

**ACCESS TO WATER RESOURCES AND CONFLICTS IN THE UPPER
EWASO NYIRO North River SUB-BASIN: A CASE OF LAIKIPIA COUNTY,
KENYA**

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This thesis is my original work and has not been presented for a degree in any other University.

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DEDICATION

This dissertation is dedicated to my loving parents the late Musa. L and Marion. W. Lesrima who made great personal sacrifices to enable me acquire education under extremely challenging circumstances. To my wife Gladys Lesrima, children, Marion Naserian, Leon Lmengati, Eric Sokoine and granddaughter Ayana Namayan for their love, patience, understanding and encouragement.

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LIST OF ABBREVIATIONS

ASAL	Arid and Semi-Arid Lands
CETRAD	Centre for Training and Integrated Research in ASAL Development
CFA	Community Forest Association
ENNRB	Ewaso Nyiro North River Basin
FAO	Food and Agricultural Organization
FGD	Focus Group Discussions
GPS	Global Positioning System
KAP	Knowledge Attitude Practices
KFS	Kenya Forest Service
KII	Key Informant Interviews
KWS	Kenya Wildlife Service
NAWASCO	Nanyuki Water & Sewerage Company
NEMA	National Environment Management Authority
NGOs	Non-Governmental Organizations
PES	Payment for Ecosystem Services
ROK	Republic of Kenya

SPSS	Statistical Package for Social Sciences
UNDESA	United Nation Department of Economics and Social Affairs
UNDP	United Nation Development Programme
UoN	University of Nairobi
USAID	United States Agency for International Development
WRA	Water Resources Authority
WRUA	Water Resources Users Association
WSRB	Water Services Regulatory Board

ABSTRACT

The purpose of this study was to assess water access, use, management and conflicts in the Upper Ewaso Nyiro North River Basin: the case of Laikipia County in Kenya. Laikipia and neighbouring Meru and Nyeri Counties have multiplicity of water users who depend mainly on river-water for their livelihood. Laikipia County depends on water from Meru and Nyeri Counties, ground water resources and rain. In spite of past research conducted in the area, reviews in national water policies and institutions on water management, the sub-basin still experiences conflicts between various waters users. Recurring conflicts over decades is an indication that long-term solutions have not been found to solve the problem. The research Questions were: how upstream and downstream water users access, use and manage water; the extent of water related conflicts and whether there is a link between water access, use and management to conflicts. Three specific objectives were: (1) to assess how water users access, use and manage water resources in the study area, (2) assess presence and trends of water related conflicts and (3) investigate effects of access to water, use and management on water conflicts in the study area. The Theory of Access and The Game Theory informed the study. The study adopted descriptive survey research design. Upstream and downstream zones dividing line was set at altitude 1800 (m.a.s.l). Data was collected using primary and secondary sources. Primary data collection tools were; structured questionnaires, key informant interviews, focus group discussions, transect, drives and walks. Descriptive statistics were used for quantitative data analysis (SPSS version 23) and summative content analysis was applied for qualitative data analysis. The results show that 87% and 45.5% of the households from upstream and downstream respectively source water from household taps. On water uses, the study results show that 45.1% and 43.7% of the respondents mention pastoralists and farmers upstream and downstream respectively as the largest consumers of water in the study area. The study further found that 43.7% and 46.9% of the respondents downstream and upstream respectively point at pastoralists as the largest water users in the study area. The study findings indicate that the study area had rules and regulation in place to manage water resources as shown by 88% of the respondent who admitted to awareness of existence of management water rules and regulations. Results show that 71.4% of the respondents go on to suggest adherence to rules regulations as major strategies to apply in order to ensure equity in water access. The study findings also find that 66.7% and 49.4% of downstream and upstream households respectively agree on the presence of water related conflicts in the study area. The households further indicate that water conflicts in the study area are seasonal (60.7%) and unpredictable (26.6%). Majority (78%) of the respondents were confident that the institutions they reported water conflicts occurrence to had the capacity and ability to deal with the problem. The results showed that water access, use and management had significant effect on conflicts. The study concluded that there is a link between accesses, use and management water to conflicts in the study area and that inequalities in water access is due to ineffective water management institutions. The study recommends adherence to water rules and regulations.

CHAPTER ONE: INTRODUCTION

1.1 Background Information

The purpose of this study is to assess the access, use, water resource management and related discrepancies in the Upper Ewaso Nyiro North River Sub-Basin in Kenya. This chapter reviews water resources access, use and management, and conflicts from the global, regional and local perspective to provide a clear understanding of the problem under investigation. The chapter further outlines research objectives, statement of the research problem, and research questions and gives justification, scope and limitations of the key aspects of the study. Chapter two of the study presents a critical analysis of literature review that helped build on previous studies conceptual and theoretical frameworks, to guide in the research. The literature review identified research gaps that assisted in conceptualization and formulation of the study variables. Chapter three of the study gives a description of study area, materials and methods used in data collection and analysis to provide answer to research questions while chapters four and five present results, discussions, conclusions and recommendations respectively.

Water is a key resource to the livelihood of many people around the world and lack of it is becomes potential source of conflicts especially in areas where majority of the population rely on common source of water such as rivers, lakes (Wolf *et al.*, 2005; Bernauer & Böhmelt, 2014). Water access, together with its allocation and utility are vulnerable areas for potential tensions which can preside over subsequent conflicts among benefactors of this noble resource (Shrestha *et al.*,2018; Petersen-Perlman, et al2017). Such conflicts over water can be violent and direct, frequently occasioned by issues to do with access to water points or privatization of drinking (OECD, 2014; Bernauer & Böhmelt, 2014). However, this problem is not only unique to the study area but a universal problem experienced in many parts around the world. Rarely has fresh

water access been the course for international conflict from traditional experience, but currently, the dynamics of such hostility is posing an alarming likelihood of severe bone of contention to increase competition (Senehi, 2002; Petersen-Perlman *et al.*, 2017).

A report by EU (2002) noted that water is perceived as an increasingly scarce resource. The report further indicates that water will be the next drivers of wars besides oil basing on the research that show that Trans boundary agreements on the issue of water is much more likely than violent conflict (EU, 2002; Rahman, 2013). This report demonstrates the water resource access and use should be managed and governed properly to prevent conflicts. Critical study on conflict catalysts is unveiling several causal agents that are responsible for conflicts, which mentions lack of certainty on the existence of agreements among residents, rivalry over resource claims, uncertainty on the placement of effective mechanisms and institutions, the likelihood of uneven relationship of power and the characteristic inter-group tensions at border level (Onuoha, 2008; Rahman, 2013). Prospectively, there will be more than adequate resources of water globally which is required for food production in 2050, although a substantial number of regions are bound to be victimized by severe scarcity of water (FAO, 2015; Rahman, 2013). Water shortages will end up in heightened competition that will curtail production in agriculture and impact negatively on the revenues and other pertinent opportunities for the majority in both urban and rural residents (Pandey, 2011; Dinar & Hogarth, 2015; Shrestha *et al.*, 2018).

On international level tensions over water have been reported in Argentina and Paraguay in 1993 when Argentina was accused of diverting waters through canals hence affecting the irrigation scheme in Paraguay (Munia *et al.*, 2016), Namibia when it was proposed that water should be diverted from Caprivi Strip to boost the supply of

water to the capital city which resulted to disputes with downstream Botswana since it would have affected the eco-tourism industry and Okavango Delta (Wolf *et al.*, 2005) and Potential civil wars as has been experienced in Some parts of Latin America, Africa and South Asia in the past years (Ohlsson, 2000). This provides classic examples on how water can result to tensions on macro level if all users are not given equal rights to access the commodity (Shrestha *et al.*, 2018). The study by Esteban-Gracia *et al.*, (2016) found that there is worldwide implementation of policies governing water utility so as to manage stresses, although manifestations of sideline intentions between users of this water together with differences in their political power hinder the effectiveness of the water policy reform.

Guidance of this study was given by access theory and Game Theory since factors that affect access, use and management of water attract competition, equity and cooperation. Applying the Game Theory as illuminating lenses to guide investigation and understanding of a problem of importance for local and global security. Given that variables from literature suggest the limitation of availability of physical water, the challenge of the management and government of water competition through combination of economic, political, social, legal and institutional structures, interact to promote equity and sustainability can be resolved through the application of Game theory (Ostrom; 2000; Hui, et al 2016; Bhagabati & Kawasaki, 2014). Shrestha, et al(2018) highlights some tolerance attributes in the critical water situation as well as self-restraint social mechanisms in combating with uneven relationship of power sharing among common beneficiary groups.

According to statistics from the UN (2014) the continent of Africa is considered as the driest continent with arid and semi-arid areas covering up to 60% of the continent. The

demand for fresh water is estimated to rise by 40% in African states and this will cause a lot of conflict in Trans boundary basins by 2030 (FAO, 2009; Rahman, 2013). In spite of the fact that majority of Africans (80%) live in rural areas, only 37% have access to safe water sources (WHO, 2013). A study conducted in Tanzania revealed the existence of water conflicts especially during the dry seasons which have been prolonged by activities such poor land management practices, population growth and increase in smallholders' irrigation projects (Okpara, *et al.*, 2015). According to the findings of Okpara *et al.*, (2015), this conflict ranges from legal disputes to violent confrontations and destruction of property between various communities of water users.

A study by Ngigi (2006), showed that lack of adequate water has been cited as one the main challenges that hinder areas in ASALs from achieving high economic development. Because of water scarcity, areas such as Laikipia County continue to experience persistent conflicts over water sources as various water users seek to access and use the existing water supply (Ngigi, 2006). A big number of rivers in the deserts and semi-desert global regions are hit with shortage or water occasioned by agricultural hydro-consumptions, and this results in hostilities between upstream dwellers and downstream dwellers (Peng *et al.*, 2014).

As demand for water keep rising alongside dwindling rate of the same water, potential violence becomes more imminent with the passage of time (Bernauer & Böhmelt, 2014; Okpara *et al.*, 2015). According to Gichuki (2002), water scarcity and conflicts are inseparable because of the link between water resources and livelihood activities attached therefore, lack of adequate water lead to high competition and resultants conflict over use of available water sources. Other social problems such as social

inequity, marginalization and lack of source of livelihood that does not dependent on water and land further aggravate the conflicts over water resources (Meyer *et al.*,2016). The widening rift of social differences between upstream dwellers and downstream dwellers calls for our attention to intercontinental chronological insight (Zhou *et al.*, 2019; Bernauer & Böhmelt, 2014).

Access to water resource in Ewaso Nyiro North River Basin has been contentious for a very long time (Didier *et al.*,2011; Gichuki, 2002). Many actors, which include pastoralists, farmers, ranchers and agro-pastoralists, mushrooming urban centers, increase in commercial horticulture puts pressure on use of water resources (Bond, 2014). Every party claims the rights to access and ownership to the ever-decreasing water (Zhou *et al.*, 2019; Bond, 2014). This competition for water results to numerous conflicts, which have led to some of the farmers resorting to, armed guard to protect their activities (Didier *et al.*, 2011). According to Mwangi (2012), hostilities and conflicts are occasioned by austerity of sharing meager resources and discrimination among the victims whereby they resort to violence.

Laikipia County and immediate neighboring Meru and Nyeri Counties where its water originates from lie at the Upper Ewaso Nyiro North River Sub-Basin The residents of this sub-basin hosts a multiplicity of users who depend mainly on river-water for their livelihood (CETRAD, 2017). The basin experiences recurring conflicts between various waters users (Opiyo *et al.*, 2012; Kiteme *et al.*, 2008). According to Ostrom's (2003), conflicts are the visible registers of underlying water management practices as noted by. Re-occurrence of conflicts points to the fact that there has not been long-term solution to ensure equal access to water resources and proper governance in the course of water resource conflict (Mwangi, 2012).

Stakeholder perception on inequity in water allocation and consumption is according to Bond (2014) a trigger to latent conflicts over water access among multiplicity of water users. While agriculturalists claim titled property rights to land and pastoralists claim unfettered access to grazing and water, ranchers owning wildlife conservancies claim priority access rights over water for their bigger contribution to tourism economy (Bond, 2014). Water users lack coordinated system for sustainable use of water resource in the sub-basin. Given rapid population growth and large-scale commercial horticultural development, climate change in the context of devolution under a new Constitution of Kenya conflicts have persisted over water access (Ogutu *et al.*, 2014). Resources as the cause of conflict therefore, came under the scrutiny of academics, conflict analysts and media outlets for their influence in many contemporary wars (Mahlakeng, 2015).

Conflicts over water access, use and management happen between and among large-scale farmers, small-scale farmers, farmers and ranchers, pastoralists, small-scale enterprises in urban centers, and wildlife. This study examines perceptions of equity, governance and seeks to find causes for unresolved conflicts mentioned in this introduction.

1.2 Statement of the Research Problem

Every Kenyan has an entitlement for adequate, clean and safe water (The Republic of Kenya: 2010; Article 43(d)). The Water Policy accords government the role in research and training, integrated water management, climate change mitigation, and promotion of gender affirmative action, disaster, and risk and conflict reduction (Republic of Kenya, 2016). Water Policy also places emphasis on balancing allocation between commercial and domestic needs as well across county, intra-basin water resources transfer and collaborative inter basin management. This mandate is delegated to County

Governments by the Constitution (Republic of Kenya; 2010) which together with Water and Sanitation Companies and other licensed water providers provide water and sanitation to water users under the supervision of institutions under the Ministry of Water and Sanitation. Institutions such as Water Services Boards, Water Resources Authority, and Water Regulatory Board are important semi-autonomous governments agencies introduced after the reforms under Water Act (Republic of Kenya Water Act 2000) to operationalize the policy created under Water Policy (Republic of Kenya: Water Policy 1999). Under the same reforms Water Resources Users Associations are voluntary institutions recognized under the Water Act (Republic of Kenya, 2016) were introduced to manage water projects many of which include in their membership the many competing water users in the study area. Ewaso Nyiro North Development Authority (ENNDA) established in 1989 and tasked with ensuring sustainable development in the region through planning. These organizations, however, have not been effective in managing water and water conflict within Ewaso Nyiro North River Basin (Warurii, 2015). It is expected that these reform actions by Government that appear to be consistent with and influenced by Game Theory but have not been entirely effective rendered an opportunity though this study to test applicability of the Game Theory on water access, use and management and why water related conflicts persist. It is also significant to note that it was in this Sub-basin that Water Users associations were promoted in a campaign led by CETRAD (Kiteme *et al.*, 2008) ten years after the ENNDA formation(Republic of Kenya: Ewaso Nyiro north Development Authority Act 1989). This study will examine the extent of WRUAs viability in water governance especially the claim in some studies (Kiteme *et al.*, 2008; Esteban Gracia *et al.*, 2016) that they are better placed to resolve conflicts compared to Government agencies.

The ineffectiveness of these institutions is manifested in complaints over unauthorized, illegal and unequal water abstraction and is seen as promoting competition leading to water related conflicts impacting mainly on Laikipia County (Kiteme *et al.*, 2008; Gichuki, 2002). In spite of elaborate policies over the last four decades, lack of coordinated system for sustainable use of water resource by all players in the basin leading to conflict is reported among large-scale ranchers downstream and large-scale farmers upstream (Bond, 2014). Cases of inequalities in access and use of water have also been reported between large-scale commercial farmers and small-scale farmers, farmers and pastoralists, between farmers, pastoralists and wildlife leading to conflicts (Bond, 2014; Kiteme *et al.*, 2008; Gichuki, 2002).

Research by Kiteme (2004) and Gichuki (2002) found the existence of water related conflict among the communities living in Upper Ewaso Nyiro North River Basin. Muigua (2016), while recognizing the existence of the water conflicts in the region noted that these battles for acquisition, management and utility of scarce natural resources have ended up in hostile violence in the villages, culminating to heavy losses of lives and wealth. The research by Warurii (2015), found that competition for socio-economic resources among and between communities ranked high as a main cause of ethnic hostilities in Rumuruti Division of Laikipia County. Water users lack coordinated system for sustainable use of water resource in the sub-basin (Warurii, 2015). Given rapid population growth and large-scale commercial horticultural development and climate change competition over water and related conflicts have persisted. The study area has various large scale and small-scale water users including large-scale farmers, small-scale farmers, farmers and ranchers, pastoralists, industries, institutions of learning small-scale enterprises in urban centers, and wildlife. Various studies have been conducted in this area starting from Gichuki (2002) to Warurii (2015)

problems have been highlighted with some solutions given but very little improvement has taken place in water access, use and management. This is an indication of knowledge gap that this study addresses on water governance providing possible solution to the persistent problems.

1.3 Research Questions

- i. How do upstream and downstream water users' access, use and manage water resources in the Upper Ewaso Nyiro North River Sub-Basin in Laikipia County?
- ii. What is the extent of water conflicts in the Upper Ewaso Nyiro North River Sub-Basin in Laikipia County?
- iii. How does water access, use and management cause water related conflicts in the Upper Ewaso Nyiro North River Basin in Laikipia County?

1.4 Research Objective

The main objective of this study was to assess water access, use and management of water resources and conflicts in the Upper Ewaso Nyiro North River Sub-Basin in Laikipia County.

1.4.1 Specific Objectives

The specific objectives were;

- i. To analyze how water users' access, use and manage water resources in Upper Ewaso Nyiro North River Sub-Basin in Laikipia County
- ii. To assess presence and trends of water related conflicts in Upper Ewaso Nyiro North River Sub-Basin in Laikipia County.
- iii. To investigate the effects of access to water resource on water conflicts by water users in Upper Ewaso Nyiro North River Sub-Basin in Laikipia County

1.5 Justification of the Study

This study is useful to communities living in the Upper Ewaso Nyiro River Sub- Basin where Laikipia County is situated, empowering water users enable improve their understanding of water resources management and how to mitigate conflicts. Conflicts over access, use and management in the in the Upper Ewaso Nyiro river sub-basin impacts negatively on economic development which depend on water (Bond, 2014). Findings and recommendations from this study supplement current stakeholders' efforts seeking evidence-based research findings for adoption to obtain a positive impact on sustainable access to water resources while at the same time reducing conflicts.

This study is of great value to the nation, the county governments and other stakeholders in making policies, which may help in mitigating current heightened water resources conflicts. If the study findings are adopted, it can initiate a process that could lead to part of a lasting solution to the perennial problems of water scarcity and related conflicts. Finally, the study will further enrich the knowledge base in this field of research by academicians and other researchers who may will use this study as a source of reference or use to further expand the knowledge water resources governance.

1.6 Scope and Limitations of the Study

This study concentrated on a specific water basin dominated by a concentration of rivers originating from the northwestern part of Mt. Kenya covering adjacent Sub-Counties, Buuri and Kieni of Meru and Nyeri Counties respectively and Laikipia North and East respectively. These rivers then form Ewaso Nyiro North River downstream sharing this space equitably. Meru County and Nyeri County lie at the upstream of Laikipia North and Laikipia East both Sub-Counties which qualifies as downstream. Delimitation is

done since it was not possible to be everywhere for reasons of cost and time and the topic chosen of conflict generated by sharing in upstream downstream relationship sets the boundary of conceptual relationships as well as the physical one (Adu, 2011; Simon, 2011). The weakness of this delimitation is cured by the use of altitude as the defining boundary.

The total Upper Ewaso Nyiro administrative sub catchment was not sampled for cost reasons but the formula for large population recommended by Mugenda and Mugenda (2003) supports the strength of the quality of the sample when random sampling is done in terms of representation and in selecting randomly the study sample of 384. Research problem and purpose did not cover quantities of water for allocations, as these were already available in Government records together with allocation quotas. The study confined itself with perceptions of participants on water access, use and management of water through research design that allowed triangulation of results from statistical analysis, FGD, transect walks, and use of secondary data.

Variables on pollution and sanitation except on views about waste disposal practices were left out because of cost, time to carry out research and the long periods required to confirm direct link of pollution to damage to environment and scarcity. Use of Kichoa a GPS enabled mobile phone was a challenge overcome through training and use. It was possible to track the movements of research assistants to ensure they randomly selected households for interview thus minimizing lack of honesty.

Completed questionnaires were returned at the same time of the afternoon of implementation to ensure consistency in participants responses and to ward off possibility of bias by interviewers who are assumed to be honest but difficult to control that aspect (Adu, 2011,Simon, 2011) may be tempted to fill the data on their own since data recording cannot be manipulated once logged.

CHAPTER TWO: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.0 Introduction

This section presents literature review on access, use and management of water resources and water related conflicts at global, regional, national and local level. The section also reviews Game Theory proposed since it is a fitting lens through which competition and cooperation is best explained. Literature review helped in identification of knowledge gaps informed on the construction of the conceptual framework to be validated by the study.

2.1 Review of Empirical Studies

The review includes the research on, research methodology, historical contexts and theoretical frameworks applied, variables, and findings and made by other studies on the research topic especially on upstream downstream water basins. Literature is from peer reviewed recent published articles, conference published proceedings on water access and conflicts, case studies and published books on integrated water management and conflicts.

2.1.1 Access of Water Resources

The study by Shrestha *et al.*, (2018) analyzed flows of change: dynamic water rights and water access in peri-urban Kathmandu. The study findings show that these water-related changes cause contestations and conflicts between peri-urban water users. Priority is given to urban water supply with uncontrolled ground water exploitation. Solution proposed is coordinated management of current surface water before exploiting ground water. The study revealed that amid increasing competition for water, people are using new sources and technologies, searching for negotiated solutions based on local norms and rights, and co-opting other water users through cooperation to create

access opportunities and avoid conflicts. However, the focus of the study was on peri-urban which imply that different economic and social factors of different population could results to different outcomes in terms of water access, use and management and related conflicts. Proponents' access theory such as Ribot and Peluso (2003) also highlights that economic, technological, social network and power influence the level of access to natural resources. This is the gap the current study sought to address.

A study conducted by Francis *et al.*, (2018) focused on water access today and tomorrow: domestic water sustainability under informal water supply markets in Dar es Salaam, Tanzania. Four different data set were comparatively analyzed from interviews with the Municipal Water Engineer (MWE), Ward Health Officer (WHO), 3 village leaders from 3 informal settlements, interviews with 43 informal water sellers from three informal settlements, including a survey sample of (n = 292) clients in three informal settlements. The study showed that households have unsustainable access to improved water due to the financial, hydro-technical, institutional and organizational incapacities of the informal water sellers coupled with the low financial abilities of low-income earning households to continuously purchase water for domestic activities. The research by Francis *et al.*, (2018) however, focused on informal water suppliers which are not subject to game theory and access theory unlike river basins which natural resources that suffer the threat of overexploitation. This study addressed the gap by focusing on rivers which are subject to game theory.

Karuaihe *et al.*, (2014) focused on rural water access and management approaches in southern Africa. The study found that CBM (community-based management) systems of water points offer an alternative in terms of ownership and self-reliance based on institutional arrangements at community level. The study focused on community

management approaches hence there is need for attention to be given to state driven approaches in management and to ascertain whether CBM can be applicable to other basins. The equivalent in Kenya would be water users' associations therefore it necessary to know which are more effective as guided by game theory.

Ribeiro and Sant'Anna (2014) analyzed water security and interstate conflict and cooperation. The study was based on an interdisciplinary literature review that aims to contribute to the development of studies on Trans boundary water policies, encompassing concepts such as water security, water justice and water governance. The study reported that cooperation in the use of Trans-boundary waters might spare distributive conflicts on water use. Ribeiro and Sant'Anna (2014) study however doesn't explain water resources access, use and management, and conflicts between various actors in water basins, which was the main focus on the current study.

The study by Sultana *et al.*, (2014) conducted a study on low-cost aquifer storage and recovery: implications for improving drinking water access for rural communities in coastal Bangladesh. The study showed that demand for more ambitious information systems, which not only support monitoring but also fit-for-purpose designs, was evident. Sultana *et al.*, (2014) study was conducted in coastal regions in Bangladesh while the current study was carried out in the parts of Laikipia County and neighboring counties of Meru and Nyeri, which fall under Upper Ewaso Nyiro Sub-Basins of Laikipia. Concerns over aquifer depletion were made by Timau Kisima ranch farmer who are WRUA members who object to use of bore holes and strict observance on dam harvesting for dry periods.

Another study by Mutiga *et al.*, (2010) was carried out on water allocation as a planning tool to minimize water use conflicts in the Upper Ewaso Ny'iro North Basin, Kenya.

The study used GIS enabled software to evaluate how different groups access water resources. The finding showed that farmers practicing irrigation farming had highest demand for water. This demand led to illegal water abstractions reducing water accessibility by users downstream. This study however fails to establish the role of the water management institutions and mechanism that were put in place to ensure equitable water access. The current study bridged this gap by analyzing the water management practices employed to ensure equitable water access.

