because of these, most members of the water projects in the upper LBB feel they do not own their projects thus fail to contribute funds, labour or materials to the projects as expected. It was also revealed that the leaders impose ideas on the members and change projects' visions. Due to this, the project members have the perception that the projects belong to the officials.

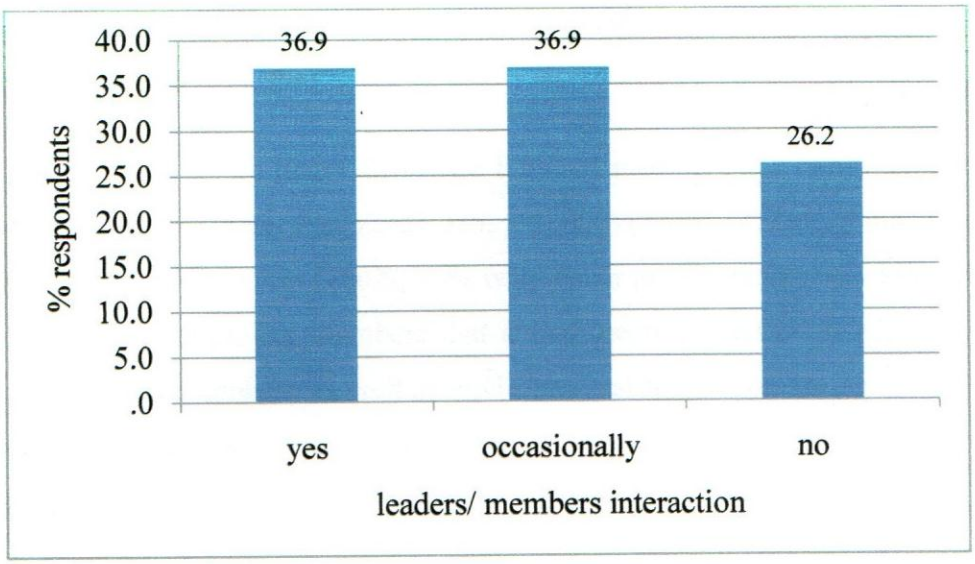

Figure 17: Interaction of leaders with the water project members

A good leader should win the trust of the members for them to remain faithful in their contribution and to interact freely. Free interaction enables leaders to know what the members are thinking and enable them to gather useful ideas, which help improve the projects. Lack of free interaction between leaders and project members lead to communication breakdown and create anxiety within the members. This may culminate in lack of commitment and withdrawal of members from project activities. If the leadership of a community is committed and receptive to change, the process is likely to proceed smoothly, but if the local leaders are too dominant and want to pull all the strings of community life, they can also be counter-productive (Lammerink, *et al,* 1999). Leadership positions require people with leadership skill as per the requirement of the LBB-WRUA constitution. It is upon the LBB water project members to assess individuals with these qualities before electing them into leadership positions.

4.3.10.6 Community knowledge of Water Act (2002) and water abstraction permit

Eighty one percent of the 221 household survey respondents were not aware of the Water Act 2002. Meetings are fora used by the LBB-WRUA and other stakeholders to involve community members on water issues including educating them on the requirements of the Water Act (2002). Very few people attend such fora explaining why only a few people are aware of the Act. The Water Act 2002 Section 15(5) provides for establishment, at the local level, of Water Resources Users Associations (WRUAs) in the management of water resources to ensure that water users

participate in decision making concerning management of water resources in sub-catchment areas (Republic of Kenya, 2002).

There was a significant difference between members and non- members on the existence and contents of the Water Act($\chi 2$=27.285; p=0.000) (Table 17).Out of the 19% respondents that were aware of the Water Act (2002), 76% were water project members while 24% were non-members. The few water project members that attend meetings and other educative fora where issues of environmental concern as well as environmental legislation are discussed get enlightened unlike non-members whose chances of being invited to educative fora are slim. As far as the water issues are concerned it is safe to be a WRUA member.

Table 17: Comparing members and non-members on knowledge of Water Act 2002

	knowledge of Water Act		Total
Membership	**yes**	**No**	
Member of water project	31	54	85
Non-member	10	119	129
Total	41	173	214

$\chi 2$ =27.285; df=1; p=0.000

Information obtained during the in-depth interview indicated that all the projects, apart from Lari Wendani were found not to have water abstraction permits. The Water Act imposes a permit requirement on any person wishing to acquire a right to use water from a water resource with exception of minor users fetching water for domestic purposes, uses of underground water in areas not considered to face groundwater stress and therefore not declared to be groundwater conservation areas, and uses of water drawn from artificial dams or channels which being artificial or natural are not considered to be water resources for the country (Republic of Kenya, 2002). Section 2.2 of FAO, (2008) indicates that no permit can be issued without water pans measuring 20m× 20m × 1m. Apart from Lari Wendani, most project members have water pans, some smaller than the required ones. This explains why these water projects lack water abstraction permits hence reduced effectiveness on water management.

4.4 The current status of water supply to communities in the upper LBB

From the FGD held in the study area, it emerged that the LBB-WRUA has been making efforts to initiate means of curbing water shortage in the respective water projects. Based on the study findings, WRUA once negotiated with Kaptarakwa elders. They were seeking to construct Akuisi water project intake point at Kaptarakwa which is the highest point that would allow flow of water by gravity. This idea was met with opposition from Kaptarakwa residents, sabotaging the effort of bringing water closer to the users.

LBB is a basin that has a history of tribal clashes and lack of good will among the different communities. This means that the dream of expanding the area under irrigation and improving water accessibility is shuttered unless the issue of community cohesion is addressed. Non-riparian land owners will continue depending on rain fed agriculture although the rains are unreliable, while some community members continue trekking long distances in search of water. However, during the FGD, it was pointed out that both the WWF and LBB-WRUA officials spent sleepless nights planning for peace meetings which saw communities here avoid chaos that erupted in 2008 after elections. All is not over for the LBB-WRUA because the same way they prevented the chaos, they can persuade the different communities to join the WRUA and as a team manage the catchment water developmental issues regardless of their ethnic backgrounds.

