

**ASSESSMENT OF WATER RESOURCES UTILIZATION AND MANAGEMENT IN
CHAHI SUB-CATCHMENT, KISORO DISTRICT, UGANDA**

BY

TERA MARAHI MOSES
B.SC. ALUM (MUK)
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DECLARATION

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

Signature_____Date_____

Tera Marahi Moses
Candidate

We confirm that the work reported in this thesis was carried out by the candidate under our supervision

Dr. S.K Murimi
Department of Geography
Kenyatta University
P.O Box 43844-00100
Nairobi, Kenya

Signature_____Date_____

Prof. Majaliwa Mwanjalolo
Department of Geography, Geoinformatics and Climatic Sciences
College of Agricultural and Environmental Science
Makerere University
P.O Box 7062
Kampala, Uganda

Signature_____Date_____

DEDICATION

I dedicate this thesis to my dear parents, Mr. Kule Nason and Mrs. Margret Kule who brought me into being and shaped a career for me.

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TABLE OF CONTENTS

DECLARATION.....	ii
DEDICATION.....	iii
ACKNOWLEDGEMENTS	iv
TABLE OF CONTENTS	v
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF PLATES	xi
ACRONYMS AND ABBREVIATIONS.....	xii
ABSTRACT.....	xiv
CHAPTER ONE: INTRODUCTION.....	1
1.1 Background to the Study.....	1
1.2 Statement of the Problem	5
1.3 Justification of the Study.....	6
1.4 Objectives of the Study	7
1.4.1 General Objective.....	7
1.4.2 Specific Objectives.....	7
1.5 Research Questions	7
1.6 Significance and Anticipated Output	8
1.7 Scope and Limitations of the Study	9
1.8 Chapter Summary.....	9
1.9 Operational Definition of Terms and Concepts	10
CHAPTER TWO: LITERATURE REVIEW.....	12
2.1 Introduction.....	12
2.2 Overview of Water resources in Africa.....	12
2.3 Water Resources Management.....	13
2.4 Water Resources Utilization.....	15

2.5 Water Resources Scarcity.....	16
2.6 Coping with Water Scarcity	18
2.7 Evaluation of Drivers of Water Resources Scarcity.....	19
2.7.1 Climate Change	19
2.7.2 Population growth.....	20
2.7.3 Pollution.....	21
2.7.4 Land Use Practice	22
2.7.5 Economic growth.....	22
2.7.6 Poverty.....	23
2.7.7 Level of Education.....	23
2.8 Challenges and Opportunities to Water Resources Management	24
2.9 Conceptual Framework	25
2.9.1 Achieving Sustainable Water Resources Management (SWRM)	26
2.9.1.1 Technologies	28
2.9.1.2 Institutions.....	28
2.9.1.3 Economics.....	29
2.10 Chapter Summary.....	30
CHAPTER THREE: MATERIALS AND METHODS	32
3.1 Introduction	32
3.2 Study Area.....	32
3.2.1 Location	32
3.2.2 Climate.....	32
3.2.3 Soils	34
3.2.4 Socio-Economic Activities.....	35
3.3 Selection and Training of Research Assistants	35
3.4 Research Design.....	35
3.5 Sampling Procedure	36
3.6 Data Collection.....	37

3.7 Data Analysis	37
3.7.1 Data Pre-processing	37
3.7.2 Statistical Analysis	38
3.7.3 Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis	39
3.8 Chapter Summary	41
CHAPTER FOUR: RESULTS AND DISCUSSION	42
4.1 Introduction	42
4.2 Characteristics of Respondents	42
4.2.1 Gender	42
4.2.2 Age	43
4.2.3 Marital Status	43
4.2.4 Level of Education	44
4.2.5 Occupation	45
4.2.6 Duration Stayed in Chahi Sub-catchment	45
4.3 Local Uses and Management of Water Resource	46
4.3.1 Local Water Resource Use in Chahi Sub-catchment	46
4.3.2 Sources of Water in the Sub-catchment	48
4.3.3 Involvement in the Utilization and Management of Water Resources	51
4.3.4 Factors Limiting Households and Institutions in Sustainably Managing Water Resources	52
4.3.5 Interventions to Ensure Sustainable Water Supply and Management	54
4.4 Drivers of Water Resources Scarcity	55
4.4.1 Status of Water Resources in Chahi sub-catchment	56
4.4.2 Drivers of Water Scarcity	56
4.4.3 Effects of Declining Water Supply	58
4.5 Local Coping Mechanisms to Water Shortages	59
4.5.1 Relationship between Local Coping Mechanisms and Time Stayed in Chahi Sub-catchment by Households	63

4.6 Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis of Challenges and Opportunities	64
4.6.1 Key to the Strengths, Weaknesses, Opportunities and Threats Matrix	66
4.7 Opportunities and Challenges	67
4.7.1 Strengths	67
4.7.2 Weaknesses.....	70
4.7.3 Opportunities	72
4.7.4 Threats	75
4.8 Discussion of Results	78
4.8.1 Utilization and Management of Water Resources	78
4.8.1.1 Limitations to Sustainable Management of Water resources	81
4.8.2 Drivers of Water Resources Scarcity.....	84
4.8.3 Coping with Water Resources Scarcity	89
4.8.4 Policy Framework in the Utilization and Management of Water Resources	92
CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS.....	93
5.1 Introduction	93
5.2 Summary of Findings	93
5.3 Conclusions	96
5.4 Recommendations	97
5.5 Areas for Further Study.....	99
REFERENCES.....	101
APPENDICES.....	110
Appendix 1.0: Sample Questionnaire.....	110
Appendix 2.0: Key Informant Interview Guide	117
Appendix 3.0: Field Observation Guide	120

LIST OF TABLES

Table 3.1: Strengths, Weaknesses, Opportunities and Threats Analytical Matrix	41
Table 4.1: Respondents Gender	42
Table 4.2: Age of Respondents	43
Table 4.3: Respondents Marital Status	44
Table 4.4: Respondents Level of Education	44
Table 4.5: Respondents Occupation	45
Table 4.6: Time Spent by Respondent in Chahi Sub-catchment	46
Table 4.7: Chi-square Results of Households' Perceptions on the Interventions to Ensure Sustainable Water Supply and Management	55
Table 4.8: Chi-square Results of Coping Mechanisms and the Time Spent in the Catchment	64
Table 4.9: SWOT Matrix for Challenges and Opportunities	65
Table 4.10: Key to SWOT Matrix	66

LIST OF FIGURES

Figure 2.1: Conceptual Framework for Sustainable Water Resources Management	27
Figure 3.1: Map of Chahi Sub-catchment.....	33
Figure 3.2: Mean Monthly Rainfall Totals in Millimetres for Chahi Sub-Catchment from 2000 to May 2007	34
Figure 4.1: Water Utilization in Chahi Sub-catchment	47
Figure 4.2: Water Sources in Chahi Sub-catchment.....	49
Figure 4.3: Level of Involvement in Water Management.....	51
Figure 4.4: Limitations to Households and Institutions in Managing Water Resources	52
Figure 4.5: Interventions to Ensure Sustainable Water Supply and Management	54
Figure 4.6: Status of Water Resources over the Years	56
Figure 4.7: Main Drivers of Water Resources Scarcity	57
Figure 4.8: Impacts of Water Shortages	58
Figure 4.9: The Identified Coping Mechanisms	60

LIST OF PLATES

Plate 4.1: Examples of home gardens in Nyarusiza and Chahi Sub-counties, respectively	47
Plate 4.2: Chuho, the only Stream in the Sub-catchment (4/3/2011).....	49
Plate 4.3: An example of piped water in Nyakabande Sub-county	50
Plate 4.4: One of the constructed safe water point in Chahi sub-catchment.....	50
Plate 4.5: A dysfunctional borehole in Nyakinama Sub-county.....	53
Plate 4.6: Some form of Pollution of Chuho Stream (4/3/2011)	58
Plate 4.7: A Woman Transferring Water from an Earthen pot to a Jerry can.....	61
Plate 4.8: Sagitwe Hill in Nyarusiza Sub-county.....	62
Plate 4.9: Water Harvesting and Storage Tanks Supplied by Compassion International	62
Plate 4.10: Example of Ferrocement Tanks in the sub-catchment (13/2/2011).....	63

ACRONYMS AND ABBREVIATIONS

CA: Comprehensive Assessment of Water Management in Agriculture

CMP: Sub-Catchment Management Plan

DAAD: German Academic Exchange Service

DFID: Department for International Development

DIIS: Danish Institute for International Studies

DRWH: Domestic Rainwater Harvesting

FARA: Forum for Agricultural Research in Africa

FIEFOC: Farm Income Enhancement and Forestry Conservation

GWP: Global Water Partnership

HMC: Hill Management Committee

ICWE: International Conference on Water and Environment

IDRC: International Development Research Centre

IPs: Innovation Platforms

IPCC: Intergovernmental Panel on Climate Change

IUCN: International Union for the Conservation of Nature and Natural Resources

KDLG: Kisoro District Local Government

KITOWASO: Kisoro Town Water and Sanitation Office

Km: Kilometre

MGDs: Millennium Development Goals

MWE: Ministry of Water and Environment

NEMA: National Environment Management Authority

NGOs: Non-governmental Organizations

NWP: National Water Policy

RWH: Rainwater Harvesting

SCMP: Sub-Catchment Management Plan

SPSS: Statistical Packages for Social Sciences

SSA: Sub-Saharan Africa

SWOT: Strength, Weakness, Opportunities and Threats

SWRM: Sustainable Water Resources Management

UNDP: United Nations Development Programme

UN: United Nations

USD: United States Dollar

WfP: Water for Production

WRM: Water Resources Management

WUCs: Water User Committees

WWC: World Water Council

ABSTRACT

There is a growing global concern over the future of the world's water resources due to the preceding vulnerability. Some of the factors contributing to the increase in water resources vulnerability include population growth and poor land use practices. This study assessed the local uses and management of water resources and the local coping mechanisms, identified the drivers of water resources scarcity and evaluated the opportunities and challenges of managing water resources in Chahi sub-catchment, Kisoro District, Uganda. To achieve the objectives of the study, the following empirical tools were used; a structured questionnaire, key informant interviews and field observation guides. A total of 100 households and 20 key informants were interviewed. Numerical tools for data analysis comprised descriptive statistics and non-parametric test. SWOT analysis tool was used to examine the challenges and opportunities. The study identified pipe borne water (89%), stream (58%), rain (40%) through roof catchment and vendors (8%) as the major sources of water in the sub-catchment, with domestic (100%) and agricultural (24%) being the major local uses of water. Women played a key role in the management of water sources, making use of the water and fetching of water from the water sources. Construction of water points, maintenance of available water points, fencing of the water source, participatory planning in water management, equitable distribution of water tanks and training on water management were identified by households as interventions to ensure sustainable water supply and management in the sub-catchment. Drivers of water resources scarcity in the sub-catchment included climate change (98%), poverty among the households (80%), population growth (77%), pollution (41%), inadequate information on water management (33%), land use practices (20%) and deforestation (16%). Various coping mechanisms; domestic rainwater harvesting (DRWH), water storage during plenty, water pricing, use of earthen pots, moving long distances and innovative agricultural practices were being used by the households. However, not any of all these coping mechanisms considered depicted a significant relationship with the households' longevity in the sub-catchment. Major challenges hindering water resources management (WRM) in the sub-catchment are; low coverage of rainwater harvesting technology at household level, lack of internal training on WRM technologies and inadequate support of water initiatives by the households. Conversely, the opportunities established include; location, support from the Central Government through the District Local Government and involvement of different stakeholders in water management. The study concludes that water shortage appears as a powerful incentive to change, eliciting major adaptations and coping strategies from users. This study recommends focus on building more water infrastructure and involvement of the households in the planning and allocation of water resources. This will contribute to improved understanding of the need for efficient water resources utilization and management on household livelihoods and also help design appropriate WRM strategies for the poor peasant farmers and provide guidance for policy makers for similar situations in Uganda and beyond.

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

There is a growing global concern over the future of the world's water resources due to the increasing human pressure over the intricate and finite water resource which has led to water resources scarcity (Cosgrove and Rijsberman, 2000; Taha, 2007). The problem of water scarcity is expected to increase significantly in the coming years, unless a sustainable awareness of resources management emerges (Ayenew, 2007). Water resource is not only a basic need, but is also a centre-piece of sustainable development and a crucial part of poverty alleviation (Förch and Thiemann, 2004). The Dublin principles and the Earth Summit's Agenda 21, also emphasise the need for integrated water management, recognising water as one of a number of natural resource elements that needs to be managed in a sustainable manner (Figueraes *et al.*, 2003). Many parts of the world, markedly the Middle East and the sub-Saharan Africa (SSA) are experiencing intense competition over water resources due to management failures. This situation is serious in shared drainage basins where it has heightened political conflicts (McCartney, 2000) and it is not any better in Uganda.

In this context, water is a precious resource on which all dimensions of an extended security concept (food security, economic security and human security) depend. This crucial importance of water in the world makes it an essential component of international, national and local security (Danish Institute for International Studies, 2006). The study on sustainable utilization of regional water resources in China indicates that water resources are one of the most important factors hindering sustainable development of the world economy and society. This makes water resource one of the main factors restricting the local sustainable development (Liu *et al.*, 2010). Livelihood security in sub-Saharan Africa is strongly

dependent on water resources among smallholder farmers, the main challenge being to improve the management and productivity of the available water resources (Rockström, 2000). This therefore calls for a tilting in water resources management (WRM) from raindrop to river and lakes, a strategy that would widen the prioritization of water management and policy options (UN, 1997). Otherwise, the concepts underlying WRM are recognized as important for MDG goal 1 (related to extreme poverty and hunger), goals 4, 5 and 6 (human health) and especially goal 7 (environmental sustainability and access to safe water and improved sanitation) (Jonch-Clausen, 2004). In support of the facts surrounding WRM, the real revolution in WRM is expected to be achieved when all stakeholders, where possible, have the power to manage their own water resources (Mitchell *et al.*, 2004). In this respect, concerted efforts should be made to maximize productive water use and overall conservation of water catchment areas (Ngana *et al.*, 2004).

However, water scarcity is a growing concern worldwide (Rijsberman, 2006; Rockström and Barron, 2007), with SSA mainly struggling with economic water scarcity due to human, institutional and financial constraints (CA, 2007). Uganda is no exception to this economic form of water scarcity. In Uganda, water resources cover 16 % of the country's total area and are facing the biggest pressure from the growing population and poor waste management practices of industries located near the water system (NEMA, 2007). With the current population growth rate of 3.2%, Uganda is predicted to experience water stress by the year 2017 when the population reaches 38.8 million and its water availability will be less than 1700 m³ per person per year. Already some districts such as Kiruhura, Kisoro, Luwero, Masaka, Sembabule and Isingiro are water stressed (NEMA, 2008). Water resources in Uganda and indeed in many other African countries are prone to degradation mainly because

they are traditionally a common property, utilized by anybody but in practice owned by nobody (UN-Water, 2006). Water degradation and consequent limited access to clean and safe water resources have been reported to be a major problem in Kisoro district for along time (NEMA, 2007). However, under the Five Year Plan (2006- 2011) Water for Production sub sector, Uganda is encouraging consumptive use of its freshwater resources for productive agricultural and industrial purposes tailored towards improving rural household incomes. The WfP is intended to meet the following strategic interventions; improved access to water for livestock, promotion of water harvesting for small-scale supplementary irrigation, promotion of small-scale aquaculture and creation of an enabling environment for private sector investment (NEMA, 2008). This has done no significant improvement yet in Chahi sub-catchment, particularly in promoting water harvesting for small-scale irrigation.

Increasing population, rapid urbanization, industrial development and poor WRM systems continue to put pressure on the water resources (Park, 2006; Flint, 2004). This necessitates that in ameliorating WRM constraints, utilization and management of water require the involvement of government, civil society and the private sector while respecting the subsidiarity principle (GWP, 2000). It is in this light that WRM requires the social and/or community adaptive capacity by harnessing technology, accepting institutional changes and adapting to new consumption patterns. Attaining this notion is the core of capacity building and sustainable water management at the local level (Flint, 2004). However, in 2002, the World Water Vision presented by the World Water Council at the 2nd World Water Forum clearly stated that the water crisis existing in many parts of the world is generally caused by poor water management (WWC, 2000). This is supported by the Human Development Report of 2006, which states that most countries have enough water to meet all human and

environmental needs, and that what passes for scarcity is a policy-induced consequence of mismanaging the resource (UNDP, 2006). The management of water resources in Uganda and in Chahi sub-catchment in particular is no exception to this mismanagement aspect.

It is against this background that many past failures in water management are attributed to the fact that water has been, and still viewed as a free good or at least that the full value of water has not been recognized (Figueraes *et al.*, 2003). The International Conference on Water and Environment (ICWE) held in Dublin in 1992 describes water as a social and an economic good (Figueraes *et al.*, 2003). This has necessitated the need for full-cost pricing to encourage water conservation through maintenance of infrastructure, to ensure more water is available to go around and to pay for the proper operation to prevent water resource degradation (Cosgrove and Rijsberman, 2000). In line with this management aspect, IWRM must be adopted and water policy interventions applied to ensure efficient and sustainable use and management of the valuable resource for the present and the future (Sylvain, 2006). This is aimed at increasing the various water uses that must be coordinated with, and integrated into, the overall water management of the different regions of the world if sustainability and environmental protection are to be achieved (Bouwer, 2003).

These contentions indicate that water resources utilization for various functions in most basins often leads to conflicts that are related to scarcity and distribution to competing uses, upper catchment and lower catchment demands, sanitation, pollution, damming and abstraction (Figueraes *et al.*, 2003; Agwata, 2005). These conflicts require appropriate interventions in the form of conservation, protection of water sources and apportionment to meet various water needs in an integrated and sustainable manner (Förch *et al.*, 2005).

1.2 Statement of the Problem

The increasing exposure of natural resources to degradation is among the challenges to humanity in most catchments of Uganda (Mutekanga *et al.*, 2010). This is no exception in Chahi sub-catchment of Lake Bunyonyi catchment in Uganda. Whereas water security is necessary, water resources in the sub-catchment are limited and poorly managed (KDLG, 2008). The major concern is the future of the available water resources in the sub-catchment which is probably the limiting factor and the subsequent livelihood of the people. Some of the factors contributing to the increase in water resources scarcity include the phenomena of population growth, land fragmentation and poor land use practices. Increase in population and inadequate managerial capacity and control have led to water scarcity and degradation of the environment (Nyiraneza and Hoellhuber, 2002). This has resulted in a heavy increase in demand for water, primarily in the small-scale farming areas and rapidly growing urban areas. In addition, water resources in the sub-catchment are not evenly distributed and many areas are threatened by persistent lack of access to safe water due to limited water sources, poor water management technologies and managerial control. The District Water Office Annual Report 2001 for Kisoro District indicates that natural water sources are limited (KDLG, 2008). This is partly attributed to the pyroclastic volcanic rocks with large voids that allow rapid rates of percolation hence reducing surface water retention although rainfall is high with short dry season (Nyiraneza and Hoellhuber, 2002). A big part of the district especially the sub counties of Nyakabande, Chahi, Muramba, Nyakinama and Nyarusiza are most affected (KDLG, 2008), which are part of Chahi sub-catchment. The study therefore assessed the utilization and management practices of water resources while identifying other appropriate practices for sustainable WRM in Chahi sub-catchment.

1.3 Justification of the Study

The basis of conducting this study was motivated by the following reasons; Chahi sub-catchment is one among the most affected catchments in Uganda by water resources depletion, which has endangered the water resource base (NEMA, 2007). The stress on natural resources in Chahi sub-catchment, Kisoro District in general is manifested by loss of agricultural productivity, water scarcity, loss of forest cover, disease prevalence, encroachment on wetland areas and increasing land degradation (KDLG, 2008). In addition, soil and water conservation measures are weak, resulting in more adverse effects on water and other land resources than expected. It is revealed that 80% of Kisoro district, Chahi sub-catchment inclusive, is severely affected by soil erosion due to poor land use practices, poverty and topography of the area (NEMA, 2007). Secondly, the population in the sub-catchment is growing at a high rate (estimated at 2.8%) (Uganda Bureau of Statistics, 2005), thus putting strain on water and other land resources through increasing the demand for water resources. Thirdly, Chahi sub-catchment is one of the most affected water catchments by limited access to safe water (KDLG, 2008) and little has been done to address these water related scenarios. Studies by Cornelius *et al.* (2008); MWE (2008) indicate that only 43.9% of the people in Kisoro district, Chahi sub-catchment inclusive, have access to safe and clean water, which is below the national average of 67%. Suitable WRM techniques need to be put in place to reverse this trend.