2.1.2 Water Resources Use

Degefu *et al.*, (2019) analyzed the impact of upstream water users on downstream users and found that 2.12 billion people in 336 sub-basin areas experience water stress level change, from no water stress to one of the water stress categories, for at least one month as the result of upstream withdrawal. The study however, did not point the exact water use practices by upstream users, which led to withdrawal of water from the rivers. Therefore, there is a need for studies on water uses upstream that that increase the demand and over abstraction of water creating scarcity to users downstream. This study also did not find water competition as the sole cause of conflict between upstream and downstream and that conflict was there before in latent form it would be interesting if similar situation prevails in the study area in Laikipia sub basin.

Munia *et al.*, (2018) developed a framework to quantify the dependency of downstream water stress on upstream water supply and applied the framework to global Trans-boundary river basins. Surprisingly, they found that the majority (1.15 billion) of those people (1.18 billion) currently suffer from water stress only because they excessively use water within each basin and the water use from upstream does not have significant impact on the downstream stress status. There is a great need for further

research in this area on upstream and downstream interactions since theories reviewed indicate direct quantification of influence of upstream water use on downstream water scarcity in river basins. It is possible that other factors such as management of waters which were included in the current study had influence on conflicts between upstream and downstream water resources users.

Wada *et al.*, (2016) carried out a study on modeling global water use for the 21st century. The study found that in order to sustain the growing of food to meet demand and increasing standard of living, global water use increased by nearly 6times during the last 100 years, and continues to grow. The methodology used by the study was longitudinal, the current study employed cross-sectional descriptive study focusing on water access, use and management by households and related conflicts in the Upper Ewaso Nyiro Sub-Basins of Laikipia.

A study conducted in Tana basin of Kenya by Agwata (2005), focused on water resources utilization, conflicts and interventions. The study showed that various land use activities in the basin require water for their operations and since there is lack of sufficient quantities of the resource to satisfy all water needs. Water scarcity increased competition, which resulted to conflicts. Agwata (2005) however did not focus on management practices that had been adopted to mitigate water related conflicts, which is in the scope of the current study. Similarly, the study also failed to highlight theoretical framework that guided the analysis of water resources utilization, conflicts and interventions while the current study approach water resources competition through the lenses of game theory.

Baur *et al.*, (2000) focused on upstream/downstream competition for water in the Usangu Basin, Tanzania. The study reported that water is under pressure from

competing uses, causing changes in the hydrology of the basin and in the availability of the resource to others within the basin and downstream. The study was conducted in Usangu wetland lies in the south west of Tanzania between the towns of Mbeya and Iringa. The study focus did not include management practices and how competing water uses influence conflicts. This gap will be addressed by the current study.

2.1.3 Management of Water Resources

The study by Esteban *et al.*, (2018), conducted a study on interest group perceptions on water policy reforms: insight from a water-stressed basin. The findings show that water stakeholders with diverse local conditions share different opinions about water policies. The results highlight the existence of notably differences between the preferred measure to face with water scarcity together with sizable divergences in the active lobbying capacity of the interest groups depending on the size of the group, the specific basin location (upstream or downstream), and group characteristics. The study does not however highlight other factor besides lobbying capacity that influence inequalities in water access that the current study sought to establish.

De Stefano *et al.*, (2018) study focused on groundwater governance in the Rio Grande: co-evolution of local and intergovernmental management. De Stefano, et al (2018) revealed conflicts caused by institutional interplay in the management of water resources at different level. The study however, does not highlight the role played by water management institutions in ensuring equitable water access, use and management of ensuing conflicts among various water users. The current study sought to address this research gap.

Döll *et al.*, (2015) focused on integrating risks of climate change into water management. Anthropogenic climate change has made water management more

difficult as hydrological conditions will change in the future in a highly uncertain way. To achieve water security in a changing climate, the well-established approach of adaptive IWRM needs to be extended with respect to the risks of climate-change. The current study discusses climate change issues influenced the water resources management in study area and how the institutions responded to matter of climate change in their water management mechanism.

A study by Kiteme and Ehrensperger (2005), focused on Upper Ewaso Nyiro River Basin water management information platform-survey on development priorities, information needs and conflict management efforts. The study used interviews on WRUAs representatives in data collection and showed that there were concerns about the quantitative availability of water, efficient water infrastructure and the stiffening competition over water resources go hand in hand with the prevalence of small- and large-scale irrigation farming, horticulture, urban lifestyle and strong immigration. The study by Kiteme and Ehrensperger (2005) however, relied on information provided by WRUAs representatives who are responsible for water resources management and fail to factor in households who are the major beneficiary of water in the study region. The current study focused on households in collecting data necessary for assessing the water access, use and management within the study region. Nesting Ostrom (2003) good governance at project level more effective than at higher level see De Angello *et al.*, (2004) who came to Kenya to validate Ostrom.

2.1.4 Water Resource Conflicts

Okpara *et al.*, (2015) found that conflict is a probable outcome in locations that are already challenged by a multitude of other context-specific factors besides resource scarcity. In the Lake Chad context, the likelihood of scarcity-driven conflict depend on whether vulnerability increases or decreases in the face of a declining water supply.

This study was specific for Lake Chad context which therefore implies the further studies are need in other context to establish whether conflict is linked to context-specific factors in other water basins such as Upper Ewaso Nyiro North Basin. Seasonality of conflict is also context based.

Warurii (2015), study is based on inter-ethnic conflicts: trends, causes, effects and interventions in Rumuruti Division of Laikipia County, Kenya. The objectives of study included; tracing the historical trends, investigating the causes of inter-ethnic conflicts; examining their effects on food security as well as the intervention measures. The sample population was 100 respondents drawn from a research population of 78,930 in Rumuruti Division of Laikipia County. The study found out that competing interest on land resource utilization has prevailed since the colonial period. Competition for socio-economic resources among and between communities ranked high as a main cause of inter-ethnic conflicts in Rumuruti Division of Laikipia County. Warurii (2015) failed to bring out the specific role played by water resources access, use and management on inter-ethnic conflicts in Rumuruti Division of Laikipia County. The study although mentioned the aspects of legality without mentioning whether there was a need for additional legal framework or implementing of existing laws. The current study sought to address this research gaps.

Muigua (2016), conducted a study on natural resources and conflict management in East Africa. This study focused mainly in areas within the east Africa region including Kenya, Uganda and Tanzania. The study established that the current framework has not been efficacious in resolving conflicts and there is a need to develop a new approach to conflict management. The study failed to analyse some of the water use practices that resulted to conflicts, which limit the effectiveness of the current management

framework. The current study addressed this gap by analyzing the access, use and management of water resources and whether they had an impact on water conflicts among various water users in Upper Ewaso Nyiro Sub-Basins of Laikipia.

Yang and Cai (2014), studied practice and strategies for managing water conflicts between human and ecosystems in Canada. Conflicts over fresh water are of increasing concern between human beings and ecosystems across the world. Due to increasingly intensive disturbances by human beings in many river basins, great potential damages and risks are believed to be associated with indigenous ecosystems. A cascade of adverse impacts on water quality and quantity, river regime and hydraulic features has occurred, leading to many effects upon ecosystems. Managing conflicts over water resources between human beings and ecosystems are thus of great significance in many watersheds across the worlds. Yang and Cai (2014) study focused on management of water resources between human and ecosystems, the current study focused on management practices of water resources between various human water users, which delineates the focus of the two studies.

A study by Opiyo *et al.*, (2012) focused on drought-induced conflicts over grazing resources and their study-analyzed a number of factors that spark and aggravate conflicts in the ASALs areas of Northwestern Kenya. Between 2008 and 2011, focus group discussions and interviews were carried out with 376 members of the Turkana and Pokot communities and key informants. The research established a number of factors include competition among water users, persistent droughts, lack of strong institutions to manage equitable water use, political differences and biased property rights over water governance led to conflicts. The study however was not specific on

the water use practices and their effect on conflicts among upstream and downstream users.

A study by Pandey (2011), focused on understanding patterns of water conflicts: social and political variables. The study reported that conflicts over resources, particularly over water, are couched in different dimensions of politics. Pandey (2011) argued that there is a need to deconstruct the social dimension of water usage and the politics behind its sharing at all levels. The study however, does not mention how politics can be shaped in management of the water conflicts and implementation of existing laws to mitigate the conflicts, the gaps that the current study sought to address.

Mahlakeng (2015), analyzed environmental conflicts: the case of the Nile River basin. The study argues that, given the reduced outputs due to population growth, degradation and depletion of the Nile and its uneven distribution, the fierce competition over the already finite water resources increases the potential for an inter-riparian conflict in the Nile basin. Mahlakeng (2015) points out that the solutions of water conflicts should be addressed from the bilateral perspective without giving attention to local solutions as suggested by game theory and Ostrom principles. The current study will be driven game theory in analyzing water conflicts management in the study area.

Similarly, Le Meur, *et al.*, (2006) carried out a research on conflict over access to land and water resources within Sub-Saharan Dry Lands. The objective was to help national decision-makers and international development agencies to formulate policies and prioritizing their action for an improved sustainable use of the land and water resources, while resolving conflicts among the different users. The study findings showed the acuteness of local and regional conflicts, often labeled as “ethnic” without further empirical exploration, were deemed to be linked to competing access to increasingly

scarce natural resources, land, water or mining products. Le Meur *et al.*, (2006) focused on water conflicts through lenses of ethnic however the study area is a settlement area consisting of many ethnics therefore the issues of ethnic in water conflict in latent and may not be the primary cause.

A study by Wiesmann *et al.*, (2000) on mitigating conflicts over scarce water resources in the highland-lowland system of Mount Kenya found that developments in the area have set the stage for increasing conflicts over water resources. They further noted that water is becoming ever scarcer, especially in the dry areas of the Laikipia Plateau and the Samburu plains to the northwestern part of the Mt. Kenya. This study was conducted before the setting up of county governments now playing a significant role in the existing institutional arrangement in water governance. This study will bridge the gaps by examining the role played by water management institutions under devolved systems of governance created under constitution (RoK, 2010).

2.3 Theoretical Framework and Conceptual Framework

This study was anchored on two fundamental theories, The Theory of Access by Ribot and Peluso (2003) on the concept of property rights reinforced by structural and relational components (Ribot & Peluso, 2003) and Game Theory (Forgo, 2004). The study analyzed water access, use and management through the lenses of these two theories.

According to Ribot and Peluso (2003), several mechanisms help us understand conflict caused by access to natural resources. Rights-based access mechanisms include permission to property ownership. The proponents of this argue that access to resources is a clear factor shaping the conflict because it looks at the rights through land ownership. The theory is relevant because it fronts the argument to expand

conceptualizations of access beyond rights-based approaches to consider “a larger array of institutions, social and political-economic” (Peluso & Ribot, 2003). The theory guided the study in assessing whether communities within the study area have equal rights in access, use and management of water resources or whether some users have more rights, which they exploit to the detriment of other users.

Game theory on other hand describes, strategic decision making in which people must cooperate to gain advantage since the loss of one is the net gain of the other (Von Newman, 1944). This theory was relevant in analyzing the relationship between access to water, use and management since competition entails a focus on self-interest. Dinar and Hogarth (2015), argues that both in its non-cooperative (NCGT) and cooperative (CGT) forms, game theory has been central in its contribution to the analysis of important aspects related to water resources.

The study adopted game theory, in assessing existence of collaborative efforts in water resources access, use and management within the study area and the impact of management systems and structures adopted on occurrence of conflicts. Jhavar *et al.*, (2018), Bhagabati and Kawasaki (2014) and Hui *et al.*, (2016) also applied game theory as a tool for dispute management in shared resource utilization. The author highlighted that cooperation reduces the disputes among various users of shared resources. Petersen-Perlman, *et al.*, (2017) also used game theory in assessing the trans boundary water conflicts and found that use cooperation in management of the water conflict have gained much awareness.

The study further looked at the applicability of Ostrom (2003) 8 principles for managing a common, which are generated, from the game theory and whether they were applied within the study area. Ostrom (2003) argues that a more effective way of managing the

common must bring together all the users in a long-lasting and cooperative manner. According to Ostrom, effective commons governance is easier to achieve when these rules are observed. The rules must define boundaries for all the groups to exclude potential beneficiaries who may not be willing to cooperate. The rule governing use of the commons must be integrated with local need and conditions since resources vary in type such as water or fishing and the core amounts to be preserved while the fringe benefits are exploited sustainably need to be determined and whoever is affected by the rules should be invited to modify them. The participants in the current study area do not have control over available quantities of water but are concerned by unequal allocations (Gichuki *et al.*, 2003). The idea of participation in rules and policy making is enshrined in Kenya Constitution but the practice of consultation is weak in laws governing water management on the ground (RoK, 2016).

A gap therefore exists on the reason why reluctance to implement regulation exists. External authorities must respect the rule making rights of all the stakeholders, while a system must be developed and implemented by the community to monitor behavior of members (Ostrom, 2000). In the study area WRUAs can make rules which are endorsed by WARA. Another principle recommends for graduated sanctions for rules violators. It is expected to confirm if this is the case in study area in the area of penalties for non-compliance or whether the rules governing non-compliance are applied in a graduated manner or not. Disputes resolution must be done in a low cost manner and should be accessible to all the stakeholders and finally responsibility for managing the commons should be done in an interconnected manner from the lowest level to the highest level (Ostrom 2003). De Angello *et al.*, (2004) from former Ostrom Florida University in Florida confirmed the working of the rules nested at project level but a gap exists as to why same governance rules is defective at WRUA and higher level.

2.3.1 Conceptual Framework

Access, use and management of water and its relation to conflicts were driven by the interaction of a number of social, economic and physical factors as shown in the Fig.1 below. The interactions of these factors cause affect the water availability and the water demand, with physical factors affecting the availability whereas the socio-economic factors affecting the water demand. The interaction of the water availability and the demand affects water stress, scarcity, vulnerability and security, which later affect the relationship of various water users known as actors. This result in actions that drives coping with water scarcity triggering water related conflicts. Below is a figurative representation of the variables to be explored. The construction of the conceptual framework was informed by the theoretical framework.

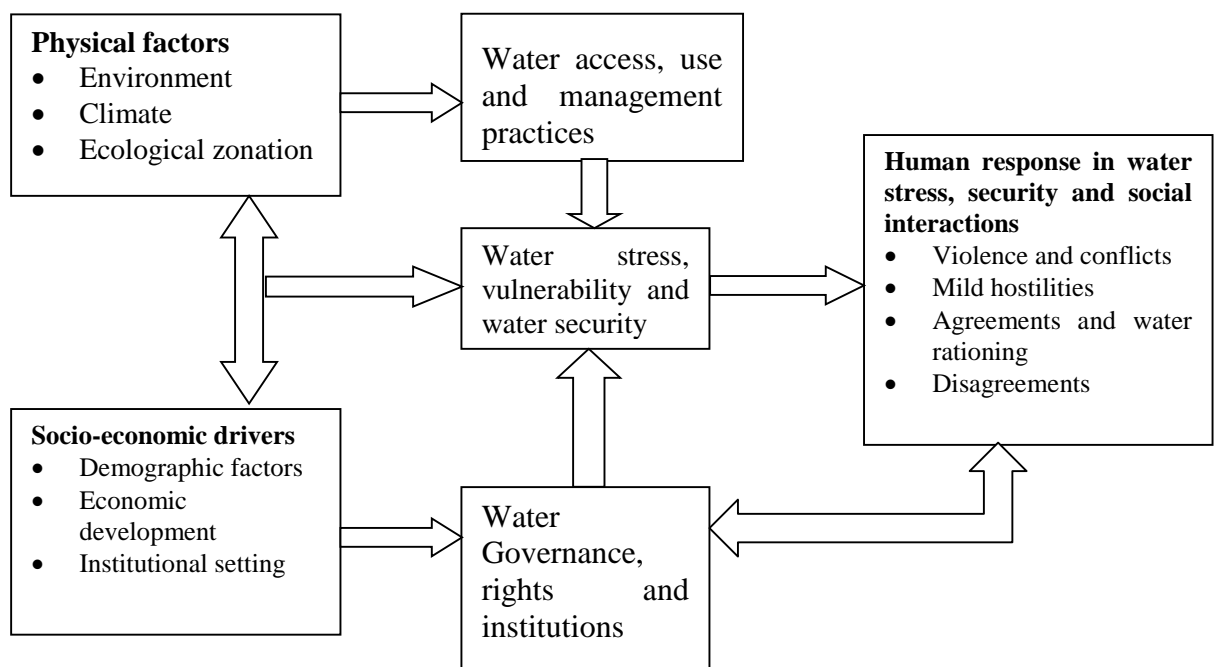


Figure 2.1: Conceptual Framework

Source: Author, (2018)

CHAPTER THREE: MATERIALS AND METHODS

3.1 Study Area

The study area was Upper Ewaso Nyiro North River Sub-Basin which is about 2,175 Km² situated within Nanyuki sub-region (4,232 Km²). It is one of the five sub regions (Isiolo, Mandera, Marsabit, Nanyuki, Rumuruti) that form the greater Ewaso Nyiro North River Basin (210,000 Km²). The study area is traversed by a number of rivers originating from Mt. Kenya starting from Naro Moroto Timau River with only river Moyok originating from the Aberdare ranges. Over 242,201 (ROK, 2009) people reside here where pastoralism is the main means of livelihood in the lower regions while crop and dairy farming taking places within the humid regions on the slopes of Mt. Kenya and Aberdares. Nanyuki town which is the headquarters of Laikipia County is found within the study area.

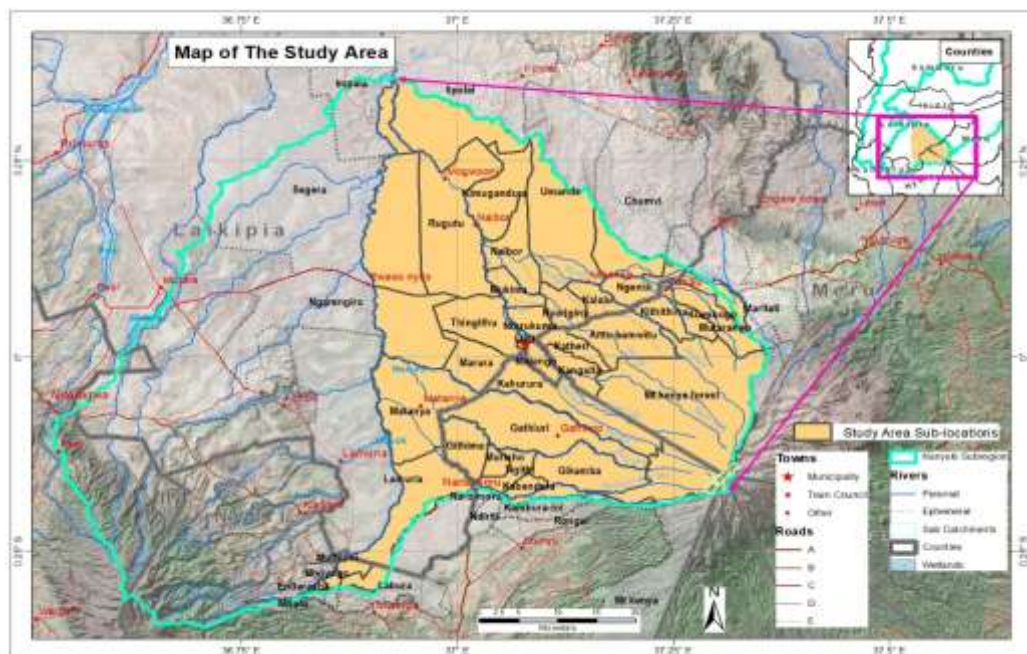


Figure 3.1 (a): Map of the Study Area.

Source: CETRAD Data base (2015).

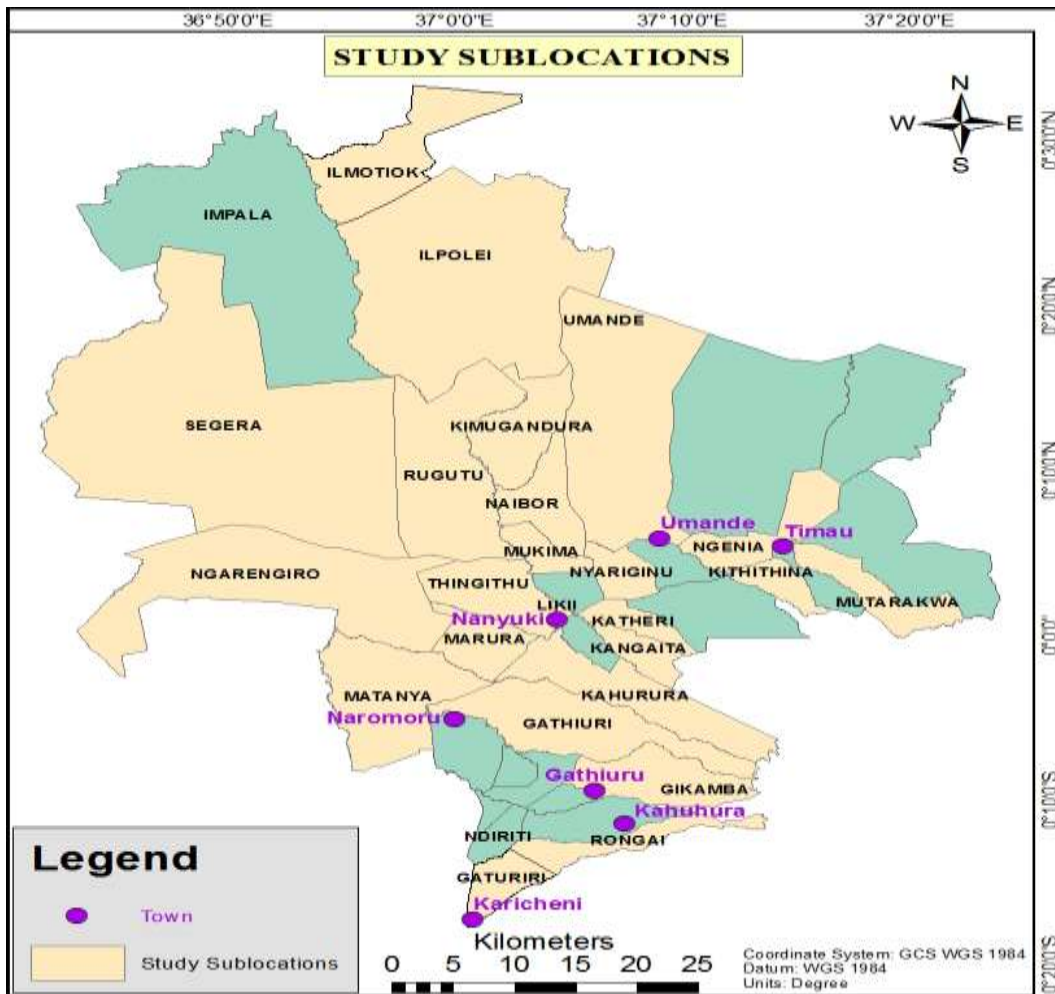


Figure 3.1 (b): Study Area: Administrative Sub-Locations

Source: By Author (2015)

3.1.1. Biophysical Features

This section presents the biophysical features of the study area. These include climatic conditions, soils, hydrological aspects, vegetation, fauna and land use.

3.1.1.1 Climate and Hydrological Aspects

The study area experiences five agro-climatic zones, which include humid, sub-humid, semi-humid, semi-humid-semi arid and semi-arid respectively as distance from the Mt Kenya increases. Majority of the areas in Laikipia receive less than 1400mm of rainfall

annually making households rely more of river flows for water from the foot zones of Mt. Kenya Liniger & Gichuki (1994), as shown in Appendix VI.

Table 3.1 Agro-Climate and Hydrological Aspects

CLIMATE	Area (Km ²)	Perc (%)	Rainfall (mm)	
			Minimum	Maximum
Humid	163	8	1100	2700
Sub-Humid	282	13	1000	1600
Semi-Humid	194	9	800	1400
Semi-Humid - Semi-Arid	460	21	600	1100
Semi-Arid	1,076	49	450	900
Totals	2,175	100		

Source: CETRAD Database (2014)

The study area receives low amounts of rainfall, which is attributed to its location on the Leeward side of Mt. Kenya, the Aberdare and Nyambene mean annual rainfall ranges between 2030mm in Mt. Kenya to fewer than 300mm in the lowlands in parts of Samburu, Isiolo and Nyambene districts. The flow of Ewaso Nyiro at Archer's post in a dry year or month is highly dependent on contribution of Mt Kenya. The lowland plains produce significant proportion of the total flow in wet years and months due to high surface runoff during the rainy seasons, which is rarely captured. The highland areas are therefore crucial to the sustainability of the flows downstream particularly during the periods of high rainfall.