4.4.1 Water accessibility

The household survey indicated that about 56% of the 221 respondents used to cover more than one kilometer to fetch water before inception of the LBB-WRUA in 2005. 24% used to cover 1 km while 21% covered less than a kilometer. Currently, the number of people fetching water more than 1km away has reduced by 4% to stand at 52% (Table 18).

Table 18: Distance covered to fetch water before and after WRUA formation

Distance covered	Frequency		Percent	
	before	after	Before	after
less than 1 kilometer	45	64	20.5	28.4
1 kilometer	52	43	23.7	18.7
more than 1 kilometer	122	117	55.7	52.0

There was a significant difference between the distance covered to fetch water before and after the inception of the LBB–WRUA ($\chi 2$ =69.886; p=0.000) (Table 19). This is an indication that some water projects have managed to provide irrigation and domestic water through pipes and canals to most of their members. These include Lari Wendani, Wiyumiririe and Akuisi water projects. It was observed that not even a single pipe has been laid by Nyamamithi water project. In such a farm, the non-riparian land owners who are members of the water project have been waiting for installation of pipes so as to access the resource within a short distance and carry out irrigation. Though WRMA has permitted use of portable pumps, some members cannot access water due to the long distance between their farms and the river. As stated earlier in section 4.2.9, a lot of funds come from different donor agencies including the government. These funds are meant to initiate and improve water structures hence ensuring that water users access water within 1km from their homes. If the funds are misappropriated as it appears in case of Nyamamithi, the WRUA might not attain its objective of ensuring water users access water within 1km from their residences.

Table 19: Comparison between the distances covered to fetch water before and after WRUA formation

Kilometers covered to fetch water before projects	Kilometers covered to fetch water after project formation			
	< 1km	1km	> 1km	Total
less than 1 km	37	0	1	38
1 km	13	10	0	23
more than 1 km	5	3	17	25

Chi-Square=69.886; df=4; p=0.000

Many man hours which could be utilized in other activities are lost when distance to be covered to fetch water are long. Predominantly girls, spend their day fetching water instead of attending school or playing with siblings or friends (Syder, 2013).The heavy water, fetched in containers that vary in size, is carried on a child's head for many miles, and with children carrying an average of one gallon or more, this water plus the container can weigh up to 10 pounds or more, which can also cause physical damage to a child's body (Syder, 2013).

The availability of clean water close to home reduces woman workloads, and the time saved in fetching water may be spent on other activities to strengthen livelihood resilience, including productive activities such as crop production. (Gender and water alliance, 2003). Rural family incomes tend to rise when Kenyan women don't have to spend several hours a day lugging water to their villages (Lasnier, 2011). Women and children in the LBB must be relieved this burden for their lives to continual normally.

4.4.2 Water sources

Ninety nine percent of the 221 household survey respondents use Waseges River water, while 0.1% use wells for irrigation. This implies that Waseges River is a very important source of water for the community in the upper LBB and should be protected at all costs. Failure to do so amounts to risking the lives of individuals living and depending on this river. Upstream communities get the lion's share of water due to their proximity to the source of the Waseges River. The farmers who rely on rain fed irrigation claimed that the reason they do not use other sources of water, like rivers and wells, to carry out irrigation is the long distance that has to be covered to access the water.

The household survey indicated that about 91% of the 221 respondents depend on Waseges River as the main source of drinking water (Figure 18). The water in this river becomes scarce or the river channel dries up during the dry spell resulting from the many water activities going on along this river. Communities downstream follow the river course upwards in search of water or get water from water vendors. This situation demands that the LBB-WRUA speed up the process of catchment rehabilitation, deal with cases that lead to water shortage as they seek alternative water sources. Failure to address this issue may lead to increased water shortage, food insecurity and increased levels of poverty as much time is wasted in search of water. Achievement of MDG number 7 target C of halving the proportion of the population lacking access to safe drinking water and basic sanitation by 2015 (UN, 2006)[b] will be far from being feasible.

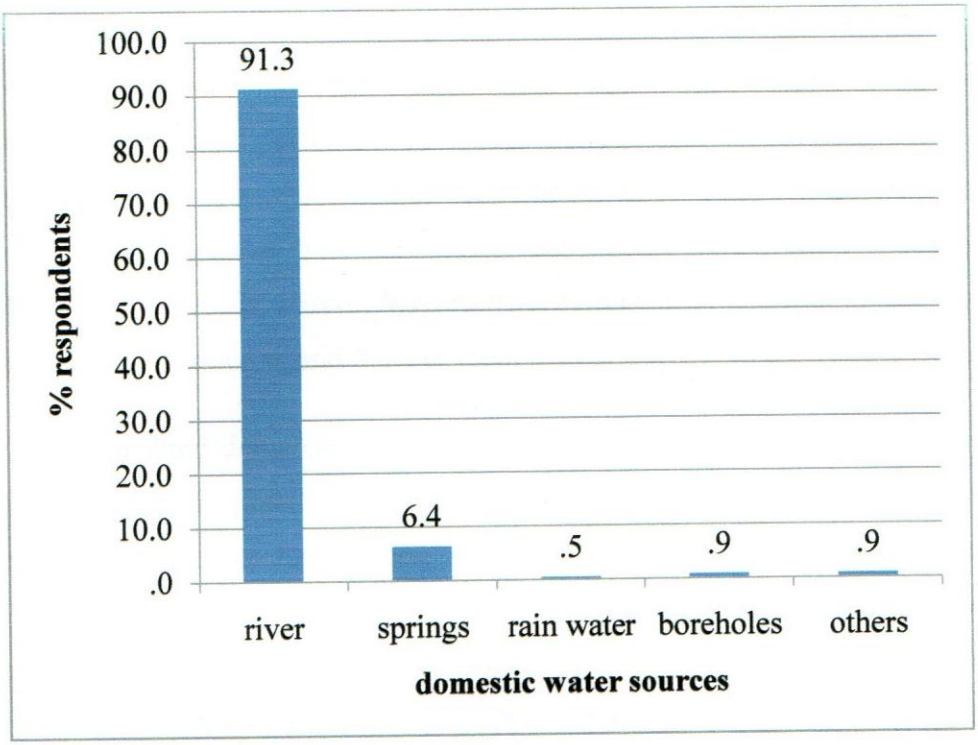

Figure 18: Source of water for domestic purposes

The per capita water availability per day is about 14 litres for communities in Subukia Division and 17 litres for Mbogo-ini Division communities (Table 20). According to WHO (1992), adequate water is water that can satisfy human basic needs and should be at least be 25 litres per capita per day for all people. From these results, per capita water availability in the study area was less by 11 litres and 8 litres for Subukia and Mbogo-ini Divisions respectively. Lack of adequate water may affect general hygiene of communities leaving in the LBB hence the need for the LBB-WRUA to seek alternative water sources.