Availability of information on addressing these issues is thus crucial for enhancing the development of a Sub-Catchment Management Plan (SCMP) in Chahi sub-catchment and for addressing key issues of water management, food security and environmental degradation. The study dealing with the utilization and management of water resources may be very useful

for filling in these gaps. This study is thus valuable to different categories of stakeholders; farmers, researchers, the Local government as well as NGOs involved in water management and environmental conservation.

1.4 Objectives of the Study

1.4.1 General Objective

The general aim of the study was to assess the utilisation and management practices of water resources in Chahi sub-catchment and identify other appropriate practices for sustainable water resources management.

1.4.2 Specific Objectives

The study was guided by the following specific objectives:

- i. To assess the local uses and management practices of water resources in the catchment.
- ii. To identify the drivers of water resources scarcity in the catchment.
- iii. To assess the local coping mechanisms to increasing water resources scarcity in the catchment.
- iv. To evaluate the opportunities and challenges of managing water resources at household level in the catchment.

1.5 Research Questions

The study was guided by the following questions:

- i. What are the local uses and management practices of water resources in Chahi Sub-catchment?
- ii. Which factors contribute to increasing scarcity of water resources in the study area?

- iii. What are the local coping mechanisms adapted in response to increasing water resources scarcity in the study area?
- v. What are the opportunities and challenges of managing water resources at household level in the sub-catchment?

1.6 Significance and Anticipated Output

Water resources are an important resource both to human kind and the environment at large. The local community in Chahi sub-catchment depends on water for its livelihood. The study on utilization and management of water resources in the sub-catchment is a necessary milestone towards the sustainability of community livelihoods. Therefore, the information attained would add value to the available information on management of water resources for sustainable livelihoods. It will help in achieving the Millennium Development Goals (MDGs) and the Uganda's vision 2025 on environmental sustainability if the information gathered is used to create awareness and educate the society on ecosystem sustainability.

Moreover, developing an approach for identifying other appropriate options for sustainable water resource use and management is key to water resources planning and development. This may facilitate different water resources users in Chahi sub-catchment and other related environments with information in efforts to conserve and manage water resources sustainably. By this, Uganda will be on the way to achieving the MDG of ensuring environmental sustainability and access to water and improved sanitation (Goal 7). The outcome of this study may be used as a planning and management tool and in addition serve as an input to the SCMP of the sub-catchment. The study is thus important in coming up with effective WRM practices appropriate for policy makers, resource users and the vulnerable poor farmers in the sub-catchment.

1.7 Scope and Limitations of the Study

This study was carried out in Chahi sub-catchment, Kisoro district of Uganda. It assessed the utilization and management of water resources at household level. This covered local uses of water resources to the households, water resource management practices and the coping strategies to the limited water resources. To achieve this, both surface and underground water resources management issues were investigated. This is because underground water resources are said to be the major sources of water in the catchment (Nyiraneza and Hoellhuber, 2002). Relevant officials and experts were also consulted and their views incorporated in the study.

The study was limited in the following aspects. Data on various parameters for Chahi sub-catchment; ground water, pollution levels and water availability per person per year were not available. This made it a bit hard to expressly ascertain the exact degree to which water resources in the sub-catchment were threatened. However, the available average national figures for Uganda describing the state of water resources filled this gap.

1.8 Chapter Summary

Chapter one covered the background to the study problem, hinting on various issues regarding water resources globally, regionally and locally. The chapter also tackled the statement of the problem, research questions and objectives, justification of the study, significance of the study and anticipated output and scope and limitations of the study. The chapter highlights that water resources are an important resource to human livelihoods as well as economic development. It is therefore worthwhile protecting the resource through adopting better utilization and management practices so as to ensure their sustainability.

1.9 Operational Definition of Terms and Concepts

Integrated Water Resources Management: Is a paradigm for the management of water resources that holistically treats the use of water in different sectors of the economy (Orlove and Caton, 2010). It is a systematic process for the sustainable development, allocation and monitoring of water resource use in the achievement of social, economic and environmental objectives. It emphasizes that solutions to water problems can not be found in only one sector of society such as agriculture, because water is used across the society as a whole, therefore a broad, multi-sectoral approach must be taken.

Watershed: Also referred to as a water catchment, is an area of land which drains downhill to a lowest point. It is a possible management unit (Orlove and Caton, 2010). The boundaries of this area of land define a set of participants in this management, which includes natural scientists, government officials, members of local organizations and ordinary citizens. Similarly, a catchment is defined as “drainage basin, or an area of land within which all waters flow to a single river system” (Heathcote, 1998). The catchment under study is Chahi Sub-catchment which is one of the drainage areas of Lake Mulehe.

SWOT: It is an acronym for strengths, weaknesses, opportunities and threats that any particular organization faces towards achieving its goals (Boseman and Phatok, 1989; Khayesi, 1998). In the context of this study, Chahi sub-catchment has strengths, weaknesses, opportunities and threats in its struggle to achieve sustainable water resource use and management.

Water Resources Management: It refers to a system of laws, institutions and principles that govern the protection, allocation and use of the water resource. In a wider perspective, it is

defined as the sustainable management of water resources so as to secure and provide water of adequate quantity and quality for all social and economic needs for the present and future generations (Mukwaya, 2010). This is attained through monitoring and assessment of the quantity and quality of water resources; storing, processing and disseminating water resources data and information to users, regulating water use and providing advice on the management of water resources.

Climate change: This refers to the long-term change of one or more of the elements of climate; temperature and rainfall that eventually result into change in the state of the environment. The patterns of change in climate result into climate variability that either cause high temperatures, low temperatures, high rainfall and low rainfall (IPCC, 2008). These cause a change in seasons. Climate change can be human induced through their activities like deforestation and wetland degradation which lead to variations in humidity levels and their associated effects.

Poverty: It encompasses both income and non-income dimensions: including lack of income and other material means; lack of access to basic social services such as safe water, health and education; and lack of empowerment to participate in political process and in decisions that influence one's life. Poverty does not result from the lack of one thing but from many interlocking factors.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviews empirical works done by other scholars in the field of water use and management. The chapter dealt with areas such as overview of water resources in Africa, conceptual framework, water resources management, utilization of water resources, water resources scarcity and challenges and opportunities of water resources management. An outline of related research and gaps that need to be filled in order to answer the questions of water resources use and management are also discussed.

2.2 Overview of Water resources in Africa

Water is one of the several current and future critical issues facing Africa. Water supplies from rivers, lakes and rainfall are characterized by their unequal natural geographical distribution and accessibility, and unsustainable water use (IPCC, 2008). About 25% of the contemporary African population experiences water stress, while 69% live under conditions of relative water abundance (Vörösmarty *et al.*, 2005). However, the relative abundance does not take into account other factors such as the extent to which water is potable and accessible, and the availability of sanitation. Increased populations in Africa are expected to experience water stress before 2025, mainly due to increased water demand. The population at risk of increased water stress in Africa is projected to be 75- 250 million and 350- 600 million people by the 2020s and 2050s, respectively (Arnell, 2004). Similarly, Annan (2000) noted that about one third of the world's population already lives in countries considered to be water stressed, where consumption exceeds 10% of the total supply. He adds that if the present trends continue, two out of every three people on earth will live in this condition by 2025.

2.3 Water Resources Management

Water is a precious natural resource vital for sustaining all life on the earth. Due to its multiple benefits and the problems created by its excesses, shortages and quality deterioration, water as a finite resource requires special attention (Pinderhughes, 2004). WRM is defined as essentially the modification of the hydrological cycle for socio-economic development. It involves not only the beneficial use of water resources, but also the prevention, avoidance or minimization of the effects of water excess (flood) or deficiency (drought) (Olokesusi, 2006). The major areas of concern pertaining to WRM are related to poor watershed management, inadequate water accessibility and quantity, poor water quality and inadequate institutional capacity, and in addition, as with other sectors of Ugandan economy, there are institutional weaknesses and lack of infrastructure to effectively manage water resources (Syngellakis and Arudo, 2006).

In ensuring sustainable WRM, integration across sectors is required which needs to take into account development, supply, use and demand, and to place the emphasis on the community, their livelihood and the ecosystems that sustain them (Donkor and Wolde, 1999). On the demand side, enhancing water productivity (the volume of production per unit of water) in all sectors is paramount to successful programmes of water scarcity alleviation. Furthermore, protecting and restoring the ecosystems that naturally capture, filter, store and release water, such as rivers, wetlands, forests and soils is crucial to increasing the availability of water improving its quality (Donkor and Wolde, 1999).

However, the single biggest challenge to water resources is the extreme reluctance of governments, states and communities to tackle water management as a serious issue (IDRC, 2005). In a similar context, the management of water resources is known to be an overriding

concern in a world well supplied with urgent environmental issues due to the increasing incidence of the demand for water resources; which incidence is being driven not only by a growing population but also by the aspirations of that population for an ever increasing standard of living (Flint, 2004). In contrast, population dynamics affect the environment both positively and negatively. In the former case, population pressure triggers innovations in environmental management and in the latter case, the pressure on natural resources as a result of demand factors triggers environmental degradation (Tukahirwa, 2002). In addition, the growing demands for adequate quality water resources create an urgent need to improve water management in terms of monitoring, assessment and forecasting of water resources (Akumiah, 2007). This calls for effective development and management of water and other resources to ensure sustainable livelihoods of the people (Orindi and Huggins, 2005). In this regard, a study by Twinomugisha (2005) suggests that water resources sector adaptation measures in Uganda call for improved water management systems throughout the country. The study focuses on the economic benefits of the water resource with little consideration of its management practices, which this study has tackled. Thus, better water management is a sure way of meeting the MDGs for poverty and hunger (Goal 1) and sustainable environment (Goal 7) (CA, 2007). Similarly, a study by Cong (2007) recommended need to establish an effective framework for water management in Uganda to ensure integrated and sustainable WRM. The study did not highlight issues pertaining to practices within the effective framework for WRM, which this study has documented. This is key to reducing vulnerability of rural production systems through ameliorating the impact of uneven rainfall distribution (like through better water storage) and providing protection against water pollution, thus providing secure livelihoods of watershed communities (Orindi and Huggins, 2005).

2.4 Water Resources Utilization

Water resource is one of the priority resources in Uganda and the world over, as it directly and greatly impacts on the quality of life of the people and productivity of the population (Lukwiya, 2009). However, the exploitation of water resources is faced with expanding pressures (Mohammed, 2004). Effective water use is dependent on many factors such as technical, economic, social and political, requiring the need and ability to innovate, influence and change the way water is utilized (Mualla and Salman, 2002). The study was based on factors that influence effective water use without focusing on the different sectors that use water, which this study will look at. However, access to water is difficult for millions of the poor for reasons that go beyond the physical resource base (CA, 2007). This is especially with water scarce areas where the sustainability of water utilization is impossible under the actual demand situation. This requires classifying as valuable water sources all existing water sources in order to increase the overall yield (Guttman *et al.*, 2009).

Although Uganda is considered well endowed with water resources, it is uneven in both temporal and spatial distribution (Cong, 2007). In addition, the current utilization rates of the water resources are very low (NEMA, 2008). Over the years, water demands for domestic and municipal use, agricultural purposes and industrial processing have been steadily increasing. However, the quantities of water that any country can economically develop on a long term basis unfortunately continue to remain limited (Das Gupta, 2001).

The exploitation of water resources is found to be faced with expanding pressures and the nature of the water environment deteriorates at present due to a number of reasons (Mohammed, 2004). Rapid population growth, increased urbanization and industrialization, uncontrolled environmental degradation and pollution are however, some of the challenges

affecting the utilization of water resources in Uganda today (Lukwiya, 2009). In light of this, it should be noted that the contribution of water resources to sustainable livelihoods depends on how it is accessed, used and managed which may be influenced by laws and policies. However, degradation of natural resources that adversely affects livelihoods not only results from improper use of resources but from poor policies as well. Most indigenous systems of water management were based on the concept that water for certain, limited uses was a free, open-access resource, while access for other uses was regulated and controlled by specific groups (Orindi and Huggins, 2005).

2.5 Water Resources Scarcity

Water scarcity is a growing concern worldwide (Rijsberman, 2006; Rockström and Barron, 2007) with sub-Saharan Africa mainly struggling with economic water scarcity due to human, institutional and financial constraints (CA, 2007). Economic water scarcity is defined by Descheemaeker *et al.* (2010) as a situation of water scarcity caused by insufficient human capacity or financial resources to develop adequate water resources even though sufficient water in nature is available to meet human needs. This indicates that worldwide, different regions have different water related failures, for instance, in Ethiopia water scarcity is primarily due to a lack of storage capacity (Descheemaeker *et al.*, 2010). Water scarcity in most parts of Uganda falls under this economic scarcity situation since Uganda is considered as having enough water resources. Water scarcity defined in terms of access to water, is a critical constraint in many areas of the world. In some places, water is abundant, but getting it to the people is difficult because of lack of infrastructure and restricted access as a result of political and socio-cultural issues (CA, 2007). Water scarcity is further defined as a situation where water availability in a country or region is below 1000 m³ per person per year. It causes

enormous problems for the populations and societies, for the available water is not sufficient for the production of food and alleviation of hunger and poverty in such regions. The lack of water does not allow industrial, urban and tourism development to proceed without restrictions on water uses and allocation policies for other user sectors, particularly agriculture. Water scarcity is both natural and man-made. Natural scarcity usually results from arid and semi-arid climates and drought, whereas man-made scarcity is associated with desertification and water management scenarios (Pereira *et al.*, 2002). In a study by Flint (2004), increasing water scarcity causes environmental degradation and poverty that can lead to global hunger and conflict. This can be overcome by adopting sustainable development, a centerpiece to water resource quantity, quality and societal wellbeing. The study looked at the concept of sustainable development with little consideration of coping mechanisms to environmental degradation. In this context, this study has highlighted the different coping mechanisms to water resources scarcity, an aspect of environmental degradation.

Donkor and Wolde (1999) in their study on IWRM in Africa acknowledged that water scarcity affects all social and economic sectors and threatens the sustainability of the natural resources base and that addressing such a situation requires an intersectoral and multidisciplinary approach to managing water resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. While a fifth of the world's population, more than 1.2 billion, live in areas of physical water scarcity, lacking enough water for everyone's demands (CA, 2007), Uganda experiences economic water scarcity where by it is regarded as having sufficient water in nature available to meet human needs but with insufficient human capacity and/or financial resources to develop the water resources. This affirms to the fact that about 1.6 billion people

live in water-scarce basins, where human capacity of financial resources is likely to be insufficient to develop adequate water resources now and in the future (CA, 2007).

2.6 Coping with Water Scarcity

Coping refers to the actions and/or mechanisms taken by households to survive when confronted with unanticipated livelihood failure (Ellis, 2000). Areas and regions where water has always been scarce have given birth to civilizations and/or coping strategies that have been able to cope with water scarcity. Finding such mechanisms is the challenge for the societies living in water stressed areas which impinge on the cultural, social and environmental facets of water resources (Pereira *et al.*, 2002). However, the contribution of water resources to sustainable livelihoods according to a study by Orindi and Huggins (2005) depends on how it is accessed, used and managed which may be influenced by laws and policies. The study focused on the use of water resources with little emphasis on constraints to access and management of water resources, which this study has investigated.

It is argued that an integrated technical, scientific and innovative approach is essential to develop and implement the management practices appropriate to deal with water scarcity (Pereira *et al.*, 2002). Policies and practices must be based on the assumption that water will not become abundant, so that water management policies and practices have to be specific for water scarcity. To cope with water scarcity in this context means to live in harmony with the environmental conditions specific to and dedicated by limited available water resources. Policies and practices of water management under water scarcity must focus on specific objectives according to the causes of water scarcity. Solving water management problems that are experienced in scarce regions calls for innovative approaches to cope with water scarcity. Innovation includes the adaptation of traditional know-how to the current day challenges, the

adaptation of the extremely available technologies to the prevailing physical and social conditions, and the creation of new and well adapted technologies and management approaches (Pereira *et al.*, 2002). It is noted that quite often water scarcity is exacerbated as a result of mismanagement of the available limited water resources. Thus, coping with water scarcity provides a basis for innovation in examining the value of water in conditions of scarcity, to encourage different thinking in assessment of the social, environmental and economic values of water and to establish appropriate priorities for water allocation and use (Agwata, 2005).

2.7 Evaluation of Drivers of Water Resources Scarcity

The drivers of water scarcity are defined as the stimulating forces behind changes in the pattern of water. These forces influence supply (amount of water available for use) and demand (the amount of water people use) (Ilahi and Grimard, 2000). Water resources scarcity defined as a situation where water availability in a given country is below 1000 m³ per person per year is induced by several factors (Pereira *et al.*, 2002). These factors and/or drivers range from human, institutional and financial constraints (CA, 2007). Behind today's water scarcity lie factors likely to multiply and gain complexity over the coming years. A growing population is a major factor, but the main reasons for water problems lie elsewhere; lack of commitment to water and poverty, inadequate and inadequately targeted investments, insufficient human capacity, ineffective institutions and poor governance (CA, 2007).

2.7.1 Climate Change

Climate change is defined as referring to long-term change of one or more elements of climate (temperature and rainfall) (IPCC, 2008). The patterns of change in climate result into climate

variability that either cause high temperatures, low temperatures, high rainfall and low rainfall causing change in the state of the environment. The major pressures on changes in temperature are due to human activities like deforestation and wetland degradation which lead to variations in humidity levels. This has caused changes in seasons thus causing uncertainties in the communities in estimating production and hence food insecurity (IPCC, 2008). Climate change is expected to shrink the resources of freshwater (Chartres and Varma, 2011). It affects the function and operation of existing water infrastructure, including structural flood defences, drainage systems as well as water management practices (IPCC, 2008). Adverse effects of climate change on freshwater systems aggravate the impacts of other stresses, such as population growth, changing economic activity and land use change. Globally, water demand will grow in the coming decades, primarily due to population growth and increasing affluence; regionally, large changes in irrigation water demand as a result of climate change are expected. The challenges related to freshwater are having too much water, having too little water and having too much pollution. Each of these problems may be exacerbated by climate change. Therefore, the relationship between climate change and freshwater resources is of primary concern and interest.

2.7.2 Population growth

It is noted that since the last century, the world population has tripled and is expected to rise from the present 6.5 to 8.9 billion by the year 2050. As a consequence, water use has been growing at more than twice the rate of population increase in the last century, and although there is no global water scarcity as such, an increasing number of regions are chronically short of water (IPCC, 2007). This agrees with the fact that many links exist between population growth and environmental degradation in part because an ever increasing number of people

depend on a fixed natural resource base in order to live. These demographic influences are one of the many factors that affect WRM and increase the pressure on the global water resource base (Liu and Chen, 2006).

In a watershed environment, the local population demands various services from a watershed's resources. However, various physical, legal and institutional policies are put in place to regulate demand and supply. For example, a high demand will cause pressure on resources, and once this pressure passes or exceeds a certain threshold, watershed environments begin to deteriorate. In this context, watershed management therefore needs to gather information about the population, resources and limiting factors (Poudel, 2003). In addition, Gregersen *et al.* (2007) in their study on integrated watershed management noted that the challenge of managing the environments in which people live becomes more complex and difficult as human populations increase. They observe that when human populations are high, demands on the natural resource base increase and new technologies are developed that let people willingly or unwillingly destroy their environment at a more rapid rate and with less effort to rehabilitate it than in the past.

2.7.3 Pollution

Freshwater resources are further reduced by pollution (World Water Assessment Programme, 2003). Some 2 million tons of waste per day are disposed of within receiving waters, including industrial wastes and chemicals, human waste and agricultural wastes (fertilizers, pesticides and pesticide residues). It is revealed that one estimate of global wastewater production is about 1,500 km³. Assuming that 1 litre of wastewater pollutes 8 litres of freshwater. The present burden of pollution may be up to 12,000 km³ worldwide. As ever, the poor are the worst affected with 50% of the population of developing countries exposed to

polluted water sources. Critical challenges lie ahead in coping with progressive water shortages and water pollution (World Water Assessment Programme, 2003).

2.7.4 Land Use Practice

An increasing number of people are currently practicing poor land use practices in an attempt to increase food production (Mohammed, 2004). This trend certainly has a potential impact on the natural resources in general and on the water resources in particular. Such issues need to be effectively addressed. Mohammed (2004) further notes that the most striking environmental problems other than water resources, especially in the African setting are unsustainable land use changes, land degradation, deforestation and loss of biological diversity. This occurs mainly in areas of high population density and growth which are associated with inadequate and unsound management of natural resources. This is in agreement with Onyango *et al.* (2005) in the study on the hydromonics and terronomics in the Nyando basin of Western Kenya where they noted that the management of terrestrial waters is closely linked to the use and management of land. It is in this respect that the IUCN (2000) argued that a wide range of human activities with no doubt transform freshwater or terrestrial environments and potentially alter, sometimes irreversibly, the integrity of freshwater ecosystems. The appropriate alternative for combating environmental problems associated with poor land use practices is IWRM, which is holistic in approach and focuses on the various uses of water and different categories of its users (Ahmad, 2003).