The study by Liniger & Gichuki (1994) found that seasonal rainfall pattern, low rainfall/high evaporation and drought cycles are the main natural factors contributing to the declining river flows at Archer's Post river-gauging station. Since rainfall is the main source of stream flow, seasonal rainfall directly influences stream flow. There is a spatial variability of rainfall in the basin with the months of January and February having the lowest flow regime.

The findings by Liniger & Gichuki (1994), found that the average annual evaporation, rainfall and deficit (rainfall-evaporation) over the entire basin are 1,739 mm, 651 mm and 1,088 mm, respectively. Their findings further stated that the annual evaporation is exceeded by the rainfall in only 1 percent of the basin area, resulting to a deficit of more than 1,000 mm per year is experienced (Liniger & Gichuki 1994). Data analysis on rainfall and stream flow shows that dry seasons experienced in cycles of 2-8 years leads to extreme low flow conditions (Liniger & Gichuki 1994). A correlation analysis of rainfall and river discharges has shown that the decrease in low river flow is not a result of changes in rainfall patterns (Liniger & Gichuki 1994) but is due to a combination of low rainfall and high levels of water abstraction in the upper reaches.

3.1.1.2 Soils Types

The study area has varied soil types as shown in Table 3.2. The large parts are made up of Phaeozem (26.91%), Luvisol (19.0%), Organic (11.53%), Vertisol (11.48%), Planosol (10.70%) and Andosol (10.13%). Appendix VII further shows the soils distribution of the area as indicated by CETRAD (2004)

Table 3.2 Soil Type in the Study Area

Soil Type	Area (Km2)	Perc (%)
Andosol	220	10.13
Cambisol	149	6.84
Luvisol	424	19.51
Nitisol	4	0.20
Organic	251	11.53
Phaeozem	585	26.91
Planosol	233	10.70
Regosol	53	2.45
Urban	5	0.24
Vertisol	250	11.48
Grand Total	2,175	100.00

Source: CETRAD Data base (1982)

The soils are derived from volcanic materials that are fertile and suitable for crop production. The bulk of ASAL soils has low natural fertility and is vulnerable to erosion. The combination of aridity and poor soils makes rain fed cropping risky. Despite these constraints, the ASALs within the ENNR basin are undergoing accelerated degradation on account of over-exploitation of natural resources (Liniger & Gichuki 1994).

3.1.1.3 Vegetation and Land Use

The dominant land cover classes are woody grasslands (32 %), grasslands (29%) and Natural forests (17%) and cropland (10%) constituting over 90% of the land. They occur mostly in semi-arid to very arid climatic zones.

Table 3.3 Vegetation and land Use

Land Cover Type	AREA (Km2)	Perc (%)
Woody Grassland	710.6	32.67
Grassland	637.1	29.29
Natural Forest	385.2	17.71
Cropland	219.6	10.1
Moorland	188	8.64
Planted Forest	34.1	1.57
Water	0.5	0.02
Totals	2,175.20	100

Source: CETRAD Data base (2014)

There are diverse land use practices in Laikipia which include crop farming, pastoralism, private and group conservancies as well as large scale agriculture that involve wheat farming and ranching (CETRAD, 2014). However poor land planning has resulted to continuous conflicts especially considering that a large percentage of the land is owned by large-scale farmers most of whom are settlers while others are absentee landlords. The croplands are mainly found within the upper catchments of the study area. They are concentrated within the humid to semi humid climatic zones where

main agriculture activities include rain-fed small-scale crops and livestock production. The farmers mainly grow staple foods such as maize, beans and potatoes. Those farmers near river channels also practice irrigated agriculture where they mainly grow vegetables for local consumption and sale of extra produce.

The study area has an abundance of wildlife, second in Kenya to the Maasai Mara, although wildlife roams through a mosaic of government, private and communal lands. The land previously owned by European farmers is now subdivided into small plots. The plots are under large and small-scale mixed farming, which is experiencing population, increases due to immigration and natural growth from adjacent high potential areas. The crops are both cash crop and food crops. The main cash crops include maize, beans, potatoes; the cash crops are snow peas, flowers onions tomatoes, cabbages and potatoes.

Land use is quite intensive given the fertile soils, reliable rainfall, and river water for irrigation and good transport in the upstream regions while downstream is largely semi-arid occupied by pastoralists. The main land use downstream is livestock rearing with a few people planting beans as a food crop. Generally, the livelihood depends on cattle sheep and goats while camels are being introduced in this area. The land is fragile and subject to degradation, yet they present a potentially important resource, which if managed carefully, can help serve the income, employment and food sufficiency goals.

3.1.3 Demographic Features and Community Profile

The study area is home to over 240,000 people distributed within 3 Counties of Laikipia, Meru and Nyeri and further into 46 sub-locations (CETRAD, 2015). Over 240,000 people reside here where pastoralism is the main means of livelihood in the lower regions while crop and dairy farming taking places within the humid regions on

the slopes of Mt. Kenya and Aberdares (CETRAD, 2015). The sub-basin has an estimated population of about 71681 households, who depend on water for various uses (KNBS, 2009). The main water users are pastoralists, ranchers, agriculturalists, commercial horticulturalists; fast-growing urban centers, wildlife conservancies and tourism (CETRAD, 2015). The study area also covers multiple land uses and has a history of water resource conflicts due to diverse water users. The main conflicts in Laikipia county are cattle rustling, agro-pastoral conflict, human-wildlife conflicts and water conflicts although there are emerging inter-basin, inter-County and inter institutions conflicts (Bond, 2014). Poverty, illiteracy, environmental degradation, gender inequality, illegal firearms, absentee lands, lack of security personnel, lack of extension personnel, lack of crop diversification, poor water harvesting and storage, livestock diseases, poor livestock breeds, and lack of adequate seed varieties all impede development and contribute to the complexity of natural resource management (Aarts, 2012).

Political incitement especially nearer the general elections and corruption that promotes ethnic division and conflict within the study area leads to resources exclusion, migration. Elites gain; contribute to the human insecurity of Laikipia residents (Bond, 2014). Conflicts revolve around the management of resources such as land, pasture and water and the policies, which underpin such management regimes (Bond, 2014). In relation to human-wildlife conflict, elephants are the main animals in conflict with humans. These interactions in addition to crop raiding and infrastructure damage, have led to several deaths in Laikipia County (Kasim *et al.*, 2014).

3.2 Research Design

This study adopted a descriptive survey research design. According to Mugenda & Mugenda (2011) survey research design is useful not only in securing evidence concerning an existing situation or current conditions but also identifies standards or norms with which to compare present conditions in order to plan the next step. This study aimed at studying conditions or events that exist. Descriptive survey design has been shown to be useful in describing the characteristics of a large population, makes use of large samples, thus making the results statistically significant even when analyzing multiple variables, many questions can be asked about a given topic giving considerable flexibility to the analysis, the design allows use of various methods of data collection like questionnaire and interview methods and also makes use of standardized questions where reliability of the items is determined(Mugenda & Mugenda, 2003).

3.3 Target Population

According to the 2009 population census, the study area had a population of 71,681 households (KNBS, 2009) and hence it can be defined as a large population. A large population is one that comprises of 10,000 elements and more (Mugenda & Mugenda, 2003). The target population of the study was 7,168 households and is within northwestern part of Mt. Kenya covering Laikipia East and Laikipia North in Laikipia County and adjacent Sub-Counties of Buuri in Meru County, and Kieni in Nyeri County,

Table 3.4 Target Population of Households

Region	Population of Households
Laikipia	35,002
Meru	14,325
Nyeri	22,354
Total	71,681

Source: KNBS, (2009)

3.4 Sampling Design

The number of the households surveyed was based on the sample size calculated from the households of area constituting sub basin. The ultimate test of a sample design is how well it represents the characteristics of the population it claims to represent. This study used simple random sampling technique. In such a case, a final sample estimate is calculated using a formula recommended by Mugenda and Mugenda (2003) and Gay (1981) that is used to determine a sample from a large population. Using the formula below, a sample size is determined as follows:

$$n=Z^2*p*(1-p)/d^2$$

n= the desired sample size if the targeted population is greater than 10000

Z= the standard normal derived at the required confidence level

p= the proportion in the target population estimated to have characteristics being measured.

$$q=1-p$$

d= the level of statistically significant set.

If the estimate of the proportion of the target population assumed to have the characteristics of interest is not provided, then 50% should be used. Therefore, with the proportion of the target population being .50, then the z- statistics is 1.96. Consequently,

The sample size was;=384

$$n \text{ (sample for strata)} = n = \frac{HH}{Total\ HH} * 384$$

Table 3.5 Target Population and Sample Size

Region	Population of Households	Sample Size
Laikipia	35,002	187
Meru	14,325	77
Nyeri	22,354	120
Total	71,681	384

Source: KNBS, (2009)

The study however, excluded the household, which lacked head and any members who could respond to the information needed. The households that refused to consent to the study were also excluded from the survey. The study targeted the household heads or the immediate next of kin present in the absence of the household head whose personal details are captured by the questionnaire.

3.5 Data Collection Methods

The study utilized both primary and secondary data. Reconnaissance visit was conducted before the data collection in order to identify potentially eligible groups for the survey, target populations, delimitation of study area for the households, focus group discussions and the key informant to be interviewed. Primary data was collected

through structured questionnaires, interviews, and FGDs. Among the areas visited during the preliminary study survey were; CETRAD headquarters based in Nanyuki, WRA Nairobi Head office and WRA Regional Offices in Upper Ewaso Nyiro North River Basin based in Rumuruti, Nanyuki and Isiolo to obtain background information on water access, use and management. Questions were raised on what policy and practice worked and what challenges were faced on implementation of such policies and practices. Visits were made to commercial horticultural farmers in Timau, ranchers and water projects under WRUAs in both upstream and downstream zones and the Laikipia Wild Forum.

The Kmacho application was used for the data collection; administration of the questionnaires and the taking of the GPS locations for the households surveyed. The Kmacho software installed in the 12 enumerators android mobile devices who were trained by a qualified trainer to capture geographic coordinates of households interviewed, images of water intakes/abstractions, water harvesting facilities, livestock watering points, livestock population of the households and type of crops planted on farm. Public boreholes and shallow wells, major towns and market centers, smallholder irrigation sites, location of key stakeholders, method of water harvesting access and use were similarly captured using the devices. The spatial data was used to show the distribution of the households against the water basin to appreciate how water access distribution was related to access, use and management and related conflicts.

Secondary data involved the utilization of published journals and other literature, both local and international relevant to the research. Research and data from CETRAD data base, Laikipia Wild Life Forum, Laikipia Water Inaugural Conference, Water Resources Authority, Water Users Resources Associations, County Government,

Government KWS, KWLS, Rural Focus a Nanyuki based Water management and Consultancy provided the necessary data. (list in appendix II)

3.5.1 Household Questionnaires

Questionnaires were designed based on theoretical framework on game theory and access theory. These theories informed the nature of the questions asked in terms of competition of water resources, actors involved, rules and regulations and water governance. The questions asked aimed at seeking answers to the three research questions and objectives. They were administered to households to get information, opinions and perceptions about the study objectives at the household level. Questionnaire items were both closed and open-ended with each seeking to test the research premises earlier outlined. A single questionnaire that consisted of all the questions testing all the study objectives was used. The questionnaire consisted of demographic characteristics of the respondents, social and economic/livelihood of the respondents, questions on accessibility to water, questions on water conflicts (cause, extent, socio-economic impacts, duration of the conflicts, actors in the conflicts, mitigating remedies, actors in conflict management, solutions) questions on impacts of conflicts on the environmental.

Training of the 12 research enumerators with o-degree levels two with masters was conducted by and expert PhD research assistant on use of the Kmacho software and application. Their education level was secondary to degree level of education familiar with local languages and took place in Nanyuki. The questionnaires were not administered to an individual household member alone but to as many members present as possible. Questionnaires were administered randomly among the communities' resident in the sub-basin to cover varied ecological zones and of the study area. The

researcher randomly selected proportionally n/population multiply by total sample 384 resulting in 187 households from Laikipia, 77 from Meru and 120 from Nyeri. Selecting every fifth household encountered and administering the questionnaires to the head of that households or the eldest person available in case the household heads were absent did the random sampling.

3.5.2 Key Informant Interview

The study relied on Key Informant Interviews (KII) to bring out relevant information particularly the technical and institutional, administrative and legislative ones about the study topic and area. The main key informants interviewed included representatives from; WRA one representative who worked closely with the WRUAs, CEC of environment from the 3 County Government, Chairman of Nanyuki, Likii, Naromoru, Ngushishi, Timau, and Ontulili WRUAs, and 3 CETRAD Sub regional officers. The study conducted a total of 13 interviews, which were guided using the interview guide (appendix III).

The guide consisted of questions on water accessibility, causes of water shortage, effects of reducing water to the local people, water resources related conflicts on water, what has been done to address the conflicts, institutions involved, what is being done currently to address the problem and their experiences on multiplication of institutions by various laws passed over the last twenty years. Consent or approval from the key informants was sought before the interviews started.

3.5.3 Focus Group Discussions

Focus group discussions (FGDs) were conducted to gather additional information on accessibility to water and related conflicts. They were selected on their recommendation by WRA on best practices, and the challenges faced on access use and

management the prominence as supply source for NAWASCO at the source of Likii river in Meru County. These were conducted with Nanyuki, Likii, Naromoru, Ngushishi, Timau, and Ontulili WRUA chairmen. Other FGDs conducted include village elders, women, youth groups and other water user groups identified during the mapping process. A total of 5 focus group discussions were conducted in each of the ecological zonation (upstream, mid-stream and downstream). This was ensuring that all the groups were represented in the study and all the views gathered in terms of water access and conflicts associated. Among the rivers surveyed were Nanyuki, Likii, Naromoru, Ngushishi, Timau, and Ontulili, forming good representatives of the upstream, midstream and downstream communities affected by water scarcity, pollution, and conflicts. The FGDs conducted were gender segregated during interviews (male and female different) to allow and enable different gender express their opinions freely.

A list of relevant questions was used to guide the FGDs dialogue boxes contain summaries of challenges from each WRUA such as Ngushishi in at the lower end of upstream basin complaint of too many licensed intakes, conflict created by the use of old irrigation water technology water wasting method impacting on downstream pastoralists who have no choice but to migrate upstream destroying water intakes in dry season. They are the first point of those facing the wrath of pastoralists. These occurrences often force the WRUA to rush and engage the commercial horticulture farmers whom they feel are favored by WRA by way of more water allocation. Umande water project who are members of Ngushishi WRUA expressed the same views on too many intakes upstream while theirs are old and dilapidated.

3.5.4 Transect Drives and Walks

Transect drives and walks were carried out to observe how Community and WRUAs Water Projects water intakes, NAWSCO water intake at the source of Likii river located deep in the forest operates to supply water to Nanyuki Municipality lying upstream of the study area. The old colonial intakes were still operating. Likii River intake in Meru County is at the foot zone of Mount Kenya supplying water to Nanyuki Water and Sanitation Company which runs a water purification business and at the same time supplying water to the residents of urban areas and tankers to pastoralists outside the Municipality area.

State of water infrastructure and waste disposal was observed. Transect drives and walks were conducted along rivers: Nanyuki, Naromoruto see the state of the river during rainy and dry season and the impact to residents of dry season water scarcity. During these visits, FGD meetings were held to collect views on water management challenges from Water Project Committee Members and WRUAs. Visits were made to youth groups at informal settlement of Likii and witnessed waste pollution in open drainage system. Ngushishi WRUA was among the best run in management but experiencing river water pollution due to raw sewage from overflowing toilets during rainy season.

It was reported by Ngushishi WRUA Executive Committee and officials during FGD that illegal raw sewage disposal into the rivers takes place at night for lack of sanitation infrastructure. Complaints were also raised by the same WRUA of reluctance by CFAs operating in the upstream forest area to cooperate with them in forest protection management. Timau horticulture commercial farmer interviewed who is also Chair of a WRUA expressed his views on strongly that ground water should not be exploited

but conserved for future use and instead water harvesting from roofs of greenhouses and surface water runoff be exploited for water harvesting.

Ontulili WRUA mentioned the pastoralist problem where the herders destroy intakes to access water when the flow does not reach them downstream because the commercial farmers upstream are seen to over abstract water and therefore exposing midstream agriculture farmers to the wrath of pastoralists especially during dry seasons. The Marura wetlands experiences on encroachment by titled holders but cultivated for crops during rainy season and livestock grazing sanctuary in dry season. Transect walk, interviews held with residents and observation done on water furrow diversion by agro-agricultural farmers to grow maize, potatoes beans and sugar cane. Dairy was practiced with complaints over access roads to reach the market during wet seasons.

A community member was involved to guide the drives and walks; he provided assistance especially for the entering the planned visits for example the wetlands among other places suggested to be visited. During these drives and walks water abstraction sites were identified, areas of possible damage of natural vegetation, pollution and degradation hotspots, sites where water over-utilization and dilapidated infrastructure documented. Transect walks covered short distances among the features observed during transect drives and walks were, the pollution status of the rivers, the means of waste management, water use related activities, for instance urban car washing and agricultural practices undertaken along riparian land and water harvesting mechanisms used by water users.

3.6 Methods of Statistical Data Analysis and Processing

Objective one: To investigate how upstream and downstream water user in Upper Ewaso Nyiro North Basin access and use water resources. This objective was achieved

by interrogating the adjacent community members on their daily water sources and uses. Household water demand was estimated by measuring the average daily usage of water by households in the study area (farmers large scale and small scale, pastoralists, ranches among other water users). Data was analyzed with the use SPSS version 23. This involved the mean volumes of water used for each of the livelihood activity undertaken by the community members.

Objective two: To assess the presence of water conflicts in upper Ewaso Nyiro North River Basins of Laikipia County this section applied descriptive analysis to achieve this objective. Findings are presented in tables, graphs and pie charts; National or County Government records on incidents of reported conflicts, nature and time of year and period were used.

Objective three: To investigate the effects of access to water resource on water conflicts by water users in the study area. This information enabled the researcher to know whether there is a relationship between water access, use and management and conflicts. Data collected and analyzed using SPSS and content analysis using Chi Square.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The purpose of this study was to assess water access, use and management of water resources and conflicts in the Upper Ewaso Nyiro North River Sub-Basin in Laikipia County. This chapter presents data analysis and interpretation of findings according to the three objectives. Descriptive statistics is used for objectives one and two while Chi-square cross tabulations is used in objectives three to determine relationships between water access, use and management and conflicts. The section further incorporates results obtained from FGD, Key Informants interviews and observations from transect walks and drives to triangulate the findings.

4.1.1 Response Rate

In this study a total of 384 questionnaires were administered to selected households in the study area. The map presented in figure 4.1 shows where the researcher and research assistants conducted the interviews and location of the households participating in the survey.

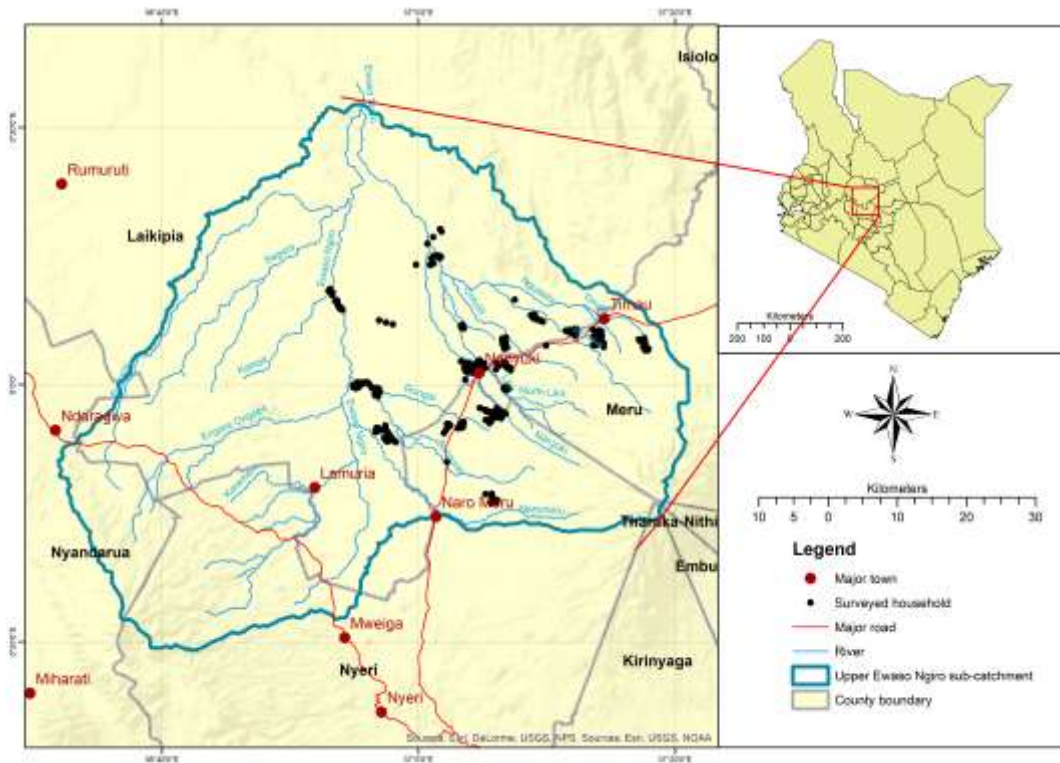


Figure 4.1 Locations of the Households Surveyed

(RoK, WRMA Map, Water Act 2002)

The areas marked show the locations of households surveyed within the study area. The K-macho technology was adopted in data collection and monitoring of data gathering process and relayed the data collected to the central computer for analysis. The study recorded a response rate of 79.4%, which was considered adequate for research according to Babbie (2004) that recommended that a response rate of above 50% is adequate for a descriptive study. This response was attributed to meticulous planning, early reconnaissance and the interest the study generated among the residents of the study area. The area however is over researched given the number of NGOs based in the area and the presence of CETRAD carrying out similar surveys albeit on different scale over water management for over 40 years.

Table 4.1 Response Rate

County	Sample Size	Response rate
Laikipia	187	160 (85.5%)
Meru	77	50 (64.9%)
Nyeri	120	95 (79.2%)
Total	384	305 (79.4%)

Source: Author (2018)

Mention the altitude used – 1850m a.s.l

The study used altitude to characterize the study area into two strata, upstream and downstream zones for the purpose of analysis although WRUAs often zoned their operations as upstream, midstream and downstream dictated mainly by mode of livelihood and rainfall.

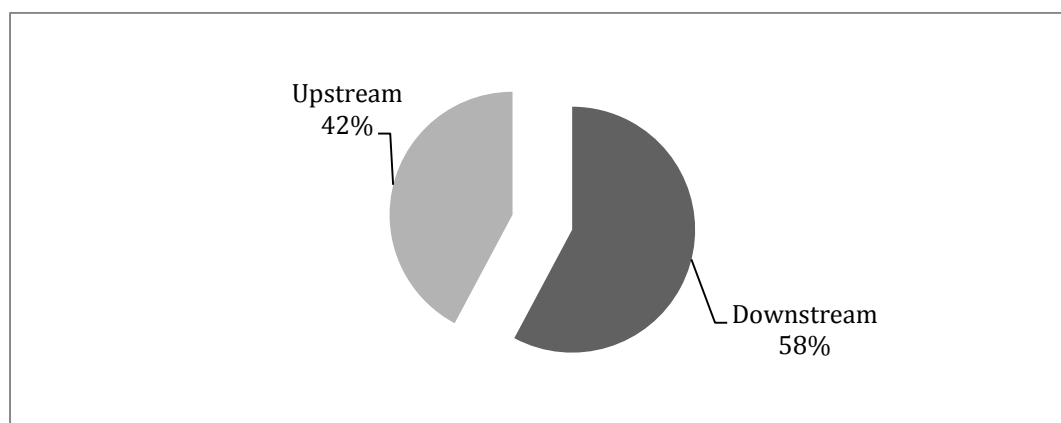


Figure 4.2 Parts of the Rivers the Households Surveyed Were Located

Source: Author (2018)

The results show that 58% of the households surveyed were downstream (Laikipia) while 42% were upstream (Nyeri and Meru). The focus on upstream and downstream household enabled the study to seek the opinion of both upstream water users and downstream water users on water access, use and management practices and whether the prevalence of water conflicts was significantly different among water users in the upstream and water users downstream.