Table 20: Amount of water per capita in Subukia and Mbogo-ini Divisions

	N	Minimum	Maximum	Mean	Std. Error of Mean
Subukia division	77	3.13	25.00	13.8974	1.06263
Mbogo-ini division	144	2.50	30.00	16.5979	0.78277
Total	221	2.50	30.00	15.8339	0.64259

The other sources of water as deduced from the in-depth interviews are not operational and they include bore holes, springs, dams and kiosks. There are some bore holes that were sunk during the colonial period but the pumps and pipes have been vandalized. These bore holes used to pump water to a very large area and almost all the community members could access water at very short distances. The bore holes that existed during the colonial period are at Marana, Limuru, Mwiteithia, Kiriko, Wiyumiririe, Nyamamithi and Mbogo-ini. The bore holes still exist but are not functional, and most of them are currently within privately owned land.

During land demarcation, some farms reserved some portions of land for construction of dams. Some dams have been encroached and have agricultural activities going on currently while some have dried up like the one shown in Plate 7. Some farms are still reserving their portions. The upper LBB had several springs in the 1970s which included Kimani, Musasia, Mama Karuga and Mama Mithana among others, which have since been allocated to private owners. Attempt to protect and rehabilitate the bore holes, dams and springs under private ownership might be treated as trespass. Community members interested in getting alternative sources of water are not able to and will continue experiencing water shortage unless something is done.

Plate 7: Cattle grazing in an encroached dam at Wiyumiririe (dam already dried up).

(Source: Photograph courtesy of Wangui, April, 2011)

The household survey indicated that about 99% of the 221 respondents admitted to have no water kiosks in the neighbourhood. Only 1% of the respondents reported to have water kiosk nearby. Apart from bringing water closer to the users, water kiosks generate income for water project members. Any effort of bringing water closer to the users would be more than welcome because water users are always ready to pay for improved water services and even support reforms that will bring about change (Sule and OKeola, 2010). The water project members have forfeited an opportunity of raising extra funds through water kiosks and their members trek long distances in search of water. This implies that a lot of time is lost as women and the youth go in search of water. A lot of energy is also lost meaning community members engage less in income generating activities. Poverty eradication which is MDG number one (UN, 2006)[b] becomes difficult when water sources are scarce.

Though most people reported lack of water kiosks, it was observed that some community members in the upper LBB buy water from water vendors who use bicycles and donkeys. As indicated in the Plate 8, water users are consuming water from any source due to water scarcity. The water is stagnated in some sections of the Waseges River and might be having very high concentration of pollutants. If this water is not treated, it may pose as a health risk to the LBB community members.

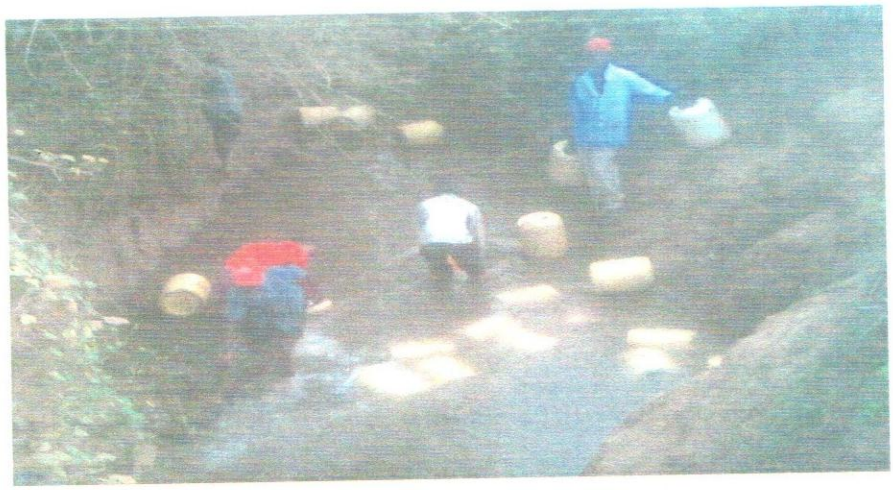

Plate 8: water vendors collect water for sale from a stagnated pool along Waseges River in Nyamamithi.

(Source: photograph courtesy of Wangui, January 2011)

During the household survey, 63 respondents revealed that they buy water from water vendors. About 15% of them reported to have been acquiring water at Kshs 5 per twenty liter jerrican and about 82% buy it at Kshs 10 (Figure. 19).