2.7.5 Economic growth

The economics of all nations are dependent on access to water resources, and its use is indispensable across all economic sectors. This implies that as the world becomes more

developed, the amount of domestic water used by each person is expected to increase significantly. This poses a big threat to the general environment and water resources in particular (Chartres and Varma, 2011).

2.7.6 Poverty

For humanity, the poverty of a large percentage of the world's population is both a symptom and a cause of the water crisis. This requires giving the poor better access to better managed water for it is believed to make a big contribution to poverty eradication. Such better management is expected to deal with the growing per capita scarcity of water in many parts of the growing world (World Water Assessment Programme, 2003). It is further noted that 1.6 billion people, or almost one quarter of the world's population live in a developing country that lacks the necessary infrastructure to take water from where it exists (rivers and aquifers). This is referred to as economic water shortage and is attributed to the poverty levels and/or economic hardships of a given nation (IPCC, 2008). In this respect the relationship between poverty (as an aspect of economics) and water issues is defined, implying that the sustainability of water resources can be effectively achieved as poverty within the country decreases (Sullivan, 2002).

2.7.7 Level of Education

Education has an important role in the sustainability of water resources. This implies that there is a strong correlation between the level of education of a community and the sustainability of its WRM (Juwana *et al.*, 2009). This affirms to the Earth Summit's Agenda 21 which requires that the delegation of WRM to the lowest appropriate level necessitates educating and training water management staff at all levels (ICWE, 1992).

2.8 Challenges and Opportunities to Water Resources Management

Water resources contribute in diverse ways to the livelihood of many people in developing countries and the world over (Kangalawe and Liwenga, 2005). However, one of the major constraints to the wise use of water resources (mainly in Africa) is lack of knowledge by planners and natural resource managers on the benefits that they provide and techniques that can be utilized in a sustainable manner. It is argued that due to the increase in population, there are environmental concerns associated with increasing utilization of water resources for agriculture and other livelihood activities, including deforestation, increasing demand on the water resources and lack of elaborate institutional framework to facilitate the integration of the various sectoral and cross-sectoral uses of water resources and among stakeholders (Ngana *et al.*, 2004). In this context, it is contended that sustainable livelihood development of watershed communities requires multidisciplinary and integrated efforts in addressing constraints in the various sectors such as agriculture, natural vegetation use and water resources among others (Kangalawe and Liwenga, 2005).

It is further highlighted that the ultimate target of watershed management is to improve environmental quality and food security (Poudel, 2003). This can be achieved through attaining a participatory integrated management approach that involves working on the natural and human resources in a watershed in accordance with the social, political, economic and institutional factors that operate within the watershed. However, water shortages and environmental degradation are the two of the main challenges facing humanity in the 21st Century (Poudel, 2003). In this context, Lal (2000) affirms that protecting and strengthening watershed ecosystems is one of the main strategies to address these two issues of water shortages and environmental degradation.

2.9 Conceptual Framework

A conceptual framework for this study was adopted from Vishnudas *et al.* (2005). The study adopted this framework used to analyze sustainable watershed management projects in Kerala, India. The framework (Figure 2.1) was modified to cater for the relationships that allow better understanding of the critical paths of influence between the different aspects and elements surrounding sustainable WRM in Chahi sub-catchment. The framework was found suitable for Chahi sub-catchment for it organizes, relates and states the best practices that can help in achieving sustainable utilization and management of water resources for sustainable livelihoods. For a WRM project to be sustainable, three groups of criteria should be considered. These include technology, institutions and economics, respectively (Vishnudas *et al.*, 2005). These elements are seen as a chain in which, if one of the elements fails to attain sustainability, the entire system will fail. Hence, these elements should be considered in an integrated manner with all the links equally strong and bonded. However, different components of each element have to be analyzed and their functions and contributions towards the path of attaining sustainable utilization and management of water resources acknowledged. In that respect, the functions of each of the elements are defined and emphasized by Vishnudas *et al.* (2005) as follows:

'For successful and sustainable WRM, water resources should be protected from degradation and maintained for use. To utilize water resources, technologies are required and should be well adapted to local circumstances. Communities should be able to maintain these themselves and the technologies should be cost effective. The rules defining access and exclusion to water resources and the services they provide should be transparent. The institutions governing the use and management of water resources should be based in the watershed community. They should involve all relevant stakeholders, particularly the community, from problem identification to all levels of planning. In the economic sense, technologies should be affordable and should be conducive to enhance conservation'.

Similarly, DFID (1999) notes that a project is sustainable if it can cope with, and recover from stresses and shocks, and maintain or enhance its capabilities both now and in the future, while not undermining the natural resource base. At the same time, for livelihoods to be considered sustainable, they should also contribute net benefits to other livelihoods (DFID, 1999).

2.9.1 Achieving Sustainable Water Resources Management (SWRM)

Sustainable development was defined in a report of the World Commission on Environment and Development (1987) as development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. Vishnudas *et al.* (2005) argue that many scholars have used the term sustainable development for specific development activities like sustainable agriculture, sustainable forestry, and sustainable energy development, among others. They add that a single development may be considered successful if it is weighed against its specific performance criteria. However, to achieve sustainability, all different aspects of development should be considered simultaneously and thus an integrated approach is essential as shown in Figure 2.1. SWRM is defined as the management of a water resource system with sustainable technological options, that ensure the sustainability of its ecosystem functioning (of land, agriculture and forestry) to conserve natural resources, with adequate institutional and economic options. These elements play an important role in the sustainable utilization and management of water resources as shown in Figure 2.1.

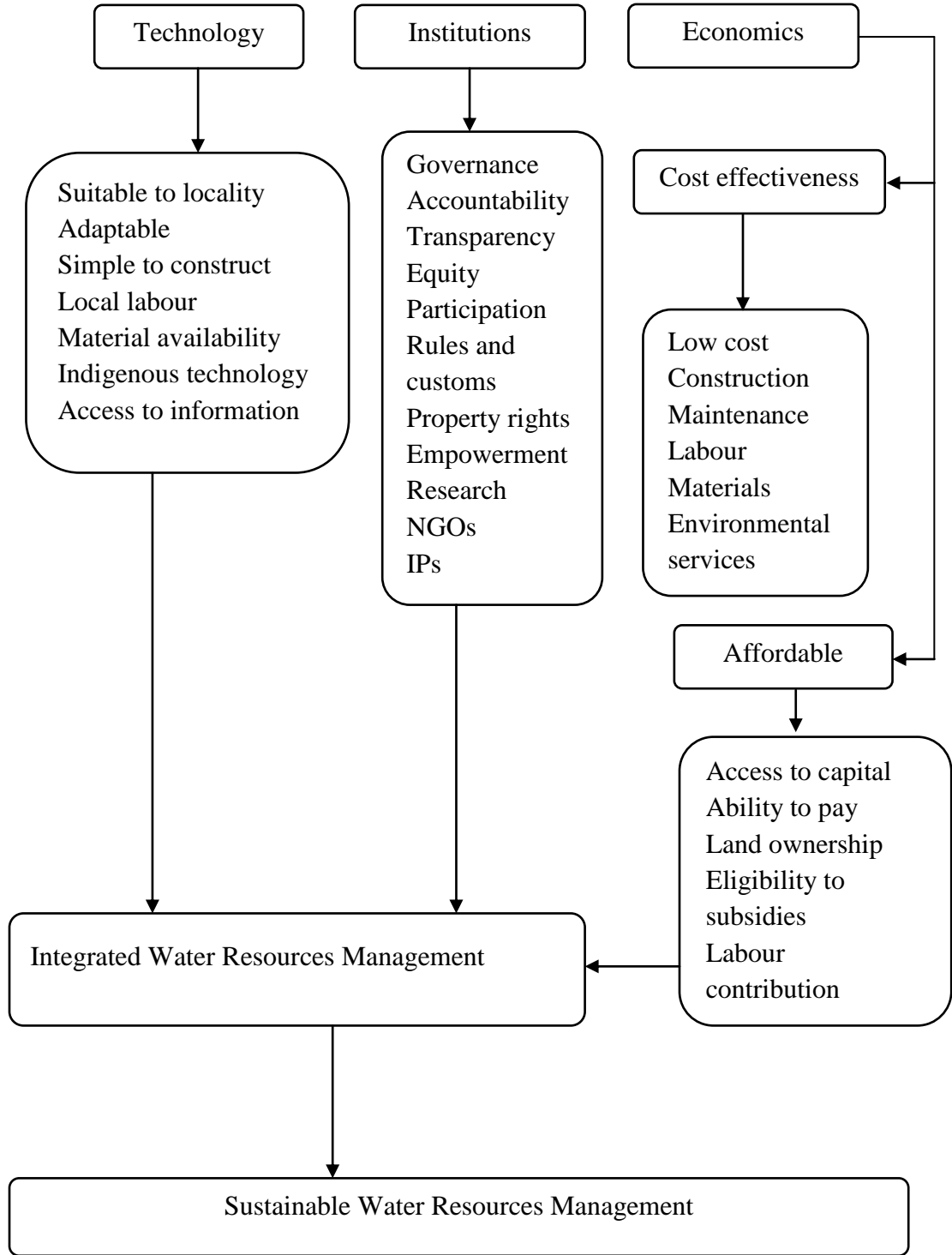


Figure 2.1: Conceptual Framework for Sustainable Water Resources Management

Source: Adopted and modified from Vishnudas *et al.* (2005)

2.9.1.1 Technologies

Technological sustainability depends on the various factors; should be suitable to the geographic situation, adaptable, simple to construct, make use of unskilled labour, should be timely, preferably locally, make use of locally available materials, indigenous technology and there should be access to information. Basing on these numerous components, the use and management of water resources can potentially be in a sustainable way through appropriate technology. Following the sustainability paradigm, appropriate would mean that a technology should be ecologically protective, socially acceptable, economically productive and economically viable (Vishnudas *et al.*, 2006). For instance, a domestic rainwater harvesting technology that has been recommended in this study should be associated with these attributes mentioned if it is to achieve sustainability.

2.9.1.2 Institutions

In a catchment, management is not only limited to water, land and biomass resources but also concerned with integration of self-reliance and holistic development of the rural poor. In this context, a catchment is recognized as a unit of integrated resource management. This would further mean integrating different uses and management of resources, different departments with sectoral interests through interdisciplinary approaches and towards alleviation of poverty (Mollinga, 2000). In this context, institutions refer to the various agencies and/or bodies in the sub-catchment involved in the management of water resources. The main actors involved are; internal agencies (including self help groups, user groups, IPs) and external agencies (including government, NGOs, researchers, local administrators and politicians). Institutional sustainability determines whether a water project in particular and/or a development plan becomes a success or a failure. In the context of Chahi sub-catchment, the institutional efforts

to organize and empower households have involved formation of a multi-stakeholder and multi-institutional innovation platform (IP) and is said to have resulted in collective action focusing on protecting the water resources. However, it needs to be strengthened if it is to achieve sustainability.

The institutions put in place should be guided by good governance where accountability, transparency, equity and efficiency of the governance structure are ensured. People's participation and that of the Project Implementation Agency is a key element in achieving institutional sustainability. Correspondence with rules and regulations and customs should be observed by the stakeholders as they also consider property rights and collective action. However, the stakeholders should be empowered to participate in decision making and institutional activities. Therefore, the SWRM framework should give authority to the official organization to make legal decisions about their functions. In the context of Chahi sub-catchment, integrated WRM requires sustainable institutions that bring all these actors together. According to Bauman (2002), the creation of an enabling institutional environment is critical for changing the terms on which the rural poor can access resources. This requires that the IPs water management committees that exist in the sub-catchment need be strengthened to ensure community participation in water resources use, conservation and management. This is one way of ensuring community ownership of projects.

2.9.1.3 Economics

Integrated WRM requires ideal interventions. Any new intervention and/or technology proposed needs to be economically viable, otherwise the people will not accept it. Even if a new intervention fulfils the requirements of all the other facets of sustainability, if it is not

economically viable, it will be doomed to fail (Prinz, 1998). The economics element in the sustainability chain determines the adoption of any technology introduced by the project in any given environment. Components of this element are construction and maintenance costs, labour costs, price of materials, access to capital, eligibility to subsidies and the cost of labour contribution. To achieve sustainability in the context of Chahi sub-catchment, WRM interventions put in place must result in generation of enough benefits to offset the costs of implementation and maintenance of the interventions. However, attaining positive results depends on the wise use of the resources available in the sub-catchment, choice of appropriate technology that the community can maintain themselves, putting in place institutions with good governance and choice of interventions (in terms of their economic viability).

Various research findings point to substantial economic benefits for households and individuals as a result of less costs of maintenance and improved water supply (Kayaga *et al.*, 2003). Since catchment management involves the use of tools governed by theories and principles dealing with a deliberate management of water and related resources across various sub-sectors (Winnegge, 2006), it is imperative for institutions to appraise plan effectiveness in terms of the economic benefits of water management interventions (Meier, 1990).

2.10 Chapter Summary

Chapter two reviewed relevant literature on the overview of water resources in Africa and the world over. This review basically focused on water resources management and utilization, water resources scarcity, coping with water scarcity, evaluation of drivers of water resources scarcity and challenges and opportunities of water resources management. The review also identified gaps in knowledge related to the study theme as summarized in Table 2.1.

Table 2:1: Key Studies and Gaps Identified

No	Author	Year	Summary of Findings	Knowledge Gap
1	Mualla, W. and Salman, M.	2002	Effective water use depends on many factors: technical, social, economic and political which interact to dictate the overall efficiency of water use	The study was based on factors that influence effective water use without focusing on the different sectors that use water
2	Flint, R. W.	2004	Increasing water scarcity causes environmental degradation and poverty that can lead to global hunger and conflict. This can be overcome by adopting sustainable development, a centerpiece to water resource quantity, quality and societal wellbeing	The study looked at the concept of sustainable development with little consideration of coping mechanisms to environmental degradation
3	Twinomu gisha, B.	2005	In Uganda, water resources sector adaptation measures call for improved water management systems throughout the country	The study focuses on the economic benefits of the water resource with little consideration of its management aspects
4	Cong, R.	2007	There is need to establish an effective framework for water management in Uganda to ensure integrated and sustainable WRM	The study does not highlight issues pertaining to practices within the effective framework for WRM
5	Orindi, V. and Huggins, C.	2005	The contribution of water resources to sustainable livelihoods depends on how it is accessed and managed	The study focused on the use of water resources with little emphasis on constraints to access and management of water resources

Source: Synthesis of Literature by Author, 2010

CHAPTER THREE: MATERIALS AND METHODS

3.1 Introduction

In this chapter, the overview of the study area, sampling procedure, research instruments and techniques used are presented.

3.2 Study Area

3.2.1 Location

The study was carried out in Chahi sub-catchment in Kisoro district, South Western Uganda (Figure 3.1). Chahi sub-catchment lies at an approximate altitude of 1,981 m above sea level. It is bounded by longitudes 29°38' and 29°47' East and latitudes 1°12' and 1°20' South as shown in Figure 3.1. The catchment drains into Lake Mulehe. According to the Uganda Bureau of Statistics (2005) report, the catchment is highly populated (with a population density of 324 persons per square kilometre). The annual population growth rate estimated at 2.8% is also relatively high (Cornelius *et al.*, 2008).

3.2.2 Climate

The climate of Chahi sub-catchment is sub-humid with a mean annual rainfall of 1100mm. It experiences minimum and maximum temperatures of 10°C and 26°C respectively, and relative humidity between 80 and 90% that falls to about 40% in the dry season. The rainfall pattern is bimodal with peaks during long rains of March-May and short rains of September-December (KDLG, 2008). Figure 3.2 shows the mean monthly rainfall totals in the catchment for the period 2000 to May 2007.

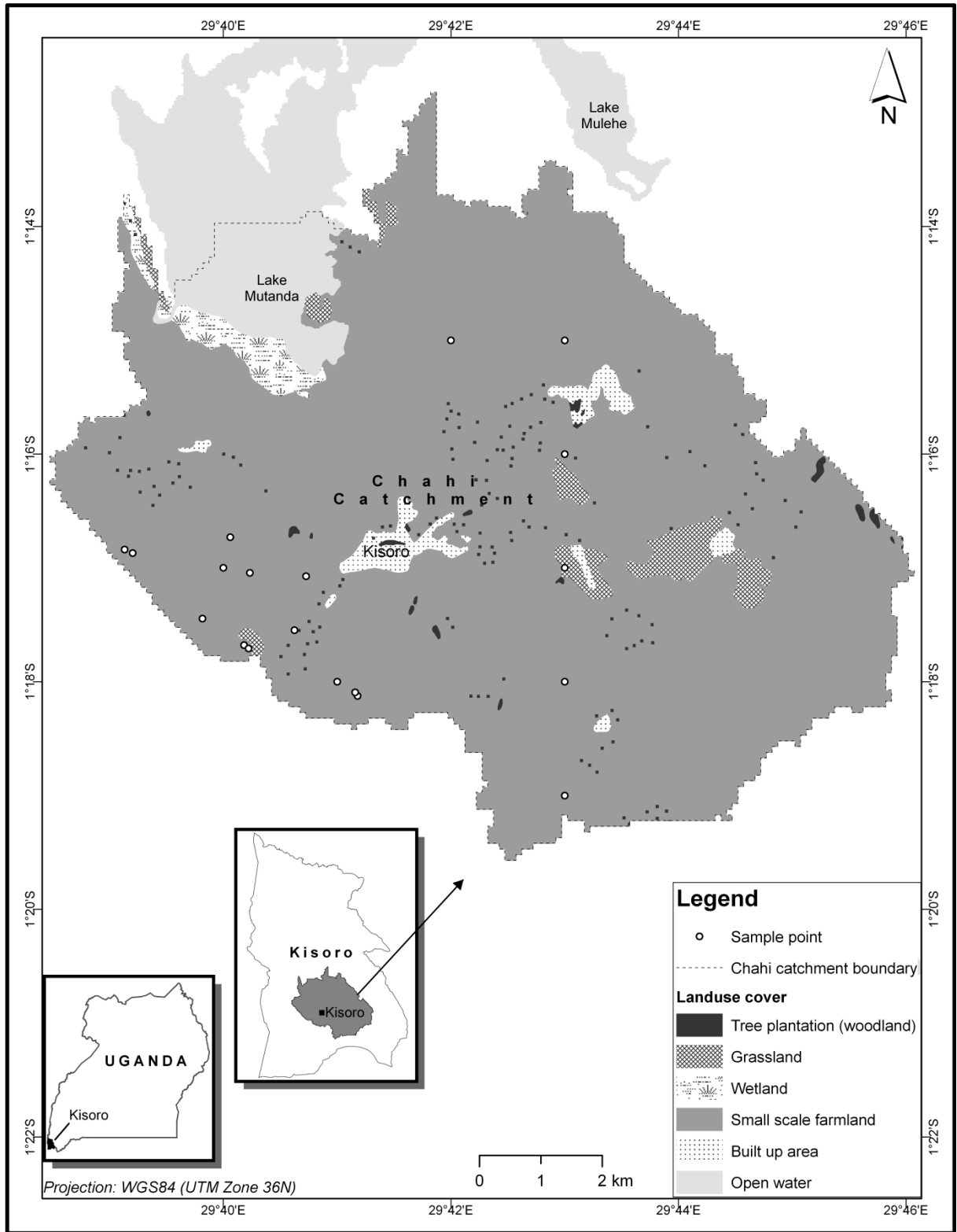


Figure 3.1: Map of Chahi Sub-catchment

Source: Author (2011)