4.1.2 Households Main Source of Livelihood

The results in Table 4.2 indicates that 70.6% of the household engage in crop cultivation, 57.6% engage in livestock keeping while 25% and 29.4% indicated that they were employed and in business respectively. The findings further show that majority of households' source of livelihood relied heavily on availability of water resources and inadequate water constitutes threat to people main source of livelihood. This further explains the importance of sustainable waster access and use by households within the study region.

Table 4.2 Economic Activities Practiced by Households in the Study Area

Economic activity	No	Yes
Livestock	42.40%	57.60%
Crop Cultivation	29.40%	70.60%
Employment	75.00%	25.00%
Business	70.60%	29.40%

Source: Author (2018)

The findings presented in Table 4.3 shows that 90.1% of the households upstream indicated they engage in crop cultivation while 61% engage in livestock keeping. The findings show that the economic activities of household upstream significantly relied

on water resources compared to downstream where slightly above 50% indicated that they practiced crop cultivation and livestock keeping as their main economic activities.

Table 4.3 Economic Activities Practiced by Households Upstream and Downstream

	Downstream		Upstream	
	No	Yes	No	Yes
Livestock	45.5%	54.5%	38.3%	61.7%
Crop Cultivation	43.7%	56.3%	9.9%	90.1%
Employment	72.1%	27.9%	79.0%	21.0%
Business	65.3%	34.7%	77.8%	22.2%

Source: Author (2018)

4.2 Access, Use and Management of Water Resources

This section presents the finding on the first objective of the study. The study sought to assess how different water users in the study area get water, use and manage the resource in the Upper Ewaso Nyiro River Basin in Laikipia County. These include water use practices, management of water resources, access to water resources. The findings presented in this section are purely descriptive statistics presented using charts, tables and graphs.

4.2.1 Access to Water Resource

The study further analyzed the households' main water sources within the study regions. The results indicated that 63% of the households relied on households' tap water, followed by rivers (26.6%) and borehole (10.2%) as shown in Figure 4.3.

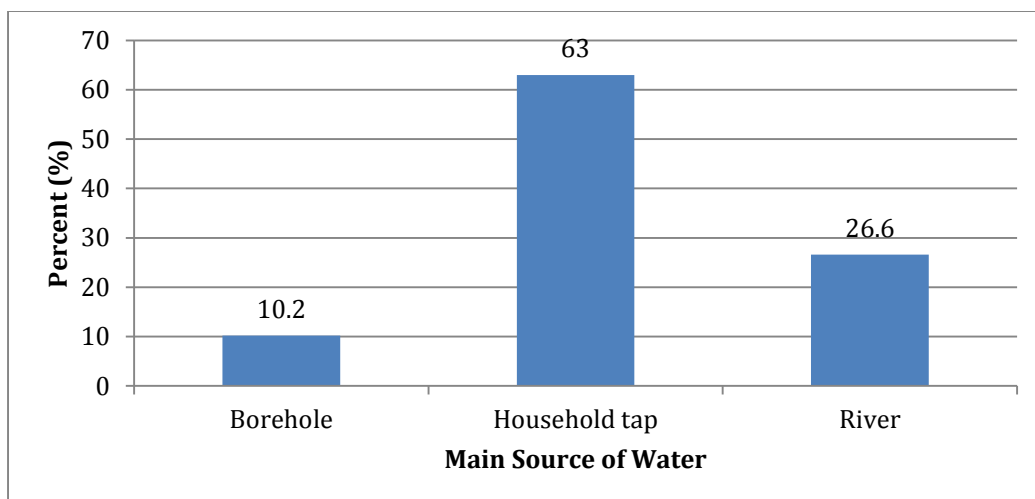


Figure 4.3 Main Source of Water

Source: Author (2018)

The results in Table 4.4 show that 87% of the households upstream indicated their main source of water was household taps while 45.5% household from downstream got their water from household taps. The results further show 38.3% of household downstream relied on rivers for water compared to 11.1% upstream. The findings established majority of households downstream drew water from the rivers directly compared to households upstream.

Table 4.4 Main Source of Water Upstream and Downstream

Main Source of Water	Downstream (%)	Upstream (%)
Borehole	16.2	1.9
Household tap	45.5	87
River	38.3	11.1
Total	100	100

Source: Author (2018)

The research findings indicate that a significant proportion of households in the study area still relied on water from rivers with majority of them residing downstream. This

implies that water use and management practices of people upstream will affect the amount of water available for people downstream.

4.2.1.1 Largest Consumers of Water as Perceived by Respondents

The results in Figure 4.4 show that 45.1% and 43.7% of the respondents perceive pastoralists and farmers upstream and downstream respectively as the largest consumers of water in the study area. These findings established that pastoralists and farmers were the main competitors in use of water resources in the regions.

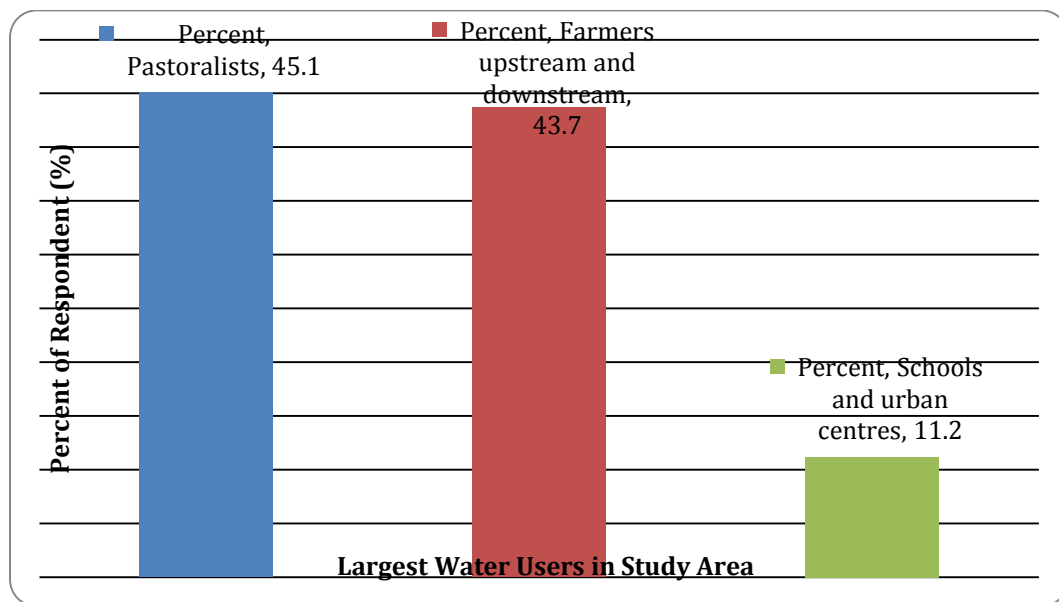


Figure 4.4 Largest Consumers of Water as Perceived by Respondents

Source: Author (2018)

The results 43.7% and 46.9% of the respondents downstream and upstream respectively perceive pastoralists being the largest water users in the study area while 42.8% and 45.1% of the respondents downstream and upstream respectively indicate farmers as the largest water users in the study area. The findings further confirmed that households both from upstream and downstream agreed that pastoralists and farmers were the largest water users within the study region.

Table 4.5 Groups utilize most Water Upstream and Downstream

Groups utilize most water in study area	Downstream (%)	Upstream (%)
Pastoralists	43.7	46.9
Farmers upstream and downstream	42.8	45.1
Schools and urban centers	13.5	8
Total	100	100

Source: Author (2018)

4.2.1.2 Hindrances to Equal Water Access in the Study Area

The study asked the respondents to name hindrances to equal access to water resources within the study area. Figure 4.5 shows that 34.6% and 31.8% of households response is that lack of trust among water users and ineffective water use policies are the main hindrances to equal access to water resources. The results further shows that 28.6% mention irregular rainfall seasons while only 4.9% mention ineffectiveness of responsible institutions posing hindrance to access to water. Lack of trusts among water users was mentioned as another main contributor to unequal access to water resources by various water users. These findings can be said to suggest that weak governance is an obstacle in ensuring equal water access.

Findings in this study concur with other researchers whose studies are guided by Game theory, which demonstrates that under non-cooperative conditions individual actors maximizes their own benefits considering that other agents also act the same.

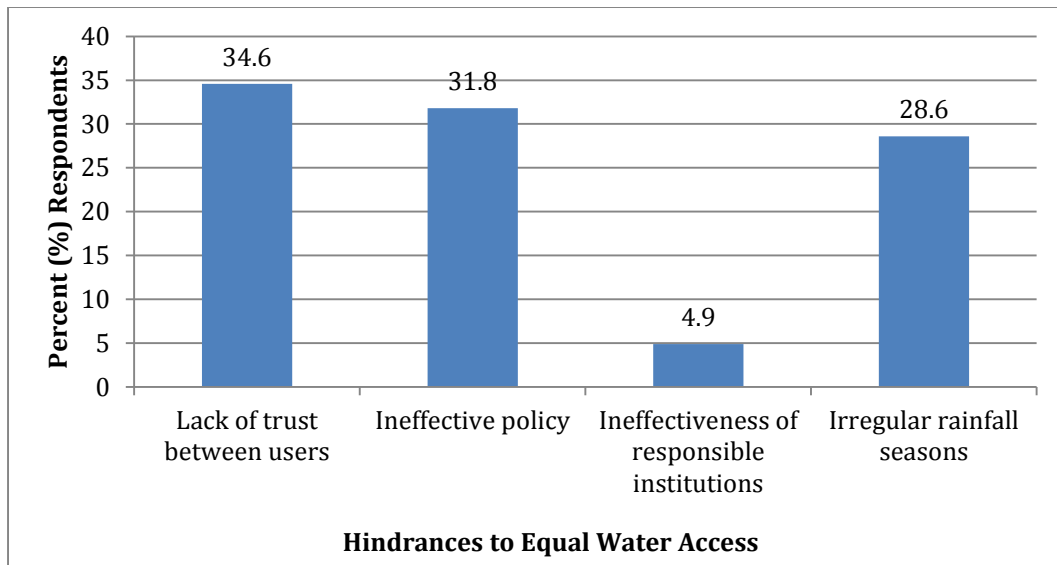


Figure 4.5 Hindrances to Equal Water Access in the Study Area

Source: Author (2018)

According to results presented in Figure 4.6, the largest hindrances to equal access to water resources by households upstream is lack of trust (38.9%) while downstream household indicated ineffective policy (38.7%). The upstream users also significantly (34.6%) indicated irregular rainfall seasons compared to 24.3% who mentioned the same.

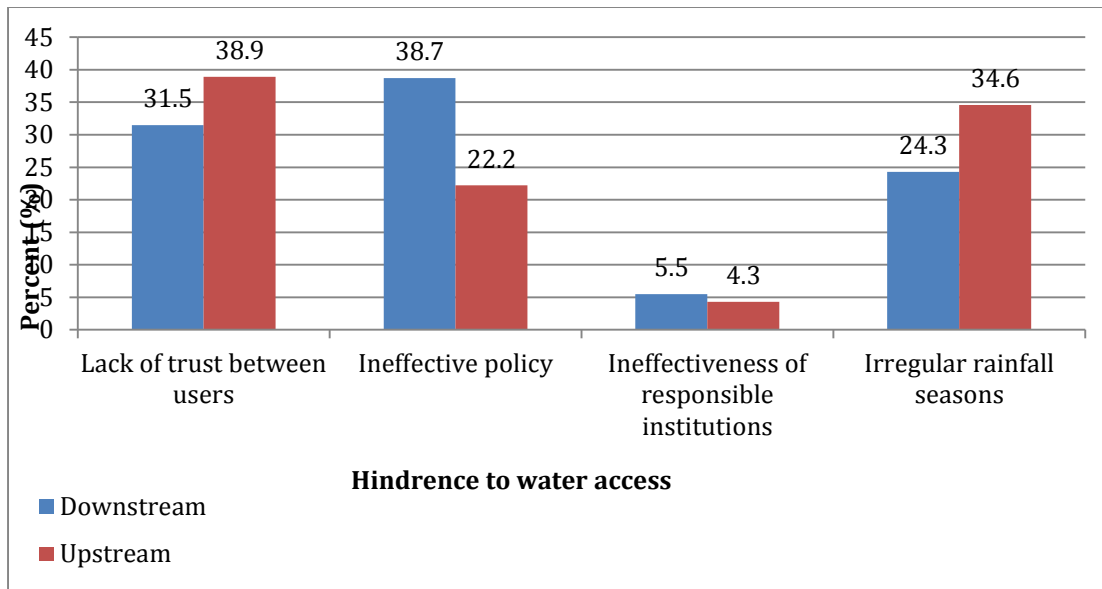


Figure 4.6 Hindrances to Equal Water Access Upstream and Downstream

Source: Author (2018)

4.2.1.3 Consequences of Poor Water Access

The findings presented in Figure 4.7 shows some of the consequences as result of poor access to water resources within the study area. The findings pointed out 53.1% of the respondents indicated increased hatred and lack of trust between groups and forced migration as the major consequences of poor access to water resources. The study findings implied that unequal access of lack of access to water has negative consequences on households within the areas.

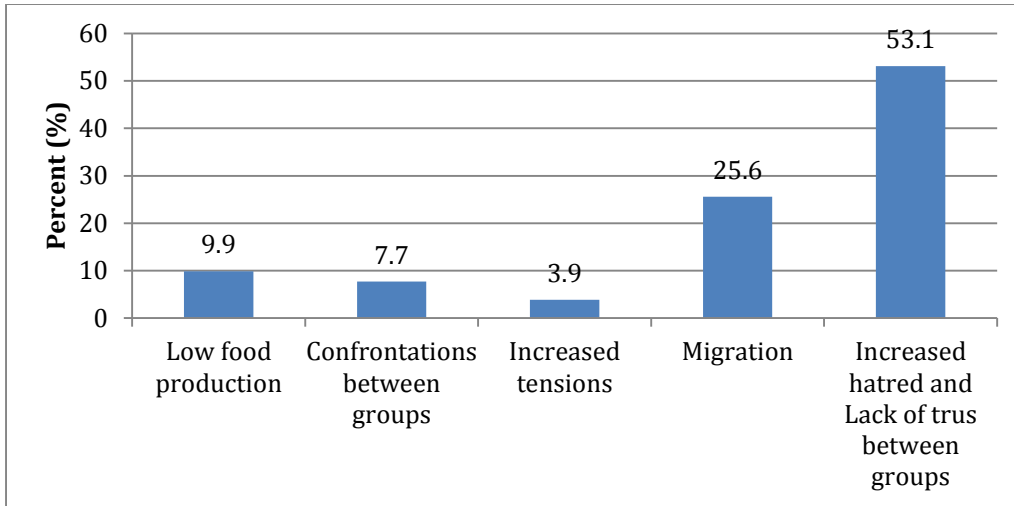


Figure 4.7 Main Consequences of Unequal Water Access

Source: Author (2018)

The results presented in Figure 4.8 show the consequences of unequal access to water resources as indicated by households up and down streams. Increased hatred and lack of trust stood out for both upstream (42%) and downstream water users (61.3%) as the major consequences of unequal water access.

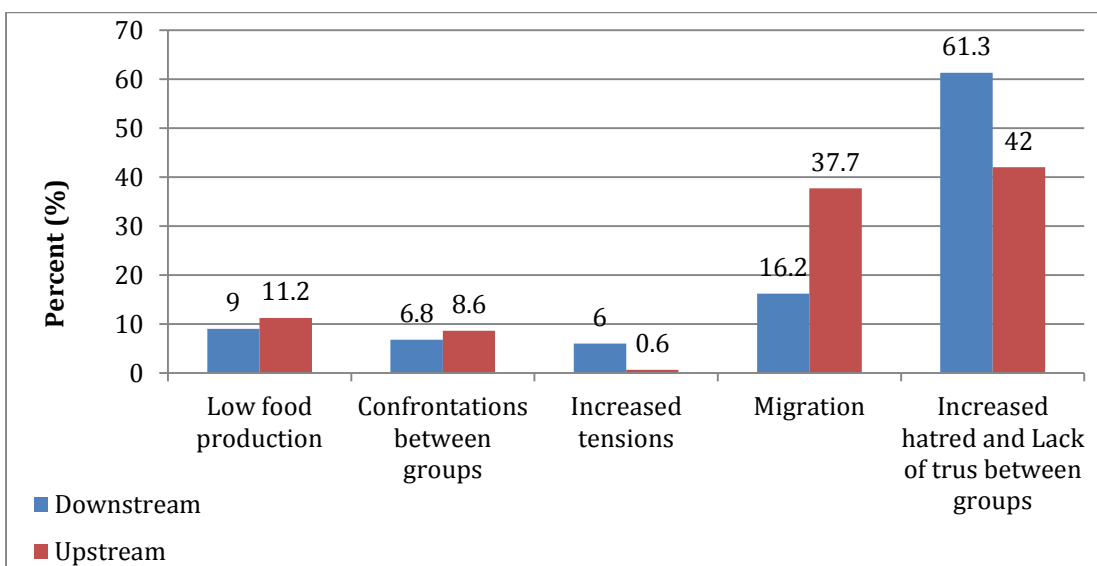


Figure 4.8 Hindrances to Equal Water Access Upstream and Downstream

Source: Author (2018)

4.2.2 Water Use Practices

Figure 4.9 shows that 34.9% of the households in the study area use water for domestic purpose and livestock, 32.6% indicate using water for domestic, livestock and irrigation, 28.4% use water for domestic purposes only while 4.2% use water for domestic purposes and livestock. These findings demonstrate that demand for water is dependent upon livelihood needs of households at their zonal location as demonstrated in the next table in Fig 4.9 (a).

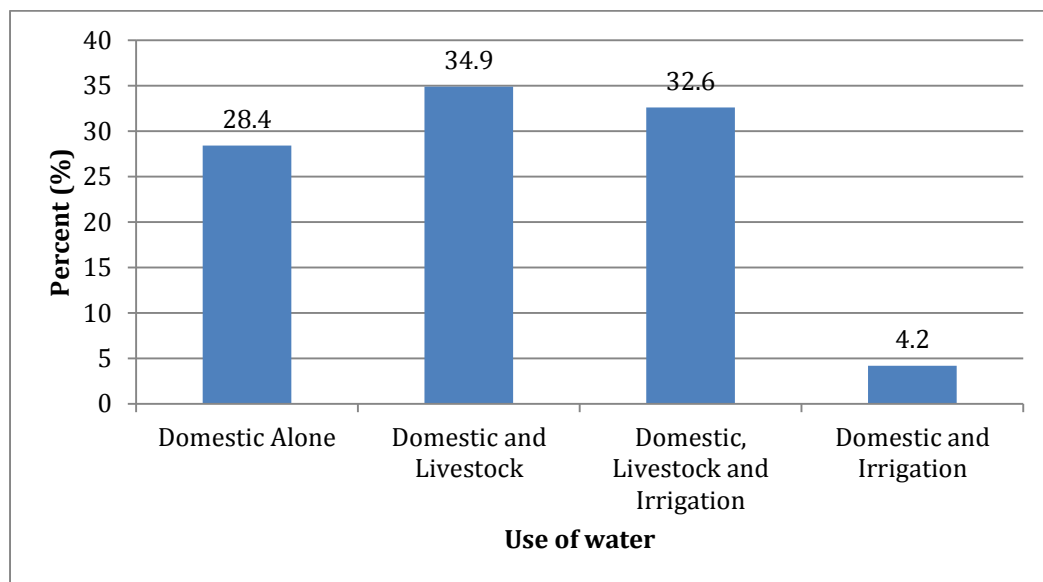


Figure 4.9 (a) Water Use Practices

Source: Author (2018)

The results in figure 4.9 shows that 40.5% of the downstream respondents use water for domestics' purposes and livestock compared to 27.2% of respondent from upstream use for same purpose. However, 45.7% of the respondents' upstream use water for domestic, livestock and irrigation purposes. The findings demonstrate that water consumption by households upstream is more than consumption by households downstream.

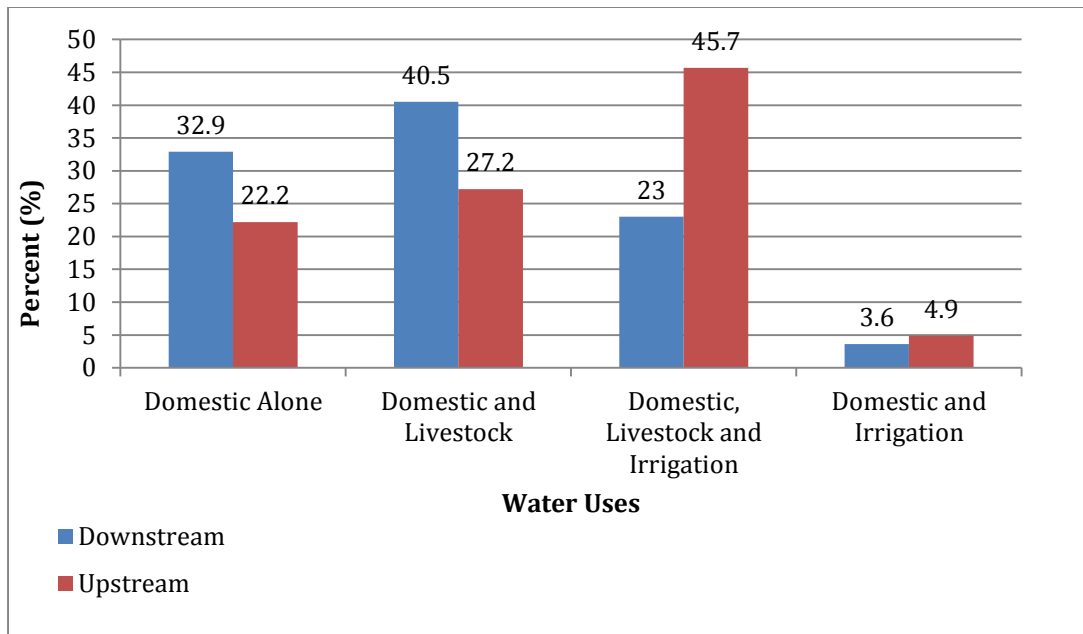


Figure 4.9 (b) Water Use Practices Upstream and Downstream

Source: Author (2018)

The results show that 40.5% of the households downstream used water for domestic and livestock purposes while 45.7% of upstream users used water for domestic, livestock and irrigation. The findings suggest that water use practices for upstream households are different from use practices downstream with majority of upstream households being crop-farmers and majority of downstream users livestock keepers.

The study analyzed daily water consumption by households within the study area. Findings in Figure 4.10 show that 24.7% of the households consume between 21 and 80 litres of water per day. The daily consumption of water among upstream households was more than downstream households. The additional water used for irrigation as shown by results on uses of water by households can explain this difference. Users of minimal quantities downstream are more while those at maximum level of use tend to equalize at upper limits (80-100 liters) since livestock and irrigation use almost same amounts in upstream and downstream zones.

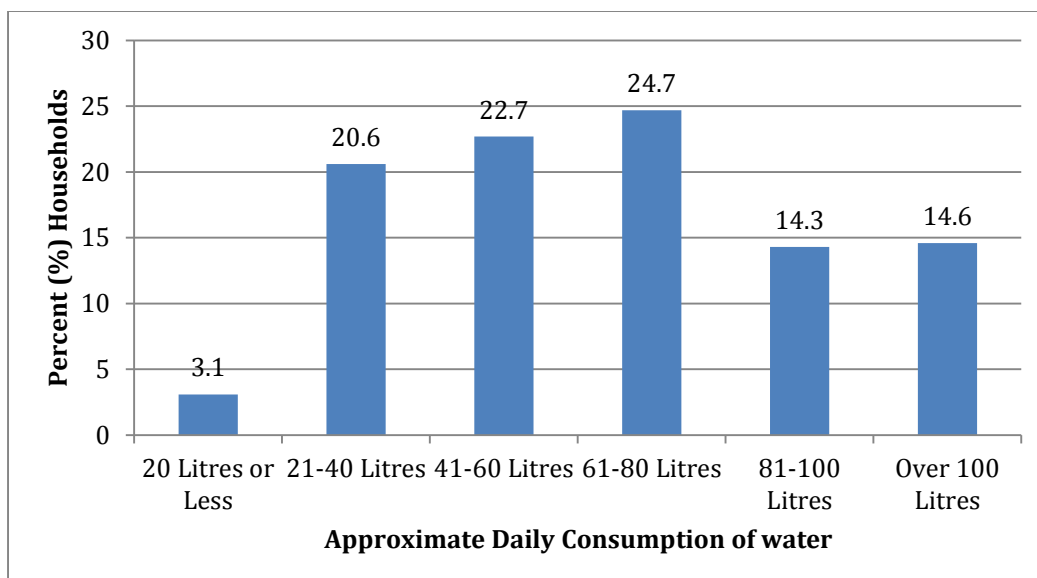


Figure 4.10 Daily Water Consumption by the Households

Source: Author (2018)

The findings in Table 4.6 shows that 29% of the households upstream use 61-80 litres per daily compared to 21.6% who use similar quantities downstream. Results further show that 23.9% of respondents downstream use between 41 and 60 litres per day compared to 21% who use the same quantity upstream. However, the daily consumption of water per day did not significantly vary between downstream water users and upstream water users as indicated by the results in table 4.6.