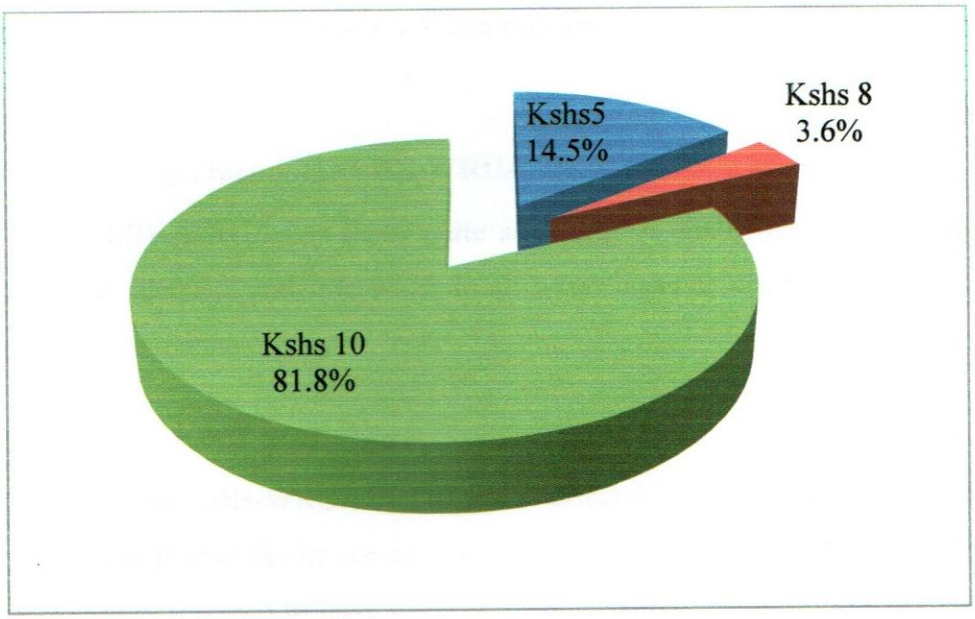

Figure 19: Prices of water per twenty liter jerrican in the upper LBB

From the household survey, the average income per capita per day is Kshs 25 and the amount going to buying water per day is Kshs 10 per person which is 40% of the income. This figure is very high considering that Water Governance Project Partners (2009) recommends that the amount going towards purchase of water should not exceed 5% of a household's income. The high prices of water makes the water become scarce implying that very few people can afford it and the only option is to walk long distances to get it. They also have to cut on the use, to reduce the water per capita consumption. It is during the dry seasons that water borne diseases increase as a result of increased concentration of pollutants in the water and poor maintenance of hygiene (LBB-WRUA, 2010). This is why the LBB- WRUA should strive to ensure water kiosks are established at various points to provide water to communities at reasonable prices. The LBB-WRUA constitution stipulates that by 2015, each water project should have forty water kiosks. It is only two years to go and only 1% of the household survey respondents have a kiosk nearby. The WRUA has to move with speed to hit this target.

According to WHO (1992), many people from developing countries rely on water from rivers for their survival. This source has been threatened by increased population, deforestation and agricultural activities upstream. From the study results, this was noted to be the case in the LBB hence the need for the LBB-WRUA to re-poses the springs, boreholes and the areas reserved for dams from private land owners. Once this has been done, the LBB-WRUA shall have addressed water scarcity.

4.5 Challenges facing the LBB-WRUA

The LBB-WRUA has faced quite a number of challenges which have slowed its process of ensuring adequate and safe water to all water users as well as manage the water resources in a sustainable manner.

4.5.1 Water scarcity

One of the LBB-WRUA challenges as alleged by the participants in the in-depth interviews is poor water flow at the intake points during the dry season. About 13% of the 71household survey respondents reported to have water in their intake points during the dry season while 38% do not get water at all (Figure 20).

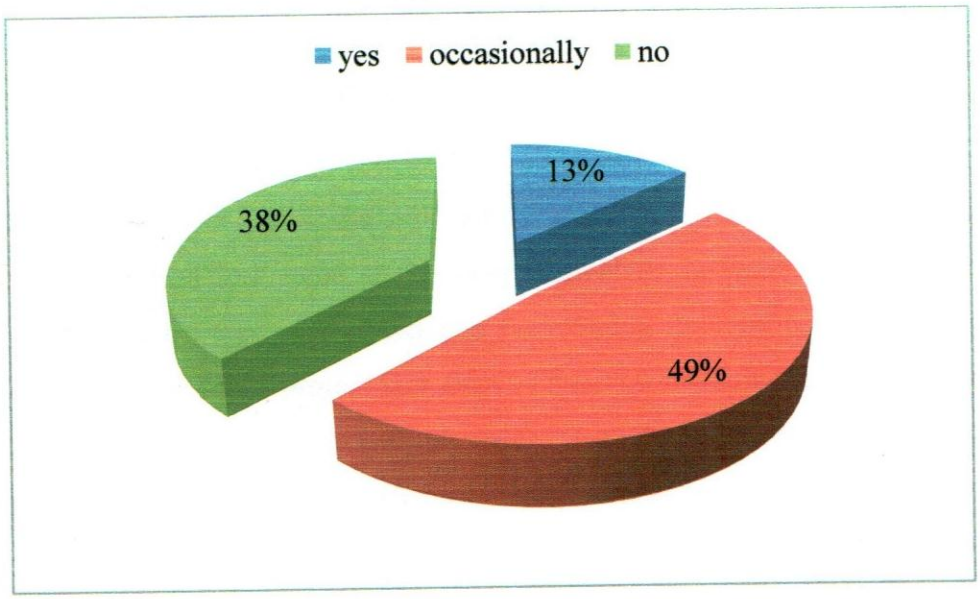

Figure 20: Water flow at intake points during the dry season

From the in-depth interviews report, it was alleged that water shortage is partly due to destructive human activities in the catchment area and partly due to climate change. Based on the same report, 25,000 seedlings in Subukia shrine were destroyed by a wild fire in early 2009. This fire originated from Sijui in Nyandarua and was associated with climate change. Water shortage affects irrigators who prefer planting vegetables and tomatoes during the dry season when their demand is high and less agro-chemicals are used in order to cut on production cost but during this very crucial time, water is inadequate.

Participants in the in-depth interview revealed that there were some project members who were not benefitting at all from the projects' water, yet they had met all the projects requirements including contribution of membership fee. The most affected people are those living and farming far from the water source where pipes have not been laid or have been vandalized. Lack of water impacts on the crops planted during the dry season through reduced yield or total loss of the crops. In India, WRUAs are able to distribute the available water amongst the users equally and usually avoid potential crop losses during the years of water shortage (Indian Society of Water Management, 2007). It is possible for the LBB-WRUA to achieve the same if the officials streamline the leadership in water projects, ensure good management of the available funds and speed up the process of rehabilitating the catchment area.