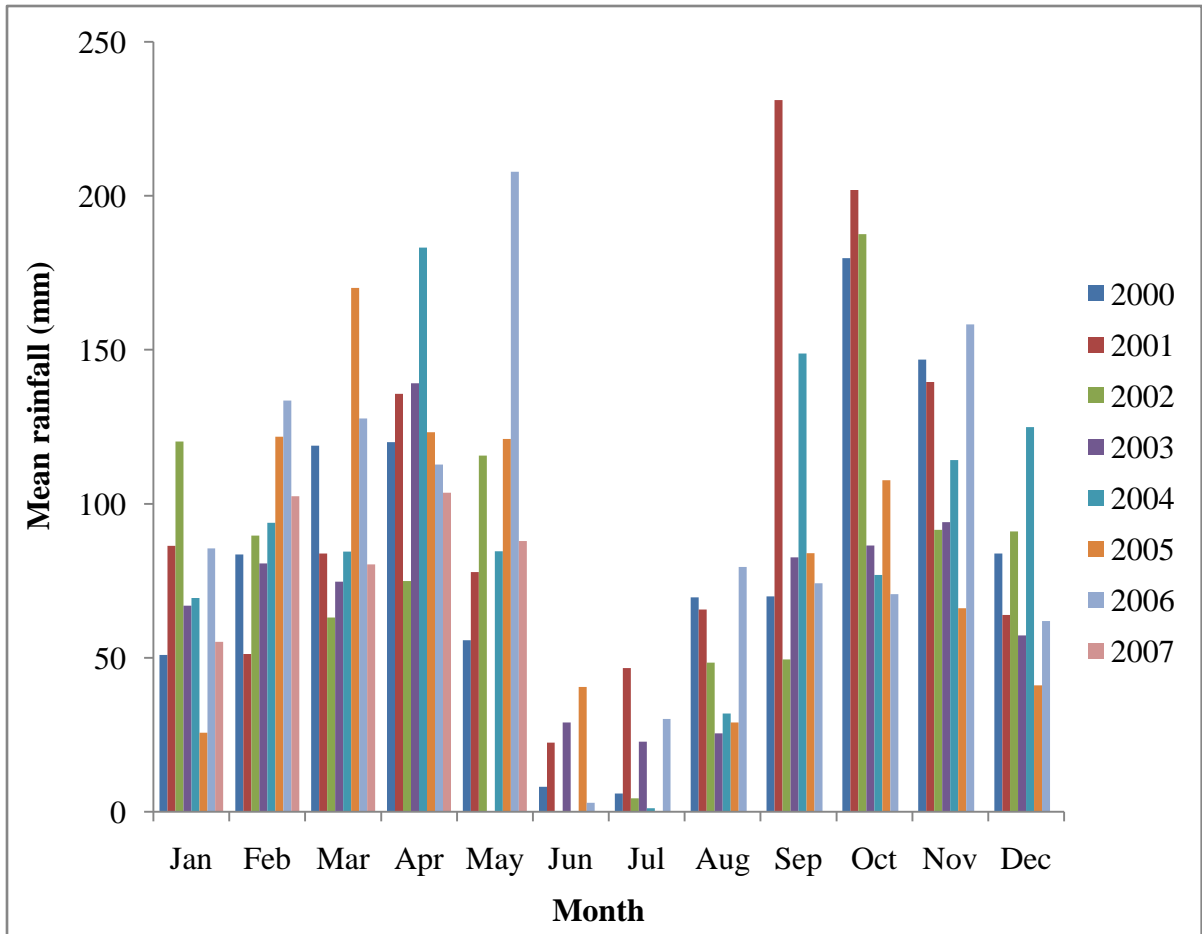


Figure 3.2: Mean Monthly Rainfall Totals in Millimetres for Chahi Sub-Catchment from 2000 to May 2007

Source: Meteorological Centre- Kabale Station (2007)

3.2.3 Soils

The major soils in the catchment are volcanic andosols that are susceptible to extreme soil erosion (FARA, 2009). The volcanic geology of the catchment results in absence of surface water although rainfall is high and due to this, the high and heterogeneous permeability of soil and underlying geological formations generates likelihood of spring water pollution in case of increased pumping of water and waste water production (Nyiraneza and Hoellhuber, 2002).

3.2.4 Socio-Economic Activities

Like in most parts of Uganda, agriculture is the major economic activity of Chahi sub-catchment and main source of income for the population, employing about 90% of the people. Majority of the population practice subsistence farming with hardly any disposable income. Crops grown include; maize, sorghum, Irish potatoes, sweet potatoes, cabbages, beans, onions and tomatoes. Livestock is kept by some people on a subsistence level (KDLG, 2008).

3.3 Selection and Training of Research Assistants

Two research assistants were selected from the study area based on their ability to speak English and Kifumbira languages fluently. This was a prerequisite as the respondents can express themselves in the local language (Kifumbira) very well. The research assistants were given one day training by the researcher who did not understand the local language. The training also involved the relevance of each question in the questionnaire as far as the research was concerned, how best to introduce the topic to the respondent and its importance for the Chahi sub-catchment, research ethics among others. The training was concluded with demonstration on how to administer the questionnaire in the field where each research assistant administered two questionnaires with supervision by the researcher.

3.4 Research Design

The study utilized a descriptive survey. It targeted households that were managing water resources in the sub-catchment. Therefore, they provided information on the water utilization patterns and management practices, drivers of vulnerability, coping mechanisms to water resources vulnerability and opportunities and challenges to the management of water resources in the sub-catchment.

3.5 Sampling Procedure

The study adopted a stratified simple random sampling to select households in Chahi sub-catchment. The catchment has a population of 101,462 with 22,918 households (Uganda Bureau of Statistics, 2005). The sample size of the study was based on the total number of households in the sub-catchment, and was calculated using the following formula (Equation 3.1) that was adopted from Yamane (1967) cited in Glenn (1992). This formula is best placed for qualitative studies like for the case of this study.

$$\eta = \frac{N}{1+N(\alpha)^2} \quad (3.1)$$

Where: η is the sample size

N is the total number of households in the catchment

α is the level of precision and/or margin of error set at 10 percent

The sample size computed by the formula is 99.6 (approximately 100). With this sample size for the sub-catchment, a proportionate stratified simple random sampling based on the proportion each zone contributes to the total number of households in the sub-catchment was used (Mugenda and Mugenda, 1999). This technique ensures that sub-groups that constitute the majority in the population are also presented proportionately (Mugenda, 2008). The site was divided and stratified into three altitudinal zones; lower, middle and upper. The lower zone with 4,516 households, middle with 8,183 households and upper with 10,219 households contributed 20, 36 and 44 respondents, respectively, basing on the proportions each zone contributed to the total number of households in the sub-catchment.

3.6 Data Collection

The study made use of both primary and secondary data sources. Primary data was collected using a structured questionnaire (Appendix 1.0), key informant interviews (Appendix 2.0) and non participatory field observations (Appendix 3.0). A structured questionnaire was used to gather data from the 100 sampled households for objectives 1, 2 and 3. Secondary data was collected from various sources mainly the Water office and the Environment office at the district level. Before the main study, a reconnaissance survey was carried out in Ngaciuma sub-catchment, Meru, Kenya to pre-test the research instruments for all necessary adjustments before being administered to households in Chahi sub-catchment. Key informant interviews with 20 relevant key persons in the area (including water department and environment office at the district and water resource users at the local levels, opinion leaders and community groups) were used to collect data for objective 4 and at the same time to complement and/or give more detailed information gathered using questionnaires for objectives 1, 2 and 3.

3.7 Data Analysis

3.7.1 Data Pre-processing

Before the data collected were subjected to analysis, they were first pre-processed. This essentially involved checking and cleaning errors of responses from the field survey to ensure accurateness and reliability. The process continued with coding of all variables considered for the study. This involved assigning numeric and alphanumeric codes to all the variables under study. This was followed with data entry and display into the software packages that were used for data analysis. The software package used was SPSS version 19.0. Data entry consisted of entering the responses of each respondent into the spreadsheet according to each variable. After data entry, the data were subjected to Data View spreadsheet display in order

to check the accuracy of data entry procedure. This process led immediately to checking of errors and thus ensuring data quality. Although it was a very tedious process considering the number of respondents and variables, the whole exercise laid a solid foundation for analytical processing of data, both qualitatively and quantitatively.

3.7.2 Statistical Analysis

Descriptive statistical analysis carried out in this study essentially dealt with measurements like frequencies and percentages using the SPSS. These measurements were used to establish the local water uses and management practices, drivers of water resources vulnerability as well as the coping mechanisms to water resources shortages in Chahi sub-catchment.

For a qualitative study of this nature where many assumptions are made, there was need to test variables identified in the study with a non-parametric statistical tool. These assumptions were based on the local uses and management of water resources, factors influencing the vulnerability of water resources to degradation and then finally the local coping mechanisms to water shortages in the sub-catchment. In this study, the non-parametric test chosen was chi-square. The chi-square (χ^2) test is a statistical test used to determine if observed data deviate from those expected under a particular hypothesis (Mugenda and Mugenda, 1999). The results were then tested for significance at 0.05 (95 percent) confidence level. The chi-square test was used due to the qualitative or categorical nature of data collected (Grant and Warren, 2001). It enabled a decision to be made on whether or not a significant relationship existed between the variables identified.

3.7.3 Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis

Analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT) was used in the study to evaluate the challenges and opportunities of managing water resources at household level in Chahi sub-catchment. Strengths are the internal capacities of an organization's objectives in a reactive and competitive environment. They arise from the resources and competencies available to the organization (Johnson *et al.*, 1989). Weaknesses are internal disadvantages that restrict the attainment of organization's objectives. They are limitations or deficiencies in one or more resources or competencies that impede an organization's effective performance (Boseman and Phatok, 1989). Opportunities are external factors and/or forces that enable an organization to achieve or exceed its objective or goal. They are described as major situations in an organization's environment, for instance technological changes and key trends in the organization's cycle (Khayesi, 1998). Threats are external factors or forces that might create problems or cause harm to the organization or community. They are key impediments to the organization's current or desired position (Johnson *et al.*, 1989). While strengths and weaknesses can be monitored and evaluated by an organization, opportunities and threats can not be controlled. The latter can even endanger its capacity to achieve its objectives.

SWOT analysis is commonly applied to a number of phenomena or issues because of its varying spatial organizational scales (Khayesi, 1998). It uses a systems approach in which catchment institutional structures are considered as endogenous factors and can be a source of strength or weakness for sustainable management of water and land related resources. In the context of this study, SWOT analysis tool was an appropriate methodology for it can be used in identifying the opportunities and challenges facing Chahi sub-catchment, planning of interventions, finding solutions to challenges and in making of context based decisions, like it

does for other organizations and or institutions. In other words, SWOT analysis is viewed as a very effective tool designed to be employed in decision making and as a precursor to strategic planning (Chen and Chen, 2002). For instance, using the SWOT analysis, Dubinyuk (2004) identified production problems to be targeted in Ukraine extension and worked with stakeholder groups to identify agricultural production priorities. This explains why it was adopted for this study.

Decision making process was based on the SWOT analytical matrix (Table 3.1). According to Wehrich (1982), the four combinations (SO, ST, WO and WT) (Table 3.1) are called the maxi-maxi (strength/opportunities), maxi-mini (strength/threats), mini-maxi (weaknesses/opportunities) and mini-mini (weaknesses/threats). He describes these four combinations as follows:

- i. Maxi-maxi. This combination shows the organization's strengths and opportunities. In essence, an organization should strive to maximize its strengths to capitalize on new opportunities.
- ii. Maxi-mini. This combination shows the organization's strengths in consideration of threats. In essence, the organization should strive to use its strengths to parry or minimize threats.
- iii. Mini-maxi. This combination shows the organization's weaknesses in tandem with opportunities. It is an exertion to conquer the organization's weaknesses by making the most of any new opportunities.
- iv. Mini-mini. This combination shows the organization's weaknesses by comparing with the current external threats. This is most definitely defensive strategy to minimize an organization's internal weaknesses and avoid external threats.

SWOT analysis can be understood as the examination of an organization's internal strengths and weaknesses and its environments opportunities and threats. It is a general tool designed to be used in the preliminary stages of decision making and as a precursor to strategic planning in various kinds of applications (Johnson *et al.*, 1989). An understanding of all external factors together with an internal examination of strengths and weaknesses assists in forming a vision of the future of the project. SWOT is used to develop a plan and/or find a solution that takes into consideration many different internal and external factors, and maximizes the potential of the strengths and opportunities while minimizing the impact of the weaknesses and threats. Glass (1991) notes that SWOT can be used as a means to open up new possibilities for the organization and/or project in question.

Table 3.1: Strengths, Weaknesses, Opportunities and Threats Analytical Matrix

	Exogenous Factors	Opportunities (O)	Threats (T)
Endogenous Factors			
Strengths (S)		SO	ST
Weaknesses (W)		WO	WT

Source: Boseman and Phatok (1989)

3.8 Chapter Summary

The chapter described the study area in terms of location, climatic features, soils and socio-economic activities. It further presented and described the research design, sampling procedure and the research instruments and techniques used in the study.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discusses the findings of the study. The findings were presented in form of tables, graphs and pie charts. Photographs taken in the field also formed part of data presentation. Interpretation was done in reference to the stated study objectives.

4.2 Characteristics of Respondents

The general social parameters used to describe the characteristics of the respondents included gender, age, marital status, level of education, occupation and duration in Chahi Sub-catchment as shown in Tables 4.1, 4.2, 4.3, 4.4, 4.5 and 4.6, respectively.

4.2.1 Gender

Higher proportions of females (72%) than males (28%) were interviewed (Table 4.1). This is attributed to the fact that households' activities (including WRM) in the sub-catchment affect both men and women. However, the higher percentage of females than men is an indication that women are more involved in household activities than men. Most males were reported to be involved in other livelihood activities within and outside the sub-catchment.

Table 4.1: Respondents Gender

Gender	Frequency (n=100)	Percent (%)
Female	72	72
Male	28	28
Total	100	100

Source: Field Survey (2011)

4.2.2 Age

The majority of the respondents (28%) were in the age bracket of 30-39 followed closely by 24% in the age bracket of 20-29; 20% aged 60 and above and those in the age bracket of 40-49 and 50-59 were 18% and 10%, respectively (Table 4.2). This indicates that it is the middle aged and relatively young populations that are mainly engaged in the management of water resources.

Table 4.2: Age of Respondents

Age	Frequency (n=100)	Percent (%)
20-29	24	24
30-39	28	28
40-49	18	18
50-59	10	10
60+	20	20
Total	100	100

Source: Field Survey (2011)

4.2.3 Marital Status

The majority of the respondents (87%) were married with only 13% widowed (Table 4.3). This shows that the management and utilization of natural resources (including water) is basically an activity for both married men and women and calls for a collective effort. However, the exclusion of singles from this analysis is not an indication that they are not involved in the management of these resources, but since this study was randomly sampling households in the sub-catchment, it was by chance that it did not consider any singles.

Table 4.3: Respondents Marital Status

Marital Status	Frequency (n=100)	Percent (%)
Married	87	87
Widowed	13	13
Total	100	100

Source: Field Survey (2011)

4.2.4 Level of Education

Most respondents had attained some formal education (Table 4.4). This was indicated by the fact that 39% had attained primary education, 10% secondary education, 1% college education (certificate and diploma) and university respectively and 49% hardly had any formal level of education.

Table 4.4: Respondents Level of Education

Level of Education	Frequency (n=100)	Percent (%)
None	49	49
Primary	39	39
Secondary	10	10
College	1	1
University	1	1
Total	100	100

Source: Field Survey (2011)

4.2.5 Occupation

Respondent's occupation in the catchment was used to find out those who are fully involved in water related activities in the catchment and at the same time those that are likely to be affected in case of water related problems. Majority of the respondents in the sub-catchment were farmers (97%) who depended entirely on farming for their livelihoods (Table 4.5). This concurs with KDLG (2007) report which revealed that farming employs 90% of the total working population and that about 96% of the population practice subsistence farming. Moreover, 1% represented a married student household while 2% represented others who were working as trader and motorist. The respondents in other occupations as their major sources of income were at the same time partially involved in farming activities to supplement their livelihoods.

Table 4.5: Respondents Occupation

Occupation	Frequency(n=100)	Percent (%)
Farmer	97	97
Student	1	1
Others	2	2
Total	100	100

Source: Field Survey (2011)

4.2.6 Duration Stayed in Chahi Sub-catchment

The majority of the respondents (78%) had stayed in the catchment for over 20 years (Table 4.6). Similarly, 10% of the respondents had stayed in the catchment for 16-20 years, 8% for 11-15 years and 2% for 5-10 and less than 5 years, respectively. The significance of having

stayed in the sub-catchment for many years was useful in that the respondents were able to state the chronology of environmental situations in the sub-catchment.

Table 4.6: Time Spent by Respondent in Chahi Sub-catchment

Time stayed in Chahi (Years)	Frequency (n=100)	Percent (%)
Less than 5	2	2
5-10	2	2
11-15	8	8
16-20	10	10
Over 20	78	78
Total	100	100

Source: Field Survey (2011)

4.3 Local Uses and Management of Water Resource

The study sought to establish the different uses water resources are put to in the sub-catchment as well as the management practices. It also established the various water sources in the sub-catchment.

4.3.1 Local Water Resource Use in Chahi Sub-catchment

The local water uses in Chahi sub-catchment identified were domestic and agriculture. Water in the sub-catchment is mostly used for domestic purposes (Figure 4.1). Only 24% of the respondents reported to be using water for agricultural activities.

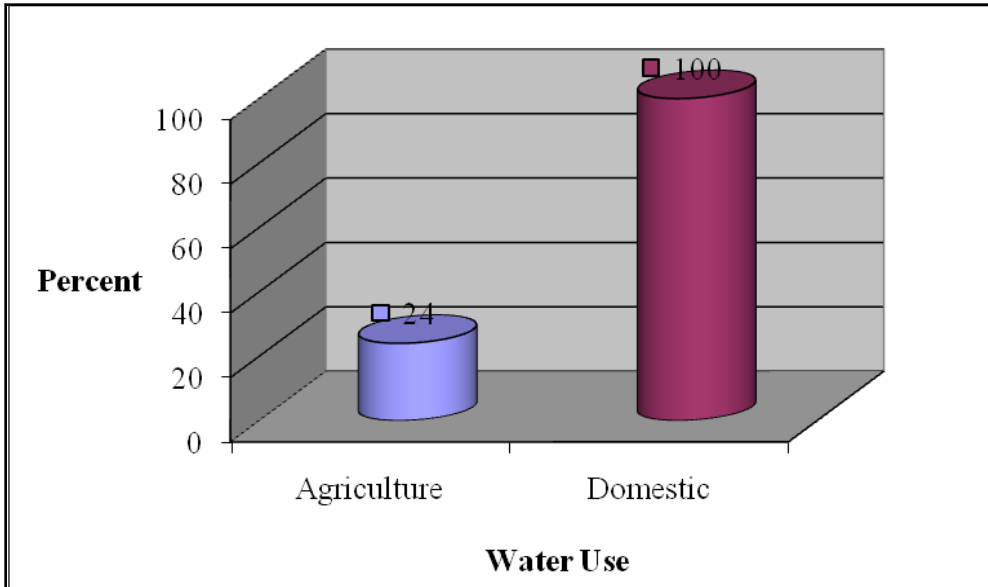


Figure 4.1: Water Utilization in Chahi Sub-catchment

Source: Field Survey (2011)

The domestic use of water in the sub-catchment ranged from drinking, laundry, cooking among many others. It was also noted that, in most cases, those who used water for agricultural purposes had livestock and were practicing home gardening of vegetables. Plate 4.1 demonstrates an example of the use of water in agriculture (in form of home gardening).



Plate 4.1: Examples of home gardens in Nyarusiza and Chahi Sub-counties, respectively

Source: Field Survey (2011)

In an effort to boost agriculture, most respondents would like the government to construct community dams from where they can draw water and apply in relatively bigger sizes of their land if food production is to be increased and water utilization enhanced in the sub-catchment.

A female respondent in Chahi sub-county reported that:

“Much as water is lowly used in agriculture, it is not negligible. It is only that our area has limited water sources. We are poor and during times of shortages, portable water is only available at the sub-county headquarters at a fee which we can not afford.”

4.3.2 Sources of Water in the Sub-catchment

There is a range of water sources from where the households in the sub-catchment get their water including the following sources; pipe borne (in form of taps), rain (through rainwater harvesting), streams and vendors (Figure 4.2). The use of the different water sources by the households is attributed to the unequal and seasonal distribution of most of the water sources in the sub-catchment. This unwillingly forces the households to resort to other social practices (that include the use of various storage methods and alternative water sources). Precisely, 89% of the respondents reported pipe borne water to be the major and reliable source of water followed by the streams (58%). This was mainly attributed to the slow improvement in water supply management, though unequal distribution of water resources in the sub-catchment was still a limitation. Similarly, 40% reported that rain is an important water source through which they obtain water through roof catchment and 8% reported that they obtain water through vendors, though at a cost that ranges between USD 0.083 to USD 0.42 depending on the season of the year. Plates 4.2, 4.3 and 4.4 show some examples of water sources.