Table 4.6 Approximate Daily Water Consumption Upstream and Down Stream.

Water consumption	Downstream (%)	Upstream (%)
20 Litres or Less	4.6	1.2
21-40 Litres	19.4	22.2
41-60 Litres	23.9	21
61-80 Litres	21.6	29
81-100 Litres	16.2	11.7
Over 100 Litres	14.4	14.8
Total	100	100

4.2.3 Water Ethics and Use of Water Resource

Figure 4.11 show that the study area had rules and regulation in place to manage water resources. 88% of the respondents agreed to existence of necessary rules and regulations to manage water usage. Rules and regulations on water use and management were made by WRUAs and projects and endorsed by WRA ensure equitable water use practices.

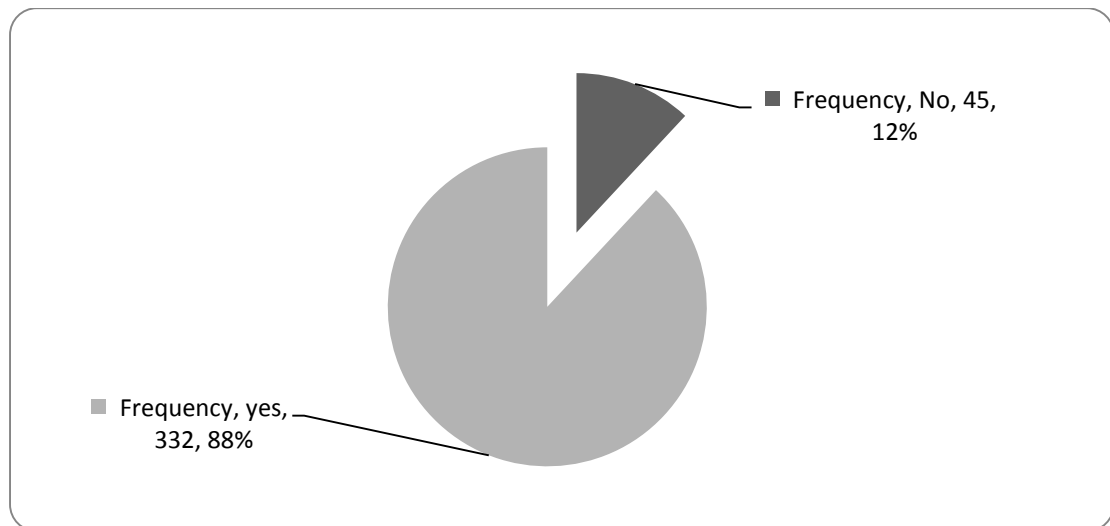


Figure 4.11 Rules and Regulations awareness on Managing Resources

The study further sought to establish whether water users in the region adhered to rule and regulations on water usage and management. The findings presented in Figure 4.12 indicated that 59% agreed adherence was observed while 41% disagreed. The findings suggest that there is lack of total adherence to rules and regulations on use and management of water resources within the study area. Lack of adherence to set rules and regulations on water use and management point to weakness in water governance.

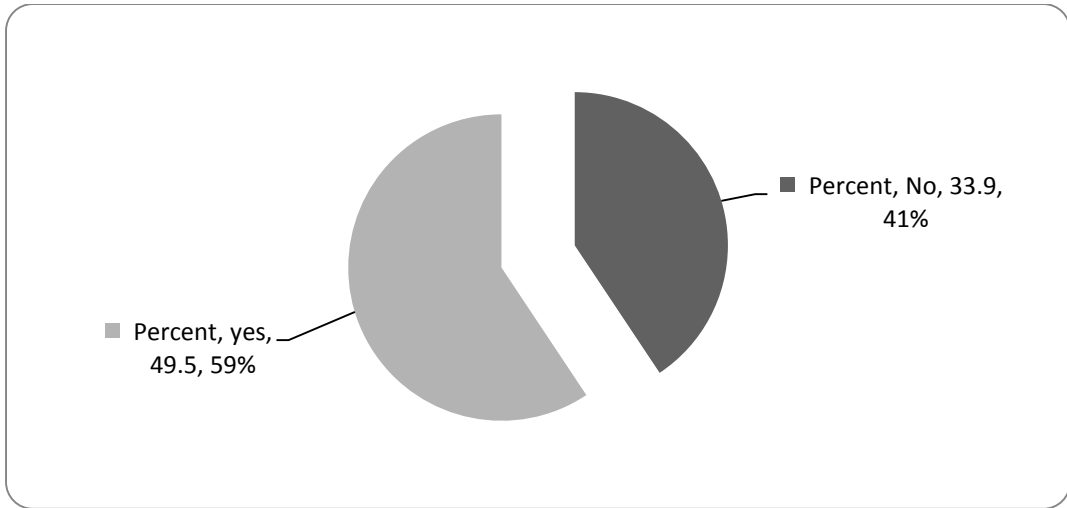


Figure 4.12 Adherence to Rules and Regulations to Manage Resources

4.2.4 Management Practices of Water Sources

The study sought to establish institutions and groups mandated with the responsibility of managing water resources within the study area. Results in Figure 4.13 and Table 4.7 shows that management of water upstream was predominantly done by NAWASCO with mention by 60.5% of the respondents while downstream water was managed by project committees as indicated by 42.7% of the respondents. NAWASCO managed more water sources, followed by project committees. NAWASCO manages mainly upstream water resources because of its proximity to river Likii and major urban centers, its dominant position in treatment, processing, and bottling, superior distribution infrastructure as per its mandate. Community, project committees and WRUAs operate in upstream in zone but dominate management of downstream water resources too.

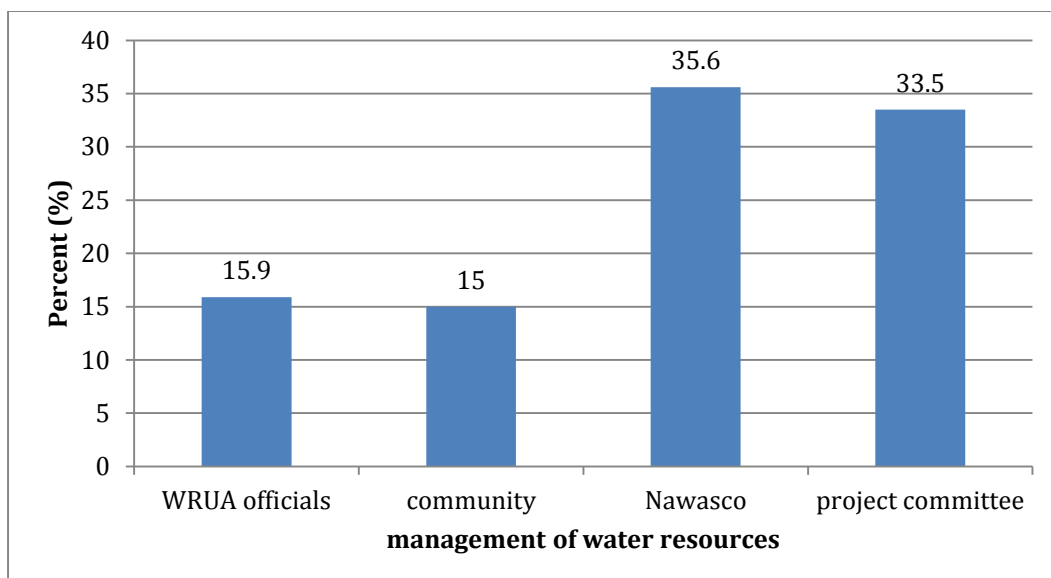


Figure 4.13 Management of Water Resources

The study findings show management practices adopted by upstream water users was different from those used by downstream users. Downstream users employed community driven water management practices.

Table 4.7 Management of Water Resources Upstream and Downstream

Management of water resources	Downstream (%)	Upstream (%)
WRUA Officials	13.1	14.2
Community	24.3	2.5
NAWASCO	19.9	60.5
Project Committee	42.7	22.8
Total	100	100

4.2.4.1 Strategies to Ensure Equal Water Access

The study also sought to establish some of the strategies respondents felt could be applied to ensure equal access to water resource within the study area. The results presented in Figure 4.14 indicated that 37.5% and 33.9% of the water users' upstream

and downstream mentioned adherence to set rules regulations and proper management of water upstream by WRUAs respectively as the major strategies that will ensure there is equal water access. Other strategies mentioned include harvesting of rainwater during the rainy seasons and increasing boreholes in the zones.

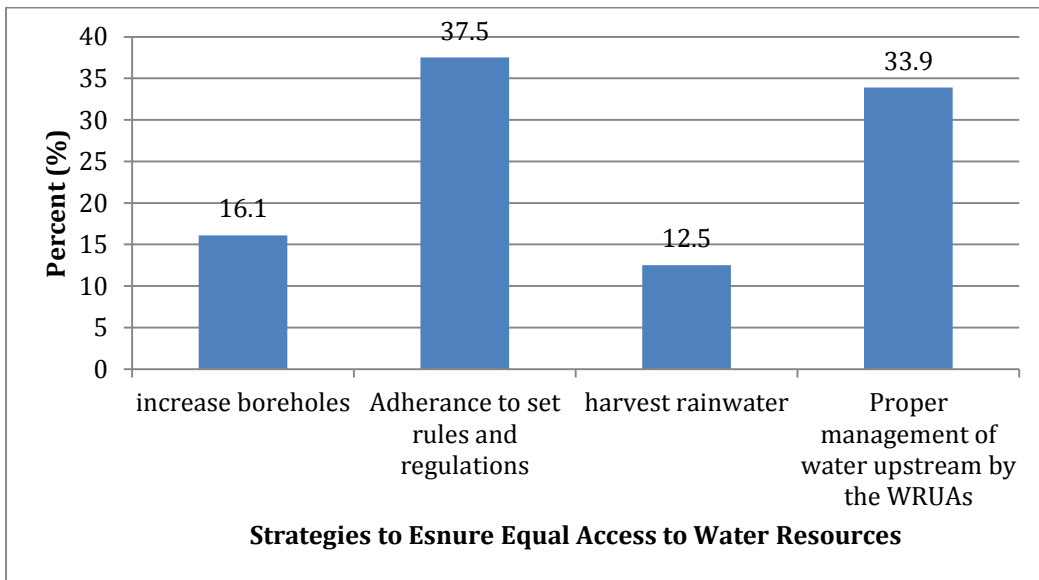


Figure 4.14 Strategies to Ensure Equal Water Access

Majority (76%) of the households upstream mention adherence to rules as the best strategy to enhance equal water access while 69% of the households downstream mention proper management of water by upstream water users as the best strategy to increase equal water access within the study area. These findings shows that majority of the downstream users consider poor management of water upstream as the main source of water access inequality. Upstream water users attributed lack of equal access to water resources to lack of adherence to existing rules. It is observed that harvesting is not considered a priority strategy by respondents and this could be because of lack of awareness of importance of water harvesting in the study area.

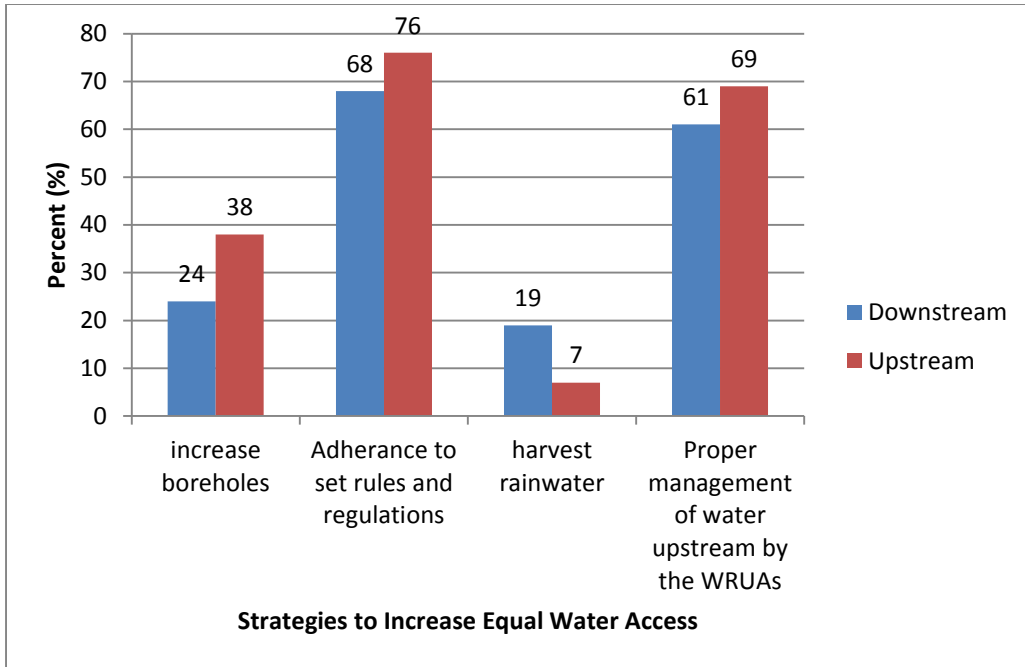


Figure 4.15 Strategies to Ensure Equal Water Access Up and Down Streams

4.3 Water Resource Conflicts

4.3.1 Prevalence of Water conflicts

The first aspect the study sought to find out from the respondents whether water related conflicts exist in the study area. The study findings presented in Figure 4.16 show that 66.7% and 49.4% of downstream and upstream households respectively agree on the presence of water related conflicts in the study area.

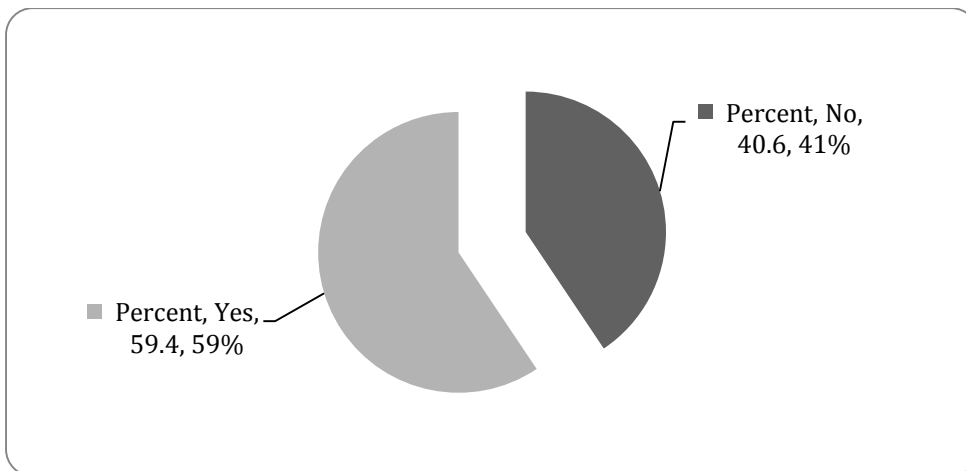


Figure 4.16 Existence of Water Conflicts

Table 4.8 Existence of Water Conflicts Upstream and Downstream

Water Conflicts Existence	Downstream	Upstream
No	33.3	50.6
Yes	66.7	49.4
Total	100	100

The results in this section indicated that water conflicts in the study regions were seasonal as indicated large percent of the households while other indicated that water conflicts were unpredictable. The findings show that upstream users face less water connected conflicts due to proximity of water resources unlike downstream users who face the brunt of migrants pastoralists communities during severe droughts encroaching on their farms in search of water and pasture.

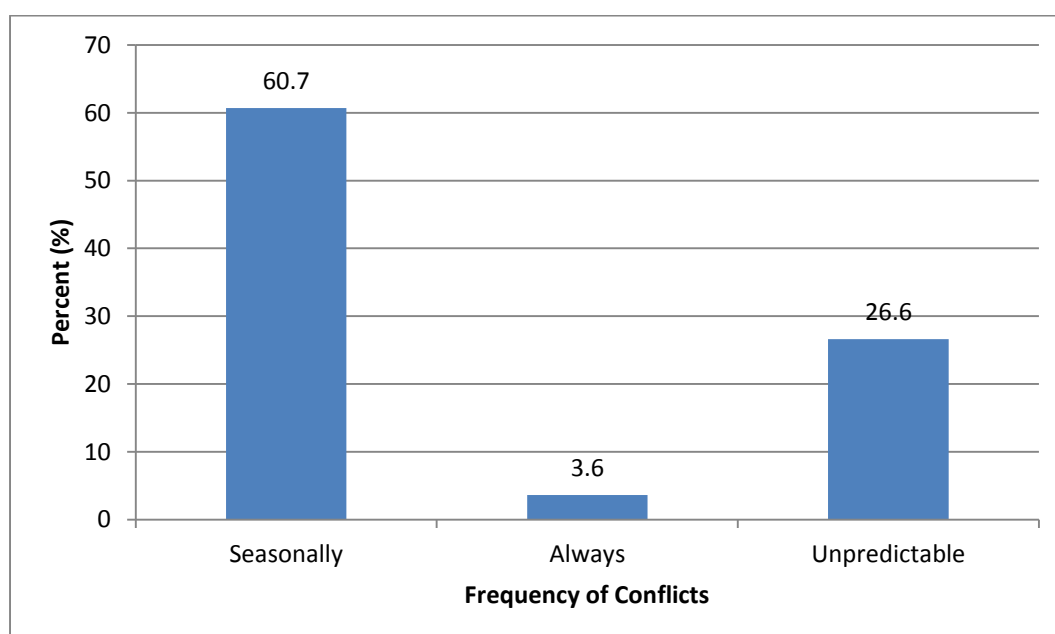


Figure 4.17 Frequency of Water Conflicts

The respondents were asked how conflicts change overtime from 1970 to 2015. The results shown in Figure 4.17 show a steady increase in water related conflicts within

the study area. The increasing trends in water conflicts could be explained partly by climate change resulting in reduction of river flow. Population and water demands have also been increasing due to economic growth leading and urbanization leading to conflicts.

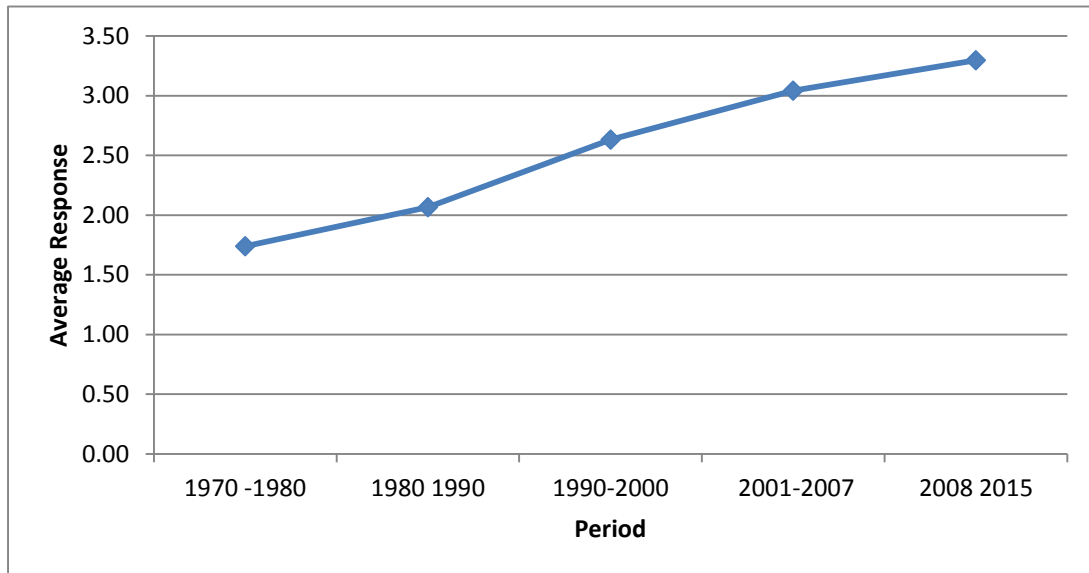


Figure 4.17(b) Trends in Water Conflicts Perception by Respondents

According to the results obtained from FGDs, years in which the conflicts were intense are 1984, 1994 and 2015 to 2017 due to water scarcity due to prolonged droughts. Increased demand for water due to population growth was also a causal factor of conflicts during the most recent droughts experienced between 2015 and 2017. Deforestation also aggravated the situation since it contributed to the low flow levels in rivers in the area. During this period there were intense conflicts between pastoralists and ranchers as pastoralists invaded ranches seeking pasture for their livestock as drought reduced water downstream to sustain their livestock.

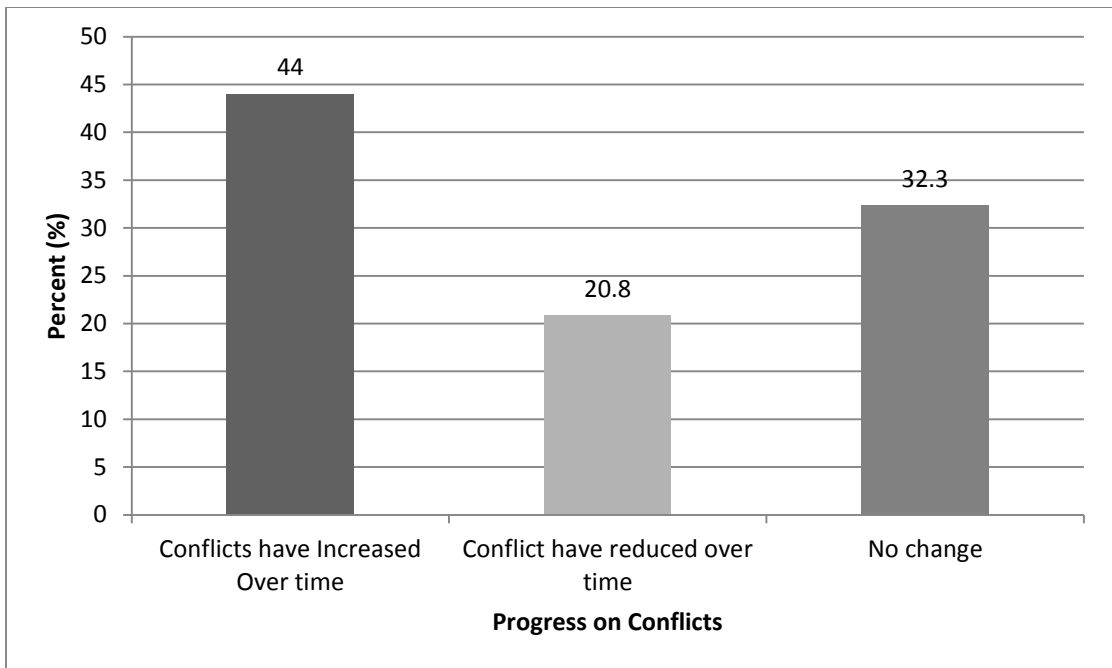


Figure 4.18 Progress of Water Conflicts over Time

The respondents were further asked to indicate how water conflicts manifested among water users in the study area. Results presented in Figure 4.19 show that 32.6% of the households mention tensions, animosity, quarrels and verbal exchanges, fighting and loss of property as the major forms of water conflicts. 31.3% indicated tensions and animosity while 16.9% indicated fighting and loss of property.