4.5.2 Vandalism and theft of pipes

From the information provided during FGD, it was alleged that some pipes laid by water project members are vandalized and the stolen pipes later sold to unsuspecting irrigators. The study revealed that some of the people involved in water pipe theft are known but they go unreported for fear of reprisals and maintaining of good neighbourliness. The pipes are very expensive for water project members to keep on replacing and thus water project members far away from the river cannot access water for domestic or irrigation purposes. Such members pull out and withdraw their contribution, both material and labour. When this happens, the benefits attributed to easily accessible water for example food security and increased household income which empowers people economically, cannot be realized. The situation may culminate to increased levels of poverty and people may result to catchment destruction since there is a link between poverty and environmental degradation (Bratt, 2009). The LBB communities will result to charcoal production to improve their livelihoods.

The Water Act 2002 enacts the principle of local users taking responsibility for guardianship of their own resource (Republic of Kenya, 2002). Members of water projects need to understand that they are the custodians of structures and the properties belonging to their water projects. It is upon the LBB-WRUA officials to create fora where water management malpractice can be reported while protecting the identity of those reporting. This way, cases of vandalism will reduce significantly.

4.5.3 Illegal water abstraction

During the FGD, it was alleged that cases of illegal water abstraction especially for irrigation purposes were rampant in the study area. The household survey indicated that 76% of the respondents knew of existence of illegal water abstraction. The study revealed that there were many farmers carrying out irrigation but are not members of any water project. The Water Act (2002) requires that a group of people interested in water abstraction come together and plan how each of the individual will get a share of this resource. Unregulated water abstraction leads to water shortage and conflicts. Plate 9 shows illegal water abstraction by an individual at Kaptarakwa. This abstraction point exists with full knowledge of the administrators since they carry out regular patrols. The study revealed that some non-members illegally abstract water at night from pipes passing near their farms but nothing has been done though they are known. Such unaccounted for water abstractions lead to water shortage.

Plate 9: Illegal abstraction of water by use of soil packed in sacks and made to pass through a pipe at Kaptarakwa.(Source: photograph courtesy of Wangui April, 2011).

Lari Wendani committee members are very vigilant and illegal abstractors cannot go unnoticed and unpunished. Currently, cases of illegal connections are mostly reported to the water project committee. About 74% of the 71 household survey respondents in water projects have been reporting illegal water abstraction to the committee members, 8% the police station, 2% to the chief while 17 % of them do not take any action. This indicates that there is a good forum for following up illegal abstractors but the law enforcers must take action. Illegal water abstraction reduce the water flow in the river channel and deny other water users access to water either for domestic or for irrigation purposes.

The 2002 Act provided for the establishment of an independent Water Appeals Board (WAB) to settle water related disputes and conflicts (Republic of Kenya, 2002). WAB was established in 2005 in Nairobi but by 2009, only three cases had been determined (water.Org, 2013) indicating that even at national levels water disputes take long to settle. The LBB- WRUA officials unlike the WAP moves with speed to settle disputes considering the way it has streamlined Lari Wendani. This is a wakeup call for all water project members to cooperate with their officials and report illegal water abstractors. Failure to do so, the LBB-WRUA will find itself busy trying to improve water conditions but making no progress. Unless the transgressors are punished the other water users will continue suffering. Illegal water activities have contributed immensely to community sufferings in terms of water scarcity and poverty. Along Indus valley in India, severe punishments were established to ensure proper utilization of water and its control was entrusted to a high official vested with full and undisputed powers (FAO, 1986).

4.5.4 Leaders' education level

Only about 44% of the 71 household survey respondents consider education level of their leaders while 56% do not. This indicates that there is a risk of electing people who are illiterate, cannot take notes in meetings or disseminate information to the members after a seminar or a workshop, or even arrange meetings. Projects that make this mistake cannot progress no matter how many training seminars are offered to their leaders. The WRUA constitution states that the minimum level of education a leader must attain is primary; class eight in Kenyan education

system. From the household survey responses, it was evident that most members do not consider education level of their leaders before electing them to offices.

4.5.5 Project meetings and election of new water project leaders

Most community members fail to attend meetings making it impossible for the stakeholders to reach and advise them on water issues. Majority of community members who attend meetings are literate and financially secure while the poor term meetings as a waste of time. This indicates high level of ignorance and if nothing is done to sensitize the communities on importance of meetings, the situation in the upper LBB is going to worsen. In fact, mobile farmers (farmers from outside the upper LBB) are taking advantage of the communities' ignorance by renting farms and carrying out irrigation activities. They also benefit from the meeting fora organized in the basin.

For a project to truly be successful, communities must be viewed and must view themselves as the owners of the project. Communities must accept to participate in project planning, building and financing, to on going project maintenance. Water projects are also supposed to be demand driven (Water.Org 2013). From WWF, 2009 LBB-WRUA was the brainchild of the WWF and they established it in liaison with WRMA in 2005. LBB-WRUA officials have some convincing to do to encourage more community members to be part of the catchment protection and management. The communities need to feel as part of the LBB-WRUA in order to fully support it and attend meetings in large numbers whenever they are supposed to do so.

Tenure of office for project leaders differs from one water projects to another. About 37% of the 221 household survey respondents reported that their water projects hold elections after every one year, 10% after two years, 18% after three years and 1% after four years. 33% do not hold elections at all, implying that the leaders elected during the inception of the project are the ones who have been in office all through. Projects that do not carry out elections after the required period of time risk leaving the project ownership to the officials. The members in such kind of projects may not find it necessary to contribute towards their projects due to the conception that the officials are the sole beneficiaries. The ownership of the project ceases being communal and targets and goals envisioned by the members easily change and the project activities fail to progress.

4.5.6 Greed and negative culture

From the FGD, it emerged that it is a difficult task trying to convince some community members living in this part of the basin to reduce acreage under irrigation so that the river water can equitably be shared among all users. The problem has also been with the pastoralists whose culture demands that they keep large herds of livestock. This has been causing detrimental effect on the forested land as well as the rehabilitated area under Community Forest Association (CFA). The pastoralists also start fires in the forests claiming that they are eradicating ticks and in the process cause massive destruction of the vegetation. Some communities do not have toilets and instead use bushes to dispose off human waste. In cases where the health officers have intervened, the toilets have been put up but very few people use them since it is a taboo for a man to share a toilet with his children. This means that when it rains, all the waste is washed into the river where it contaminates the water used by communities downstream.