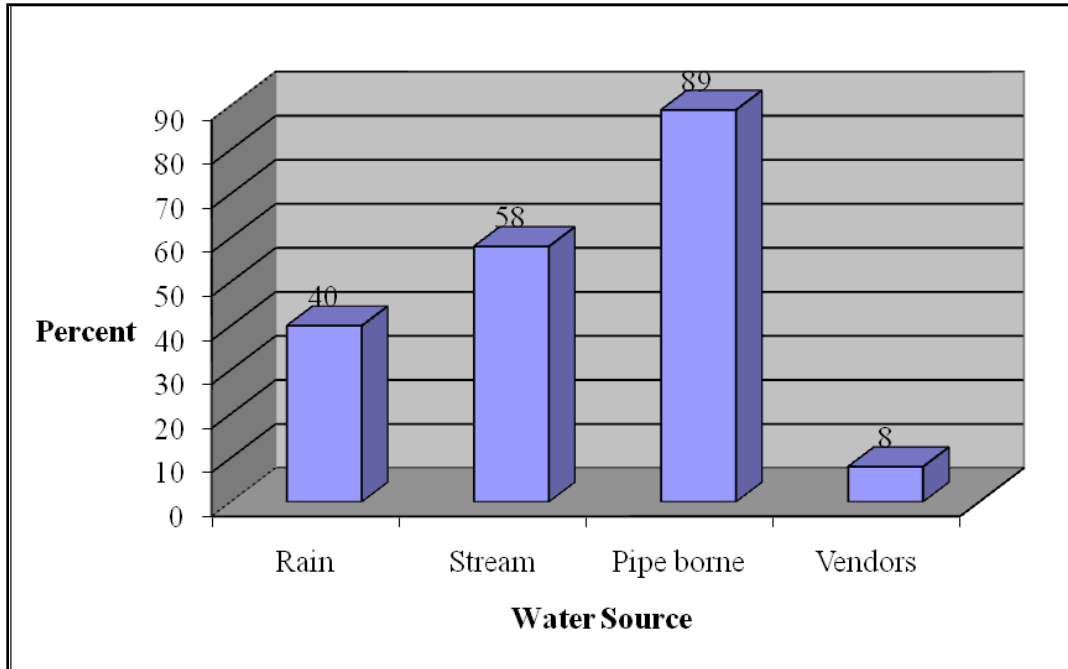


Figure 4.2: Water Sources in Chahi Sub-catchment

Source: Field Survey (2011)



Plate 4.2: Chuhu, the only Stream in the Sub-catchment (4/3/2011)

Source: Field Survey (2011)



Plate 4.3: An example of piped water in Nyakabande Sub-county
Source: Field Survey (2011)



Plate 4.4: One of the constructed safe water point in Chahi sub-catchment
Source: Field Survey (2011)

4.3.3 Involvement in the Utilization and Management of Water Resources

The utilization and management of water resources in Chahi sub-catchment differed among the various gender groups; women, men and children. Aspects considered in this context include fetching of water from the source, making use of the water and managing the water source (Figure 4.3). Women were the main players in the utilization and management of water resources in the catchment. Most of the respondents (91%) revealed that women are the ones who manage the different water sources in the catchment, followed by men (8%) and children (1%). Similarly, 84% of the respondents revealed that women were responsible for using the water in various activities, 10% in favour of children, 4% for both children and women and 1% for men. Further more, 51% of the respondents reported that women took the lead in fetching the water followed by children (27%), both women and children (20%) and men (1%).

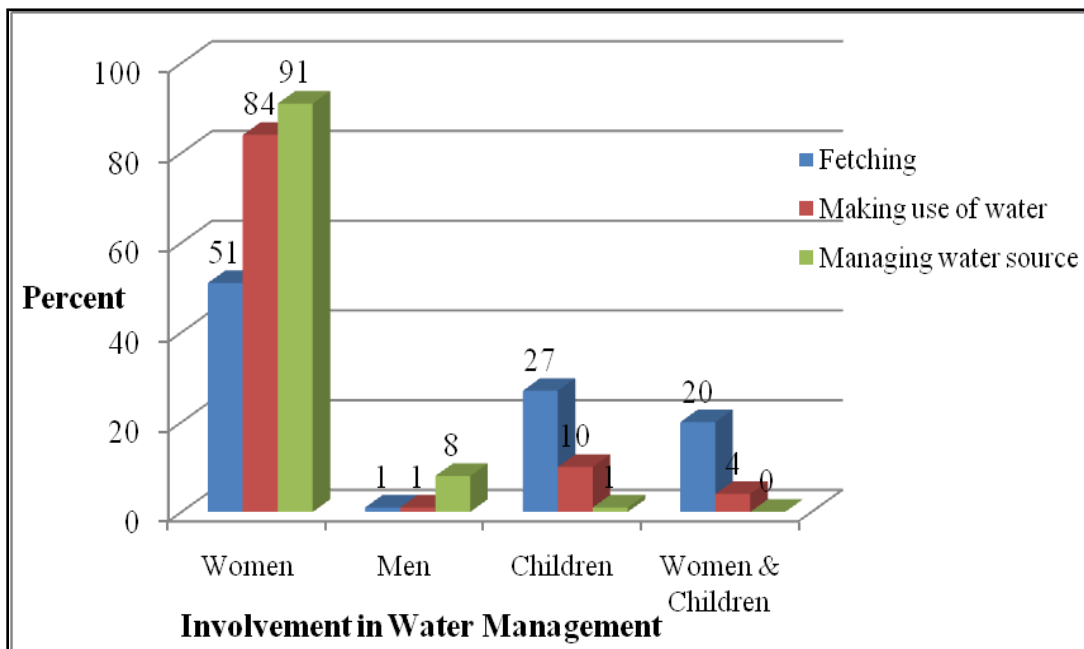


Figure 4.3: Level of Involvement in Water Management

Source: Field Survey (2011)

It was further revealed that if men were involved in managing the water sources, then in most cases their services had to be paid for. An example cited here were the men who maintain the source of Chuho stream and other safe water points (sources).

4.3.4 Factors Limiting Households and Institutions in Sustainably Managing Water Resources

Majority of the respondents (98%) reported poverty to be a major factor limiting households and institutions from minimizing water resource shortages (in managing water resources), 87% attributed this to lack of water storage facilities (this is linked to poverty) and 20% attributed it to lack of information on efficient use and management of the available water resources (Figure 4.4). Similarly, 18% attributed it to illiteracy of the masses as compared to 15% who attributed it to lack of government intervention and 12% to limited community cooperation.

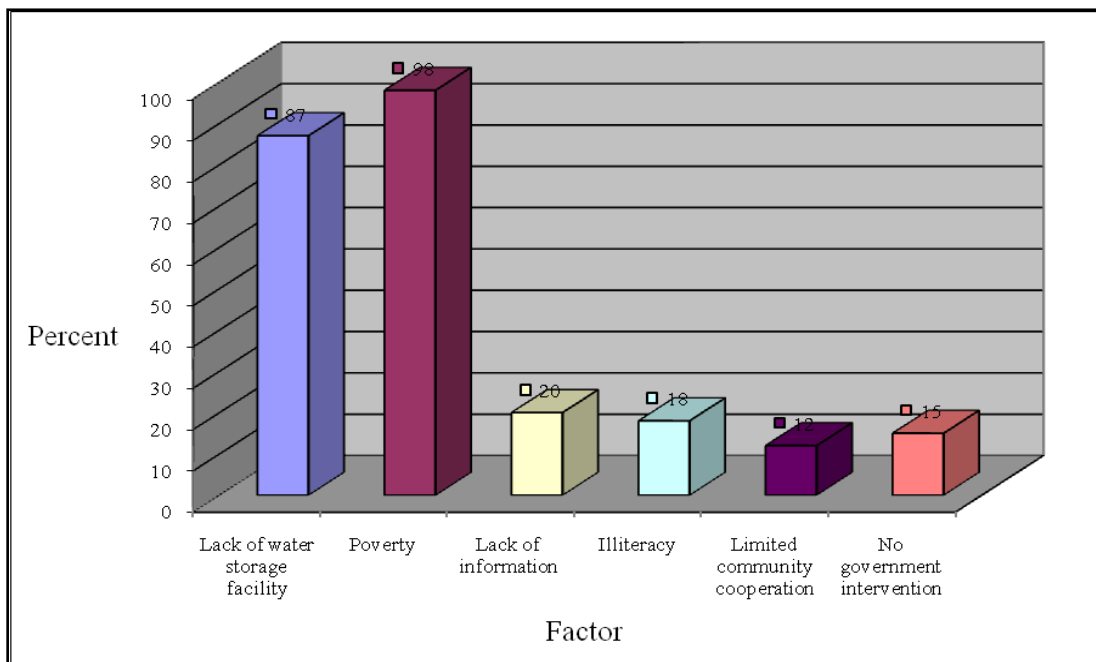


Figure 4.4: Limitations to Households and Institutions in Managing Water Resources
Source: Field Survey (2011)

Due to the above failures in water management, some of the water sources were reported to be non operational especially the boreholes (Plate 4.5). This was attributed to non cooperation among the water users, supervisory constraints and lack of maintenance by the local government staff. Invariably, the KDLG (2008) report indicates that out of the thirteen boreholes constructed in the district (Kisoro), only two were functional. These breakdowns are related to operation and maintenance failures.

Similarly, on 3rd March, 2011, a local council executive member of Nyakinama sub-county (one of the respondents) who lives close to a dysfunctional borehole reported that:

“Most of the water sources in the area have become dysfunctional due to lack of supervision and maintenance by the government. He added that calls had been made to the Community Development workers to assess the situation and intervene, but all in vain”.



Plate 4.5: A dysfunctional borehole in Nyakinama Sub-county

Source: Field Survey (2011)

4.3.5 Interventions to Ensure Sustainable Water Supply and Management

Figure 4.5 is a record of the various interventions that were suggested by households in the sub-catchment in an effort to ensure sustainable water supply and management.

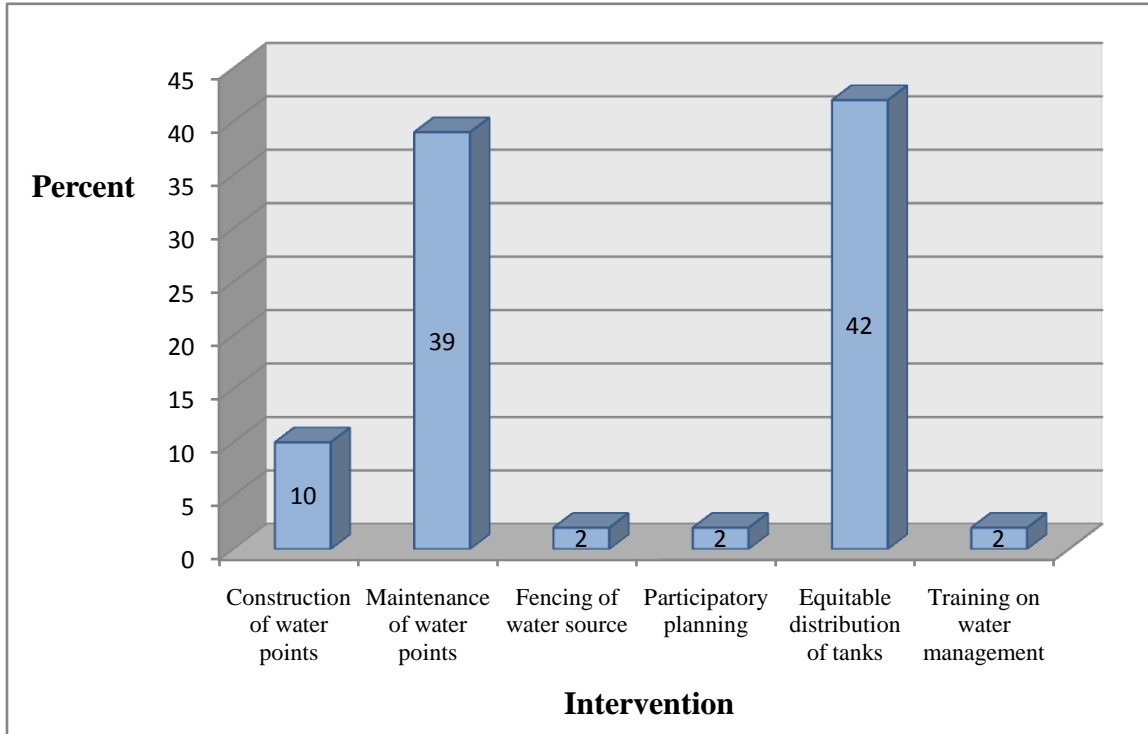


Figure 4.5: Interventions to Ensure Sustainable Water Supply and Management

Source: Field Survey (2011)

Equitable distribution of water tanks (42%) among the households was the major intervention followed closely with maintenance of available water points (39%). Construction of water points (10%), fencing of the available water sources (2%), participatory planning in water management (2%) and training on water management (2%) were also suggested. The study also sought to establish if there was a significant relationship among households' perceptions towards the aforementioned interventions (construction of water points, maintenance of available water points, fencing of the water source, participatory planning in water

management, equitable distribution of water tanks and training on water management). A non-parametric chi-square test was run and the results are indicated (Table 4.7). The results depicted that there was a significant relationship among households' perceptions towards interventions to ensure sustainable water supply and management ($\chi^2=113.124$, $df=5$ and $p=0.000$). This further confirms that the households in the sub-catchment know very well their concerns that affect them in an effort to ensure sustainable water supply and management.

Table 4.7: Chi-square Results of Households' Perceptions on the Interventions to Ensure Sustainable Water Supply and Management

Intervention	Observed	Expected	Residual
Construction of water points	10	16.2	-6.2
Maintenance of available water points	39	16.2	22.8
Fencing of the water source	2	16.2	-14.2
Participatory planning in water management	2	16.2	-14.2
Equitable distribution of water tanks	42	16.2	25.8
Training on water management	2	16.2	-14.2
Total	97		

Source: Field Survey (2011)

4.4 Drivers of Water Resources Scarcity

The study sought to establish the drivers of water resources scarcity in Chahi sub-catchment. The respondents at the same time gave their views on the status of water resources over the years which played a big role in ascertaining the facts surrounding water resources scarcity.

4.4.1 Status of Water Resources in Chahi sub-catchment

Water resources systems over the years were reported to have undergone several changes (Figure 4.6). Majority of the respondents (98%) reported that the water resources had declined while 2% reported that the water resources had not changed over the past years. The reasons were given for the decline in the water resources systems (Figure 4.7). Most importantly, climate change was cited as an important factor in the decline of water resources. However, climate change in the sub-catchment is said to be influenced by anthropogenic activities including deforestation, wetland degradation and poor land use practices among others (KDLG, 2008).

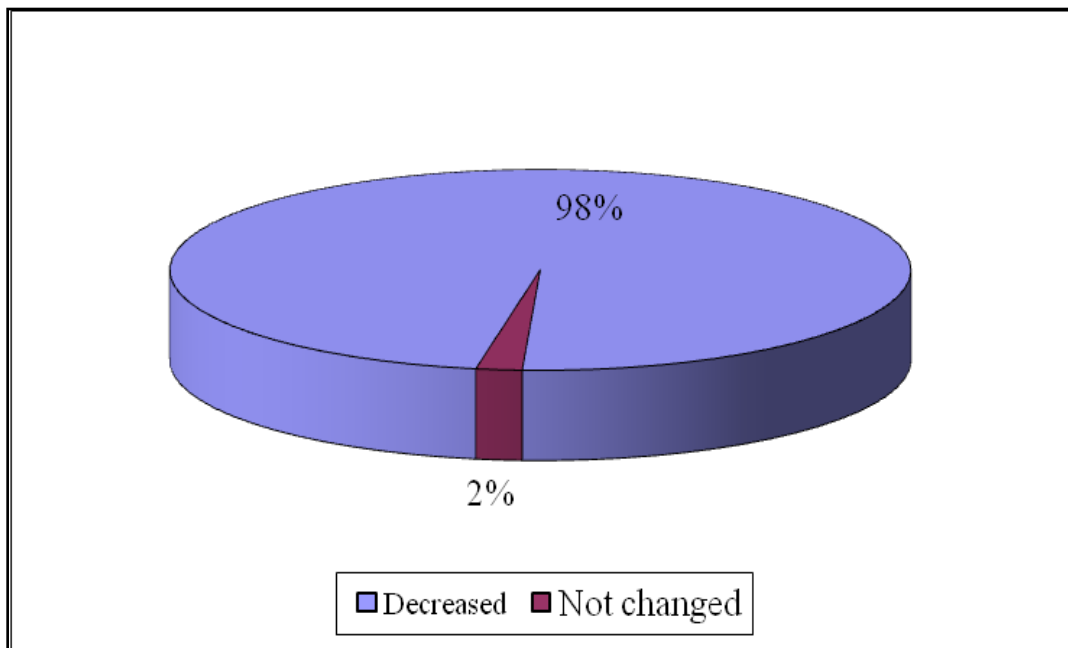


Figure 4.6: Status of Water Resources over the Years

Source: Field Survey (2011)

4.4.2 Drivers of Water Scarcity

Drivers of water resources scarcity are presented (Figure 4.7). The majority of households (98%) reported that climate change had led to water shortages due to long periods of drought

and other associated effects. However, some of the factors like deforestation and the increasing population were blamed for being responsible for climate change related scenarios. Other respondents (80%) attributed water resources scarcity to be driven by poverty of the households and 77% to population growth. This can be linked to the fact that as population increases, the demand for water resources and environmental resources in general increases. Similarly, 41% of respondents reported that their water resource was vulnerable to degradation due to pollution (both point and non-point) contributed by both humans through their activities and their animals. Another group of respondents (33%) reported the lack of the necessary information on water management, 20% and 16% blamed the vulnerability of the water resources on poor land use practices and deforestation respectively. Plate 4.6 shows some of the anthropogenic activities reported to be posing a threat to water resources in Chahi sub-catchment in form of pollution.

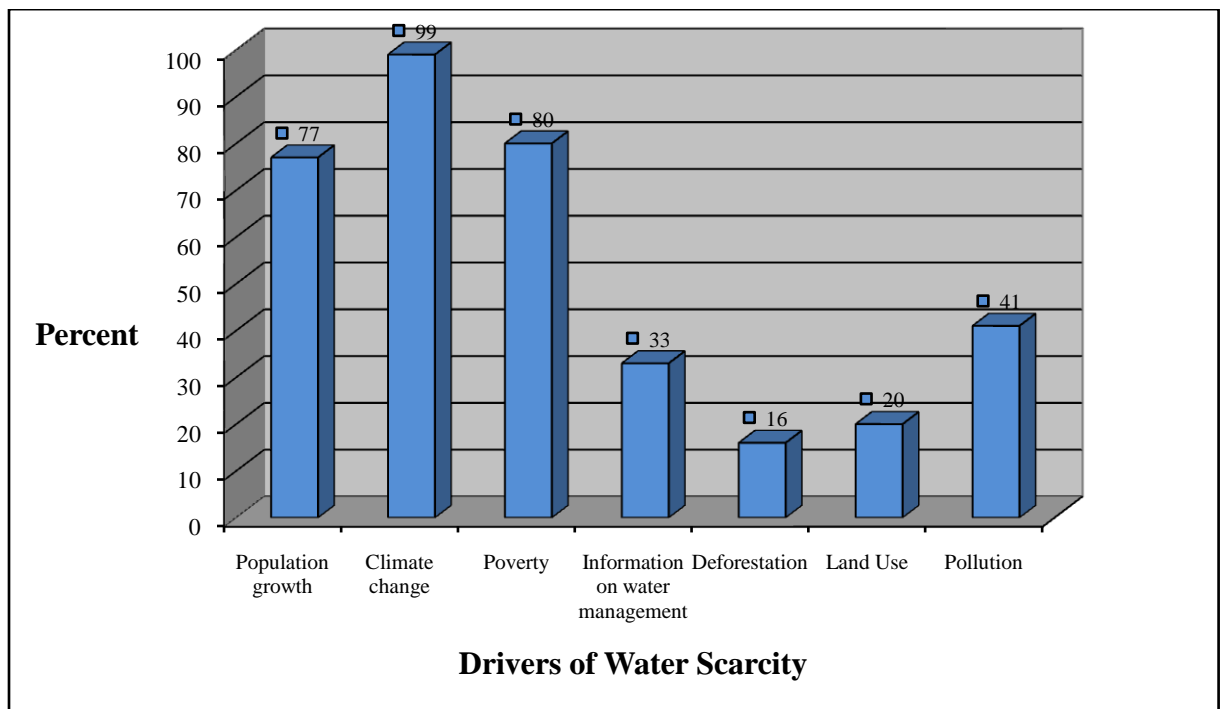


Figure 4.7: Main Drivers of Water Resources Scarcity

Source: Field Survey (2011)



Plate 4.6: Some form of Pollution of Chuho Stream (4/3/2011)

Source: Field Survey (2011)

4.4.3 Effects of Declining Water Supply

The declining supply of the water resource was associated with various effects (Figure 4.8).