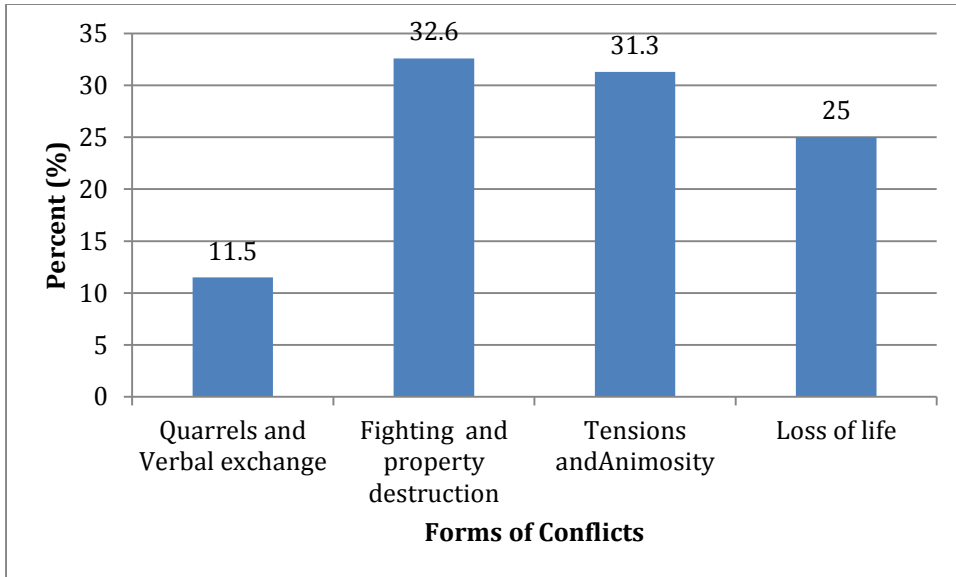


Figure 4.19 Forms of Water Conflicts

4.3.2 Causes of Water Conflicts

Some of the activities the survey established causing water conflicts include unsanctioned abstraction and illegal water abstraction mentioned by 54.2% of the respondents and followed by lack of proper water management authority as shown in

Figure 4.20

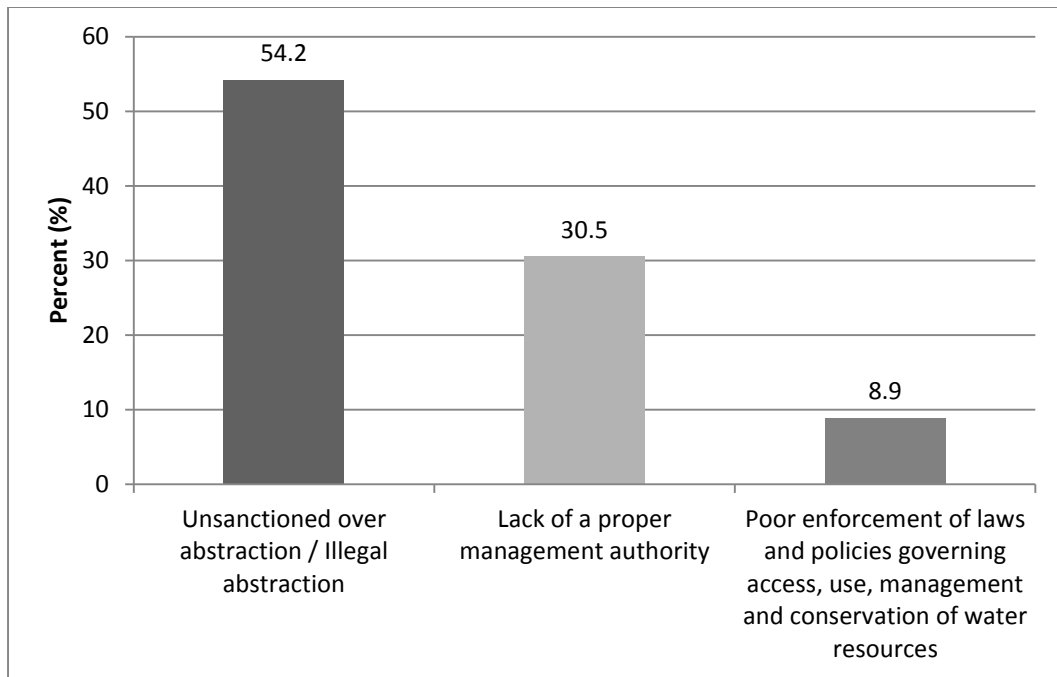


Figure 4.20 Activities that Cause Water Conflicts

The key informants revealed that water conflicts between large-scale farmers and villagers was because of the former over abstracting water, withholding water upstream when in some instances water does not reach them downstream. During intense water scarcity, water users even result to harming each other as they struggle to get water for their families. The encroachment of the riparian areas is believed to cause scarcity water resources while polluting potable water to the detriment of water users. These conflicts were further fueled by political interference and corruption. It was also noted from FGD and KII that politics played a role in intensifying conflicts related to water resources when some leaders incite their community members to fight to block pastoralists from entering their property desperately searching for water.

4.3.3 Management of Water Conflicts

Figure 4.21 shows that majority of the respondents indicated that 43.5% of the conflicts are reported to Provincial Administrations, followed by 23.7% reports made to faith-based organizations while 19.5% reported to WRUAs. According to the results it

appears that Provincial Administration still has a significant role in water related conflict resolution within the study areas. The results further show that majority of water users still trust Provincial Administrations to handle waters related issues and arbitrate between feuding parties.

The involvement of the WRUAs in resolving water conflicts was also documented by the study undertaken by (Kiteme, Liniger, Notter, Wiesmann, & Kohler, 2008) that showed that water user associations have become effective grassroots structures for handling water user conflicts in the area. However, the study finding did not find the presence of WRUA in the area to be effective in resolving the water related conflicts because the large-scale farmers some sitting in the executive members of WRUAs could not be seen to be equal partners with ordinary small scale farmer.

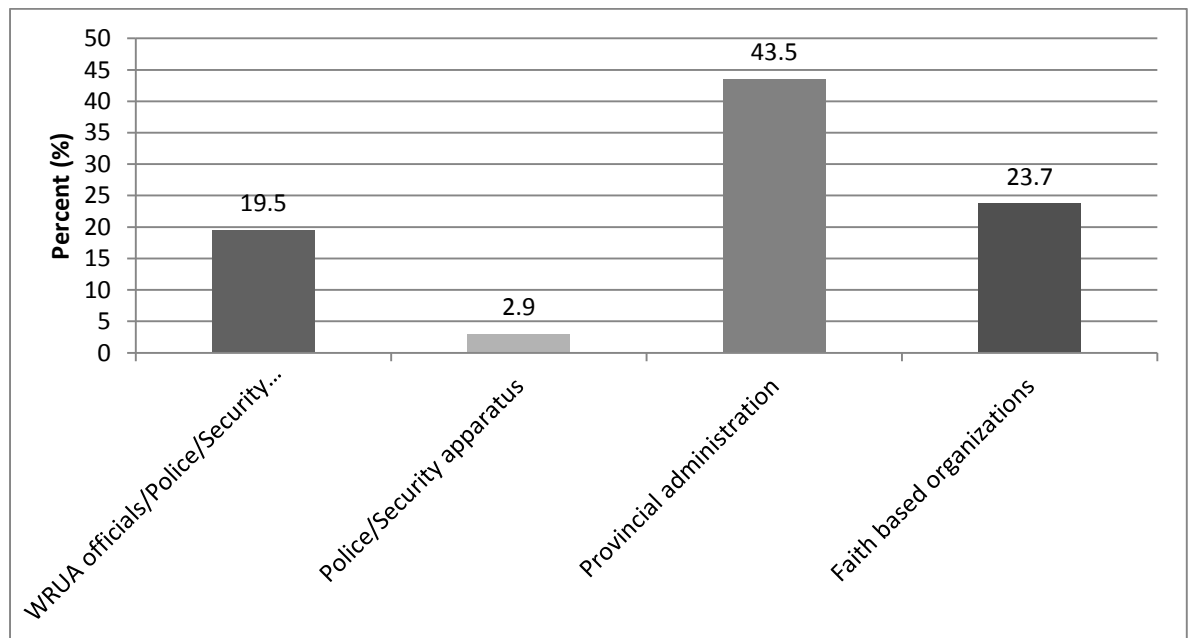


Figure 4.21 Institutions Where Conflicts on water is reported

The findings in figure 4.22 show that majority (78%) of the respondents were confident that the institutions they reported the water conflicts to had the capacity and ability to deal with those conflicts.

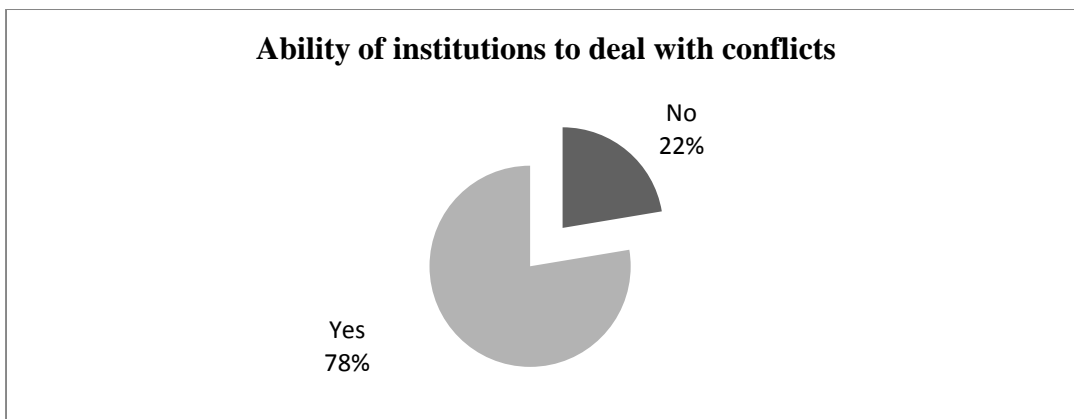


Figure 4.22 Ability to Deal with the Conflicts by Institutions

The findings presented in Figure 4.23 show that 37% of the respondents indicate that water conflicts were arbitrated between the feuding parties, 20.1% sought legal redress, and 15.6% sent warnings to rule breakers while 12.5% indicate arrests. The findings suggest that there appears to be no universal way of solving water conflicts but arbitration was the preferred mode of solving conflicts at 37%. The findings also show that waters users trusted various institutions to handle water related conflicts.

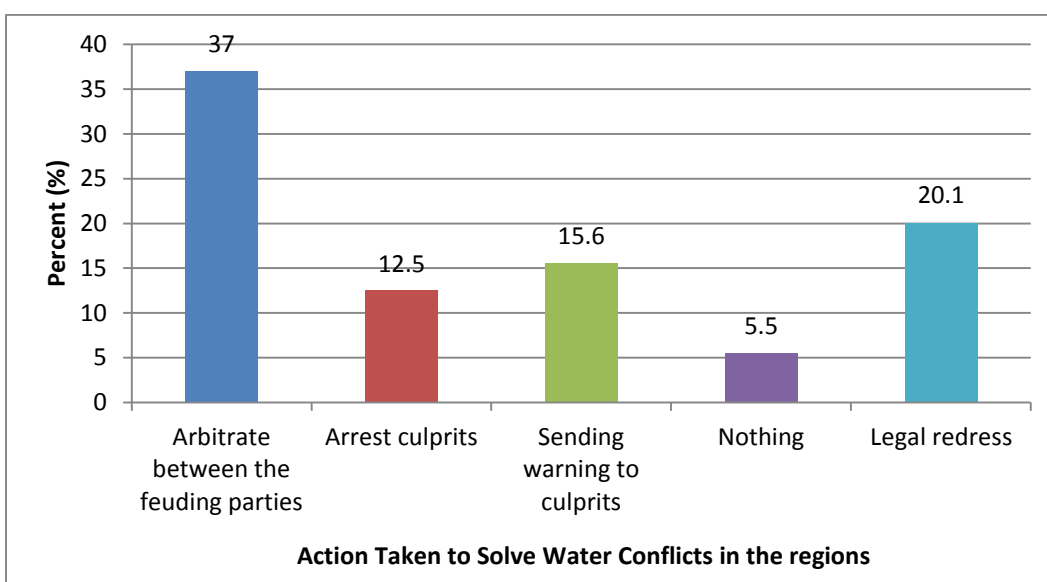


Figure 4.23 Action Taken to Solve Water Conflicts

From the FGD, the study established that water users have in the past come together to deal water access issues through demonstrations against large-scale farmers who are over abstracting water. However, these initiatives are often not successful because of political interference where some politicians inform large-scale farmers of their plans in advance. Those hoarding water upstream then release water to avert demonstrations. There are incidences when users are denied permission to demonstrate by the authorities since some of these authorities are seen to be in collusion with large-scale farmers. The key informants further mentioned that instead of responsible water authorities looking for the alternative ways of assisting water users solve water shortage, those in position exploit users by selling water to them.

4.4 Effect of Water Use Practices on Conflicts

4.4.1 Effect of Uses of Water on water Conflicts

The study sought to test the association between water source by various water users and presence of water conflicts. The findings presented in Table 4.9 shows that sourcing water from Borehole, household tap, river, report high water conflicts.

Table 4.9(a) Cross-Tabulation Results

		Water Conflicts Existence		
		No	Yes	Total
Main Source of Water	Borehole	8	31	39
	Household tap	123	119	242
	River	24	78	102
	Total	155	228	383

The findings of chi-squares in table 4.9 (b) confirmed that there was a significant association between water access sources and water related conflicts.

Table 4.9 (b) Chi-Square Tests Results

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	29.372a	2	0.000
Likelihood Ratio	30.653	2	0.000
Linear-by-Linear Association	2.858	1	0.091
N of Valid Cases	383		

a 0 cells (0.0%) have expected count less than 5. The minimum expected count is 15.78.

4.4.2 Effect of Management of Water Sources and Water Conflicts

The study similarly used chi-square analysis to test the association between management of water sources and existence of water conflicts in regions in the study area. The findings showed that areas where WRUAs, NAWASCO and project committees managed water sources experienced more conflicts. Places where water users were involved in direct water management experienced less conflict.

Table 4.10 (a) Cross-Tabulation Results between Management of Water Sources and water Conflicts

		Water Conflicts Existence		
		No	Yes	Total
Management of water sources	WRUA officials	19	33	52
	community	41	17	58
	NAWASCO	53	88	141
	project committee	42	88	130
	Total	155	226	381

The finding of $\chi^2 = 26.349$ ($p=0.000$) also confirmed that management of water sources influenced water related conflicts. The findings implied that management of water sources significantly determines whether water conflicts exist.

Table 4.10 (b) Chi-Square Tests Results for Management of Water Sources and water Conflicts

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	26.349a	3	0.000
Likelihood Ratio	26.158	3	0.000
Linear-by-Linear Association	6.043	1	0.014
N of Valid Cases	381		

0 cells (0.0%) have expected count less than 5. The minimum expected count is 21.15.

4.4.3 Effect of Water Ethics on Water Conflicts

The study also tested the existence of significant association between adherence to rules and regulation and water related conflicts. The study findings showed that zones with no adherence to set rules and regulations experienced more frequent water conflicts compared to zones with adherence to rules and regulations.

Table 4.11 (a) Adherence to rules and regulations and Water Conflicts Existence Cross-tabulation

		Water Conflicts Existence		
		No	Yes	Total
Adherence to rules and regulations	No	29	101	130
	yes	99	91	190
	Total	128	192	320

The chi-square findings also confirmed a significant association ($\chi^2= 28.556$, $p=0.000$) between adherence to rules and regulations and water conflicts within the study area.

Adherence to rules and regulation reduces water conflicts.

Table 4.11 (b) Chi-Square Tests Results for Adherence to rules and regulations and Water Conflicts

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	28.556a	1	0.000		
Continuity Correction	27.328	1	0.000		
Likelihood Ratio	29.667	1	0.000		
Fisher's Exact Test				0.000	0.000
Linear-by-Linear Association	28.467	1	0.000		
N of Valid Cases	320				

a 0 cells (0.0%) have expected count less than 5. The minimum expected count is 52.00.

b Computed only for a 2x2 table

4.5 Qualitative Data Analysis

This section contains the analysis of qualitative data collected from interviews, focus group discussions and, transects drives and walks. The study use narration in analysis of the qualitative data. Qualitative data was also analyzed based on the main research questions.

4.5.1 Water Access, Use and Management

4.5.1.1 Main sources of water

From the FGD conducted with Nanyuki WRUA, it was established that the main sources of water in all the three zones was the Nanyuki River but what differs was how water was obtained from the river. The water project has intakes along the entire river course where water is abstracted from the river into huge storage tanks then are connected to the houses. According to findings obtained from the FGD, an estimated 98% of the people have taps in the houses. The remaining 2% fetch water directly from the river. These findings concur with the quantitative results, which show that majority

of the household accessed water through household taps while minority fetch directly from the rivers.

In the middle zone, which is Nanyuki town, water is provided by Nanyuki Water and Sewerage Company (NAWASCO), which have an intake at the source of Likii river. Apart from the Nanyuki River the other sources of water are boreholes while at the lower zone 10 runoff dams are additional water sources. Japan International Cooperation Agency (JICA) in collaboration with country governments in the past constructed boreholes in the area, which have been left unserviceable for lack of sustainable funding.

The FGD with Ontulili WRUA revealed that River Ontulili was the major sources of water in addition to 3 boreholes and 15 water intakes authorized and licensed by WRA from the river serving three projects: Xweb, Wakamuga and Mwenyawa projects. River Ontulili merges with other rivers to form the Ewaso Nyiro North River at Ngarengiro downstream. The rest of rivers include: Nanyuki, Likii, Sirimon, Kongoni, and Ngunguni. Naromoru WRUA has its main source of water at the Naromoru River while Likii WRUA sources water from Likii River. Nanyuki Water and Sewerage Company (NAWASCO), draws water from the Nanyuki and Likii rivers. NAWASCO Kiosks was reported by some respondents to sell water directly fetched using fire services vehicles from Likii and Nanyuki rivers especially during times of extreme water scarcity. These incidents were however not corrected.

According to the findings obtained from FGDs from key informants who were mainly WRUA members, some of the key causes of water shortage include environment challenges. The water user members expressed concerns over some of the environmental challenges that affected water in the region. They claimed that impacts

of climate change resulted in flooding, and droughts leading to water scarcity and drying of some rivers. Flash floods, they reported caused soil erosion washing away crops from farms adjacent to the riparian land a leading to food insecurity.

Pollution of main rivers in the study are also contributed to the scarcity in the water resources due to polluted water leading to reduction potable water. The main rivers visited in the area were; Ontulili, Likii, Nanyuki Buruget, Bantu and Naromoru. Pollution of the water resources has been attributed to waste garbage, hotel wastes, overflowing toilets fecal matter and used oil from car washes including pollutants dumped or drained direct into the rivers.



Figure 4.24 Showing Solid Wastes in River Nanyuki during peak rain season.

Source of photo taken by the author

Deforestation, through logging for construction industries, charcoal burning, forest fires were indicated to have contributed to the drying of rivers causing less water flow water downstream. Illegal allocation of riparian lands for the private use leads to allottees who clear vegetation, and indigenous species to grow crops are among reasons cited for rivers to drying up contributing to upstream downstream water related conflicts.

4.5.1.2 Main User of Water

From the FGDs conducted with the WRUAs within the study area, it was indicated that the main water uses in the area are in the upper zone are Households for household purposes, livestock consumption and for kitchen gardening. The respondents further indicated farmers as major users of water for commercial farming using irrigation, while fewer respondents implicated schools and hotels (related to wildlife conservation) in excessive water use.

In the downstream zone, hoteliers, car wash owners and households are the majority of water users while in the lower zone wildlife conservancies and agro pastoralists/pastoralists rearing livestock lead in water use. Consequently, impacts created through usage of the water by the various users is the main cause of decrease in the overall quantity of water in the river, reduced quality through pollution from agrochemicals used by farmers, wastes from car washes, hotels and small industries according to documented results of the FGDs. These activities they claim affect both upstream and downstream water users and the ecosystem.

4.5.1.3 Major Uses of Water by the Respondents

The key informant from the FGD further indicated that the key water consumers in the region were; horticultural activities by the large-scale farmers in the upstream zone, commercial farming and livestock rearing- dairy cows. The respondents indicated that commercial farming demands more water quantities because they irrigate crops applying sprinkler irrigation as they await the rains. However, river water at this period is no longer enough for irrigation but can only be used for crop nursery establishment. The negative consequences of the high demand of water from the river is the drying up of the river such that water does not flow beyond NaroMoru town. Other main users of

water from the rivers are farmers, mainly small-scale farmers although according to respondents there is also large-scale farms in the area engaging in water over abstraction.

FGDs with Ontulili WRUAs revealed that over abstraction of water from River Ontulili was still going on at the time of research. The large farms abstract more water beyond the volume permitted in their licenses and abstract during the dry season when they are not permitted to fill their dams, which never run dry. These results indicate the presence of unethical water use in the area. The findings further reveal that although WRUAs were been delegated WARMA management function under the revised water Act 2016, they are yet to exercise that authority. Large-scale farmers are perceived by small scale farm and other water users to be over abstracting excessive water.

4.5.1.4 Management of Water Resources Upstream and Down Stream

According to the results obtained through FGDs, the main causes of water scarcity in the area are the over abstraction by large-scale horticultural farmers which also contributes to drying of rivers. The water users 'mitigation actions against water scarcity include; Water rationing through rotation of water allocation to the projects in which each project is allocated water each day while the others are denied access. The members of the water projects are obligated by membership rules to observe water rationing time table which releases water to specific areas within the project area during specific hours of the day. Allocation of water is decided by the WRUA Executive Board, the project heads/representatives and Water Resources Authority (WRA) who issue abstraction permits, oversight and endorse written and shared water management plans among the WRUAs. The communities are sensitized about the rationing timetables designed by consultation among Executive WRUA committees for

dissemination to the project members, Chiefs' Public meetings ("Chiefs Barazas" public participatory gatherings for dissemination of Government policies and directives) and through announcements at church gatherings.

Water user communities through WRUAs or Water Projects sponsored by NGOs invest in water storage facilities like tanks and small dams. The large-scale farmers and ranchers own large dams compared to the communities due to their superior financial capacity and therefore tend to crowd out small-scale farmers and pastoralists water users. This kind of inequity is cause to latent conflict that resurfaces during seasons of severe water scarcity.

4.5.1.5 Strategies to Ensure Equal Water Access Upstream and Down Stream

The key informant interviewed indicated that mechanisms employed by the water-user community to resolve conflicts are; water rationing to ensure water gets downstream; building water storage facilities such as tanks to store water, with 30% release for release to environment and downstream; initiating dialogue with other users of the rivers through WRUAs which have the legal mandate and a platform through which they can come together, to discuss and re-solve issues. Sensitization of the WRUA members and communities on re-forestation particularly in riparian zones. The WRUAs get support from institutions and organizations like WRA, CETRAD and active NGOs in environment protection sector to facilitate sensitization campaigns. Women groups have been formed armed with written proposals for funding to buy water tanks. In addition, WRUAs has actively written proposals for funding and have received funding from UNDP, CDTF and the Water Services Trust Fund.

On the other hand, the government agencies involved in solving water conflicts are the Water Resource Authority (WRA) formerly Water Resources Management Authority

(WRMA) who monitor the users and regulate use of water access through a permit system under the Water Act 2016. The National Government through the Chiefs and police are also involved in the enforcement of water usage regulations and often accompany WRA officials when solving conflicts or enforcing water regulations. Water conflicts are reported to WRA, chiefs and village elders.

The roles of WRUAs in water and environment resources management as indicated during the FGD included; ensuring the availability of safe and clean water in the river; regulating water usage from the river and monitoring water flows; mobilizing resources to help the water users in projects in activities such as buying tanks, getting tree seedlings for planting, drilling boreholes and establishing enterprises like car washes. WRUAs also build capacity of their members from water stakeholders such as CETRAD and pro-environmental NGOs to train members on meter installation, project management, tree planting, making energy saving stoves (jikos) for sale to earn extra income among other activities. One such positive example is where some youth and women groups are trained on making energy saving stoves to reduce deforestation. The Laikipia Wildlife Forum (LWF) also funded the WRUAs by giving them master meters for water rationing while CETRAD collaborating with CTDF to fund WRUAs build water storage facilities (4 water storage tanks were built), boreholes drilled and a resource centers constructed in one study area.

4.5.2 Water Resources Conflicts

According to key informants interviewed during the FGD, there are several types of conflicts present in the study area. Human wildlife conflicts are prevalent in the downstream zone. It is here that water scarcity, leads to serious competition for water resources between the wildlife, pastoralist communities and ranchers making

problematic animals injure people, destroy crops and fences as they follow up drying rivers upstream. Leadership conflicts within the WRUAs due to personal interests, conflict of interests promoted by poor governance regime are cases cited by residents. Some leaders are said to overstay their mandate period in office and absence of women in key management WRA or Project committee leadership is common.