UNICEF, WHO 2012 indicates that in Sub-Saharan Africa, open defecation has increased by 33 million people and that Africa has the highest proportion of people using unimproved sanitation. In Sub-Saharan Africa, treating diarrhea consumes 12 % of the health budget and on a typical day, more than half the hospital beds are occupied by patients suffering from faecal-related diseases (FAO; UN 2009). To ensure a healthy community that is economically stable proper water treatment methods requires to be used by communities in the LBB. It is therefore a challenge to the LBB-WRUA to adopt methods of convincing the various community members to dig pit latrines and stop bathing and washing cloths in the river as well as keep manageable number of livestock.

4.5.7 Poor farming practices and destruction of vegetation

From the in-depth interviews report, it emerged that there was a tendency by the farmers to mix agro-chemicals on river banks with spillage going into the river and detected downstream. In case these chemicals are consumed by human beings directly in water or indirectly though plants or fish, they may cause immediate or residual effects in their bodies. Indigenous trees along the river course have been removed and replaced with exotic trees which cannot co-exist with the undergrowth. Further, most farmers are reluctant to plant trees due to high cost of obtaining

seedlings and theft of indigenous ones. Destruction of vegetation and failure to plant trees may aggravate effects of global warming leading to persistent water shortage.

Environmental Management and Coordination Act (EMCA) number 8 of 1999 takes care of environmental impact of development and NEMA enforces it. The Act makes it mandatory to conduct an environmental impact assessment before implementation of a project such as large-scale agriculture, use of pesticides and fertilizers and irrigation development (FAO 2008). With assistance from NEMA, the LBB-WRUA can reduce cases of pollution especially agro-chemicals. In Southern Africa, water pollution from agro-chemicals and other pollutants have affected water quality and impacted negatively on public health and functioning of ecosystem including the rising cost of treatment (Tsiho 2007). The LBB-WRUA is required to use different approaches to minimize water pollution including involving all stakeholders; private sector communities, interest groups and individuals as well as governments to participate in tackling the water pollution problems in a curative as well as in a preventive manner.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter covers the conclusion and the recommendations based on the findings of the study.

5.2 Conclusion

The study results indicated that the LBB-WRUA had already initiated process of catchment protection through establishment of CFAs. The LBB-WRUA had also mobilized funds from various sources like government agencies and NGOs. However its dream of ensuring equitable water sharing among all water users had not been accomplished and the process of attaining the goal was very slow. The following conclusions can be made from this study;

I. Water conservation

a. The LBB-WRUA had exposed its members to water issues though meetings and training seminars making them more knowledgeable as compared to the non-WRUA members. The LBB-WRUA has also improved catchment protection.
b. Forty two percent of the household survey respondents were found to have large capacity water storage facilities (tanks for domestic water and water pans for irrigation water) to provide water during the dry spell. About 20% of them had the recommended sizes of water pans measuring 20m ×20m ×1m to support crops during the dry spell.
c. Only 20% of the respondents had 10% of their land under woodlots.
d. With exception of Akuisi and Limuru, Pegging had not been done along the river length.
e. Seventy three percent of the respondents were using hose pipes (uneconomical) in irrigation.
f. The attendant of meetings by the community members was found to be irregular indicating that only a few of them get involved in water resource issues. Other fora that could serve to involve the public more in water issues would be training seminars and exchange visits which were found to be few.

II. Water supply to communities

a. There was unequal distribution of water between the upstream and downstream communities. Large scale farmers in Subukia Division had dug wells adjacent to the Waseges river tributaries which drain the river water reducing water flow hence affecting the community downstream.

b. Over a half of the respondents still cover more than one kilometer in search of domestic water. Besides Waseges River, other sources of water like dams, springs, bore holes and water kiosks were very few and most of them are not operational.

c. Water safety was perceived as poor due to contamination from agro-chemicals, sewage and silt from eroded river banks. Some toilets in Subukia center are located adjacent to the river while some community members lack pit latrines or have them but not all family members use them.

III. Challenges

The LBB-WRUA is currently facing a number of challenges which include;

a. Only 14 % of the 71 household survey respondents get water at their intake points during the dry season. Most affected are the downstream communities in Mbogo-ini Division who have to trek long distances to fetch domestic water and lose crops to drought.

b. Most water projects have stagnated because they elected in office people who either lack leadership skills or have not completed primary school as stipulated in the LBB-WRUA constitution, and are left to stay in office even after their terms have expired.

c. Curbing cases of vandalism of pipes and illegal water abstraction has been curtailed by community failure to report the offenders and taking of bribes by law enforcers.

5.3 Recommendations

The following are some of the recommendations based on the study findings;

a. The LBB-WRUA should ensure that all water abstractors have standard water pans measuring 20m× 20m × 1m to enable them obtain permits as stipulated in the Water Act 2002. This will regulate the number of water abstractors in order to prevent water scarcity. Punitive measures should be taken against illegal water abstractors. WRUA should also encourage farmers to use efficient irrigation methods and reduce sizes of the land under irrigation.

b. The LBB- WRUA should encourage water project members to join hands and construct water tanks for each member through merry go round to ensure clean drinking water and reduce cases of water borne diseases.

c. The LBB-WRUA should ensure that a meeting between the upstream and downstream communities is arranged to discuss how the two should share out the Waseges River water and come up with the role that each should play to ensure catchment protection.

d. WRMA should carry out regular sampling and analysis of water to ascertain water quality. This is possible through establishing water sampling stations along the Waseges River.

e. The LBB-WRUA should arrange training seminars for water project officials to enlighten them on how to seek donations, handle funds and the procedure followed in opening and running bank accounts.

f. More study work should be done to ascertain water pollution levels arising from agro-chemicals and sewage discharge into Waseges River. As the main source of water for the community in the entire LBB, water contamination can result to disorders/illnesses.