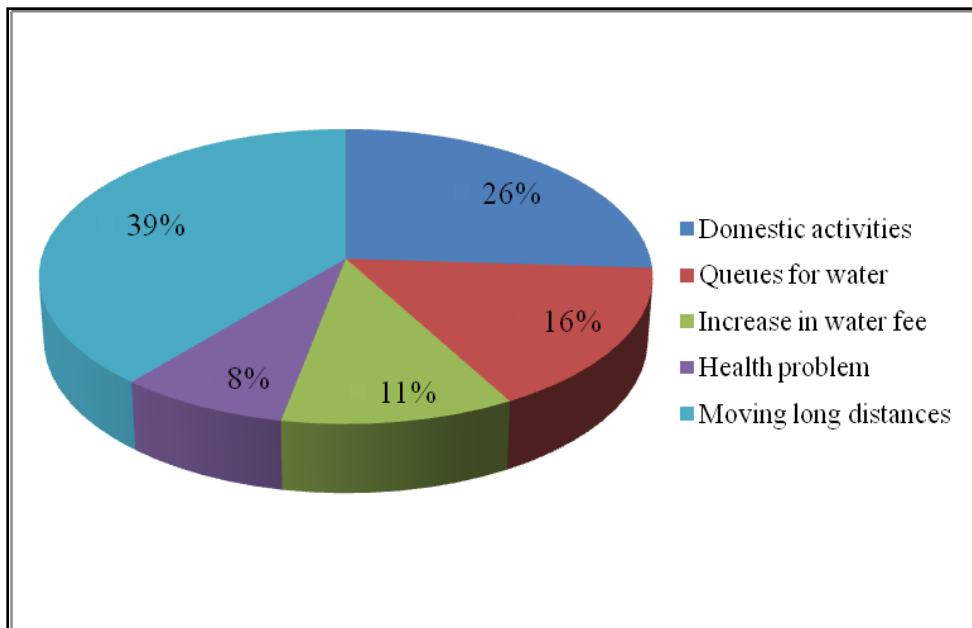


Figure 4.8: Impacts of Water Shortages

Source: Field Survey (2011)

Out of the respondents, 39% reported to have been affected through moving long distances (over 3 Km) in an effort to collect water. The study in this context revealed that water in the sub-catchment is not evenly distributed and forces households to resort to appropriate social practices. A particular case reported here was moving long distances to Lake Chahafi and Chuho stream, the only stream in the sub-catchment. Other respondents (26%) reported that their domestic activities are affected markedly and 16% reported queuing for water (Figure 4.8). Similarly, 11% of respondents reported that declining water supply was associated with increase in water fee charged per 20 litre jerry can (from the daily fee of USD 0.083 per jerry can to USD 0.208 and at times USD 0.417) and 8% cited that it is associated with health problems (including general hygiene in the community). In most of these cases (impacts of water shortages), the study found out that women mostly faced the brunt of the declining water supply in the sub-catchment. This is because they were found to be dominating water management activities that ranged from managing the water sources to domestic water use.

4.5 Local Coping Mechanisms to Water Shortages

In response to water scarcity situation in the sub-catchment, households had come up with a number of mechanisms (Figure 4.9). Most respondents (95%) reported that they had adapted to domestic rainwater harvesting (DRWH), followed closely by 85% who reported to be storing water during times of plenty, and 35% reported to be moving long distances in an effort to fetch water from the source where water is available (Figure 4.9). Similarly, 30% of the respondents had established earthen pots, 10% reported having come up with innovative agricultural practices and 4% reported some form of water pricing.

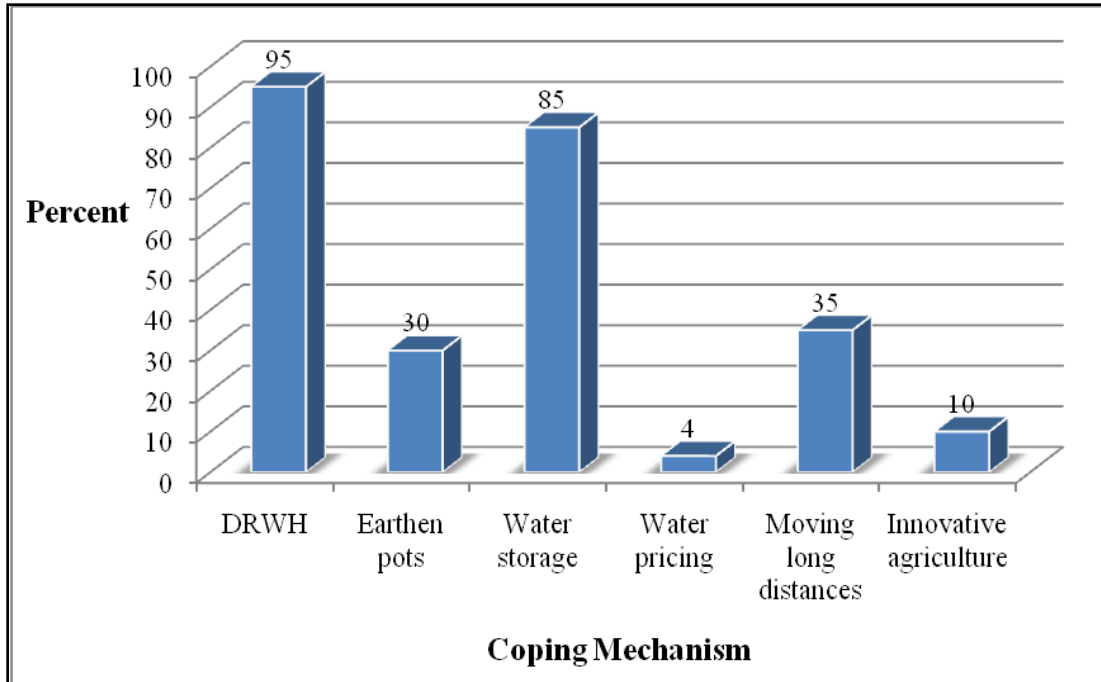


Figure 4.9: The Identified Coping Mechanisms

Source: Field Survey (2011)

Adapting to these coping strategies according to the households interviewed and key informants were due to the seasonal water shortages that occurred mostly during the period of May to August in addition to the limited water sources. These initiatives demonstrate the households' commitments to cope with the scarce water resources in the sub-catchment, even with simple technologies. Plate 4.7 shows a simple technology where a woman is transferring water from an earthen pot to a jerry can after a downpour.



Plate 4.7: A Woman Transferring Water from an Earthen pot to a Jerry can

Source: Field Survey (2011)

Information from the households interviewed and key informants indicated that walking long distances of over 3 km during times of water shortages was associated with affecting other activities both household and agricultural. In addition, innovative agricultural practices were reported to be associated with practices aimed at soil and water conservation in the sub-catchment. The agricultural practices reported and observed to be adopted by households include ridging, terracing, tree planting, fallowing and use of stone-lines. In addition to the conservation of soil and water in the sub-catchment, the management of hills was reported to be community oriented in which hill management committees (HMC) had been formed. HMC are formed to help in the hills management and enforcement of byelaws made by committees. The major challenge reported with the HMC was the district to document and recognize the efforts of the community in policy enforcement to come up with an ordinance for soil and water conservation. Specifically, alternate cropping, fallow cultivation and contours are the

management interventions practiced on Sagitwe hill. Plate 4.8 shows Sagitwe hill in Nyarusiza Sub-county on which the HMC is operational.



Plate 4.8: Sagitwe Hill in Nyarusiza Sub-county

Source: Field Survey (2011)

In the context of this study, coming up with the aforementioned coping mechanisms is an initiative aimed at creating other water sources in the sub-catchment. Plate 4.9 shows water harvesting and storage tanks installed with the help of Compassion International.



Plate 4.9: Water Harvesting and Storage Tanks Supplied by Compassion International

Source: Field Survey (2011)

Much as different people and/or organizations have a stake in addressing the water shortage problem in Chahi sub-catchment, specifically some households had gone an extra mile by undertaking their own innovations involving use of jerry cans, earthen pots and ferrocement tanks of about 4 m³ to facilitate roof catchment as coping mechanisms to water shortages. Plate 4.10 shows an example of locally made ferrocement tanks in the sub-catchment.



Plate 4.10: Example of Ferrocement Tanks in the sub-catchment (13/2/2011)

Source: Field Survey (2011)

4.5.1 Relationship between Local Coping Mechanisms and Time Stayed in Chahi Sub-catchment by Households

No significant association was detected between adoption of coping mechanisms by households and longevity in Chahi sub-catchment ($P \leq 0.05$) (Table 4.8). This qualifies the fact that since the catchment has limited water resources (sources), the households do not need time to adopt the coping mechanisms. It is therefore worth noting that as soon as a household migrates and/comes into Chahi sub-catchment, it immediately comes up with options to cope up with the limited water resources. Nevertheless, a household can not adopt all the coping mechanisms at the same time due to financial constraints and differences in other socio-

economic factors (like distribution of water resources in the catchment, distance from the alternative source of water and social networks (social capital).

Table 4.8: Chi-square Results of Coping Mechanisms and the Time Spent in the Catchment

Coping mechanism	Chi-square (χ^2)	Degrees of freedom (df)	Significance value ($p \leq 0.05$)
Domestic rainwater harvesting	1.687	4	0.793
Water storage during plenty	4.052	4	0.399
Water pricing	1.175	4	0.882
Establishment of earthen pots	5.934	4	0.204
Moving long distances	1.764	4	0.779
Innovative agriculture	3.134	4	0.536

Source: Field Survey (2011)

4.6 Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis of Challenges and Opportunities

The SWOT analytical matrix is shown in Table 4.9. Saleth (2006) suggests that before conceptualizing the analysis in a SWOT analytical matrix, it is worthwhile identifying the internal structure and the external context of catchment institutions in terms of endogenous features and exogenous influences. Once detected and sorted as shown in Table 4.9, then a SWOT analytical matrix can be used as a basis to undergo a change process in a catchment by

laying a strategic and effective intervention and programme of catchment rehabilitation management, monitoring and evaluation and enforcement of ecosystems preservation measures.

Table 4.9: SWOT Matrix for Challenges and Opportunities

<p>Exogenous factors</p> <p>Endogenous factors</p>	<p>Opportunities (O)</p> <p>O₁, O₂, O₃, O₄, O₅, O₆, O₇</p>	<p>Threats (T)</p> <p>T₁, T₂, T₃, T₄, T₅, T₆, T₇</p>
<p>Strengths (S)</p> <p>S₁, S₂, S₃, S₄, S₅, S₆, S₇</p>	<p>For effective utilization and management of water resources, strengths (S₁, S₂, S₃, S₄, S₅, S₆, S₇) need to be maximised to take advantage of the opportunities (O₁, O₂, O₃, O₄, O₅, O₆, O₇)</p>	<p>There is need to maximise institutional competences in the sub-catchment (S₁, S₂, S₃, S₄, S₅, S₆, S₇) so as to reduce the impacts of the threats (T₁, T₂, T₃, T₄, T₅, T₆, T₇)</p>
<p>Weaknesses (W)</p> <p>W₁, W₂, W₃, W₄, W₅, W₆, W₇</p>	<p>To reduce the management constraints of resources in the catchment, weaknesses (W₁, W₂, W₃, W₄, W₅, W₆, W₇) need to be minimized to make effective the environmental opportunities (O₁, O₂, O₃, O₄, O₅, O₆, O₇)</p>	<p>To ensure sustainable management of water resources, institutions (internal and external stakeholders) need to be empowered through participation, giving priority to capacity building and financial sustainability to minimize weaknesses and mitigate threats in the sub-catchment</p>

Source: Field Survey (2011)

4.6.1 Key to the Strengths, Weaknesses, Opportunities and Threats Matrix

Table 4.10 shows the key to the strengths, weaknesses, opportunities and threats of the SWOT analytical matrix. It presents the opportunities and challenges that arise in the management and utilization of water resources in Chahi sub-catchment.

Table 4.10: Key to SWOT Matrix

<p>Strengths</p> <p>S₁: The presence of the water authority</p> <p>S₂: Private sector involvement in water management</p> <p>S₃: The support by the water users</p> <p>S₄: Adequate rainfall</p> <p>S₅: Existence of Catchment Management Plan</p> <p>S₆: The presence of water user committees</p> <p>S₇: Hill Committees</p>	<p>Opportunities</p> <p>O₁: Location</p> <p>O₂: Support from the Central Government</p> <p>O₃: Availability of technical staff</p> <p>O₄: The catchment is a pilot area for the European Union Water Facility Project</p> <p>O₅: Different stakeholders in water management</p> <p>O₆: Existence of development projects</p> <p>O₇: Well established financial institutions</p>
<p>Weaknesses</p> <p>W₁: Some upper areas are not served with improved water</p> <p>W₂: Low coverage of RWH technology</p> <p>W₃: Different user fee charges</p> <p>W₄: Poor access of the locals to safe water resource in the catchment</p> <p>W₅: Lack of internal training on local RWH</p> <p>W₆: Lack of adequate support of water initiatives by the households</p> <p>W₇: Lack of cooperation among the households</p>	<p>Threats</p> <p>T₁: High population growth</p> <p>T₂: Climate change and variability</p> <p>T₃: Overcharge by the private operator</p> <p>T₄: The water users' notion that water should be freely accessed</p> <p>T₅: Lack of financial resources</p> <p>T₆: Local political interference</p> <p>T₇: Inadequate information on water management</p>

Source: Field Survey (2011)

4.7 Opportunities and Challenges

This section describes the opportunities and challenges in terms of strengths, weaknesses, opportunities and threats experienced in managing water resources in the sub-catchment.

4.7.1 Strengths

The major strengths are:

a) The presence of the water authority

The sub-catchment is blessed with the Kisoro Town Water and Sanitation Office (KITOWASO) which oversees the management of water resources. It is mandated in collaboration with the District Local Government to ensure that water infrastructural systems are developed and connections made to the users.

b) Private sector involvement in water management

In the sub-catchment it was reported that the private sector is charged with the responsibility of infrastructural development as well as connection and distribution of water to the households. It is also its responsibility to collect water user fees and maintain water points. This is in conformity with the Ministry of Water and Environment (2007) which notes that in Uganda, it is the private sector that undertakes the development of water infrastructure for water users, under contract to District local government and other development partners.

c) Support by water users

The support offered by water users in the management of water resources in the sub-catchment is through payment of water user fees that facilitates operation and maintenance of water infrastructure is an important aspect in as far as WRM is concerned. The local

involvement in water management is also through providing labour for maintenance of water systems in the sub-catchment.

d) Adequate rainfall

The sub-catchment receives adequate rainfall amounts (about 1100 mm annually) which are well distributed throughout the year. This rainwater needs to be tapped to meet the households' needs for water. This substantial water resource potential could be used, if well planned, for the social and economic development of the communities. The Ministry of Water and Environment (2007) reveals that given the high levels of rainfall in most parts of Uganda, dispersed nature of rural settlements and increased number of households with tin (mabati) roofs, improved domestic roof-water harvesting is an ideal way of providing access to safe water within the home. In this context, the households in Chahi sub-catchment are no exception to follow suit.

e) Existence of Catchment Management Plan (CMP)

Chahi sub-catchment has got a catchment management plan (CMP) that was developed through the community and the different stakeholders' involvement in identifying the critical problems facing the sub-catchment. The aim of the CMP according to the DAAD Alumni Summer School (2007) is to ensure availability of adequate amount and good quality resources for the well-being of the people and the environment in a given catchment. It is hopeful that the implementation of the different issues proposed in the CMP will ensure sustainability and equity in the management and use of natural resources in the sub-catchment.

f) The presence of water user committees (WUCs)

Information from the key informants revealed that the catchment has WUCs on every standing tap and/or water source. Besides maintenance of water points, the WUCs were reported to be charged with the responsibility of source identification and planning for the management of the water source. The presence and effective use of WUCs can deal with the operation and maintenance management based problems. It is therefore the responsibility and commitment of households (water users) in the sub-catchment to have positive attitudes towards making contributions to operation and maintenance of water sources. In view of this, Durgaprasad and Srinivasan (2003) noted that the rights of water users (communities) must be well defined in order to make the water users judicious, accountable and efficient in matters of water management in general and in domestic water in particular.

g) Hill Committees

The sub-catchment has got hill committees for soil and water conservation. These committees are charged with the responsibility of minimizing soil erosion that is known for polluting the water resources. The committees are said to be formed on every hilly area in the catchment. An example is the hill management committee on Sagitwe hill in Nyarusiza lower local government. The formation of hill committees can be seen as a result of the fact that 80% of Kisoro district, Chahi sub-catchment inclusive is severely affected by soil erosion (NEMA, 2007) and the fact that the sub-catchment has limited resources. Thus, households have the opportunity to make use of such committees to conserve soil and water resources.

4.7.2 Weaknesses

The major weaknesses are:

a) Some upper areas are not served with improved water

In this case, households walk long distances to access these water resource services. In response to this, the Uganda's Ministry of Water and Environment (2007) recommends need for increasing the density of water points and/or networks so as to reduce distance to water source of the rural communities. In the event that these upper areas are not served with improved water facilities, their rights to actively participate in the management and development of water resources in the sub-catchment are infringed.

b) Low coverage of RWH technology

Observation and interviews with the households indicated low water coverage and low water storage and management infrastructure; notably RWH tanks. This limits households' mandate to massively participate in the management and development of water resources in the catchment. Low coverage of RWH tanks was reported to be as a result of poverty of the households. In support of this, studies by the Ministry of Water and Environment (2007) show that some households have knowledge about DRWH technologies but lack the facilities to put it into practice.

c) The water users are charged different user fees especially during dry season

During times of water shortages, water users reported to be overcharged and at the same time discriminated against. In this case the water users were said to be charged according to their status and/or even their relationship with the water point operator. This poses a big threat to

the management of water resources in the sub-catchment in the sense that water users start losing confidence in the whole process of developing their water infrastructure.

d) Poor access of the locals to safe water resource in the sub-catchment

Many of the households reported to be having poor access to water resources. This was determined by considering the distance they moved to reach the nearest improved water source. According to the Ministry of Water and Environment (2007), rural water access to safe water is defined as an improved water source within 1.5 km of the home. It adds that poor water access to safe water is associated with potentially less time available for economic activity, education and child care.

e) Lack of internal training on local RWH technologies

RWH was found to be a major alternative to deal with water shortages in the sub-catchment, yet households reported to be having little knowledge on the technology. This was attributed to lack of training programmes from the service providers to the households on the appropriate RWH and management practices in the catchment. However, the Earth Summit's Agenda 21 requires that the delegation of WRM to the lowest appropriate level necessitates educating and training water management staff at all levels (ICWE, 1992). It noted that awareness creation through dissemination of information, including operational guidelines and promotion of education for water users is a vital part of a participatory approach to WRM. This concurs with the Uganda's Ministry of Water and Environment (2007) which affirms that if the communities are empowered by being involved in key decisions and trained to undertake the main water management responsibilities, the facilities will be better managed and will be more effective in serving the masses.

f) Lack of adequate support of water initiatives by the households

Information from the key informants indicated that most households in the sub-catchment were not cooperative in the initiatives towards water development and management. This is assumed to be as a result of the fact that mechanisms for interaction between the water users and the extension workers are not clear that encourage management of water resources by the water users. Otherwise according to Das Gupta (2001), it is necessary that decisions are taken at the lowest appropriate level, with public consultation and involvement of the users in the planning and implementation of water projects.

g) Lack of cooperation among the households

The households were reported to be non-cooperative among themselves on the issues concerning water supply and management. This promotes duplicated and disjointed efforts by the organizations promoting water management. A study on human social dynamics by Amaral and Ottini (2004) acknowledges that social networks and cooperation (in form of information sharing) among community members play a central role in the ability of communities to respond to environmental change and associated problems. This is supported by Robards and Alessa (2004) who argue that with social networks, the more linkages a community shares, the more options it has to respond to change by moving knowledge, goods or social capital through the network.