Conflicts between pastoralists and farmers when the former want unfettered access to water in the river but farmers have planted close to the river hampering pastoralists livestock access for fear of crop destruction. The invasion of the livestock to other peoples' farms in an incident in 2016 drought resulted in the death of a pastoralist when visiting pastoralists raided land belonging to a local farmer in the area to seek for water and pasture. Incidents have also been documented of severe conflicts between pastoralists and fellow pastoralists, ranchers and pastoralists and National Government Provincial Administration and pastoralists that rocked Laikipia County for the better part of 2016 and 2017 at the advent of The General Elections.

Conflicts between pastoralists and ranches when pastoralists want to access the pasture in the ranches as pastures downstream diminish due water scarcity was the main cause exacerbated by political campaign rhetoric of 2016-2017. This leads to the depletion of the pasture for the ranchers triggering to conflicts between different community groups. Conflicts were reported among water project members when some users use open pipes/ furrow irrigation therefore end up diverting all the water to their farmers even during rainy season at the same time denying other users water. These members use open pipes to fill up dams or ponds or for direct irrigation on the farm's contrary to WRA regulations. Conflicts between farmers and dam owners arise when water overflows

from their dams leads in run off clearing farmers 'crops. This was cited happening at in one incident at the Mirera area where there are three dams.

According to Nanyuki WRUA members, the main causes of water conflicts from the perspective of FGD include; Water scarcity especially during periods of drought. Personal interest and selfishness where some influential elites use open pipes hence denying others access to water and population growth was seen to increase demand for water. Conflicts have been occurring since independence when most of the white settlers left and people moved into the region or were settled there. Migration intensity has sine increased over time. Water conflicts coincide with the dry seasons and occur in January to March and August to October.

The types of water conflicts experienced in the area are according to key informant from Ontulili WRUA include; between pastoralists and farmers when pastoralists destroy water intakes during the dry season to gain access when water does not reach them downstream, conflicts between small-scale farmers and large-scale farmers who over abstract from the river until it dry up and do not reach them. At times small-scale farmers were reported to collaborate with pastoralists to destroy water intakes to force strategy commercial farmers seen as enjoy ng patronage from WRA, political elite, restricted information access to release water during scarcity time. Large scale commercial farmers are seen to draw more water from the rivers due to their location high up at the foot zones of Mt. Kenya. Conflicts among the ordinary water projects water users when some members get water and other don't raising suspicion that the ones receiving water have blocked their pipes while in many such incidences blockage of water pipes is at times exacerbated by soil erosion upstream causing siltation.

4.6 Discussion

The purpose of this study was to assess water access, use and management of water resources and conflicts in the Upper Ewaso Nyiro North River Sub-Basin with Laikipia County as the Case Study. The study was guided by the three main objectives; to assess water resources access, use and management, to assess the presence and trends of water related conflicts and its effects on access, use and management.

4.6.1 Water Access, Use and Management

With regard to the first objective, the study found differential access to water resources among various water users in the study area. The results indicate that 63% of the households relied on households' tap water, followed by rivers (26.6%) and borehole (10.2%). The results further show that 87% of the households upstream indicated their main source of water was household taps while 45.5% household from downstream got their water from household taps. The results further show 38.3% of household downstream relied on rivers for water compared to 11.1% upstream. The finding show that majority of households upstream have reliable water access. Water is supplied through households' taps compared to significant number of households in the downstream who fetch water directly from the rivers. This arrangement of access is potential for competition since users upstream are closer to water sources especially elite groups and hence have an upper advantage (Ribot and Peluso, 2003. Shrestha *et al.*, 2018). Warurii (2015) also found out that competing interest on land and water resources utilization ranked high as a main cause of inter-ethnic conflicts in Rumuruti Division of Laikipia County. The study finding supports Francis *et al.*, (2018) that households in majority of river basins have unsustainable access to improved water due to the financial, hydro-technical, institutional and organizational incapacities coupled with the low financial abilities of low-income earning households to continuously

purchase water for domestic activities. This study also establishes through triangulating data findings with Focus Group Discussions and Key Informant Interviews that highest consumers of water were large-scale horticultural farmers and pastoralists. This observation is disputed earlier by Wiesman *et al.*, (2000) except that their study was confined to fewer rivers within the study area two decades ago. Similarly, Derman *et al.*, (2007) found that unequal access to natural resources in sub-Saharan Africa, in particular water and land in river basin causing tensions between upstream and downstream groups.

The study further analysed water uses practices in the study area. The study results show that 45.1% and 43.7% of the respondents mention pastoralists and farmers upstream and downstream respectively as the largest consumers of water in the study area. The study further found that 43.7% and 46.9% of the respondents downstream and upstream respectively indicated pastoralists as the largest water users in the study area while 42.8% and 45.1% of the respondents downstream and upstream respectively indicated farmers as the largest water users in the study area. Competition over use of scarce water resources generates conflict and impacts on quality of water (Agwata, 2005; Baur *et al.*, 2000 Munia *et al.*, 2018). The study findings concur with Wiesmann *et al.*, (2000) with regard increase in water use by various water both upstream and downstream. Kiteme (2017), also found out that lack of trust between various water users on who consume largest water in the basin. The perception of water consumption in the study area creates competition as suggested by game theory limiting cooperative efforts in water management (Ostrom 1990, Esteban *et al.*, 2018; De Stefano *et al.*, 2018). This study established that communicating information to stake holders on water availability, as a management tool on water sharing to reduce conflict over perception on inequality. This proposition is shared by Kiteme and Ehrensperger (2005) who

recommend use of information platform system in their research on water management in Upper Ewaso Nyiro River Basin, the northwestern area Mt. Kenya.

The results further show that 40.5% of the households' downstream used water for domestic and livestock purposes while 45.7% of upstream users used water for domestic, livestock and irrigation. The findings implied that water use practices for upstream households were different from water use practices downstream. The results revealed that majority of the upstream households practice irrigation farming unlike downstream users who depend on livestock keeping.

The study also sought to determine water resource management practices within the study area. The study sought to establish whether water users are aware of existence of water governance rules and regulations and whether such rules were adhered to. The study findings indicates that the study area had rules and regulation in place to manage water sources as shown by 88% of the respondent who agreed to existence of necessary rules and regulation to manage water usage. Finally results indicate that 37.5% and 33.9% of the water users upstream and downstream mentioned adherence to set rules regulations and proper management of water upstream by WRUAs respectively as the major strategies that will ensure there is equal water access. The results from the interviews and FGD indicated that political interferences hindered the effectiveness of institutions mandated to manage water resources. Ineffectiveness of the institutions was established as the major cause of water resources inequalities. Access Theory and Game theories hypothesize that power consideration influence ability to benefit from resources (Osrtom 1990; Ribot and Peluso 2003; Hui *et al.*, 2016; Bhagabati& Kawasaki, 2014; Gichuki, 2002) conflicts over water resources are further intensified by lack of the ability by the institutions mandated to manage the use of water resources

and ensure equitable water use among all the waters users. Similarly, Mwangi (2012), found that conflicts are related to competition for scarce resources and marginalization of minorities, on many occasions, communities use violence to attempt to regain possession of lost rights or secure access to other land resources. De Stefano *et al.*, (2018) also found that water conflicts are caused by institutional interplay in the management of water resources at different level.

4.6.2 Water Resources Conflicts

The second objective of the study was to determine the prevalence of water conflicts in the study area. Findings indicate that 66.7% and 49.4% of downstream and upstream households respectively agree on the presence of water related conflicts in the study area. The results further indicated that water conflicts in the study regions were seasonal as indicate by 60.7% of the households while 26.6% agree that water conflicts are unpredictable. The findings show that that water conflicts trend is on the increase driven by increase in population and development. The findings by Kiteme *et al.*, (2008) also confirm that the months of January and February as the most dry months of the year experiencing dry seasons and a potential for the conflicts. Climate Change is likely to create unpredictability as to when in future conflict seasons may prevail.

According to the study results conflicts were intense in 1984, 1994 and 2015 to 2017 due to water scarcity due to prolonged droughts. The study further established that 32.6% of the households indicated increased tensions, animosity, quarrels, exchanges, fighting and loss of property as the major forms of water conflicts, 31.3% indicated tensions and animosity while 16.9% indicated fighting and loss of property. On conflict management, the study established that 43.5% of the conflicts were reported to Provincial Administrations, followed by 23.7% reports made to faith-based

organizations while 19.5% reported to WRUAs. According to the results, Provincial Administration still was a significant role in water related conflict resolution within the study areas.

The findings also showed that majority (78%) of the respondents were confident that the institutions they reported the water conflicts to had the capacity and ability to deal with the conflicts. The study findings showed that 37% of the respondents indicated that water conflicts were arbitrated between the feuding parties, 20.1% sought legal redress, and 15.6% send warnings to culprits while 12.5% indicated that culprits in water conflicts were arrested. The findings disagreed with Muigua (2016) who established that the current framework has not been efficacious in resolving conflicts and there is a need to develop a new approach to conflict management.

The finding agrees with Lanari *et al.*, (2018) that established that water conflicts were common during dry season and involved mainly pastoralists and large-scale farmers followed by farmers upstream and farmers downstream getting worse over the years. This finding also corroborates those of Gichuki, (2000) who posited that over-abstraction of water resources by large-scale farmers among water users have been blamed for reduced water volumes in the lower reaches increase frequency of conflicts among water users. Similarly, Gikonyo (1997) also pointed out that during the dry season, irrigation water demands and economic loss for not irrigating a water-stressed crop are highest.

4.6.3 Effect of Water Access, Use and Management on Conflicts

The study sought to test the association between major uses of water by various water users and presence of water conflicts. The findings of Chi-squares confirmed that there was a significant association between major uses of water and water related conflicts.

These associations however do not prove causation since other latent factors within the study area are at play with water scarcity is acting as a trigger to conflict (Bernauer & Böhmelt, 2014; Lund and Mandani, 2016; Mwangi 2012). The study finding implies that increase in the use of water among water users result to an increase in water related conflicts. Similar studies in similar ecosystems puts pressure on use of water resources as in the study area (Le Meur *et al.*, 2006. Calas and Mumma, 2010).

The finding also agrees with Yang and Cai (2014), found that conflicts over fresh water are of increasing concern between human beings and ecosystems across the world. Due to increasingly intensive disturbances by human beings in many river basins, great potential damages and risks are believed to be associated with indigenous ecosystems.

The findings also confirm that water management practices influenced water related conflicts. The findings implied that management of water sources significantly determines whether water conflicts exist. According to Gichuki(2002)the conflicts over water resources are further intensified by lack of the ability by the institutions mandated to manage the use of water resources and ensure equitable water use among all the waters users.

The study also tested the existence of significant association between adherence to rules and regulation and water related conflicts. The study findings showed that zones with no adherence to set rules and regulations experienced more frequent water conflicts compared to zones with adherence to rules and regulations. The chi-square findings also confirmed a significant association ($\chi^2= 28.556$, $p=0.000$) between adherence to rules and regulations and water conflicts within the study area. Adherence to rules and regulation reduces water conflicts. The study findings concurs with Funder *et al.*, (2012) who found that conflicts arise when customary practices are no longer viewed

as legitimate or consistent with national policies, or when entities external to a community are able to pursue their interests, while ignoring the needs and requirements of the insiders. Conflicts, therefore, emerge from inequalities in accessing or controlling resources.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

The purpose of this study was to assess water access, use and management of water resources and conflicts in the Upper Ewaso Nyiro North River Sub-Basin in Laikipia County. This chapter is the last chapter of the study and it entails the summary of the research findings based on specific objectives, conclusion made by the study, recommendation for practice, policy formulation and suggestion for further research.

5.2 Summary of the Findings

This section presents summary of the major findings of the study and discussion based on theoretical and empirical studies cited. The section is structured based on specific objectives of the study. The study sought to assess how different water users in the study area access water use and manage water resource. The findings shows that institutions mandated to ensure equal water access have not been effective hence the challenges of unequal water access still persist.

The respondents indicated that water users do not follow rules and regulation on water usage but are cognizant of the existence of rules. The problem is further worsened by climate change, which has led to reduction in precipitation and increase in population implying the demand for water resource has been increasing in the area while water supply has been declining. The study established different water resources management practices between upstream and downstream households. Study findings show that water is managed differently depending on the zonal occupation by users. NAWASCO predominantly manage upstream water sources dictated by the needs of urban towns and their proximity to water source at the foot zone of Mt. Kenya. WRUAs, project committees predominantly manage water downstream and occupied by ranching and

pastoralists households. The findings also show that majority of the respondents indicate pastoralists, large-scale farmers upstream, urban users and public institution as consuming more water. The findings include the ineffectiveness of institutions mandated to manage water affecting water access as manifested in presence of unfair, illegal abstraction. Corruption, lack of proper harmonized legal framework, absence of implementation of existing environmental rules and regulation on water management and utilization are reported as factors hindering sustainable access, use and management.

Stakeholders involved in conflict resolution by the water users were; the chiefs, NAWASCO officials, village elders and water resources user associations (WRUAs). The WRUA members were involved in solving conflicts whenever the water users were involved in water conflicts. These cases involve interventions by WRUAs applying mediation mechanisms, rationing water to ensure water equity among various users.

The study did not establish effectiveness of WRUAs in resolving the water related conflicts because the large-scale farmers were also WRUA members of management decision-making organs and seen to have an upper hand in decisions making. Members in some cases use their privileged position in access to capital and lobbying capacity compromising WRUAs member's interests as they depend on same big farmers for resources support for sustainability. Additionally, the WRUA officials and majority of its members were coming from the upstream regions of the rivers and therefore in most cases are not willing to engage with the downstream water users whom they compete in water access.

The second objective of the study was to assess the presence of water conflicts with the Upper Ewaso Nyiro River Sub-basin with Laikipia County as the case study. The

findings shows that both upstream households and downstream households agree that there are water related conflicts in the Upper Ewaso Nyiro River Sub-Basin. The findings further revealed that water conflicts were common during dry season and involve mainly pastoralists and large-scale farmers followed by conflicts between farmers upstream and farmers downstream. The study results also show a steady increase in water related conflicts within the study area over the decades.

The conflict is manifested in form of tensions, animosity, quarrels, exchanges, fighting and loss of property. The findings further show that majority of the respondents reported cases of conflicts for action to provincial administration, followed by faith-based organizations and WRUAs. Arbitration between the feuding parties involves seeking legal redress, warnings to rule breakers among actions taken by institutions to solve water conflicts. Lack of trust between various water users exacerbates conflict situation. Community perceptions within various water users are that large-scale horticultural farmers constitute the most water consumers in the area. This perception makes farmers the first water users to be attacked by the rest when water scarcity becomes severe.

The third objective sought to test whether there was a significant association between water usage practices and existence of water conflicts within the study areas. Findings as Chi-squares test confirmed a significant association between major uses of water, source of water, management of water resources, water sustainability, seasons, water consumption groups, adherence to rules and regulations and water related conflicts. The study findings implied that water use and management practices by various water users significantly contributed to water conflicts but water often is not the sole cause of conflict but other latent discontents could trigger conflicts during periods of scarcity.

Water scarcity has resulted to conflicts in the study area. Majority of the respondents attributed the conflicts to water scarcity resulting to competition over water resources for their various uses. The prolonged dry seasons is mentioned to be another major contributor to water scarcity in the area with respondents mentioning the months of January and March being the most dry months. This is period water scarcity is associated with severe conflicts forcing migration of pastoralists from downstream to encroach upstream farming community in search of water and pasture for their livestock.

5.3 Conclusion

The study concluded that access, use and management of water resources is linked to conflicts in the study area. High water demand due to population increase, land use practices, urbanization is some of the factors driving conflicts on an upward trend over the past four decades. Inequalities in water access affect vulnerable downstream water users triggering seasonal conflicts between upstream and downstream water users. Laikipia County, situated downstream of the study area, faces more water scarcity challenges and experiences more conflicts since it lacks water resources of its own apart from rain and ground water. It relies on water from Meru and Nyeri Sub-Counties upstream. The study further concludes that inequality in water access is due and ineffective water management institutions.

The study also concluded that ensuring equal access to water resources among water users would reduce water related conflicts in the sub-basin. Finally, findings recommend water users and stake-holders responsible for water management to adhere to regulations, laws and institutions governing the sector.

5.4 Recommendations

5.4.1 Recommendation to Improve Water Access and Manage Conflicts

The study findings show that study area experiences unequal access to water resource especially from river sources. This inequality contributes to water related conflicts. To improve water access and manage water related conflicts, the study makes the following recommendations; first the study recommends development of effective communication mechanisms to ensure all water users share science-based data and information regarding the state of water resource. Secondly authorities mandated with water regulations should be responsible for disseminating information to water users to for better management and reduction of water related conflicts. Thirdly; government, large-scale commercial farmers, and water users should invest in water harvesting and water saving technologies for sustainable water availability to minimize water related conflicts.

Water saving irrigation technology and water harvesting should be encouraged as to reduce the high dependence on the rivers for water sources. Furthermore, adequate water flow downstream reduces the compelling need for those communities downstream to follow receding water upstream hence creating conflict.

5.4.2 Recommendation for Policy

Water abstraction policies should be based on tested evidence from scientific research to avoid the making of legislation and institutions out of sync with realities on the ground. Institutions in charge of environment, for example, have overlapping mandates while policy changes have been proposed before new institutions such as the Water Harvesting Authority, The Basin Catchment Protection Committees formed under the Water Act 2016 been fully operationalized to gauge their effectiveness. The area of water ethics and education to create a pro-environmental society through providing

knowledge, attitude, and practices at all levels of stakeholders is strongly recommended to be introduced with governments taking the lead. This recommendation will deal with issues of inequalities in access brought out by this study.

The governments should promote rainwater harvesting and upscale conservation agriculture to slow down run-off and increase yields while maximize availability of water to residents downstream

5.5 Areas for Further Research

Recurring water related conflicts in the study area are on the increase. More research is recommended on quantities of water resources availability to inform on sustainable water access, reduction of competition over water and conflicts. Further research should also be undertaken on how to instill pro-environmental norms in policy implementers and water users to stem the level of impunity that is one of the factors affecting sustainable water access, use, and management and related conflicts.

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APPENDICES

Appendix I: Letter of Introduction

Date:

Dear Respondent,

RESEARCH DATA COLLECTION

I am a Doctor of Philosophy (PhD) candidate at the University of Nairobi, in the Wangari Maathai Institute. As part of the requirement for the award of the degree, I am expected to undertake a research study. I am seeking your participation in my study entitled “access to natural resources and its influence on Intercommunity relations: a case of Ewaso Nyiro North Basin in Laikipia”. The attached questionnaire will be used to gather relevant information to address the research objectives. Kindly respond or grant me permission to collect information in your firm. Please note this is academic research and the information provided will be treated in strict confidence. Strict ethical principles will be observed to ensure confidentiality and the study outcomes and reports will not include reference to any individuals.

Your assistance is highly appreciated.

Yours faithfully,

Simeon Lesrima

Appendix II: Questionnaire

LIST OF KEY INFORMANTS AND GROUPS TO BE INTERVIEWED

1. Leaders Youth/Women, Water Management Committee Members-KEY INFORMER
 2. Heads of National and County Government institutions and
 3. Semi-Government Departments /HCDA/WARMA/Water/NEMA/-KEY INFORMER
 4. Religious, GO officials.....-KEY INFORMER
 - 6 Large Ranchers Managers.....KEY INFORMER
 8. Pastoralists/ seasonal/permanent/. Agro-pastoralists groups.....KEY INFORMER
 9. Small scale/large-scale farmers groups...../FOCUS GROUP
- DISCUSSION
8. Commercial Private/Horticultural farmers groups..... .KEY INFORMER
 9. Industry Water Vendors/ Suppliers/
Tourism /hoteliers manufacturing industry-.....KEY INFORMER
 10. Institutions-Education/ health/ research /IMPALA/CETRAD
/military/officials/
 - 11 Water industry suppliers-
 12. Laikipia Wildlife Forum/KWS/KFS/Nrt/NEMA

SECTION B: BACKGROUND INFORMATION OF HOUSEHOLDS

(VARIOUS CATEGORIES)

1. Administrative information
 - a) District
 - b) Division
 - c) Location
 - d) Sub-location
 - e) Village.....
2. Nearest Major River.....
3. Nearest Tributary
4. Eco Zone

5. DEMOGRAPHICS

Name (optional)

GENDER

- 1. Male []
- 2. Female []

AGE

- 1. 18-24 years[]
- 2. 25-35 years[]
- 3. 36-49 years[]
- 4. 50-64 years[]
- 5. 65 and above[]

RESIDENCE:

- 6. 1. 1-2 years[]
 - 2. 3-4 years []
 - 3. Above 5 years []

7. What were the reasons for you moving here?

- i. Running away from conflicts
- ii. Was allocated land here
- iii. Bought land here
- iv. I live with relatives

EDUCATION LEVEL

What is your highest level of school/level completed?

- 1. Never []
- 2. Primary incomplete []
- 3. Primary complete []
- 4. Secondary incomplete []
- 5. Secondary complete []
- 6. College []
- 7. University level []

What is your occupation?

- 1. Pastoralist []
- 2. Pure farming []
- 3. Agro-pastoralist []
- 4. Small scale business []
- 5. Charcoal/firewood vendor []
- 6. Trade (e.g. carpentry, masonry etc) []

- 7. Casual labour []
- 8. Employment []
- 9. Other specify

OBJECTIVE ONE

INVESTIGATION OF ACCESS TO WATER BY GROUPS IN LAIKIPIA

COUNTY

8. Do you get enough water to satisfy your needs?

Yes ()

No ()

9. What do you mainly use water for?

a) Irrigating farms ()

b) For livestock ()

c) Industrial purposes ()

d) Domestic use ()

e) Power generation ()

f) Fish ponds ()

10. How many litres of water do you need in a day? (Approximate)

a) Less than 100 ()

b) 100-500 ()

c) 500-1000 ()

d) 1000-5000 ()

e) Over 5000 ()

11. What cost do you incur to access water for your needs (of whichever nature)

a. Monthly billKsh

b. Supply line maintenance..... Ksh

c. Water project membership fee and other charges..... Ksh

d. Water transport cost..... Ksh

e. Others name them.....Ksh

12. What is the average quality of water in this region

High quality ()

Moderate quality ()

Low quality ()

13. What are some of the effects experienced in this region due to access to water?

- a) Low food production
Yes () No ()
- b) Migration
Yes () No ()
- c) Increased tensions
Yes () No ()
- d) Increased Hatred
Yes () No ()
- e) Lack of trust
Yes () No ()
- f) Confrontations between groups
Yes () No ()
- g) Others (specify).....

14. What are some of the factors that prevent equal access to water in this region?

- a) Lack of trust between users
Yes () No ()
- b) Ineffective policy
Yes () No ()
- c) Ineffectiveness of the responsible institutions
Yes () No ()
- d) Ethnic differences
Yes () No ()
- e) Political differences
Yes () No ()

15. Which groups utilizes most of the water in this region?

- a) Pastoralists ()
- b) Agro-pastoralists ()
- c) Large scale farmers upstream ()
- d) Farmers downstream ()

- e) Industries ()
- f) Ranches ()
- g) Schools and Towns ()
- h) Others (specify)

16. What is your opinion on what should be done to ensure equal accessibility to water of high quality and quantity by all

17. Kindly give your opinion on the following statements

Statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
There unequal access to water by all parties					
Failure of institutions mandated to manage water are responsible to shortage					
Increasing population is the cause of water reduction					

OBJECTIVE TWO

EVALUATION OF IMPACT OF WATER ACCESS ON ENVIRONMENTAL DEGRADATION

1. Which one of these is/are the major causes of environmental degradation in this region
 - a) Overstocking ()
 - b) Poor land use ()
 - c) Fight over water ()
 - d) Lack of awareness ()
 - e) Waste products from large farms ()
 - f) Others (specify)
2. What aspect of environment suffers to affect water here?
 - a. Soil []
 - b. Tree cover []
 - c. Pollution []
3. Environment is mostly destroyed by
 - a. Pastoralists ()
 - b. Agro-pastoralists ()
 - c. Large scale farmers upstream ()
 - d. Farmers downstream ()
 - e. Industries ()
 - f. Ranches ()
 - g. Urban areas ()
 - h. Others (specify)
4. Government organisations have been effective in environmental management issues
 - a. True () False ()

5. What is the major contributor to natural vegetation destruction in this region
- Land use practices ()
- Overstocking of livestock ()
- Deforestation ()
- Increased population ()
6. Who should be responsible for environmental management in this region?
- The community ()
- National Government ()
- County Government ()
- Local NGOs ()
- WRUAs ()
7. The following should be responsible for protecting the environment in priority order
- a) Community leaders []
- b) ENNDA, []
- c) County government, []
- d) Provincial administration []
- e) My family and self []
- f) WRMA []
8. At what place is water polluted before it reaches you?
9. What part of the environment (soil trees grass) does water affect most when it is too much rain? What time of the year?
10. When is water most damaging to soil?
11. What affects the quality of water here?
12. At what stage is water polluted before reaching here?
13. What is the social and economic cost of environmental degradation in this region?