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APPENDICES

Appendix 1: Survey questionnaire for the Upper LBB WRUA water project members

The researcher is a Masters of Science (Environmental Science) student in Egerton University. This questionnaire is intended to solicit views from respondents on the provision of accessible, adequate, and quality water by the various WRUA water projects and their level of management. The information you provide in the questionnaire will be used for research purposes only and all the responses will be treated with utmost confidentiality.

A. WRUA member personal details

Water project name _____,

Location_____, Farm _____.

If a WRUA member, position in water project _____

Name of the respondent, (optional) _____

Respondent's age_____, sex (female__ male___) (tick appropriately).

Total number of family members in your family._____

Position in the family

Father [ ] Mother [ ] Son [ ] Daughter [ ]

Respondent's level of education;

None [ ] Primary [ ]

Secondary [ ] College [ ] others [ ] (specify).

Family income in Kshs earned from wage/employment per month_____.

Family income in Kshs earned from farming per year_____.

Family income in Kshs earned from other sources per month____ (specify).

Total household income in Kshs earned per year_____

E. Water management and conservation by WRUA through water projects

1. Does your family harvest rain water for domestic use?

   Yes [ ] No [ ]

2. If yes, where do you store this water? _____

3. Was your family carrying out irrigated agriculture before your water project started?

   Yes [ ] No [ ]

4. If yes, what was the source of your irrigation water? _____

5. If no why? _____

6. Currently, does your family carry out irrigated agriculture?

   Yes [ ] No [ ]

7. If yes, how many times per week does your water project provide water for irrigation purposes?

   Once [ ] Twice [ ] Thrice [ ] never [ ]

8. Is the quantity of water you get enough for your irrigation?

   Yes [ ] occasionally [ ] No [ ]

9. Does your family collect storm flood/surface water when it rains?

   Yes [ ] No [ ]

10. If yes, where do you store this water? _____

    If you store in a dam, what is the length, width and depth of the dam in meters?

    Length_____ width_____ depth_____

11. Which irrigation method do you use in your farm?

    Drip [ ] overhead sprinkler [ ] low ground sprinkler [ ]

    Flood [ ] Bucket [ ] others (specify)_____

12. Approximately what percentage of your land is under woodlot/has trees?

    5% [ ] 10% [ ] more than10% [ ] None [ ]

13. Where does your water project get funds for putting up new structures?

    Government [ ] NGOs [ ] Member contribution [ ]

    Well wishers [ ] Bank loans [ ] Others [ ] (specify)

    _____

14. .Does your water project have an account with any bank?

    Yes [ ] No [ ]

    If no, why?_____

C. The current status of water supply to the community of the upper LBB

15. How many kilometers were your family members walking to fetch water before water projects were formed?

    Less than 1km [ ] 1km [ ] More than 1km [ ]

16. Currently, how many kilometers do your family members walk to fetch water?

    Less than 1km [ ] 1km [ ] more than1km [ ]

17. On average, how much water do your family members use per day?

    Less than 50 litres [ ] 50 litres [ ] 100 litres [ ]

    More than 100 litres, (specify quantity) _____ litres.

18. How many times a week does your water project provide piped water for use in the house by your family members?

    Once [ ] Twice [ ] Four times [ ]

    All the days [ ] Never [ ]

19. How many hours per day does your water project provide piped water?

    Less than 6 hours [ ] 7 to12 hours [ ] More than 12 hours

20. Are there water kiosks in your neighbourhood?

    Yes [ ] No [ ]

21. If yes, how many are there? _____

22. How much money is charged for a 20-liter jerrican? _____

23. Can your family afford this kind of money?

    Yes [ ] Occasionally [ ] No [ ]

24. What is the source of your drinking water?

    River [ ] springs [ ] rain water [ ] Boreholes [ ]

    Other sources (specify) _____

25. In your own views, do you think the water provided by your water project safe for home use?

    Yes [ ] No [ ]

26. If no, does the water project/WRUA treat the water before distributing it to the members in your water project?

    Yes [ ] Occasionally [ ] No [ ]

27. If no to question 33, does your household treat the water at home?

    Yes [ ] Occasionally [ ] No [ ]

28. If yes, which treatment method does your household normally use?

Boiling [ ] water guard [ ] leaving in container to settle [ ]

Filtration [ ] Others (specify)_____

29. How often do you or a member of your family get treated for water related diseases?

Very often [ ] Often [ ]

Occasionally [ ] Never [ ]

30. Specify the disease treated in 37 above if any _____

B. Community involvement in water Projects

31. Are you a member of any water project?

Yes [ ] No [ ]

Yes [ ] No [ ]

32. Are there some project water pipes/channels passing through your farm/neighbour's farm?

Yes [ ] No [ ]

33. If yes, were you/your neighbour consulted when the pipes/channels were being laid?

_____

34. Were you consulted on the choice of the water conveyance (e.g. pipes or channels) before they were installed?

Yes [ ] No[ ]

35. If no, why?_____

36. If a non-member wants to join your water project, can the person be allowed?

Yes [ ] No [ ]

37. How often does your water project provide training sessions on environment and water conservation for its members?

Once a year [ ] Twice a year [ ] Thrice a year [ ]

Never [ ]

38. How often are an agricultural extension officers invited to advice members on appropriate irrigation methods?

Once a year [ ] Twice a year [ ] Thrice a year [ ]

Never [ ]

39. How often does your water project organize tours to other water projects outside your location?

Once a year [ ] Twice a year [ ] Thrice a year [ ]

Never [ ]

40. Do the training sessions (if any) help you on the wise use of water?

Yes [ ] Occasionally [ ] No [ ]

41. How adequate do you utilize acquired skills from the training sessions?

Very adequate [ ] Adequate [ ]

Moderately adequate [ ] Not adequate [ ]

Is never utilized [ ]

42. Does your water project consult experts on appropriate water distribution designs? Yes [ ]

Occasionally [ ] No [ ]

43. If no, why_____

44. How often do you voluntarily contribute ideas in group discussions on the performance of the water project?

Very often [ ] Often [ ]

Occasionally [ ] Never [ ]

45. How often do you voluntarily oppose the general views/ideas of members or leadership in water project meetings without fear?