4.7.3 Opportunities

The major opportunities include:

a) Location

Chahi sub-catchment takes advantage of its location in the sense that it is within it that the local government is located. Thus, the proximity of the households to the appropriate

stakeholder departments of the district (local government) can serve as professional advice from the technical personnel on water management and environmental conservation in general.

b) Support from the Central Government

The sub-catchment gets support from the Central Government through the District Local Government and then through the lower local governments (sub-counties) to facilitate water management programmes. This initiative is through Ministry of Water and Sanitation in collaboration with other line ministries of Finance, Environment, and Agriculture, among others. For instance, the Ministry of Water and Environment through the District Forestry Department is implementing the Farm Income Enhancement and Forestry Conservation (FIEFOC) project in some parts of the sub-catchment. One of the major activities according to KDLG (2008) is to support communities to plant trees in selected degraded areas. The project is reported to have established community tree nurseries. It is an opportunity that the communities can make an impact on to sustainably manage the sub-catchment. It was also noted that the district funds activities mainly environment mainstreaming and environment audit workshops held at district level for sub-county technical staff and political leaders.

c) Availability of technical staff in the sub-catchment

Of particular importance in line with this is that the sub-catchment has various technical staff; water, environment, community development, agricultural and forestry officers at the district and some at the sub-county levels. These can offer another window of opportunity to the members of community if consulted for professional advice.

d) The sub-catchment is a pilot area for the European Union Water Facility Project

This is the reason this study is carried out in the sub-catchment. The European Union Water Facility Project in addition has been involved in facilitating some staff of the district and other members of the community in trainings and planning meetings. Through these trainings, the catchment has been able to come up with a sub-catchment management plan. Other projects in the sub-catchment include Sub-Saharan Africa Challenge Programme (SSA-CP) and the Lake Kivu Pilot Learning Site (LKPLS) for testing of innovations. The community in Chahi sub-catchment has the opportunity to make use of these outputs to improve on their livelihoods in the fields of water management and environmental management in general.

e) The existence of different stakeholders involved in water management

These stakeholders range from Community Based Organizations to NGOs. Examples of these organizations in the sub-catchment include; Compassion International in collaboration with Muhabura Diocese, Africare, Good Samaritan, Gisorora Tubake Association (GTA), Red Cross and Water School for water treatment through solar disinfection, among others. Of particular reference here is the Compassion International which has played a key role in addressing water management issues. This it has achieved through sensitization and training of households on water and sanitation matters. Secondly, it has supplied households with rainwater harvesting and storage tanks in an effort to respond to limited water resources.

f) Existence of development projects in and around Chahi sub-catchment

For instance, the Sub-Saharan Africa Challenge Programme in the sub-catchment has formed an Innovation Platform (IP) which through agricultural research is charged, among others, with the responsibility of soil and water conservation, value addition of agricultural produce, sourcing for market of farmers produce and generally watershed management. Another

project is the ecotourism industry in the catchment which households can take advantage of, to get employment opportunities and use the returns to improve water resources supply and management infrastructure.

g) Well established financial institutions

The sub-catchment has well established financial institutions ranging from banks to micro financial institutions. These institutions if utilized can offer another window of opportunity, the fact that they are reaching even people in the rural areas. The households can therefore make use of these institutions to put up new and improve on the existing water supply and management infrastructure.

4.7.4 Threats

The threats are:

a) High population growth

It is reported that population in Chahi sub-catchment is increasing water demands upon the degraded and depleted resources in the catchment. The annual population growth rate in the sub-catchment and Kisoro district in general is estimated at 2.8% (KDLG, 2008), which is relatively high. The fact that the people in the sub-catchment depend on the catchment resources for their livelihoods, makes the resources (including water) susceptible to degradation. This is in agreement with Gregersen *et al.* (2007), who in their study on integrated watershed management, acknowledged that the more the human population increases, the more it becomes a challenge to manage the environment in which they live. In this context, challenges are in form of high demand on the natural resource base, introduction of new technologies that let people willingly or unwillingly destroy their environment.

b) Climate change and variability

Climate variability has been cited in the catchment as a result of changes in patterns of climate that have caused high temperatures, low temperatures, high rainfall and low rainfall causing change in seasons. The major pressures on changes in the temperature were said to be due to human activities like deforestation and wetland degradation. This has caused changes in the seasons thus causing uncertainties in the communities in estimating production and hence food insecurity (KDLG, 2008). Climate change in the sub-catchment was reported to have caused migration of members of households, especially household heads. Climate change in the catchment is further evidenced by the presence of unpredictable rainfall regimes, seasonal wells and diseases. It was reported that Kisoro district, Chahi sub-catchment inclusive, was in the past regarded as part of the Switzerland of Uganda due its cold weather, but presently, the weather patterns have since changed.

Moreover, due to the very cold weather, mosquitoes that transmit malaria never used to exist in the sub-catchment, but have since existed due to climate variability. Flintan and Tamrat (2003) affirm that under climate change disasters, traditional water infrastructures are susceptible to damage and constant costs of maintenance. Kisoro district in general is said to be lacking a fully-fledged centre for monitoring changes in climate (KDLG, 2008). This is a challenge that needs to be addressed if changes in climate are to be monitored closely for purposes of understanding climate trends. However, in response to this the Sub Saharan Africa Challenge programme has installed a weather station in the sub-catchment at Chahi sub-county headquarters and it is used under the Chahi IP. To sum it all, climate change poses a big challenge to water resources development and management in the sub-catchment.

c) Overcharge by the private operator

Water users were said to be charged according to their status and/or even their relationship with the water point operators. This was during the times of water shortages in the sub-catchment. This poses a big threat to the management of water resources in the sub-catchment in the sense that water users start losing confidence in the whole process of developing their water infrastructure.

d) The water users' notion that water should be freely accessed

Water users in the sub-catchment still have the conception that water is freely available by nature and therefore need not to pay for it. This is in support of the information from the water office which revealed non cooperation of water users in the management and development of water infrastructural systems.

e) Lack of financial resources to put up appropriate water management infrastructure

Most of the households in the catchment are reported to be poor and this is a threat to the development of water resources both at individual and sub-catchment levels. This explains why some households were found to be using poor and traditional water storage facilities (like pots and jerry cans) for they did not have access to alternative water harvesting and storage facilities. This is attributed to the low financial status of most households.

f) Local political interference

The study found that the political atmosphere in the sub-catchment interferes with some of the water management activities. It was reported that some area residents have a tendency of demobilizing the activities of others simply because they do not agree politically. This is said to have led to skewed participation in water management. In essence, this strong link between

politics and water management fails water projects in the sub-catchment. According to the ICWE (1992), the development and management of water resources requires an enabling environment where the capacity of both people and institutions are built to plan and implement water projects. Mualla and Salman (2002) in affirmation noted that political and social factors determine and dictate the overall efficiency of water use and management. The study by Orindi and Huggins (2005) in the Lake Victoria Basin also argued that the contribution of water resources to sustainable livelihoods of the people depends on how it is accessed, used and managed which may be influenced by laws and policies.

g) Inadequate information on water management

This was attributed to the reluctance of the different service providers in the sub-catchment to deliver on the appropriate water management practices. This is opposed to the Earth Summit's Agenda 21 which requires that creation and promotion of awareness through dissemination of information, including operational guidelines and promotion of education for water users is a vital part of a participatory approach to WRM (ICWE, 1992).

4.8 Discussion of Results

The results presented in this study are discussed in the following sections and are based on the logical inferences arising from the results in response to the study objectives.

4.8.1 Utilization and Management of Water Resources

Water resources are mostly used for domestic purpose in Chahi sub-catchment. This is due to limited water resources and/or insufficient water supply in Chahi sub-catchment. In addition, Chahi soils have very low water holding capacity and therefore very little water is retained at the surface amidst high rainfall and short dry season (Nyiraneza and Hoellhuber, 2002). This

limitedness of water resources in the sub-catchment was found to be constraining households from exploiting and increasing other livelihood options, mainly in agriculture. This is partly in line with Liu *et al.* (2010) observation in China that the problem with water resource use at the local household level is mainly insufficient water supply.

Additionally, the management of water resources in Chahi sub-catchment was mostly done by women. This was attributed to the fact that most men had resorted to selling their labour within and outside the sub-catchment as an alternative source of income. In the process they leave women with a full task of managing water resources and other domestic activities. This social imbalance is said to hamper participation in planning and implementation for equal opportunities in the sub-catchment (KDLG, 2008). However, roles of women in the management of water resources are said to affect other roles (productive and reproductive). This was attributed to the rampant water shortages that result into moving long distances in an effort to access water. This concurs with Ray (2007) who found out that throughout the developing world, the task of providing domestic water is a female one. He adds that in most cases, women are responsible for the daily provision of domestic water; and therefore insinuating that they should play a crucial role in the management of water resources and problems related to access will affect them more than men. In addition, most of the water sources are not protected and under difficult or unreliable accessibility conditions (UNDP, 2006). Chartres and Varma (2011) noted that although women spend a lot of time collecting and using water, they are not empowered to manage this resource. In addition, an econometric study of time allocation in rural Pakistan found out that 15% of an average woman's monthly work effort went to collecting water (Ilahi and Grimard, 2000). It is therefore argued that

increased accessibility to water infrastructure would allow women devote more time to income generating activities and/or microenterprises (Ilahi and Grimard, 2000; Ray, 2007).

Nevertheless, the need to streamline these gender differences in water management follows the Dublin's gender principle of Agenda 21 which acknowledges that women play an important role in the management of water and therefore their central role in the provision, management and use of water as well as safeguarding it should be respected and reflected in institutional arrangements (ICWE, 1992). It requires that the acceptance and implementation of this principle needs positive policies to address women's specific needs and to equip and empower them to participate at all levels in water resources programmes, including decision-making and implementation, in ways defined by them. Meinzen-Dick and Zwarteveen (1997) supported this initiative by recommending the need for increasing the recognition and legitimacy of women's water related needs and interests and of gender as a source of differences. The GWP (2000) in affirmation acknowledged the fact that women as major water users play a key role in the collection and safeguarding of water for domestic, and in many cases agricultural use, but have a much less influential role than men in management, problem analysis and in the decision-making process related to water resources. The fact that social and cultural circumstances vary between societies suggests that the need exists to explore different mechanisms for increasing women's access to decision-making and widening their spectrum of activities through which they can participate in IWRM. To this end, it recommends the need to ensure that the water sector as a whole is gender aware, a process which should begin by the implementation of training programmes for water professionals and grass root mobilizers.

4.8.1.1 Limitations to Sustainable Management of Water resources

In an effort to utilize and manage water resources in the sub-catchment, many challenges are met. These include inadequate water storage facilities, limited community cooperation in water management initiatives, illiteracy and poverty among the households. Most of the households had rudimentary and/or poor water storage facilities. This was mostly attributed to lack of capacity of the households to buy improved and adequate water storage facilities. As noted by Orindi and Huggins (2005), better water management can reduce vulnerability of rural production systems through adequate water storage. In this context, availing adequate water storage facilities can be a positive move towards ensuring sustainable water supply and management in Chahi.

In addition, some community members were not cooperative in the use and management of water resources. This management gap was said to be due to lack of coordination between the locals and the local governing authority. According to UN-Water (2007), community cooperation is a crucial element in as far as water management is concerned. It acknowledges that being inter-sectoral in its nature, the response to water shortage requires the sharing of joint visions and policy principles and joint action in addressing the issues (collaboration). However, the major challenge in this respect is the institutional fragmentation of responsibilities in the water development sector. Moreover, information from the respondents revealed that the water supply and management initiatives in the sub-catchment were supply-driven where the local governing authority initiates programmes and/or interventions without involving the beneficiaries (end users). However, results from key informants revealed that households (as the basic water users) in the sub-catchment are not cooperative on issues concerning water planning and management. In this context, low cooperation by the local

households may be due to their low involvement from inception stage, planning, implementation, ownership and management of water related activities and programmes. This might be the reason why some water points in the sub-catchment have become dysfunctional. The KDLG (2008) report on the state of the environment notes that out of the thirteen boreholes constructed in Kisoro district, only two were functional. This is attributed to operation and maintenance related problems.

A related study conducted in Kakamega District, Kenya by Shisanya (2005) on the 'analysis of accessibility and pricing of water supply in rural watersheds' affirmed that supply-driven initiatives do not involve the beneficiaries and are bound to fail, rendering them to being unsustainable. This is supported by Jonch-Clausen (2004) who argues that most institutions are rooted in a centralized culture with supply-driven management and sub-sectoral approaches to water management. It is against this that the recent development of the 'Subsidiarity Principle' as recommended by the GWP (2000) should be reflected in all water management and other development initiatives so that the local households can freely participate in decision-making. The principle requires that matters ought to be handled by the smallest, lowest or least appropriate unit.

In this context, a household in Chahi sub-catchment could be the lowest appropriate unit. Ray (2007) supported this argument by noting that a household is the most basic social unit in which resources are allocated and decisions about water use made. The principle further highlights that participation in water management is an instrument that can be used to pursue an appropriate balance between a top-down and a bottom-up approach to IWRM, adding that it is a way of providing mechanisms and information to allow communities and individuals to make water sensitive choices (GWP, 2000).

Poverty was also reported to be a serious limitation to the supply and management of water resources in Chahi sub-catchment. The average annual income per household in Kisoro district is estimated at USD 27 with the poorest earning as little as USD 2.08 per month (Oberthur *et al.*, 2009). This income is not enough for households to invest in water management practices. It is believed that poverty jeopardizes the environment as a whole, as the poor in such communities tend to be less educated (because they do not have the time and resources) and less politically powerful in influencing programmes (UNDP, 2006). In addition, poor households have inadequate financial capital and this limits their ability to pay for water and the costs of operating, investing and maintaining water infrastructure. However, reduction in poverty is associated with reduced ecosystem degradation and improved local-level sustainable development, including water management in form of more reliable water supplies (UNDP, 2006).

Hanjra *et al.* (2009) noted that in order to ameliorate poverty related challenges from the communities, both public and private investments that improve access to water are necessary. They argued that improvements in human capital are needed to reform rural institutions that limit access for the poor and to foster technological change. One example cited was the investments in water management mainly in agriculture which was noted to contribute to poverty reduction by accelerating broad-based agricultural growth as well as creating opportunities for improvements in water infrastructure. This, if applied in Chahi sub-catchment can improve the situation, the fact that the main source of livelihood of the community is agriculture. However, some NGOs are trying to arrest the situation by supplying water harvesting facilities, but do not ensure equitable distribution among the households. Das Gupta (2001) argues that the need for WRM is often related to four main

factors; the first and major factor being the desirability of achieving equitable distribution of scarce water resource among the users as a way of reducing poverty. He further noted that the principle of equity is a dominant factor in the development assistance programmes of many support agencies.

Moreover, illiteracy limits the sustainable management of water resources. Illiteracy rate in Kisoro district is still high with literacy rate estimated at 32.8% (Oberthur *et al.*, 2009). Illiteracy was said to be associated with lack of knowledge and access to information on interventions to ensure sustainable water management. This makes the households less politically powerful in influencing programmes as well as making sensitive choices related to sustainable WRM. Studies indicate that illiteracy and management of water resources are related. UNDP (2006) notes that less educated people have fewer resources and therefore can not influence policies related to resource allocation and management. Similarly, Juwana *et al.* (2009) notes that literacy has a role to play in the sustainability of water resources. A study on water management problems in the Ethiopian rift by Ayenew (2007) found that low level of education impedes water management and other services in many rural areas. In this respect, the Earth Summit's Agenda 21 requires that the delegation of WRM to the lowest appropriate level necessitates educating and training water management staff at all levels if sustainability in water management is to be achieved (ICWE, 1992).

4.8.2 Drivers of Water Resources Scarcity

Climate change, poverty, population growth, pollution, lack of information on water management and poor land use practices were found to be the main drivers of water resources scarcity in Chahi sub-catchment. They consist of both socioeconomic and environmental factors. According to UNDP (2006), four main drivers are and will be responsible for the

increasing water problems now and in future; climate change, population growth, pollution and poverty. However, there are other several drivers aside the aforementioned. Climate change affects the function and operation of existing water infrastructure as well as aggravating the impacts of other stresses, such as population growth, changing economic activity and land use change (IPCC, 2008). As one of the drivers of water scarcity, CA (2007) notes that climate change will affect all facets of society and the environment, directly and indirectly, with strong implications for water and agriculture now and in the future.

Similarly, KDLG (2008) report on the state of the environment emphasize that changes in climate on the natural resources in Kisoro district were being manifested by loss of agricultural productivity, water scarcity, decline in annual rainfall amounts, change in seasons, disease prevalence and increasing land degradation. Bouwer (2003) in a study on integrated watershed management for the 21st Century further states that future climatic changes may also include more weather extremes, like more periods with excessive rainfall and more periods with low rainfall that cause droughts. He argued that to protect water supplies against these extremes and changes, more storage of water is needed, including long-term storage (years to decades) to build water resources during times of water surplus for use in times of water shortage. UNDP (2006) contends that climate change is expected to account for about 20 percent of the global increase in water scarcity, and argues that areas which already suffer from water shortages will be hit hardest. It adds that neither being reasonably expected to happen, the impact of a changing climate will affect not only bulk water availability but also worsen the extremes of drought.

Moreover, CA (2007) highlights that climate is changing at an alarming rate, causing temperature rise, shifting patterns of precipitation and more extreme events. This necessitates

that the future impacts of climate change need to be incorporated into project planning, with behaviour, infrastructure and investments, all requiring adjusting to adapt to a changing set of climate parameters. To this end, water storage and control investments will be important rural development strategies to respond to climate change. UNDP (2006) concludes that with no mitigation of climate change, the severe droughts that occur only once every 50 years will occur every other year by 2100. Most areas in Uganda including Chahi sub-catchment are no exception to these climate change scenarios and their associated effects and other main drivers stated.

In addition, poverty was regarded as a driver of water resources scarcity in the sub-catchment. The average annual income per household in Kisoro district is USD 27, which is less than the annual average for Uganda as a whole (Oberthur *et al.*, 2009). Several studies indicate that a poor population is associated with depending on the environment for its livelihood and this makes environmental resources (including water resources) susceptible to degradation. Pender *et al.* (2004) argue that households that are poor are less apt to adopt most environmental management practices. This is no better in Chahi sub-catchment where about 90% of the population is said to depend on agriculture (environmental resources in general) (KDLG, 2008). The World Water Assessment Programme (2003) adds that poverty within a given group of a population is both a symptom and a cause of the water crisis. This requires giving the poor better access to better managed resources, including water, for it is believed to make a big contribution to poverty eradication.

Population growth also stands out as a major driver to the scarcity of water resources in Chahi sub-catchment. It is revealed that Kisoro district, Chahi sub-catchment inclusive, has a high annual population growth rate, estimated at 2.8% (Uganda Bureau of Statistics, 2005). Many

studies indicate that as human populations increase in given environments, the demand for environmental resources (including water) increases. Gregersen *et al.* (2007) in the study on integrated watershed management acknowledged that the challenge of managing the environments in which people live becomes more complex and difficult as human populations increase. They believe that when human populations are high, demands on the natural resource base increase, and new technologies are developed that let people willingly or unwillingly destroy their environment at a more rapid rate and with less effort to rehabilitate it than in the past. A similar study conducted in the Tana basin of Kenya by Agwata (2005) affirms that due to limited water resources amidst high population growth rate, the demands for water have to be met from areas with abundance and excess stored during the wet season for use in the dry season. However, he cited that with continued population growth that increases the demand for water to meet the various needs, there is an urgent need to manage water resources in any given catchment in a sustainable and integrated way.

Over and above, pollution arising from anthropogenic activities was perceived to be a big threat on the sustainability of water resources. This is attributed to illiteracy and lack of information on water management practices. Similar results presented in a study by Ayenew (2007) on water management problems in the Ethiopian rift reveal that the expanding pollution of the world's water, the large scale deforestation taking place and the depletion of key natural resources on which people depend for their livelihood are ample evidence of degradation of water resources. The GWP (2000) further noted that pollution of water is inherently connected to human activities. In addition to serving the basic requirement of biotic life and industrial processes, water also acts as a sink and transport mechanism for domestic, agricultural and industrial waste causing pollution. Deteriorating water quality caused by

pollution, according to GWP (2000), is said to influence water usability downstream, threaten human health and the functioning of aquatic ecosystems so reducing effective availability and increasing competition for water of adequate quality.

Lack of information on water management was cited among the drivers of water resources scarcity in Chahi sub-catchment. Provision of information on natural resources management (water inclusive) is a crucial element in that it guides decision making processes (Rockström, 2000). Similarly, Roa *et al.* (2008) add that lack and inconsistency of information on water availability, use and other management aspects is one of the factors that impede decision making to improve water services in many different areas. This also concurs with the findings of the study in the Kilombero valley in Tanzania by Kangalawe and Liwenga (2005) who found that information deficiency is one of the major constraints to the wise use and management of African water resources. They attribute this deficiency to lack of elaborate institutional framework to facilitate the management of water resources. In response, Rockström (2000) argues that the management challenge involves training of the different water stakeholders to ensure participation in and ownership of water management programmes.

Poor land use practices as well emerged as a serious driver of water resources scarcity. This was attributed to the poor extension services and inadequate information received by the households on water management. A study in the Nyando basin of Kenya by Onyango *et al.* (2005) acknowledged that the use and management of land is closely linked to the management of water; that water does not exist in a vacuum. This concurs with results of a study conducted by Ayenew (2007) on water management problems in the Ethiopian rift which confirmed that land use and water use are inseparable, in that poor land use systems

automatically affect the hydrologic regime of the catchment. It further argues that in the event that households are not informed about the existing land and water management practices, then their community is susceptible to degradation. It is in this regard that the IUCN (2000) argued that a wide range of human activities will no doubt transform freshwater or terrestrial environments and potentially alter, sometimes irreversibly, the integrity of freshwater ecosystems.