OBJECTIVE THREE

RELATIONSHIP BETWEEN WATER ACCESS AND INTERGROUP

RELATIONSHIP

1. What time of the year do you experience water shortage in this region?
What is the cause of shortage at that time?
2. How do communities deal with this shortage?
3. Which groups are the most affected by these water conflicts in Laikipia County?
4. Who uses the most of this water?
5. Are you satisfied by the manner water is shared?
Yes []

No []
6. What should be done to make water available all the time?
7. Which groups (list order of preference) should get priority in allocation in times of drought?
8. When do water conflicts frequently occur?
9. Who are the major groups that are involved most over water
 - a) Pastoralists and pastoralists ()
 - b) Pastoralists and agro-pastoralists ()
 - c) Pastoralists and Farmers ()
 - d) Large scale farmers and large scale farmers ()
 - e) Farmers downstream and farmers upstream ()
 - f) Small scale farmers and large scale farmers ()
10. What causes reduced water supply in this region?
 - a) Natural causes ()
 - b) Human made causes ()
 - c) Both ()
11. Who causes water conflicts most in this region?
 - a) Upstream users ()
 - b) Middle stream users ()
 - c) Lower stream users ()

12. Do all groups in this region access water equally?

Yes () No ()

13. Do the following activities cause water conflicts in this region? Please respond to all the questions.

Probable cause	Yes	No
Unsanctioned over abstraction		
Illegal abstraction (e.g. at night etc)		
Water pollution by upstream users		
Catchment destruction (e.g. by shamba system)		
Clearing of the riverine forest		
Lack of a proper overseeing authority / body in the region		
Inadequate legal and policy framework		
Poor enforcement of laws and policies governing access, use, management and conservation of water resources		
Weak local institutions such as the WUA & community water projects		
Incompatible livelihood strategies mainly between Agriculturalists and pastoralists		

14. Nature of conflicts

a) What form do these conflicts mostly take?

- i. Tension / animosity ()
- ii. Quarrels / verbal exchanges ()
- iii. Fighting ()
- iv. Loss of life ()
- v. Loss of property ()

b) What is the frequency of water conflicts

- i. Always ()
- ii. Seasonally ()
- iii. Annually ()
- iv. Unpredictable ()

15. Are there rules and regulation that regulate water utilization by all groups in this region?

Yes () No ()

16. If yes in question 21, are the rules and regulation followed by everyone?

Yes () No ()

17. Where is water resource conflicts reported?

- i. Provincial administration []
- ii. Community water project officials []
- iii. RWUA officials []
- iv. Local Ministry of water officials []
- v. NGOs []
- vi. Faith based organizations []
- vii. Police / security apparatus []

18. What action do the above mentioned authorities take to mitigate or resolve such water use related conflicts?

- a. Arbitrate between the feuding parties ()
- b. Arrest culprits ()
- c. Send warning to culprits ()
- d. Hold peace/reconciliation meetings ()
- e. Nothing ()
- f. Legal redress ()
- g. Advise on alternative water sources ()
- h. Enforce the law accordingly ()

19. What do you think should be done to resolve water conflicts experienced in this region?

- a)
- b)
- c)
- d)

1. water conflicts? If yes, why do these conflicts persist despite the existence of an array conflicts resolution and mitigation

20. Your agreements on the following statements by ticking where appropriate.

Statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Water sources are destroyed by water users during the struggle for rights of accessibility					
Environmental management practices are neglected by majority of water users in this region					
These region has no/few institutions or organisation spearheading environmental management issues					
Environmental degradation has played a role in reduced flow of rivers in this region					
Large scale farming and overstocking of livestock have led to environmental degradation in the region.					
Environmental degradation drastically reduces the quality of water in rivers					

21. In what other ways does water conflicts by different groups in the region impact on environment

.....

Appendix III: Focused Groups Discussion Guide

1. What do you think about the way water is shared in this region?
2. Do all people in this region have equal access to water?
3. What do you think should be done to address the gap if any?
4. Does this region have mechanism to handle water conflicts?
5. Which are the effective organs to deal with water allocation?
6. Which water committees do women and youth belong to?
7. Why do these conflicts persist despite the existence of an array conflict resolution mitigation measures?
8. Are you members of peace committees on water?
9. What in your own opinion should be/is the role of local and community leaders, ENNDA, County Government, Provincial Administration, WRMA and NGOs in the water conflicts?
10. According to you, who should be responsible in planning and mitigating these water conflicts?

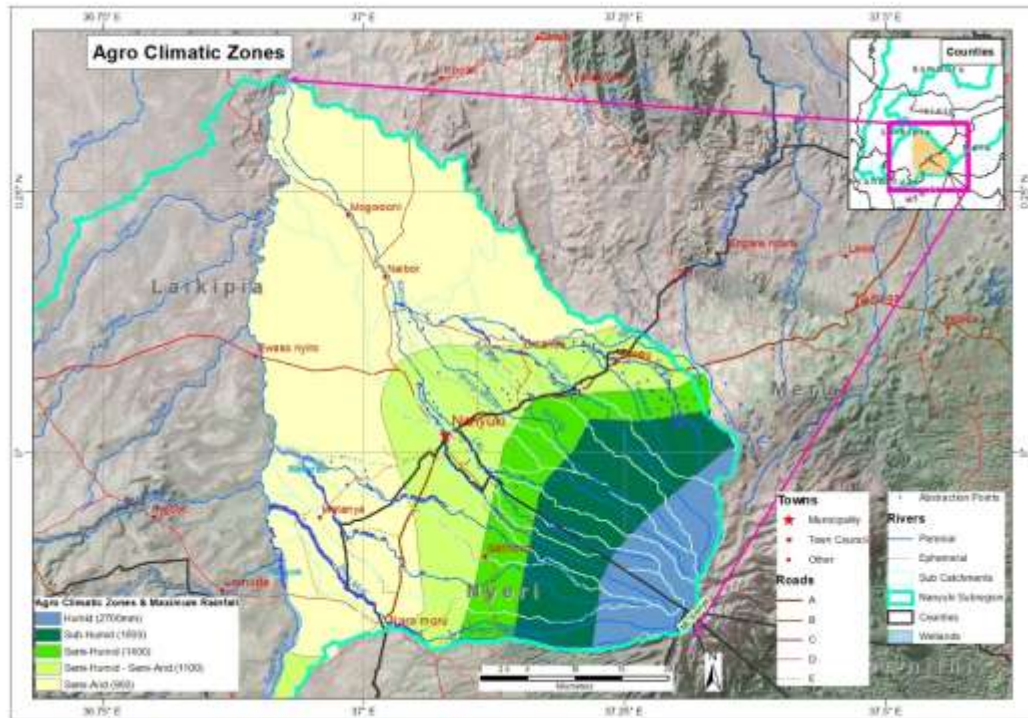
Appendix IV: Key Informant Questions Guide

1. Which groups of people in this region lack access to water, when? Why?
2. What are some of the effects of lack of access to water by different groups in this region?
3. What is the root cause of water conflicts in this region?
4. Describe how water is shared by different groups in this region?
5. What is the role of policy and legal issues in water conflicts?
6. Both upstream users and downstream users depend on rivers for water; explain how the use of water by these groups contributes to water conflicts?
7. Water is a source of conflicts globally therefore there is need to have effective institutions and systems to in place to manage water and resolve related conflicts. Do we have such systems here?
8. How does unequally sharing of water in this region contribute to environmental degradation and describe the extent of environmental degradation in this region?
9. Explain how land use system affects environmental degradation in this region?
10. Why do we have recurring conflicts over water in this region? Give the role of ethnic difference, different socio-economic structure, water use, effectiveness of institutions mandated to manage water resource, water catchment destruction, water and land rights, population increase etc.

Appendix V: Observation Checklist

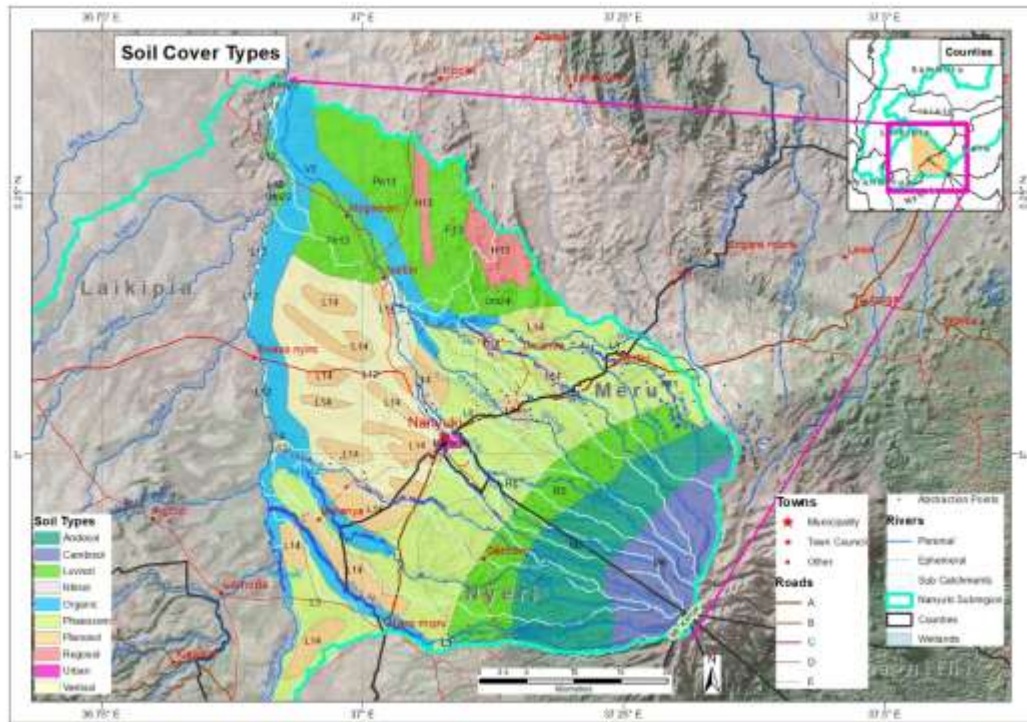
1. Water sources (rivers, dams, boreholes, shallow wells)
2. Water uses (Domestic, livestock, irrigation etc)
3. Water resource developments such as storage tanks, surface harvesting dams, intakes, community water projects
4. Drainage Methods of irrigation Livelihood approaches
5. Land use types Land cover/ vegetation type Soil types (physical characteristics)
6. Public utilities in major towns, market centers and villages
7. Infrastructure including road network, power supply, communication etc
8. Natural resources such as forests, wildlife, minerals
9. Social amenities such as schools, dispensaries/health centres, churches
10. Crop and animal husbandry Unharnessed economic potentials
11. Eco-tourism Off-farm livelihood options On-farm activities
12. Governance structures / institutions

Appendix VI: Map of Agro-Climatic Zones of the Study Area



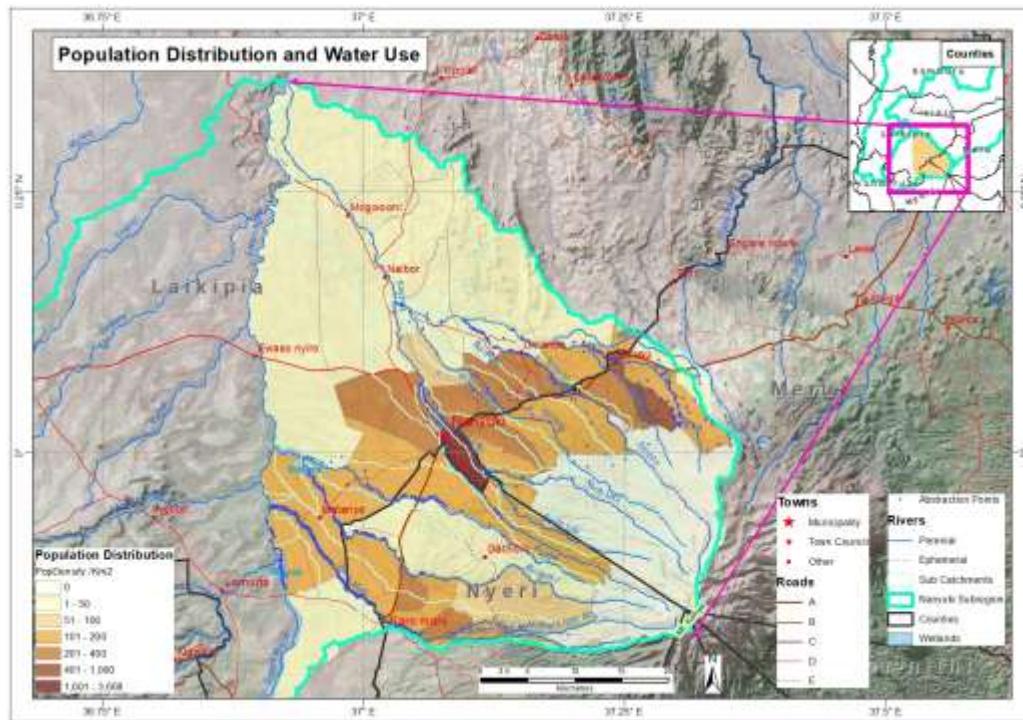
Source: CETRAD (2014)

Appendix VII: Map of Soils Covers of the Study Area



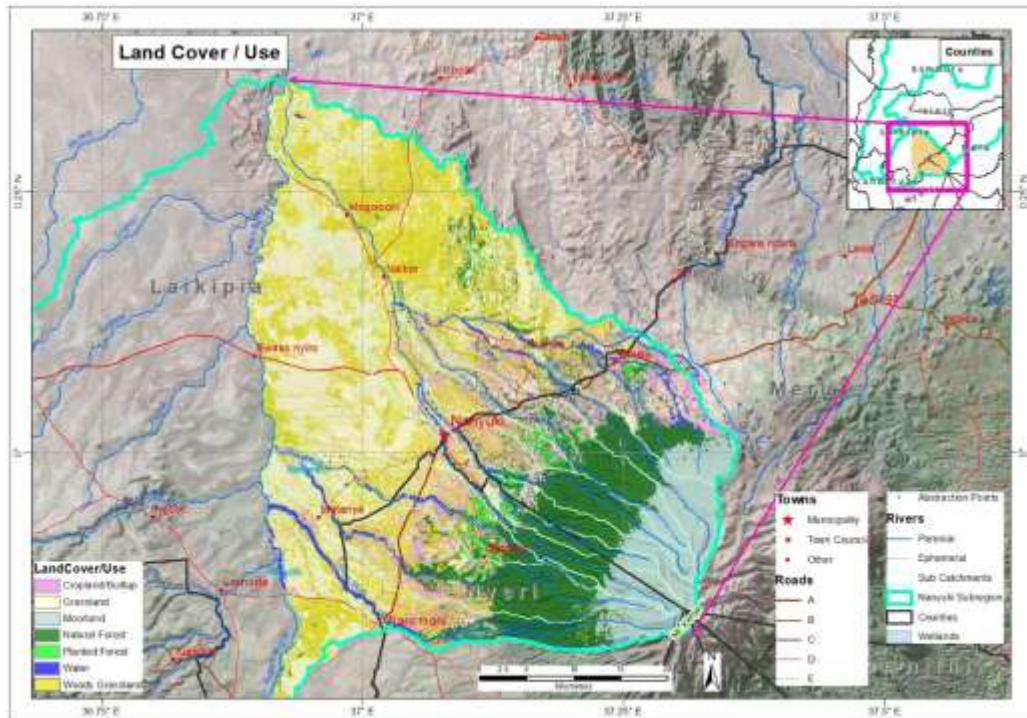
Source: CETRAD (2014)

Appendix VIII: Population Distribution and Water Use in the Study Area



Source: CETRAD (2014)

Appendix IX: Land Cover and Use in the Study Area



Source: CETRAD (2014)

Appendix X: Sampling Frame

										Area (Km2)		
County	Constituency	District	Division	Location	Sub location	Male	Female	Total	House holds	Original	Clipped	Density
Laikipia	Laikipia East	Laikipia East	Central	Impala	Rugutu	1,179	1,246	2,425	621	162	162.10	15.0
Laikipia	Laikipia East	Laikipia East	Central	Marura	Marura	3,368	3,333	6,701	1,754	41	41.21	162.6
Laikipia	Laikipia East	Laikipia East	Central	Nanyuki	Majengo	9,537	8,517	18,054	5,391	16	15.73	1,147.7
Laikipia	Laikipia East	Laikipia East	Central	Nanyuki	Thingithu	6,935	7,200	14,135	4,200	62	62.25	227.1
Laikipia	Laikipia East	Laikipia East	Central	Nturukuma	Likii	3,037	3,060	6,097	2,189	2	1.69	3,607.7
Laikipia	Laikipia East	Laikipia East	Central	Nturukuma	Nturukuma	2,177	2,157	4,334	1,213	19	18.58	233.3
Laikipia	Laikipia East	Laikipia East	Central	Segera	Ngarengiro	1,186	848	2,034	824	233	85.51	8.7
Laikipia	Laikipia East	Laikipia East	Central	Segera	Segera	1,916	1,994	3,910	981	587	121.78	6.7
Laikipia	Laikipia East	Laikipia East	Daiga	Ethi	Chumvi	1,774	1,832	3,606	710	241	40.44	15.0
Laikipia	Laikipia East	Laikipia East	Daiga	Ethi	Ngenia	3,009	2,957	5,966	1,713	54	31.89	111.2
Laikipia	Laikipia East	Laikipia East	Daiga	Naibor	Kimugandura	930	1,102	2,032	434	66	65.95	30.8
Laikipia	Laikipia East	Laikipia East	Daiga	Naibor	Mukima	964	923	1,887	477	22	21.68	87.0
Laikipia	Laikipia East	Laikipia East	Daiga	Naibor	Naibor	1,089	1,131	2,220	560	50	49.83	44.6
Laikipia	Laikipia East	Laikipia East	Daiga	Umande	Kalalu	2,671	2,657	5,328	1,540	22	21.82	244.2
Laikipia	Laikipia East	Laikipia East	Daiga	Umande	Nyariginu	2,976	3,010	5,986	1,608	26	26.32	227.4
Laikipia	Laikipia East	Laikipia East	Daiga	Umande	Umande	2,521	2,366	4,887	1,308	241	129.30	20.3
Laikipia	Laikipia East	Laikipia East	Lamuria	Lamuria	Lamuria	6,307	5,907	12,214	4,105	441	85.53	27.7
Laikipia	Laikipia East	Laikipia East	Lamuria	Tigithi	Matanya	7,338	7,510	14,848	4,095	121	119.72	122.7
Laikipia	Laikipia North	Laikipia North	Mukogodo	Ilmotiok	Impala	873	621	1,494	486	348	18.62	4.3
Laikipia	Laikipia North	Laikipia North	Mukogodo	Ilpolei	Ilpolei	1,820	1,647	3,467	793	384	103.30	9.0
Meru	North Imenti	Imenti North	Mt. Kenya Forest	Mt. Kenya Forest	Mt.kenya forest	0	0	0	0	276	252.29	0.0
Meru	North Imenti	Imenti North	Timau	Kirimara	Kiambo go	5,553	5,272	10,825	3,613	18	18.41	588.0
Meru	North Imenti	Imenti North	Timau	Kirimara	Kithithina	3,324	3,265	6,589	1,754	23	22.84	288.5
Meru	North Imenti	Imenti North	Timau	Ngusishi	Maritati	2,919	2,692	5,611	2,129	117	23.93	47.9
Meru	North Imenti	Imenti North	Timau	Ngusishi	Mutarakwa	2,498	2,380	4,878	1,740	47	38.79	103.0
Meru	North Imenti	Imenti North	Timau	Ontulili	Antu bamwitu	3,758	3,644	7,402	2,273	66	66.19	111.8
Meru	North Imenti	Imenti North	Timau	Ontulili	Kangaita	2,076	2,054	4,130	1,188	26	25.57	161.5

Meru	North Imenti	Imenti North	Timau	Ontulili	Katheri	2,732	2,716	5,448	1,598	22	21.69	251.2
Meru	South Imenti	Imenti South	Mt. Kenya Forest	Mt. Kenya Forest	Mt. Kenya forest	0	0	0	0	268	0.70	0.0
Nyeri	Kieni	Nyeri North	Kieni East	Gakawa	Gathiuri	2,886	2,484	5,370	1,609	118	118.21	45.4
Nyeri	Kieni	Nyeri North	Kieni East	Gakawa	Githima	2,416	2,439	4,855	1,363	39	39.04	124.4
Nyeri	Kieni	Nyeri North	Kieni East	Gakawa	Kahurura	7,981	8,115	16,096	5,125	94	94.29	170.7
Nyeri	Kieni	Nyeri North	Kieni East	Kiamathaga	Gikamba	2,183	2,001	4,184	1,098	66	66.41	63.0
Nyeri	Kieni	Nyeri North	Kieni East	Kiamathaga	Kabendera	1,419	1,472	2,891	830	11	11.31	255.6
Nyeri	Kieni	Nyeri North	Kieni East	Kiamathaga	Muricho	1,353	1,321	2,674	762	11	11.31	236.4
Nyeri	Kieni	Nyeri North	Kieni East	Kiamathaga	Tigithi	1,175	1,019	2,194	666	21	21.05	104.2
Nyeri	Kieni	Nyeri North	Kieni East	Naro Moru	Kamburaini	3,224	3,190	6,414	1,813	43	16.10	150.4
Nyeri	Kieni	Nyeri North	Kieni East	Naro Moru	Naromoru	2,040	2,061	4,101	1,661	7	1.36	625.2
Nyeri	Kieni	Nyeri North	Kieni East	Naro Moru	Ndiriti	1,964	1,869	3,833	1,094	17	0.52	228.8
Nyeri	Kieni	Nyeri North	Kieni East	Naro Moru	Rongai	1,681	1,954	3,635	989	38	3.62	96.4
Nyeri	Kieni	Nyeri North	Kieni West	Endarasha	Endarasha	3,143	3,473	6,616	1,907	17	0.01	398.6
Nyeri	Kieni	Nyeri North	Kieni West	Endarasha	Mitero	1,785	1,805	3,590	901	15	1.90	241.4
Nyeri	Kieni	Nyeri North	Kieni West	Mwiyogo	Labura	2,745	2,750	5,495	1,494	65	13.49	83.9
Nyeri	Kieni	Nyeri North	Kieni West	Mwiyogo	Muthuini	986	1,008	1,994	571	20	8.95	101.0
Nyeri	Kieni	Nyeri North	Kieni West	Mwiyogo	Mwiyogo	861	890	1,751	471	16	4.02	108.8
Nyeri	Mathira	Nyeri North	Mt Kenya	Mt Kenya	Mt Kenya	0	0	0	0	248	66.09	0.0
						122,309	119,892	242,201	71,651	4,847	2,171	238

Source: CETRAD (2014)

Appendix XI: Household Population and Sample per Sub-location

	Location	Sub-location	No Of Households	Sample	
LAIKIPIA NORTH	Ilmotiok	Impala	486	5	
		Lpolei	793	8	
		Segera	981	10	
			Ngarengiro	824	8
		Impala	Rugutu	621	6
		Naibor	Naibor	560	6
			Mukima	477	5
			Kimugandura	434	4
		Ethi	Ngenia	1713	17
LAIKIPIA EAST	Umande	Umande	1308	13	
		Nyaringinu	1608	16	
		Nanyuki	Thingithu	4200	42
		Nturukuma	Likii	2189	22
	Marura	Marura	1754	18	
NYERI	Tigithi	Matanya	4095	41	
		Gakawa	Kahurura	5125	51
			Gathiuri	1609	16
		Kiamathaga	Gikamba	1098	11
	Naromoru	Ndiriti	1094	11	
		Rongai	989	10	
MERU	Kirimara	Kithithina	1754	18	
		Ngushishi	Mutarakwa	1740	17
		Ontulili	Kangaita	1188	12
		Ontulili	Katheri	1598	16
			38238	393	