Very often [ ] Often [ ]

Occasionally [ ] Never [ ]

46. Are you aware of the new Water Act of 2002?

Yes [ ] No [ ]

G. WRUA challenges

47. Do you consider the level of education when electing your leaders?

Yes [ ] No [ ]

48. If yes, which level of education does your water project consider?

Primary [ ], specify class_____ secondary [ ], specify form____

College [ ]

49. Does your water project leader freely interact with the water project members?

Yes [ ] occasionally [ ] No [ ]

50. Are the leaders in your water project trained on leadership skills?

No [ ] Yes [ ]

51. How often do the leaders in your water project attend trainings on leadership skills?

Ones a year [ ] twice a year [ ] thrice a year [ ] Never [ ]

52. If no, why are they not trained?_____

53. How often do you attend your water project meetings?

Very often [ ] Often [ ]

Occasionally [ ] Never [ ]

54. How often do leaders in your water project organize for general meetings?

Once a year [ ] twice a year [ ] thrice a year [ ]

Never [ ]

55. How often does your water project hold general elections?

After every one year [ ] After every two years [ ]

After every three years [ ] After every four years [ ]

Never [ ]

56. If never, why?

_____

57. Did your water project consult experts on where to locate the weir/dam across the river and intake point/water tapping point?

Yes [ ] No [ ]

58. Does the water at the intake points flow during the dry season?

Yes [ ] Occasionally [ ] No [ ]

59. Does your water project ensure equal distribution of water within its members?

Yes [ ] Occasionally [ ] No [ ]

60. How does your water project share out water to its members during the dry season when water volume has reduced?

_____

61. Has your water project noted cases of illegal connections?

Yes [ ] Occasionally [ ] No [ ]

62. If yes, what is usually done to those who connect water illegally?

Taken to police station [ ] Reported to the chief [ ]

No action taken [ ]

Appendix 2: Focus group discussion questions

1. In your own views, has the LBB-WRUA succeeded in ensuring equitable water distribution and safety?
2. How does the WRUA ensure equitable distribution of water during the dry season?
3. What measures is the LBB- WRUA putting in place to ensure environmental protection?
4. Does the LBB-WRUA carry out routine monitoring of water and water infrastructure?
5. In your own views, has water conservation improved since inception of the LBB-WRUA or it has been deteriorating?
6. What are the main challenges facing the LBB- WRUA in its efforts to provide water and in ensuring its conservation?
7. What can the WRUA do to overcome these challenges?
8. What is the average size in meters of the dams/ pans that are already constructed?
9. How does the WRUA ensure water quality in the upper catchment of the LBB?
10. How often does the LBB-WRUA invite irrigation officers to monitor irrigation methods being used by the farmers?

Appendix 3: In-depth interviews (For the key informants)

1. During the dry season, how do you manage the little flow of water in the river for irrigation purposes?
2. Where do you get drinking water when the river flow reduces
3. When digging shallow wells, do you consider location of toilets first.
4. Are there some people who abstract water from the river using portable machines?
5. Do all the irrigators wash their knapsack sprayers 100 meters away from the river?
6. Are there people who still bath in the river? What has been done about this and what can be done?
7. Are there shallow wells or bore holes in this area and if yes, are they functional
8. Without water kiosks in the area, where do people far away from the river get water from especially during the dry season?
9. In your own views, do you think Waseges River water is equally shared between the upstream and downstream communities? If no sharing who uses the water more, what do they do with the water?
10. In your projects, have you planted trees and where have you planted them? Which/how many projects have tree nurseries?
11. Are there springs in your area? Are they encroached?
12. Which area(s) do you think the WRUA should improve on?
13. As irrigators and domestic water users, what challenges do you face in your projects?
14. How can these challenges be overcome?

Appendix 4: Observation schedule

Item	present	absent
Irrigation methods Horse pipes Canals Bucket Drip Low ground Sprinkler Overhead sprinkler	✓ ✓ ✓	 ✓ ✓ ✓
Piping	✓	
Water pans	✓	
pegging	✓	
Tree nurseries	✓	
weirs	✓	
Water intakes	✓	
Encroachment of river banks	✓	
Toilets adjacent to river banks	✓	
Dried river channel	✓	
Water kiosks	✓	
Functional bore holes		✓
Functional water springs		✓
Shallow wells	✓	
dams	✓ (not operational)	
woodlots	✓	
Illegal water abstraction	✓	

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PAGE 3

Research Permit No. *NCST/RRI/12/1/I/ES011/56*

Date of issue *17th October,2011*

Fee received *KSHS. 1000*

THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss/Institution
Veronica Wangui John
of (Address) *Egerton University*
P.O BX 536, Egerton
has been permitted to conduct research in

	Location
Subukia	**District**
Rift Valley	**Province**

on the topic; ***Assessment of water resource users association in water management and conservation-upper catchment of Lake Bogoria Basin, Kenya***

.....
Applicant's Signature

.....
Secretary National Council for Science and Technology

for a period ending 30th *April* **2012**

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

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Our Ref: **NCST/RRI/12/1/ES-011/56/4**

Date: **17th October, 2011**

Veronica Wangui John
Egerton University
P. O. Box 536
EGERTON

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "***Assessment of water resource users association in water management & conservation - upper catchment of Lake Bogoria basin, Kenya***" I am pleased to inform you that you have been authorized to undertake research **in Subukia District** for a period ending ***30th April 2012.***

You are advised to report to **the District Commissioner, the District Agricultural Officer, the District Medical Officer of Health & the District Education Officer, Subukia District** before embarking on the research project.

On completion of the research, you are expected to submit **one hard copy and one soft copy** of the research report/thesis to our office.

P. N. NYAKUNDI
FOR: SECRETARY/CEO

Copy to:
The District Commissioner
Subukia District

The District Agricultural Officer
Subukia District

The District Medical Officer of Health
Subukia District

The District Education Officer
Subukia District