Invariably, several studies indicate that declining water resources due to the aforementioned factors and/or drivers is associated with various effects. These effects range from human to environmental. For instance, the UN Water (2007) reveals that in most countries, the agriculture sector predominantly depends on water, accounting for more than 70 percent of the world's total water use, but water shortages highly impact negatively on crops. Ray (2007) in affirmation notes that the health consequences of lack of access to water and transporting water on a daily basis, and the policy frameworks in which access can be improved, are of particular relevance to women and development. This requires development of water infrastructure to improve accessibility.

4.8.3 Coping with Water Resources Scarcity

Households in Chahi sub-catchment have resorted to a number of practices in response to the scarcity of water resources. These include moving long distances, innovative agricultural practices, development of new water sources (through DRWH and use of other simple storage facilities) and water pricing. The scarcity of water resources in this context is manifested by limited water resources in the sub-catchment (mainly surface water resources) and the driving factors of the same resources to degradation. For example, households in response to limited

water resources have resorted to moving long distances to access water. However, this practice according to many studies is associated with very many effects on household activities. Households in Chahi sub-catchment are no exception to these effects. For instance, Pearson (2007) reveals that coping with water shortages in rural and sometimes remote areas is difficult because of the distances between homes and water sources, water shortages during dry seasons, the complex and individualized water uses and the needs of small communities. This requires need for infrastructural development if households' quest for water planning and management is to take course.

Households had adopted various innovative agricultural practices. While it is desirable to sustainably use and manage water resources and the environment in general, innovative agricultural practices have taken route in the sub-catchment, aimed at soil and water conservation. These innovations and/or systems are predominantly found as small islands of success in as far as WRM in the sub-catchment is concerned. They include ridging, terracing, tree planting, fallowing and use of stone-lines. These innovations centre on the management of hills which are under committees. Comparing this with the Thailand experience, a study conducted by Molle *et al.* (2009) in Chao Phraya river basin, Thailand revealed that as water availability partly declined, farmers partly suspended cultivation and generally resorted to a single non-water-consuming crop (mostly cotton) on the remaining areas of their farms, adding that water tanks become a common feature of the landscape. This brings to light, leaving other factors constant, that households in Chahi sub-catchment can also install rain water tanks in different areas of their landscapes if they are to increase their agricultural productivity under limited water resources.

Some households in Chahi sub-catchment had developed new water sources as a coping mechanism to limited water resources. This had been achieved through adoption of DRWH and use of simple storage facilities (like earthen pots). According to Park (2006), additional water resources need to be explored and adopted to increase water supply, and should be at the forefront if we are to ensure reliability and sustainability of water supply in water constrained areas of the world. Andre de la Porte *et al.* (2007) also suggested the adoption of the technical approach, oriented towards exploring new sources of water supply through increasing the exploitation of groundwater resources and pursuing the 20th century's dam building policy among others, and reducing water consumption (technical innovation) through waste water recycling. The WWC (2000) further contends that in many areas, water shortages stem from inefficient use of the available water.

Moreover, water pricing was found to be an emerging coping strategy of ensuring sustainable water availability. It was however found to be associated with having some resistance from the community. This was because the households were still considering water as a free good, provided by nature. However, water pricing in the catchment is a positive move towards water management considering the 1992 Dublin's International Conference on Water and Environment (ICWE), which described water as a social and an economic good (Figueraes *et al.*, 2003). The ICWE in this context calls for full-cost pricing to encourage water conservation through maintenance of infrastructure and water pollution prevention (Cosgrove and Rijsberman, 2000). According to Ngana *et al.* (2004), this justifies the need to pay for water as a commodity and to develop appropriate infrastructure for its delivery to the users. The payment in this context needs to meet the costs of water conservation, water infrastructure maintenance and development.

4.8.4 Policy Framework in the Utilization and Management of Water Resources

The government of Uganda through its line ministries takes lead in the utilization and management of water resources. This is achieved through formulation of policies and laws and empowering institutions to implement them. Since the 1990's, the government of Uganda has put in place comprehensive policies, legal and institutional frameworks for the management of water resources. This has taken root through the process of decentralization of responsibilities from the central government level to the district local government (Cong, 2007). Policy frameworks in this context are suggested in the study results as a management strategy that can help in the utilization and management of water resources in Chahi sub-catchment. In a broad sense, the government policies and legal frameworks that impact on the management of water resources are; the Constitution of the Republic of Uganda (1995), the Local Government Act (2000), the Water Act (1995) and the accompanying Water Resources Regulations (1998), the Uganda Water Action Plan (1995), the National Environmental Management Policy (1994) and the National Water Policy, among others (Mukwaya, 2010). Specifically, the National Water Policy (NWP) adopted in 1999 provides the overall policy framework for the water sector. It promotes the principles of IWRM as a means to ensuring sustainable management and utilization of Uganda's water resources. In this respect, it provides the legal framework for use, protection and management of water resources. Therefore, management of Chahi sub-catchment calls for the implementation of the NWP at the local level. However, the policy faces the following weaknesses; lack of effective implementation mechanisms at district and local levels, and lack of harmonization of policies, legislation and action plans of the multi-sectoral units through an ecosystem approach.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter deals with summary of main findings, conclusion, the recommendations of this study and areas for further research. The main objective of the study was to assess the utilisation and management of water resources in Chahi sub-catchment and identify other appropriate options for sustainable WRM. To this end, it set the objectives of coming out clearly with the local uses and management of water resources, the drivers of water resources scarcity, the local coping mechanisms to water resources scarcity and the opportunities and challenges of managing water resources.

Empirical tools used in conducting the field survey were; structured questionnaire, key informant interview guide and in-field observation guide. Analytical tools were mainly descriptive statistics (frequencies and percentages), non-parametric test involving the use of chi-square and SWOT analysis.

5.2 Summary of Findings

The study identified the following sources of water in the catchment; pipe borne water (89%) as the major source of water, stream (58%), rain (40%) through roof catchment and vendors (8%). The study in addition identified the following local uses of water in the sub-catchment: domestic (100%) and agricultural (24%). In as far as management and utilization of water in the catchment are concerned (considering aspects; fetching of water from the source, making use of the water and managing the water source), the study found out that women in both cases are key players. This was attributed to the fact that women were the ones who were

more into the domestic roles (both productive and reproductive) which require water than any other gender dimension. However, poverty (98%), lack of water storage facilities (87%), lack of information on efficient use and management of the available water resources (20%), illiteracy of the masses (18%), lack of government intervention (15%) and limited community cooperation (12%) were the limiting factors to households and institutions in managing water resources.

Meanwhile, the study identified various interventions aimed at ensuring sustainable water supply and management and the perceptions households have towards them in the catchment:

- i. Construction of water points
- ii. Maintenance of available water points
- iii. Fencing of the water source
- iv. Participatory planning in water management
- v. Equitable distribution of water tanks
- vi. Training on water management

These interventions were reported by respondents to ensure sustainable water supply and management in Chahi sub-catchment. Using a chi-square test, the results depicted that there was a significant relationship among households' perceptions towards interventions to ensure sustainable water supply and management in the sub-catchment.

The study identified the drivers of water resources scarcity in the catchment; climate change (98%), poverty among the households (80%), population growth (77%), pollution (41%), inadequate information on water management (33%), land use practices (20%) and deforestation (16%). What came out clearly was climate change which was cited as having led

to water shortages due to long periods of drought and other associated effects as compared to the conditions of the sub-catchment two decades ago or so.

The study assessed the various coping mechanisms that had been adopted by households in response to the scarcity of water resources in the sub-catchment: domestic rainwater harvesting (DRWH), water storage during plenty, water pricing, establishment of earthen pots, moving long distances to water source and innovative agricultural practices. What came out strong was the use of the DRWH technology, much as most households were using rudimentary (simple and undeveloped) infrastructure. The study went further to establish whether there was a relationship between the households' longevity (time stayed) within the catchment and the adoption of coping mechanisms. Using a chi-square test, the results found that not any of the coping mechanisms considered (DRWH, water storage during plenty, water pricing, establishment of earthen pots, moving long distances and innovative agriculture) depicted a significant relationship with the households' longevity in the sub-catchment. This qualifies worth noting that since the catchment has limited water resources (sources), the households do not need time to adopt the coping mechanisms.

The study established the opportunities and challenges of managing water resources in the catchment using the SWOT analytical matrix. The opportunities established include: location, support from the Central Government through the District Local Government, availability of technical staff in the sub-catchment, the catchment is a pilot area for the European Union Water Facility Project, different stakeholders involved in water management, existence of development projects in and around the sub-catchment and well established financial institutions. Conversely, low coverage of RWH technology at household level, poor access of the locals to safe water resource, lack of internal training on local RWH technologies,

inadequate support of water initiatives by the households and lack of cooperation among the households were some of the challenges established.

5.3 Conclusions

The findings from the study reveal that households in Chahi sub-catchment mainly use water for domestic purpose with little use in agriculture. This was mainly due to the limited water resources (sources) in the catchment. In addition, management and utilization of water in the sub-catchment, considering aspects; fetching of water from the source, making use of the water and managing the water source, women played a key role compared to men.

The drivers of water resources scarcity identified included climate change, poverty, population growth, pollution, lack of information on water management and poor land use practices. Climate related scenarios were found to be mostly responsible for water shortages in the sub catchment. This presents the case for coming up with innovative approaches to act as a buffer against climate-linked water shortages. In this regard, water shortage appears as a powerful incentive to change, eliciting major adaptations and coping strategies from users.

In response to the scarcity of water resources, the various coping mechanisms; moving long distance, innovative agricultural practices, development of new water sources and water pricing had been adopted by households. Innovation in this context includes the adaptation of traditional know-how to the current day challenges, the adaptation of the extremely available technologies to the prevailing physical and social conditions, and the creation of new and well adapted technologies and management approaches. However, poverty is a major challenge to minimizing water shortages in the sub-catchment in which case the households have limited

alternative options other than bearing the brunt of the shortages. When available supply is insufficient, domestic use is almost invariably the first sector that is hit hardest.

Major hurdles facing households in managing water resources are low coverage of RWH technology, discriminate water user fee charges, poor access to safe water resources, lack of internal training on local RWH technology, lack of adequate household support of water initiatives and lack of coordination (cooperation) among the households and institutions in supporting local water initiatives. However, the sub-catchment can boast of the presence of the water authority (KITOWASO), private sector involvement in water supply and management, support by water users, adequate rainfall, the presence of water user committees (WUCs) and the Catchment Management Plan (CMP). It is thus worth noting that these study findings reinforce the fact that in order to ensure and achieve sustainable water resources management, economic, technological and institutional factors need to be given special attention.

5.4 Recommendations

Based on the findings of this study, the following are the recommendations to the policy makers, NGOs, extension agents, households and other environmental managers in the area to manage Chahi Sub-catchment sustainably:

- i. Institutional innovations need to be strengthened by government and local authority so as to improve both conservation and/or efficiency and allocation equity. This can be for example, in form of capacity building of the water technical staff (including extension officers at sub-county level) to negotiate future allocations in times of water shortage as well as for drought mitigation and other climate related changes that are

predicted to pose serious threats on to the future of water resources. This is because nearly all households who were interviewed could not appreciate the services of the technical staff in the sub-catchment.

- ii. There is need for the relevant agencies charged with planning and policy formulation (government alongside other stakeholders) to focus on building more water infrastructure in the sub-catchment such as community dams and other water harvesting equipment so as to cater for the increasing population as well as non-functional water points (sources). Otherwise, welfare approaches such as water access are a means to provide a safety net for households during the times of shortages.
- iii. During formulation of policies and other various ordinances, the efforts made by the households in Chahi sub-catchment in the struggle to respond to water challenges through their different innovations should be recognized by the local authority. This is because of the fact that addressing water shortages requires actions at local, sub-catchment and national levels. This is in recognition of the recommendations made at the massive Earth Summit in Rio in 1992 that governance of water resources needed to be decentralized in order to improve efficiency and equity.
- iv. The government with other stakeholders should promote DRWH further through empowering households with improved rainwater facilities. This is because according to Gikas and Angelakis (2009), rainwater is an alternative freshwater source in water scarcity areas which to a large extent remains underexploited, and that sustainable WRM should take precedence to the development of new water sources.

- v. The government should come up with strategies that work towards moderating population growth rate since it is regarded as one of the major drivers of water resources scarcity. This can be achieved through sensitization of the masses as well as adopting holistic approaches of integrated water management principles.
- vi. The government of Uganda should consider Chahi sub-catchment in its implementation of the Water for Production programme. This programme caters for water-short areas in which Chahi is no exception. It is overdue that the government's focus on water infrastructure through construction of small scale irrigation schemes, dams and tanks was launched but no commendable results have been realized in Chahi sub-catchment.

5.5 Areas for Further Study

This study was mainly based on assessing the utilization and management of water resources in Chahi sub-catchment. It only covered a small area of Kisoro district due to financial resources constraints. In view of the current trend to promote WRM in Uganda, the study should be replicated in other water scarce areas of the country. Information gathered in other districts could provide an appropriate yardstick for making appropriate policy redesign and recommendations. In addition, the findings should be tested in other sub-catchments with similar situations in Uganda and beyond.

There is quite a set of scattered development efforts on water management scenarios. Thus, research should be done on the following:

- i. The limitations and potentials of water harvesting systems in the sub-catchment.

- ii. The effect of water harvesting technology on both surface and sub surface hydrology.
- iii. The future of Chahi sub-catchment studies need to include gender and related contemporary issues. For instance, the effect of water resources utilization and management on gender dimension in the sub-catchment.

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APPENDICES

Appendix 1.0: Sample Questionnaire

Preamble

Hello, my name is **Tera Marahi Moses**. I am a student at Kenyatta University, Kenya pursuing Master of Science Degree in Integrated Watershed Management. I am currently conducting a research study on the ‘Assessment of Water Resources Utilization and Management in Chahi sub-catchment, Kisoro district-Uganda’. The purpose of my study is to come up with comprehensive findings on issues concerning utilization and management practices of water resources. The information provided in this study will be kept strictly anonymous and confidential and will be used solely for research on finding solutions to common problems.

Household information

Respondent’s number _____ Sub-county _____

Instructions: Tick the appropriate option

Gender	Age	Occupation	Level of Education
1. Female 2. Male	_____ Years	1. Farmer 2. Salary worker 3. Trader (specify) 4. Unemployed 5. Others	1. None 2. Primary 3. Secondary 4. College 5. University
Marital status	Type of household	Time stayed in Chahi	Sources of information
1. Single 2. Married 3. Divorced 4. Widowed	1. Female-headed 2. Male-headed 3. Child-headed	1. Less than 5 years 2. 5- 10 years 3. 11- 15 years 4. 16- 20 years 5. Over 20 years	1. Radio 2. Newspapers 3. Television 4. Others

How many people live in your household? _____

SECTION 1: INFORMATION ON UTILIZATION AND MANAGEMENT PRACTICES OF WATER RESOURCES

1. Which of the following sources do you get water from?

- a. Pipe borne water b. Streams c. Bore holes d. Wells
 d. Rain e. Vendors f. Others (specify)_____

2. Which water sources are reliable?

- a. Pipe borne water b. Streams c. Bore holes d. Wells
 d. Rain e. Vendors f. Others (specify)_____

3. At what distance is/are the water source(s) located?_____

4. Is the water source(s) available in the dry season? a. Yes b. No

5. Indicate the level of involvement of various household members in the use and management and water

Activity	Women	Men	Children	Both men & women	Others (specify)
Fetching					
Making use of water					
Recycling water					
Managing water source					
Others (specify)					

6. How do you make use of the water in your household?

- a. Domestic b. Industrial c. Agricultural d. Others(specify)_____

7. Do you experience any challenges in meeting the above water uses? a. Yes b. No

If Yes, explain _____

8. Do you have any organization promoting use and management of water resources in your area?

a. Yes b. No

If Yes, which ones

a. NGOs b. Government institutions

c. Private (individuals) d. Private (companies) e. Others specify) _____

9. What problems if any do you have with water supply?

10. In your own view, do you think water is efficiently used and managed in your area?

a. Yes b. No

If Yes/No, give reasons

11. What are the main threats to water resources in your area?

a. Population growth b. Pollution c. Poverty

d. Deforestation e. Soil erosion f. Wetland encroachment

g. Climate change h. Poor land use practices i. Others (specify) _____

12. In your own view, what management practices should be put in place to minimize these threats?

- a. Education of the masses b. Afforestation
 c. Soil & water conservation d. Wetland conservation
 i. Others (specify)_____

SECTION 2: INFORMATION ON DRIVERS TO INCREASING WATER SCARCITY

1. Do you notice any changes in the water resource systems? a. Yes b. No

2. If Yes, how have the water resources systems changed over the years in terms of quantity, quality and availability?

- a. Increased b. Decreased c. Not changed d. Do not know

3. If it has decreased, mention factors leading to declining water availability/supply in your area

- a. Population growth b. Poor land use practices Pollution
 d. Poor water governance e. Poverty f. Topography
 g. Lack of infrastructure h. Climate change (variability)
 i. Lack of information on water management j. Deforestation
 k. Others (specify)_____

4. In your own view, how has the declining water situation impacted on you and other people in your community?

SECTION 3: INFORMATION ON COPING MECHANISMS TO INCREASING WATER SCARCITY

1. In which months of the year do you experience water scarcity/declining water supply?

2. How severe are you affected by this situation?

- a. Not affected b. Moderately affected
 c. Severely affected d. Do not know

3. Where do you get water during shortages?

4. Do you change the ways in which you use water during shortages?

- a. Yes b. No

If yes, explain

5. Which interventions have you (been) put in place to cope with the scarcity situation/ declining water supply?

Coping mechanism	Tick	Coping mechanism	Tick
Construction of dams		Use of water tanks	
Rain water harvesting		Use of Pots	
Water storage during plenty		Others (Specify below)	
Drilling boreholes			
Innovative agriculture methods			

Temporal water allocations during critical periods			
Water pricing and penalty polities			

6. Do you have any knowledge, information and skills to ensure sustainable water availability/supply? a. Yes b. No

If yes, explain

7. Are there any other interventions you know in your area aimed at ensuring water availability/supply? a. Yes b. No

If yes, explain

8. Who promotes and/or comes up with such interventions as in (7) above?

- a. Government
- b. NGOs
- c. Community members
- d. Individual households
- e. Others (specify) _____

9. In your own view, what can be done to minimize the increasing level of water resource shortages in your area?

10. Choose factor (s) limiting households and institutions from minimizing water resources scarcity situations in your area.

Factor	Tick
Lack of water storage facility	
Illiteracy	
Poverty/Low incomes	
Lack of information	
Culture	
Lack of alternative options/ technologies	
Topography	
Others (specify)	

Thank you!

Appendix 2.0: Key Informant Interview Guide

Hello, my name is **Tera Marahi Moses**. I am a student at Kenyatta University, Kenya pursuing Master of Science Degree in Integrated Watershed Management. I am currently conducting a research study on the ‘Assessment of Water Resources Utilization and Management in Chahi sub-catchment, Kisoro district-Uganda’. The purpose of my study is to come up with comprehensive findings on issues concerning utilization and management practices of water resources. This interview guide looks at the strengths and weaknesses as well as possible opportunities and threats that promote and hinder the management of water resources in Chahi Sub-catchment. The information provided in this study will be kept strictly anonymous and confidential and will be used solely for research on finding solutions to common problems.

Name	
Institution	
Position/Profession	

1. What are the local uses of water resources in your area?

2. Are there any water related problems in your area you know? If yes, explain.

3. How do the communities cope in times of water problems?

4. As implementers of programmes in the catchment, what challenges do you face?

5. What efforts are made to reduce future incidences of water related problems?

Strengths

6. What advantages does Chahi Sub-catchment have for effective utilization and management of water resources?

7. What management practices are done well in the sub-catchment?

8. What relevant resources do people in the catchment have access to?

Weaknesses

9. What could be improved?

10. What is done badly?

Opportunities

11. What are the good opportunities that the Chahi sub-catchment has to enhance effective utilization and management of watershed resources?

Threats

12. What obstacles are being faced in the catchment as far as water resource utilization and management is concerned?

Thank you!

Appendix 3.0: Field Observation Guide

1.0 The different water sources in the catchment

- Pipe borne
- Borehole
- Stream
- Well
- Lake

2.0 Agricultural Practices used for soil and water conservation

- Fallowing
- Tree planting
- Contouring
- Terracing
- Others

3.0 The level of management of water resources in the catchment

- Gender in relation to water use and management
- Land use practices that are a threat to water resources

4.0 Challenges in the management of water resources

Thank you!